

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

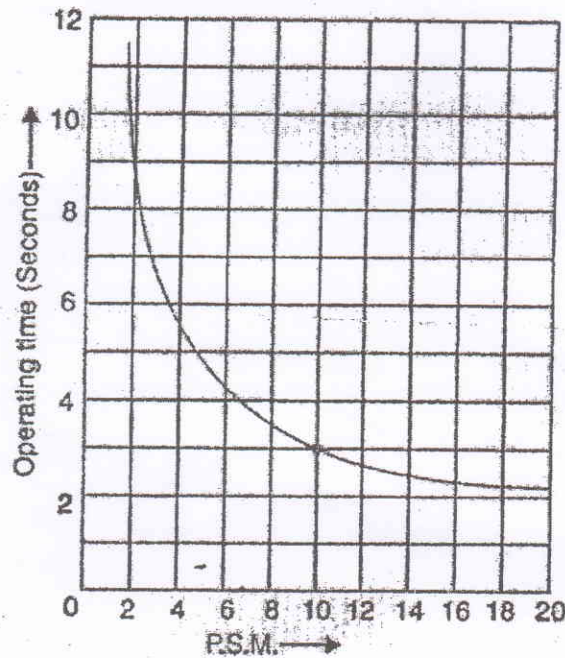
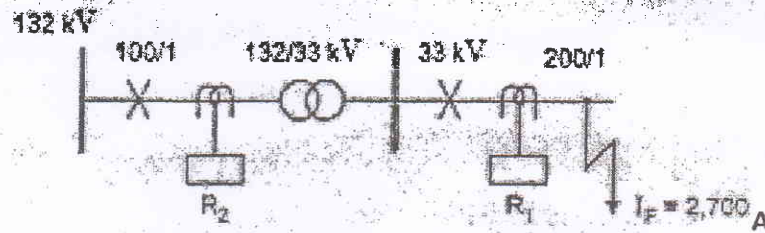
Subject: - Switch Gear and Protection (EE651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) What are the basic requirements of protection scheme? Differentiate between a protective system and protective scheme. [6]
- b) Explain why the secondary of CT should not be left open and secondary of PT should be short circuited. [4]
- c) Write short notes on the following: [3+3]
 - i) Low voltage HRC fuse
 - ii) Drop-out fuse
2. a) What are the basis difference between Isolator and circuit breaker? Explain why we use isolator and circuit breaker simultaneously? [6]
- b) A 33 kV, 3 phase 50 Hz, overhead line 60 km long has a capacitance to ground of each line equal to 0.015 μ F per km. Determine the inductance and KVA rating of the Peterson coil. [5]
- c) What are the factors affecting soil resistivity? How can we reduce earth resistance? [5]
3. a) The system inductance per phase of a system is 8 mH and the frequency of transient oscillation is 10.273 kHz. If a 50 Hz, 6.6 kV generator is connected to that system. Calculate: [4]
 - i) Max voltage across the contacts of the CB at an instant when it passes through zero.
 - ii) System capacitance per phase
 - iii) Average rate of rise of voltage up to the first peak of oscillation, neglect resistance
- b) Compare the performance and characteristics and working principle of: [8]
 - i) Minimum oil circuit breaker Vs Bulk oil circuit breaker
 - ii) Air blast circuit breaker Vs puffer types SF₆ circuit breaker
- c) Explain the operation of auto reclosure. [4]
4. a) Describe the construction and principle of operation of induction type directional over-current relay. Explain IDMT characteristics and how they are obtained in an induction type relay. [8]
- b) A 125 MVA, 220/132 kV three phase power transformer is protected by percentage differential relays. The current transformers located on HV and LV sides of the power transformer are 400/5 A and 1200/5 respectively. If the HV side is delta connected and the LV side is star connected, determine: [4]
 - i) The output line currents of both CT at full load
 - ii) The relay current at 15% overload
 - iii) The minimum relay current setting to permit 25% overload

- c) It is given that fault current level at 33KV side is 2700A, CT ratio at 33 KV side is 200:1 and 132 KV side is 100:1 (figure below). If both the relays R1 and R2 are set for 100% plug setting, determine the operating time for both the relays when time grading margin of 0.6 second is given and TMS for relay R1 is 0.15. (PSM/Operation Time graph is given below)

[4]



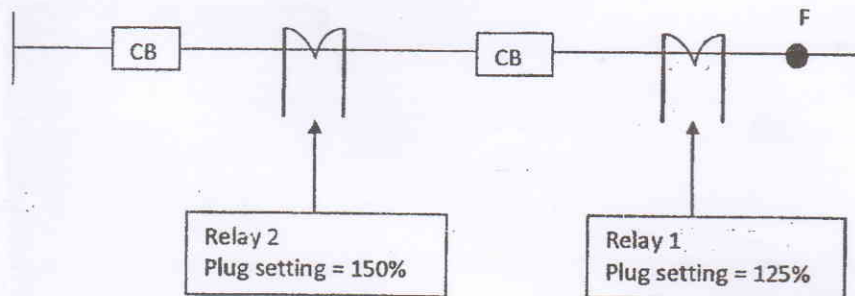
5. a) Explain essential components of a static relay with block diagram. [8]
 b) Explain carrier current protection and bus bar protection with suitable diagram. [8]

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1. a) Explain the fault clearing process with the help of trip circuit. [6]
- b) Explain the need of Instruments transformers in system. Mention the errors on CT. [4]
- c) Describe the time / current I^2T characteristics of a HRC fuse and explain how they are used to select the ratings of fuses in series. [6]
2. a) What is isolator? With the single line diagram, explain the working of isolator with consideration of closing and opening of circuit breaker kept in high voltage installation? [2+4]
- b) Why the neutral in a power system grounded? Explain different methods of neutral grounding. [5]
- c) A 33KV, 3 phases, 50 Hz overhead line 60 km long has a capacitance to ground of each line equal to $0.015\mu F$ per Km. Determine the inductance and KVA rating of Peterson coil. [5]
3. a) Describe the construction, principle of operation and application of vacuum circuit breaker. [8]
- b) Explain the terms related to Circuit Breaker i) Making Capacity ii) Breaking Capacity iii) Operation Duty iv) Rated Current [4]
- c) Explain operation of HVDC circuit Breaker. [4]
4. a) What are the various types of over current relays? Discuss their area of application. [4]
- b) Explain distance protection relay. Mention their applications. [6]
- c) Calculate the time of operation of relay 1 and time setting multiplier for relay 2 for the conditions given below. [6]
 - (i) Time grading margin between the relays is 0.5 sec
 - (ii) The time setting multiplier of relay 1 is 0.4
 - (iii) CT ratio of both CTs is 300/1
 - (iv) The fault occurs at point F and fault current is 3000A.
 - (v) Time current characteristic of both relays is given in table



PSM	2	3.6	5	6.67	8	10	15	20
Time in sec	10	6	3.9	3.5	3.15	2.8	2.2	2.1

5. a) With the help of neat block diagram, explain the function of directional static over current relay. [8]
- b) Draw the block diagram of microprocessor based protective scheme for protection of transmission line. [8]

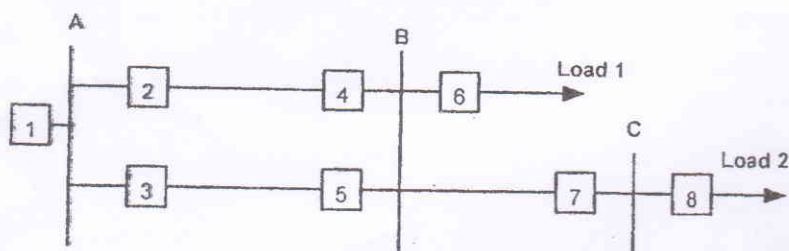
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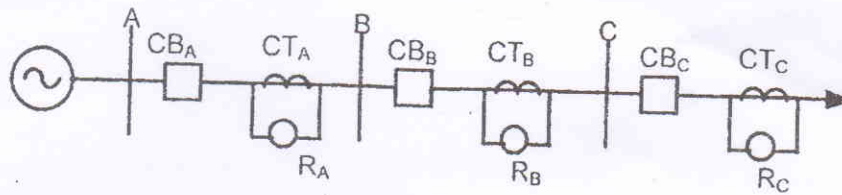
1. a) Consider the system portion shown in figure below. (i) Sketch the zone of protection (ii) Describe a possible backup scheme for failure of breaker 7 for a fault on line BC, is load 1 interrupted. (iii) Describe a means of clearing a fault on line BC without a momentary interruption of load 1.

[6]



- b) Define current transformer its working principle and their application areas. [4]
- c) Explain the construction and operation of HRC fuse. Also mention the difference between Fuse and MCB. [3+3]
2. a) What are the basic difference between Isolator and circuit breaker? Explain why we use isolator and circuit breaker simultaneously? [6]
- b) What is neutral earthing? Briefly discuss different types of neutral earthing. [6]
- c) Determine the inductance and kVA rating of the arc suppression coil for a 60 km long 33 kV, 50 Hz, 3 phase overhead line having capacitance to earth equal to 0.015 μF per km. [4]
3. a) A 50 Hz, three-phase synchronous generator has an inductance per phase of 1.7 mH and its neutral is grounded. It feeds a line through a circuit breaker. The total stray capacitance to ground of the generator and circuit breaker is 0.0025 μF . A fault occurs just beyond the circuit breaker, which opens when the symmetrical short circuit current is 7500 A. (rms). Ignoring the first pole to clear factor, determine the following. (i) Natural frequency of Oscillations. (ii) Peak value of TRV (iii) Time at which peak value of TRV occurs (iv) Maximum rate of rise of TRV (v) Time at which the maximum in part (a) occurs. [8]
- b) Describe the construction and working of a puffer type SF₆ circuit breaker. Also mention the properties of SF₆ gas which make it a good arc quenching medium. [8]
4. a) Describe how an overcurrent and earth-fault protection scheme by IDMT relays for a transformer could be converted into the form of differential protection. What are the advantages over the other protection schemes as applied to transformer. [8]

- b) IDMT relays for protection of sectionalised radial feeder shown in figure below and the method of selection of their settings are given below. Time setting multiplier is 1. [8]



Relay Point	CT ratio	Fault current	Current setting
A	400 / 5	4000 A	100 %
B	300 / 5	3000 A	75 %
C	200 / 5	2000 A	50 %

IDMT Characteristics.

PSM	2	4.2	6.5	8.8	10	12.4	13.3	16.3	18	20
Time in sec	8	4.2	3.8	3.1	2.8	2.6	2.5	2.4	2.3	2.2

5. a) Discuss the advantages and limitations of static relays over electromagnetic relays? Also mention the main the components of static relays and their role. [8]
- b) Describe working principle of static distance relay with a block diagram [8]

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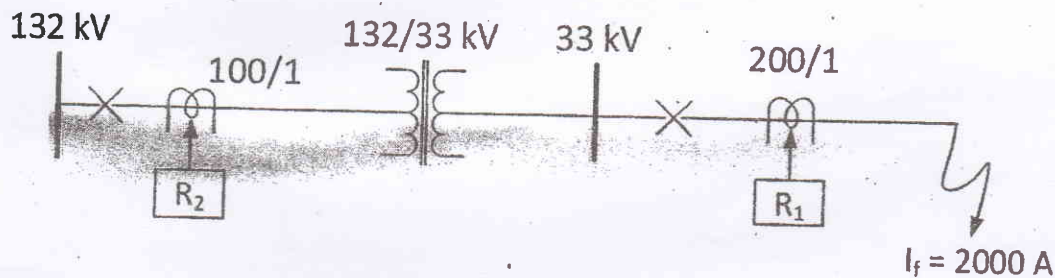
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1. a) What are the basic requirements of protection scheme? [4]
- b) What are the main facts to distinguish current transformer and potential transformer? [4]
2. a) Explain the following terms showing the sketch of the cut off characteristics of fuse. [6]
 - i) Minimum fusing current
 - ii) Rated current
 - iii) Perspective current
 - iv) Cutoff current
 - v) Fusing factor
- b) Explain the construction, operating principle and application of isolator. [6]
- c) An alternator rated at 10 kV protected by the balanced circulating current system has its neutral grounded through a resistance of 10 ohms. The protective relay is set to operate when there is out of balance current of 1.8 A in the pilot wires, which are connected to the secondary windings of 1000/5 ratio current transformers. Determine: (i) the percentage winding which remain unprotected (ii) The minimum value of earthing resistance required to protect 80% of the winding. [8]
3. a) Explain what do you understand by: [3+5]
 - i) Rated symmetrical breaking current
 - ii) Making capacity
 - iii) Short time current rating

Obtain their value for a three phase CB rated as 500 A, 500 MVA, 11 kV, 3 sec
- b) Explain the construction and working principle of SF6 circuit breaker. [6]

4. a) It is given that fault current level at 33 kV side is 2000 A. CT ratio at 33 kV side is 200:1 and 132 kV is 100:1 as shown in figure below. If the both relay R_1 and R_2 are set for 100% plug setting, determine the operating time for both relays assuming that both the relay have same characteristics as shown in table below. For the discrimination the time gradient margin between two relays is 0.5 second and the time setting multiplier for R_1 is 0.2. Also determine the time setting multiplies for R_2 . [8]

PSM	2	3.6	5	8	10	15	20
Time in second for TMS=1	10	6	3.9	3.15	2.8	2.2	2.1



- b) A three phase, 11/132 kV, delta-star connected power transformer is protected by differential protection. The CTs on the LV side have a current ratio of 200/1. What must be the current ratio of the CTs on the HV side? How the CTs on both the sides of the transformer are connected. [6]
- c) Explain with a neat sketch the percentage differential protection of an alternator. [8]
5. a) Explain the working of static differential relay with the proper block diagram and circuit diagram. [8]
- b) Discuss the advantages of digital relays. Describe the basic functional blocks of a digital relay. [8]
