KATHMANDU UNIVERSITY
End Semester Examination
June/July, 2019

Marks Scored:

Level : B.E.
Year : IV

Course : EPEG 415
Semester: II

Exam Roll No. :

Time: 30 mins.

F.M : 10

Registration No.:

Date :

SECTION "A"
[20Q × 0.5 = 10 marks]

Circle the most appropriate answer for the following questions.

1. The distribution system shown in Figure-1 is to be protected by over current relays. For proper discrimination directional over current relays will be required at locations ....
a. 1 and 4 b. 2 and 3 c. 1, 4 and 5 d. 2, 3 and 5

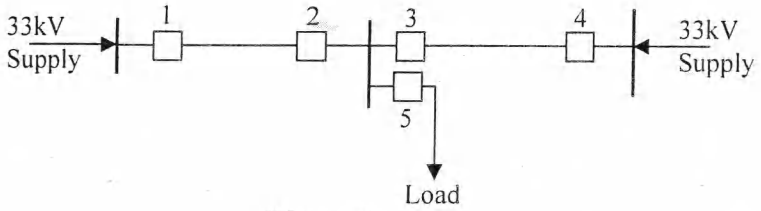

Figure-1

2. Consider a stator winding of an alternator with an internal high resistance ground fault. The currents under the fault condition are as shown in the Figure-2. The winding is protected using a differential current scheme with current transformers of ratio 400/5 A as shown in figure-2. The current through the operating coil is .....
a. 0.1875A b. 0.2A
c. 0.375A d. 60kA

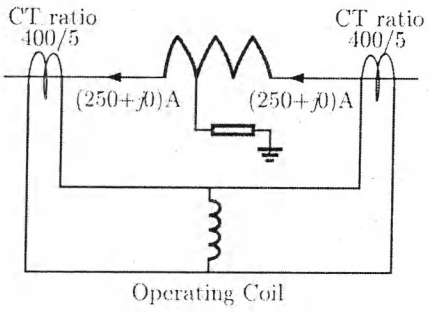

Figure-2

3. If the fault current is 2000A, the relay setting is 50% and the CT ratio is 400:5, the plug setting multiplier will be .....
a. 25A b. 15A c. 50A d. 10A

4. A three phase, 33kV oil circuit breaker is rated 1200A, 2000MVA, 3s. The symmetrical breaking current is .....
a. 1200A b. 3600A c. 35kA d. 104.8kA

5. A power system with two generators is shown in Figure-3. The power system network is protected by six over-current relays 1 to 6. Assuming mix of non-directional and directional relays at appropriate locations, the backup relays for relay 6 are .....
a. 1 and 2 b. 2 and 4 c. 2 and 3 d. 1 and 4

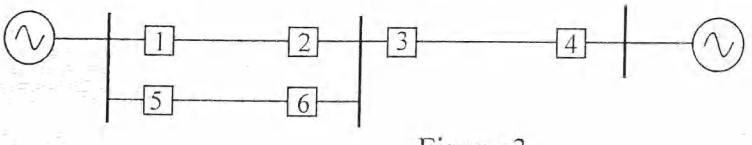

Figure-3

6. The distribution feeder has IDMT over-current relay being used for its protection. The maximum fault current in the feeder is 2000A and the ratio of CT used is 100:1. If the plug setting of the relay is 100% and the time multiplier setting is 0.1, the operating time for the relay will be .....
a. 0.017s b. 0.198s c. 0.226s d. 0.441s

7. A power system network has a transmission line section with total impedance 2+j20 Ω. The distance protection scheme has a CT ratio is 400/1 A and the PT ratio is 420kV/110V. If the reach of the mho relay with characteristic angle 60° in the first zone is 80%, the first zone setting of the relay will be .....
a. 1.84Ω b. 1.68Ω c. 2.30Ω d. 1.93Ω

8. A current of 5A fuses a lead fuse wire of diameter 0.0195 inches. The current required to fuse a wire of diameter 0.0392 inch will be..... A
a. 2.37 b. 0.395 c. 11.94 d.14.25

9. Which of the following sequences of operations represents the rated operating duty cycle of a circuit breaker? (O –open, C-close, t = 3s, T = 3 minutes)
a. O-CO-t-CO-T-C b. O-t-CO-T-CO c. O-C-t-OC-T d. O-CO-T-CO-T-C

10. If the percentage reactance up to the fault point is 40%, and the base kVA is 10000, then the short circuit kVA is .....
a. 25,000 b. 5,000 c. 1000 d. 500

11. The pressure of SF_6 gas in circuit breakers is of the order of ....
a. 100mmHg b. 1-2kg/cm^2 c. 2.5-5kg/cm^2 d. 25-50kg/cm^2

12. The directional over-current relays have two exciting coils connected across ....
a. CT secondaries of two different phases
b. PT secondaries of two different phases
c. CT and PT secondaries of same phase
d. CT and PT secondaries of two different phases

13. The distance relay is said to be inherently directional if its characteristics on R-X diagram is .....
a. a straight line off set from the origin b. a circle that passes through the origin
c. a circle that encloses the origin d. a straight line parallel to the R-axis

14. Thermal relays are used for protection of motors against over-current due to .....
a. short circuit b. earth fault c. heavy load d. single phasing

15. The average current value of lightning stroke is .....
a. 10A to 50A b. 100A to 1kA c. 10kA to 100kA d. >1000kA

16. The majority of distribution substations in Nepal are ..... type.
a. pole mounted b. indoor c. outdoor d. underground

17. A Buchholz relay is ..... actuated relay.
a. oil b. gas c. current d. temperature

18. The relay used for feeder protection is .....relay.
a. undervoltage b. thermal c. Buchholz d. Translay

19. For a single circuit one terminal 3phase transmission line how many distance protection units are required?
a. one b. two c. three d. six

20. The transient voltage that appears across the contacts at the instant of arc interruption is known as .....voltage
a. recovery b. restriking c. prospective d. peak

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SECTION "B"

*Attempt **ANY FIVE** questions.*
Assume necessary data if required.

1. a. Describe the operation of a HRC fuse with its construction details. Explain the cut-off characteristics and time-current characteristics of a HRC fuse. [4]

   b. A generating station has three section bus-bars connected with a tie-bar through 6% reactors rated at 5000 kVA as shown in Figure-1. Each generator is of 5000 kVA with 12% reactance and is connected to one section of bus-bars. Find the total steady input to a dead short-circuit between the lines on one of the sections of bus-bar (i) with reactors and (ii) without reactors. [4]

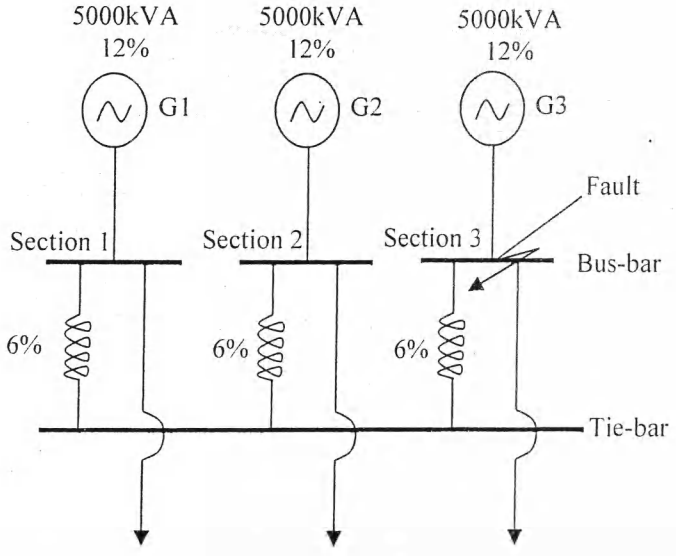

Figure-1

2. a. A 11kV, 3 phase generator has a maximum rating of 100MW at 0.8 p.f. and its reactance is 0.1 p.u. It is equipped with differential current protection scheme which is set to operate at fault current not less than 500 amps. Determine the magnitude of the neutral earthing resistance that leaves the 10% of the winding unprotected. [2]

   b. A 400V/33kV three phase transformer is connected in star delta. It is equipped with differential current protection scheme. The CTs on the 400V side have turns ratio of 1000/5. Determine the turn ratio of CTs on the 33kV side. [2]

   c. Describe the operation of a microprocessor based over current relay using suitable block diagram and flow chart for the operation. [4]

3. a. With a schematic diagram describe the balanced earth fault protection scheme for a three phase alternator. [3]

b. Figure-2 shows single line diagram of a portion of power system network. The line parameters of L_1, L_2 and L_3 are as follows:

Line	Voltage(kV)	Impedance (Ω/km)	Distance (km)
L_1	132	0.025 + j 0.10	200
L_2	132	0.03 + j 0.12	100
L_3	66	0.05 + j 0.2	50

The mho relay R with characteristics angle of 60° is used to protect the 132kV line. The CT ratio is 1000/1 A, and the PT ratio is 132kV/ 110V. The three zone settings of relay R is $K_1 = 14.21$, $K_2 = 160\%$ of K_1, and $K_3 = 200\%$ of K_1. Find out in terms of distance in kilometers the followings: [5]

(i) Zone 1 reach of relay R from bus A for line L_1
(ii) Zone 2 reach of relay R from bus B for line L_2
(iii) Zone 3 reach of relay R from bus B for line L_3

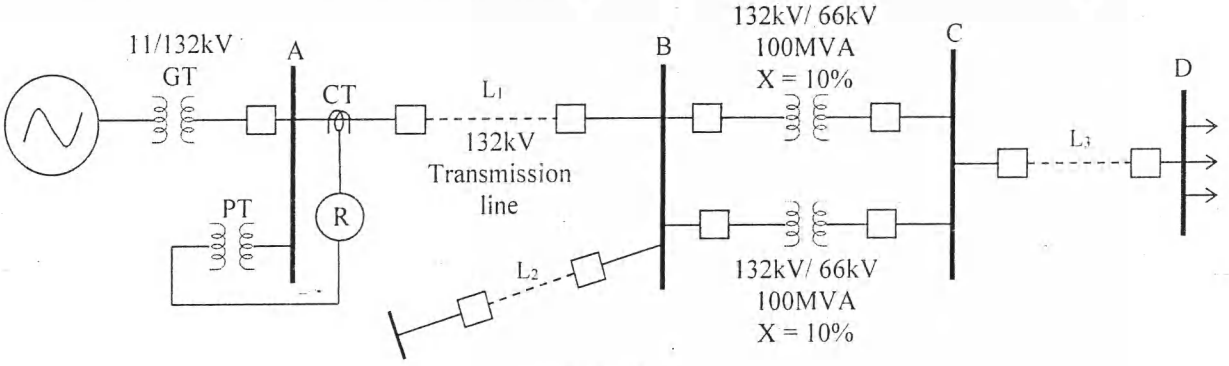

Figure-2

4. a. With a schematic diagram explain the use of percentage differential for protection of induction motor from phase faults. [2]

b. Explain with a suitable diagram how a Buchholz relay can be used for transformer protection. [2]

c. A 50 cycles, 3 phase alternator with grounded neutral has inductance of 1.6mH per phase and is connected to busbar through a circuit breaker. The capacitance to earth between the alternator and the circuit breaker is 0.003μF per phase. The circuit breaker opens when the rms value of current is 7500A. Determine the maximum rate of rise of restriking voltage, time for maximum rate of rise of restriking voltage and the frequency of oscillations. Neglect the first pole to clear factor. [4]

5. a. Explain the current interruption process in an ac circuit breaker after the occurrence of a fault. With a suitable diagram explain the arc quenching phenomenon in a SF_6 circuit breaker [4]

b. Figure-3 shows a single line diagram of a radial feeder. The relays used are IDMT having rated current of 1A. The PS of the relays are given in Figure-3. The TDS value of relay R3 is 0.15. Determine the TDS of other relays. [4]

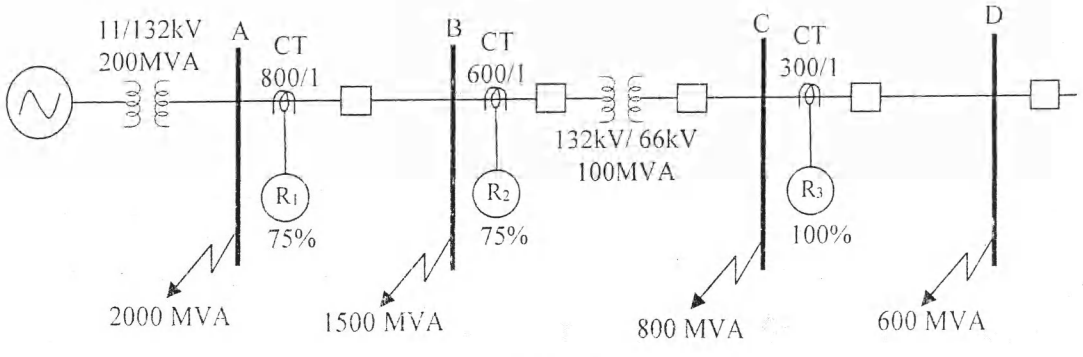

Figure-3

6. a. Describe the lightning phenomenon, with its wave shape. Explain how power system apparatus can be protected from travelling waves caused due to lightning. [4]

b. Figure-4 shows a part of a power system. For the discrimination, the time grading margin between the relays is 0.5 sec. Determine the time of operation of the two relays assuming that both the relays have the characteristics as shown in the attached graph. The time setting multiplier for relay 1 is 0.2. Also find the time setting multiplier for relay 2. [4]

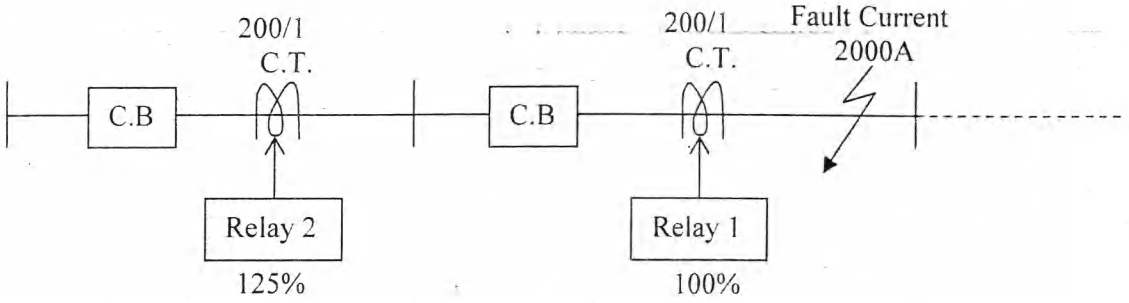

Figure-4