POWER SYSTEM – II
(ELE3102)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) A transformer rated for 500kVA, 11kV / 0.4kV has an reactance of 10% and is connected to an infinite bus. The fault level of the transformer is
(a) 500 Kva (b) 500 MVA
(c) 20 MVA (d) 5000 kVA

(ii) A balanced 3-phase system consists of
(a) zero sequence currents only
(b) positive sequence currents only
(c) negative and zero sequence currents
(d) zero, negative and positive sequence currents.

(iii) The rating of circuit breaker is usually determined on the basis of
(a) symmetrical fault (b) single line-to-ground fault
(c) double line-to-ground fault (d) line-to-line fault

(iv) Four alternators each rated at 5 MVA, 11kV, with 20% reactance are working in parallel. The short circuit level at bus bar is
(a) 6.25 MVA (b) 20 MVA
(c) 25 MVA (d) 100 MVA

(v) Which among the following quantities are specified at the load bus?
(a) P and Q (b) P and |V|
(c) Q and |V| (d) P and δ

(vi) The critical clearing time of a fault in power system is related to
(a) reactive power limit (b) short circuit limit
(c) steady - state stability limit (d) transient stability limit

(vii) Which relay is used to detect and protect a transformer from any internal fault?
(a) Buchholz relay (b) Directional relay
(c) Thermal relay (d) Distance relay

(viii) What is the purpose of back up protection?
(a) To increase the speed (b) To increase the reach
(c) To leave no blind spot (d) To guard against failure of primary

(ix) Which of the following circuit breakers is highly reliable and has a least maintenance?
(a) Oil circuit breakers (b) Air blast
(c) Vacuum circuit breakers (d) SF_6 circuit breakers

(x) The primary protective function of neutral grounding is to protect against
(a) Overcurrent in generators (b) Phase-to-phase faults
(c) Single line-to-ground faults (d) Three-phase balanced faults

Fill in the blanks with the correct word

(xi) For simulation of LG fault the three sequence networks are to be connected in _____.

(xii) The dimension of Y-bus matrix for an n- bus power system is _____.

(xiii) A _____ differential relay is designed to avoid unwanted tripping due to CT saturation or transient conditions.

(xiv) SF6 circuit breakers are widely used in high-voltage applications because SF6 gas has excellent _____ properties.

(xv) Acceleration factor is used to increase the rate of convergence in _____ method of load flow analysis.

Group - B

2. (a) State Fortescue's theorem for three phase unbalanced system.
[(CO1)(Remember/LOCQ)]

(b) What are the assumptions made in the analysis of unsymmetrical fault?
[(CO1)(Remember/LOCQ)]

(c) A symmetrical 3-phase short circuit occurs on the 6.6 kV bus-bars of the circuit shown as one line diagram in Fig. 1. Calculate the fault current and fault level. Assume the system was under no load condition before fault. Take 100 MVA as base MVA and transmission line voltage as base voltage at transmission line.

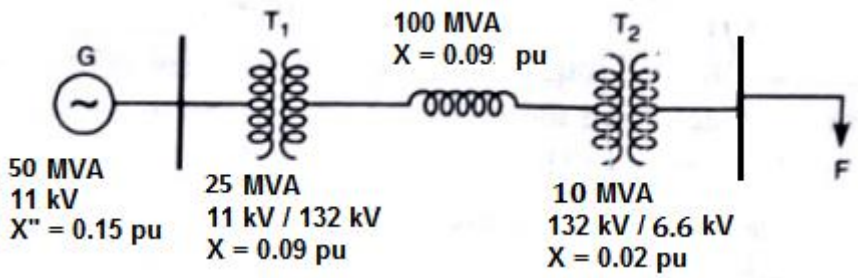

Fig. 1

[(CO1)(Apply/IOCQ)]
2 + 2 + 8 = 12

3. (a) What are current limiting reactors? Discuss the various types of current limiting reactors according to their location. *[(CO1)(Remember/LOCQ)]*

(b) Two generating stations each having short circuit capacities of 1300 MVA and 900 MVA respectively are operating at 11kV and are linked by an interconnected cable having a reactance of 0.55 Ω/phase. Determine the short circuit capacities of each station. *[(CO1)(Apply/IOCQ)]*

6 + 6 = 12

Group - C

4. (a) What is swing curve? What information is supplied by it? *[(CO3)(Understand/LOCQ)]*

(b) A 500 MVA synchronous machine has H_1 = 4.6 MJ/MVA, and a 1500 MVA machine has H_2 = 3.0 MJ/MVA. The two machines operate in parallel in a power station. What is the equivalent H constant for the two, relative to a 100 MVA base? *[(CO3)(Apply/IOCQ)]*

(c) An alternator is connected to an infinite bus, as shown in Fig. 2 below. It delivers 1.2 pu current at 0.8 pf lagging at V = 1.0 pu. The reactance is 1.5 pu. Determine the active power output and steady state power limit. Keeping the active power fixed if the excitation is reduced find the critical excitation corresponding to operation at stability. *[(CO3)(Analyse/HOCQ)]*

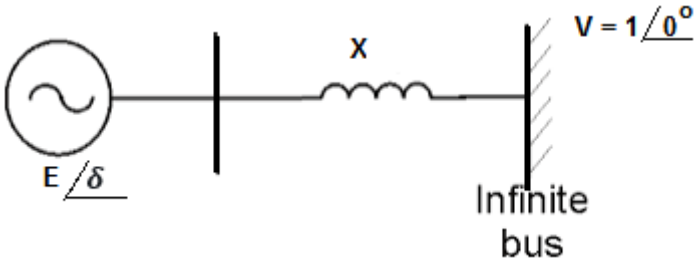

Fig. 2

(2 + 2) + 2 + 6 = 12

5. (a) Show that two synchronous generating sources of inertia constants M_1 and M_2 respectively and interconnected by means of a transmission line may be regarded for purpose of stability studies as a single generator of inertia constant $\frac{M_1 M_2}{M_1+M_2}$ connected through the same transmission line to an infinite bus-bar. *[(CO3)(Apply/IOCQ)]*

(b) What are the methods of improving transient stability? *[(CO3)(Apply/IOCQ)]*

(c) What is synchronizing coefficient? How the stability of a power system can be determined with the help of synchronizing coefficient? *[(CO3)(Analyse/HOCQ)]*

5 + 3 +(2 + 2) = 12

Group - D

6. (a) Determine the time of operation of an Over current relay of current rating 5A and having a relay current setting of 150%. Time setting is 0.8. It is connected to a supply circuit through a C.T. of 400/5 ratio. The fault current is 3000 A.

PSM	2	4	5	8	10	20
Operating Time(sec)	10	5	4	3	2.8	2.4

[(CO4)(Evaluate/HOCQ)]

(b) Why is an impedance relay affected by arc resistance, while a reactance relay is not? *[(CO4)(Apply/IOCQ)]*

8 + 4 = 12

7. (a) What do you mean by MTA in Directional Over Current Relay? Explain. *[(CO4)(Remember/LOCQ)]*

(b) An over-current relay of current rating 5A and current setting 200% is connected to the secondary of C.T. of ratio 200/5. Calculate the current in lines for which the relay picks up. *[(CO4)(Evaluate/HOCQ)]*

(c) Write a short note on Buchholz's protection for transformers. *[(CO4)(Remember/LOCQ)]*

3 + 3 + 6 = 12

Group - E

8. (a) Explain the following terms in a Circuit Breaker:
   (i) Breaking current,
   (ii) Making current and
   (iii) Short-time rating *[(CO5)(Understand/LOCQ)]*

(b) In a short circuit test, with earthed neutral, on a 33 kV, 3-phase circuit breaker, the p.f. of the fault was 0.3, the recovery voltage was 0.95 of full line value, the breaking current was symmetrical and the restriking transient had a natural frequency of 16 kHz. Estimate the rate of rise of the restriking voltage. *[(CO5)(Evaluate/HOCQ)]*

(2 + 2 + 2) + 6 = 12

9. (a) Briefly describe the zig-zag transformer grounding. *[(CO6)(Understand/LOCQ)]*

(b) What do you mean by Step potential? *[(CO6)(Remember/LOCQ)]*

(c) An OCB is rated for 1000 MVA, 2 kA, 66 kV, 3 phase, 3 sec. What are its (i) rated operating voltage, (ii) rated operating current and (iii) rated symmetrical breaking current? *[(CO5)(Evaluate/HOCQ)]*

4 + 2 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.5	29.1	34.4