Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – May / June 2026

Date: 20- 05-2026 **Time:**01:00pm – 04:00pm

School: SOE	**Program:** B.Tech	
Course Code : EEE3003	**Course Name:** Switchgear & Protection	
Semester: VI	**Max Marks**:100	**Weightage**: 50%

CO - Levels	CO1	CO2	CO3	CO4	CO5
Marks	12	22	22	22	22

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

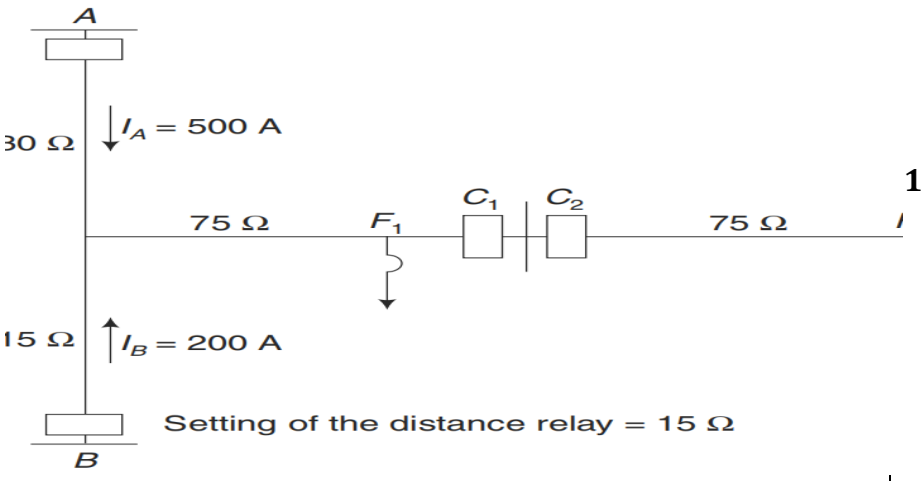
Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

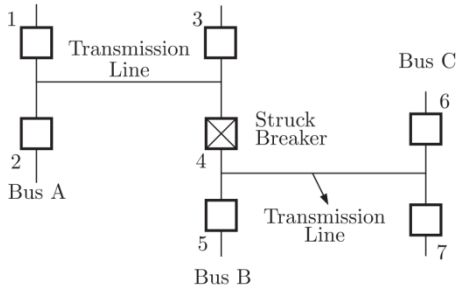
1.	Explain the critical safety function of interlocking systems in power substations, detailing how electrical or mechanical permissive conditions prevent the opening of isolators under active load.	**2 Marks**	**L2**	**CO1**
2.	Illustrate the integration of series reactors in a power grid effectively increases the total fault impedance, thereby reducing the short-circuit MVA level to a value that existing circuit breakers can safely interrupt.	**2 Marks**	**L3**	**CO1**
3.	Explain the specific advantages of using a High Rupturing Capacity (HRC) cartridge fuse in high-power distribution circuits, focusing on its energy-limiting capabilities and the role of its quartz sand filling in arc suppression.	**2 Marks**	**L2**	**CO1**
4.	Illustrate the cascading effects of an uncleared fault in a heavily interconnected power system, thereby justifying the indispensable need for a highly reliable and fast-acting protection infrastructure.	**2 Marks**	**L3**	**CO1**
5.	Apply the concept of voltage regulation to explain how specific control compensation devices are utilized in transmission networks to	**2 Marks**	**L3**	**CO1**

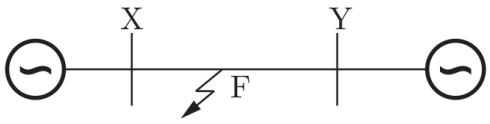
	counteract voltage dips caused by heavy inductive loads or system faults.			
6.	Interpret the strategic placement of current-limiting reactors—such as bus-tie or feeder reactors—and explain how their location dictates their effectiveness in localizing voltage drops during severe fault conditions.	**2 Marks**	**L2**	**CO1**
7.	Explain the concept of prospective voltage in the context of circuit breaker operation, distinguishing it from the restriking voltage and detailing its significance in defining the breaker's transient recovery voltage rating.	**2 Marks**	**L2**	**CO2**
8.	Apply the concept of pilot communication channels (such as power line carrier or fiber optics) to a distance relaying scheme, demonstrating how it facilitates simultaneous and accelerated tripping for faults occurring anywhere along the protected line.	**2 Marks**	**L3**	**CO3**
9.	State the concept of through fault current in differential protection.	**2 Marks**	**L1**	**CO4**
10.	Illustrate the application of circulating current principles to the differential protection of a power transformer, explaining how the scheme accounts for inherent phase shifts and turns ratios between the primary and secondary windings.	**2 Marks**	**L3**	**CO5**

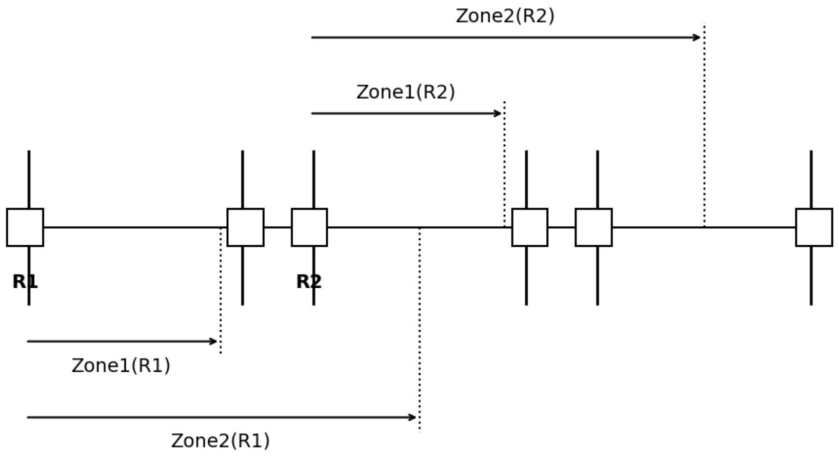
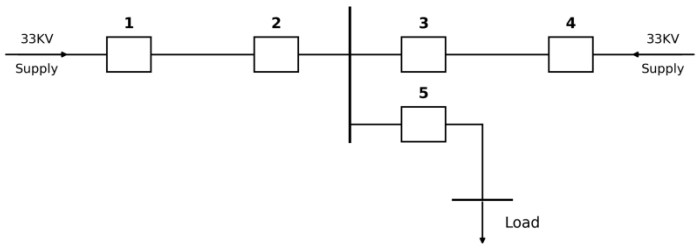
Part B

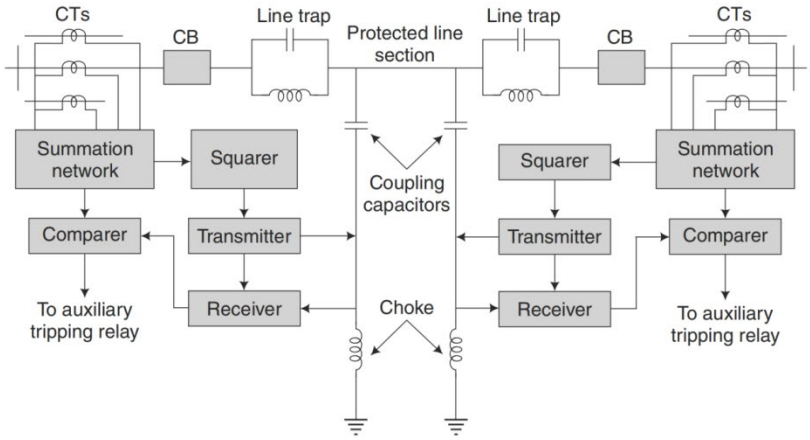
Answer the Questions. **Total Marks 80M**

11.	**Figure shows distance protection for a section of a power system. The** **I zone setting at A and B is 100 ohms.**  **For the distance-protected line section:**	**10 Marks**	**L4**	**CO3**

	a) Calculate the impedance seen by relay B for a fault at F1. b) If breaker C2 fails for a fault at F2, analyze whether relays at A and B will clear the fault based on zone reaches and time delays. Provide reasoning.			
	Or			
12.	**Consider the protection system shown in the figure below. The circuit breakers numbered from 1 to 7 are of identical type. A single line to ground fault with zero fault impedance occurs at the midpoint of the line (at point F), but circuit breaker 4 fails to operate (''Stuck breaker''). If the relays are coordinated correctly, Interpret a valid sequence of operation of circuit breakers out of the following operations (A) 1, 2, 6, 7, 3, 5 (B) 1, 2, 5, 5, 7, 3 (C) 5, 6, 7, 3, 1, 2 (D) 5, 1, 2, 3, 6, 7 by providing a proper explanation.** 	**10 Marks**	**L2**	**CO3**

13.	**A Power system supplied by two Synchronous generators at the two buses X and Y respectively has been shown below. The Transmission line XY has positive sequence impedance of Z_1 Ohms and zero sequence impedance of Z_0 Ohms. An Single Line to Ground fault with zero fault impedance occurs at the centre of the transmission line in Phase R. Bus voltage at X and line current from X to F for the phase 'R', are given by Va Volts and Ia amperes, respectively. Impedance relay has been installed for the protection of transmission line at bus X. Put contrast on how relay operates for Single Line to Ground fault as shown in the figure below.** 	**10 Marks**	**L4**	**CO3**
	Or			
14.	**Mukesh, a protection engineer was assigned the responsibility of relay coordination of the zones given in the figure below. Some sample time settings has been mentioned below. Identify the best time setting as per the situation with proper explanations**	**10 Marks**	**L2**	**CO3**

	TZ2R1=0.6s, TZ2R2=0.3s **TZ2R1=0.3s, TZ2R2=0.6s** **TZ2R1=0.3s, TZ2R2=0.3s** **TZ2R1=0.1s, TZ2R2=0.3s** 			
15.	**The distribution system shown in figure is to be protected by overcurrent system of protection. For proper fault discrimination, identify the directional overcurrent relays to be installed in the locations with proper explanations.** 	**10 Marks**	**L2**	**CO4**
	Or			
16.	**Mr. Rahul was concerned that external faults or inrush currents might cause false trips in the differential protection system. His mentor assured him that modern relays can distinguish between inrush current and internal faults. Could you help Mr. Rahul identify the protection scheme to avoid nuisance tripping during transformer energization? Also put contrast on the operating principle of the relay.**	**10 Marks**	**L4**	**CO4**
17.	**Carrier protection, also known as carrier current protection or pilot-wire protection, is a method used in electrical power systems to provide selective and high-speed protection for transmission lines and other critical equipment. It involves the transmission of a carrier signal over the power line itself, typically at a higher frequency**	**10 Marks**	**L2**	**CO4**

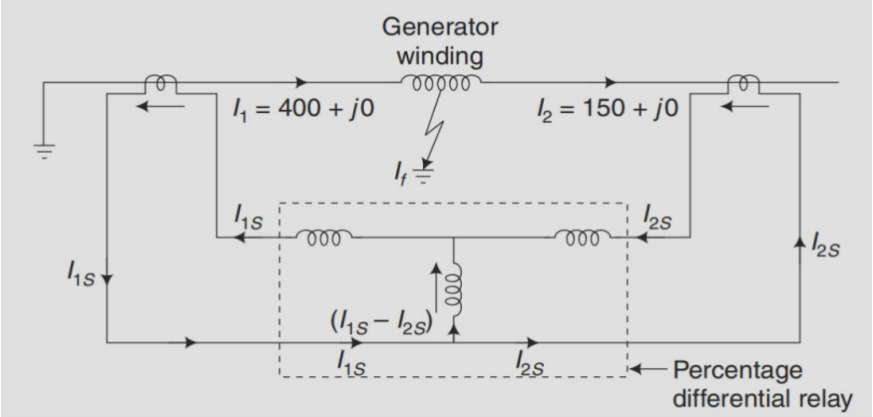
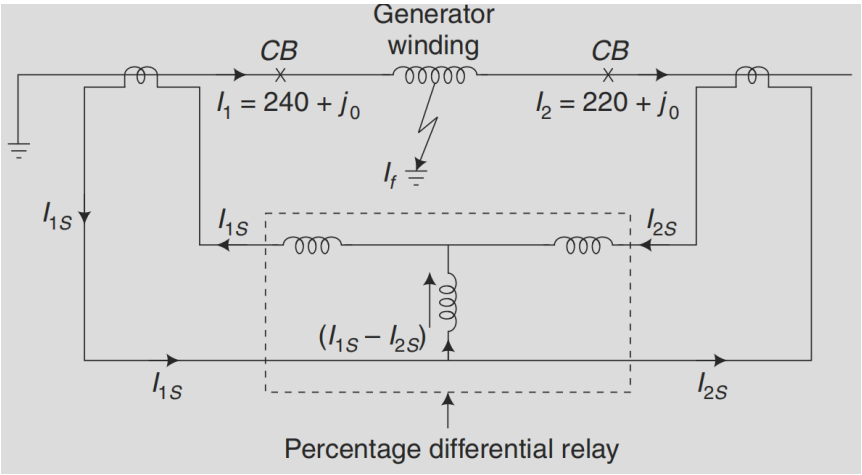
	than the power frequency, to communicate between relay devices installed at different locations along the line. In the diagram shown below, explain the role of line trap and also the concept behind communication at very high frequency through the power lines in the range of kHz to MHz.  			
	Or			
18.	**While monitoring transformer operations, Ajay noticed a rapid rise in temperature and oil pressure. The plant engineer informed him that a special type of relay could have prevented the escalation. Help Ajay Rahul identify the relay and examine why it is crucial for transformer fault detection?**	**10 Marks**	**L4**	**CO4**

19.	**National Thermal Power corporation employed an oil Circuit breaker at the terminals of a 3 Phase 50 Hz alternator which has rated voltage 20 kV connected to circuit breaker, inductance of 10 mH and Capacitance of 2 micro-Farad. After identifying the unknown parameters that could be computed from the given data, Solve for the unknown parameters.**	**10 Marks**	**L3**	**CO2**
	Or			
20.	**The phase to ground capacitance in a 132 kV transmission line commissioned between gulbarga to hubli is 0.01 microfarad. The value of line inductance is 6 Henry. Determine the voltage across the pole of a circuit breaker when a magnetizing current of 10A is abruptly stopped. The air blast circuit breaker is a three-phase device with a rating of 2500A, 1000MVA, operating at 33 kV for a duration of 3 seconds. After identifying the unknown parameters that could be computed from the given data, Solve for the unknown parameters.**	**10 Marks**	**L3**	**CO2**

21.	**SF_6 (Sulfur Hexafluoride) circuit breakers are widely used in electrical power systems due to their excellent insulating and arc-quenching properties. Some key applications include: High Voltage and Extra High Voltage (EHV) Power Systems used in 132 kV, 220 kV, 400 kV, and even up to 800 kV power transmission systems. Provides reliable and efficient protection in long-distance transmission lines, Gas-Insulated Substations (GIS), essential for compact, indoor, and space-constrained substations. Identify the concepts and properties of SF6 circuit breaker.**	**10 Marks**	**L3**	**CO2**
Or				
22.	**A 3 phase, 60 Hz, 2 cycle Circuit breaker is interrupting a fault current. The fault current lags voltage by 60 degrees. If circuit breaker contacts get fully opened at voltage zero crossing, Solve for the breaker operating time.**	**10 Marks**	**L3**	**CO2**

23.	**A three-phase, 11 kV/33 kV, Y-D connected power transformer in KPTCL Yelahanka substation, is protected by differential protection. The CTs on the LV side have a current ratio of 400/5. Solve for the ratio of CTs on the HV side.**	**10 Marks**	**L3**	**CO5**
Or				
24.	**An 11 kV, 100 MVA alternator is grounded through a resistance of 5 W. The CTs have a ratio 1000/5. The relay is set to operate when there is an out of balance current of 1 A. Solve for the percentage of the generator winding that will be protected by the percentage differential scheme of protection.**	**10 Marks**	**L3**	**CO5**

25.	**A generator winding is protected by using a percentage differential relay whose characteristic is having a slope of 15%. A ground fault occured near the terminal end of the generator winding while generator is carrying load. As a consequence, the currents flowing at each end of the winding are shown in the Fig. Assuming CT ratios of 400/5 amperes, Identify whether the relay operate to trip the breaker.**	**10 Marks**	**L3**	**CO5**

				
Or				
26.	**Figure shows percentage differential relay applied to the protection of a generator winding. The relay has a 0.1 A minimum pick-up and 20% slope of its operating characteristic on (I1s + I2s)/2 versus (I1s – I2s) diagram. A high resistance ground fault occured near the grounded neutral end of the generator winding while generator is carrying load. As a consequence, the currents flowing at each end of the winding is shown in the figure. Assuming CT ratios of 500/5 amperes, Identify whether the relay operate to trip the breaker.** 	**10 Marks**	**L3**	**CO5**