Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3170908 Date: 27/06/2023

Subject Name: Switchgear And Protection

Time: 10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define the reach, underreach, and overreach of the relay.	**03**
	(b)	Discuss various zones of protection for a modern power system and explain the primary and backup protection.	**04**
	(c)	Explain with a neat diagram the working of the numerical relay.	**07**
Q.2	**(a)**	Describe with a neat diagram the time-graded protection of a radial feeder.	**03**
	(b)	Discuss the time-current characteristics of an IDMT, normal inverse, very-inverse, and extremely inverse overcurrent relays with their areas of application.	**04**
	(c)	A radial feeder ABC is sectionalized into parts AB and BC. Part AB near the source has a relay R2 and part BC at the far end has a relay R1. R1 is set to 100 % and R2 is set to 125 % plug setting. CT ratios for both relays are 600/1A. Determine the time of operation of both relays when a fault occurs at the end of the feeder section BC. The fault current is 6000 A. The time multiplying setting (TMS) of R1 is 0.2. Determine the TMS of R2. Both relays follow the characteristics given below in Table 1. Consider the coordination time interval (CTI) as 0.3 sec.	**07**

Table 1 PSM Vs Time of operation characteristic.

PSM	2	3.6	5	6.6	8	10	15
Time for TMS	10	6	3.9	3.5	3.15	2.8	2.2

OR

	(c)	Draw the phasor diagram for the 30° and 60° connection of a directional overcurrent (OC) relay and explain the limitations of normal OC relay.	**07**
Q.3	**(a)**	Describe the operation of 3–stepped distance protection.	**03**
	(b)	Explain the Mho and Offset Mho relay with a neat R-X characteristic.	**04**
	(c)	Discuss the following in brief with regard to the distance relay operation: (a) Effect of arc resistance and (b) Effect of power swing.	**07**

OR

Q.3	**(a)**	A 3 – phase transformer having a line voltage ratio of 440 V/11 kV, is connected in star/delta. The protective transformers on the 440 V side have a current ratio of 500/5 A. What should be the CT ratio on the 11 kV side?	**03**
	(b)	Write a short note on Buchholz relay.	**04**
	(c)	Explain the percentage differential relay's construction, working, and operating characteristics.	**07**

Q.4	**(a)**	Give the detail of various normal, abnormal, and faulty operating conditions of an alternator.	**03**
	(b)	Explain the scheme for the detection of turn-to-turn faults for an alternator.	**04**
	(c)	Explain in brief the factors to be considered in the selection of the CT for protection application.	**07**

OR

Q.4	**(a)**	Classify various busbar protection schemes.	**03**
	(b)	Discuss the impact of CT saturation on busbar protection.	**04**
	(c)	Explain in detail with a neat diagram the application of reverse phasing protection to an induction motor.	**07**

Q.5	**(a)**	Discuss the phenomena of current chopping.	**03**
	(b)	Describe various types of ratings for circuit breakers.	**04**
	(c)	With a neat figure, explain the construction and working of an SF6 circuit breaker including its advantages and disadvantages.	**07**

OR

Q.5	**(a)**	Explain in brief the concept of adaptive protection.	**03**
	(b)	Calculate the RRRV of the 132 kV circuit breaker with neutral earthed. The Short circuit data given as: the broken current is symmetrical, restriking voltage has a frequency of 20 kHz, p.f. is 0.15. Assume fault is also earthed.	**04**
	(c)	Derive the expression for the restriking, RRRV, rate of rise of TRV, the maximum value of RV, and maximum value of RRRV.	**07**