Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VI SEMESTER B. TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2024

SWITCHGEAR AND PROTECTION [ELE 3252]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 02 May 2024** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A Explain the Cassie's theory of zero current interruption in an AC circuit breaker. ***(03)***

1B With the help of a neat sketch, describe the construction and the principle of operation of a vacuum circuit breaker. ***(03)***

1C In a 132kV, 50Hz, 3ϕ grounded neutral systems, the inductance of each conductor is 16mH and capacitance of conductor to ground up to the location of circuit breaker is 0.02μF. For a ground fault with a symmetrical fault current and a power factor of 0.6 determine:

a) Average and Max values of RRRV.
b) Natural frequency of oscillations.
c) Critical value of resistance.
d) Damped frequency of oscillations, if a resistance of 500Ω is connected across the contacts of the circuit breaker. ***(04)***

2A A circuit breaker interrupts the magnetizing current of a 3-phase, 100MVA, 220kV transformer. The magnetizing current of the transformer is 4.5% of the full load current. If the magnetizing current is interrupted at 60% of its peak value, determine the maximum voltage that may appear across the contacts of the circuit breaker. Also determine the critical value of resistance to be connected across the circuit breaker to eliminate this restriking voltage transient. The stray capacitance of the transformer is 0.01μF and the magnetizing inductance is 30 H. ***(03)***

2B Justify the following with respect to auto-reclosure of circuit breakers:

a) In EHV transmission lines, only one reclosure is allowed.
b) In EHV lines, dead time delay is necessary before auto-reclosure is attempted.
c) In distribution lines, auto-reclosure is attempted more than once and with

sufficient time delay. ***(03)***

2C. With the help of relevant circuit schematic and phasor diagram justify why Peterson coil method of neutral grounding is the best method of neutral grounding to overcome the effect of arcing ground. Define all the parameters used in circuit schematic and phasor diagram.

Inductive reactance of a Peterson coil (with negligible resistance) in a 132kV, 3-phase, 60Hz. 150Km transmission line is set to 1381.55Ω to neutralize the capacitance of 80% length of the line.

i. Determine the capacitance per km of the transmission line.

ii. Determine the KVA rating of the Peterson coil to neutralize the capacitance of 100% length of the line. ***(04)***

3A. Compare local and remote backup protection schemes with respect to protecting power system equipment.

Describe the backup protection by duplication. Discuss how does this scheme overcomes the limitations of both the local and remote backup protection schemes. ***(03)***

3B. An over current relay has a low set plug setting of 75% and high set plug setting of 1250%. Time multiplier setting for the low set relay is 0.5, and time of operation for the high set relay is 0.1s. Determine the time of operation of this relay when the fault current is a) 1800A b) 13000A. Relay is connected to the power system through a 1000A/5A CT. Determine the time of operation of the relay, assuming the relay characteristics to be

i. IDMT 1.3s

ii. Extremely inverse

iii. Very inverse ***(04)***

3C. Draw the biased differential protection schematic for the protection of a 3-phase star-star connected power transformer.

Discuss the reason for this protection scheme likely to mal operate when the transformer is energized under no load condition. Suggest a suitable method to avoid the mal operation of the relay under this condition. Justify your answer. ***(03)***

4A A 150MVA, 11kV, 3 phase, 50Hz alternator is protected by a current differential protection system. The synchronous reactance of the alternator winding is 35% per phase and the resistance of the alternator winding is 7% per phase. The protective relay is set to operate when the out of balance current exceeds 12% of the full load current. The neutral of the alternator is grounded with a resistance of 2.2Ω. If a ground fault occurs in 'Y' phase winding at 8% from the neutral end, will the relay operate? Justify your answer.

If the relay does not operate, suggest a suitable grounding resistance to make the relay operate. ***(03)***

4B With the help of relevant diagram and wave forms explain the phase comparison method of carrier pilot protection of transmission lines ***(04)***

4C With the help of a relevant sketch, explain the method of protecting a 3 phase Induction motor against single phasing. Discuss the consequences of single phasing. ***(03)***

5A With the help of relevant phasor diagrams, show the duality property between amplitude and phase comparators. ***(03)***

5B With the help of a relevant block diagram, explain the operation of a static relay. Discuss its merits and demerits. ***(03)***

5C With the help of a relevant block diagram and flowchart, explain the working of a microprocessor based reactance relay ***(04)***