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END SEMESTER EXAMINATION
(Regular/Retest) – 2020

Semester : 6th

Subject Code : CAI-603

SUBSTATION, SWITCHGEAR & PROTECTION

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

Instructions :

1. *All* questions of PART–A are compulsory.
2. Answer any *five* questions from PART–B.

PART – A

Marks – 25

1. Fill in the blanks : 1×10=10

   (i) An AC circuit is more easily interrupted than a DC circuit because alternating current provides _____.

[Turn over

(ii) If the length of the arc increases, its resistance is _____.

(iii) The value of fusing factor is always _____ than unity.

(iv) A fuse has _____ time current characteristics.

(v) The chief cause of over speed in an alternator is the _____.

(vi) Earth relays have _____ current setting.

(vii) The most commonly used system for the protection of generator is _____.

(viii) In equipment grounding, the enclosure is connected to _____ wire. (ground/ neutral)

(ix) L-L-L-G fault is _____ type of fault.

(x) Buchholz relay is installed between _____ and conservator.

2. Write true or false : 1×10=10

(i) In an R-L AC series circuit, current leads the applied voltage by an angle 90°.

(ii) The voltage element of an impedance relay is excited from a potential transformer.

(iii) Pickup current is the maximum current in the relay coil at which the relay starts to operate.

(iv) Current transformers are used in the sub-stations for the measurement of high magnitude current.

(v) In a balance star-connected system, line to line voltage is 230V. The phase voltage is also 230V.

(vi) The outdoor type switchgear is generally used for voltages beyond 66kV.

(vii) In solid grounding method, the neutral point of three phase system is directly connected to earth through a conductor of negligible resistance.

(viii) HRC fuses are used widely in industries. The full form of HRC fuse is High Resonance Capacity fuse.

(ix) Buchholz relay can detect faults above oil level in the transformer.

(x) In India, the standard frequency for AC voltages is 501 Hz.

3. Choose the appropriate option : 1×5=5

(a) What is the purpose of back-up protection ?

(i) to increase the speed

(ii) to increase the reach

(iii) to leave no blind spot

(iv) to guard against failure of primary protection

(b) The power factor in an AC circuit is

(i) The angle between voltage and current

(ii) The angle between voltage across resistor and voltage across inductor

(iii) The angle between series voltage vector and parallel voltage vector

(iv) The cosine angle between the voltage vector and current vector

(c) The concept of symmetrical component method is widely used for fault calculation in electrical engineering. It was first given by

(i) Michael Faraday

(ii) Dr. C. L. Fortescue

(iii) Nikola Tesla

(iv) Isaac Newton

(d) In electrical power generating stations large alternators are used to produce electric power. When the prime mover of the alternator fails

(i) The alternator will run as an induction motor

(ii) The alternator will run as an induction generator

(iii) The alternator will run as a single phase machine

(iv) None of the above

(e) A differential relay measures the vector difference between

(i) two currents

(ii) two voltages

(iii) two or more similar electrical quantities

(iv) None of the above

PART – B

Marks – 45

4. (a) Draw a neat diagram of 11kV/400V indoor substation with essential parts. 4

(b) Write the names of necessary equipments of a transformer sub-station. 5

5. (a) Why it is important for an electrical engineer to estimate short-circuit currents ? 4

(b) Briefly write about the essential features of switchgear. 5

6. (a) Write briefly about the Merz-Price circulating current scheme for the protection of a 3-phase delta/delta power transformer against phase-to-phase fault. Draw necessary diagrams. 7

(b) Write two advantages of Buchholz relay. 2

7. (a) What do you mean by equipment grounding and system grounding ? 2+2=4

(b) Write five advantages of neutral grounding. 5

8. (a) What do you mean by pickup value and current setting of relay ? 1+1=2

(b) Write the general relay equation. 1

(c) Using the general relay equation, find the condition for tripping of over current and directional relay. 3+3=6

9. (a) Write four important components of switchgear and briefly explain about each of them. 8

(b) What do you mean by restriking voltage associated with circuit breaker's studies. 1

10. What is operator 'a' ? Show that 9

(i) $a^2 = -0.5 - j0.866$

(ii) $1 + a + a^2 = 0$

(iii) $a - a^2 = j\sqrt{3}$