

POWER SYSTEM - II
(ELEC 3201)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which is an over current relay with directional restraint?
(a) Impedance relay (b) Mho relay
(c) Reactance relay (d) Over current relay.
 - (ii) In a biased differential relay, the bias is defined as a ratio of
(a) Number of turns of restraining and operating coil
(b) Operating coil current and restraining coil current
(c) Fault current and restraining coil current
(d) Fault current and operating coil current.
 - (iii) The operation of the relay which is most affected due to arc resistance is
(a) Mho relay (b) Reactance relay
(c) Impedance relay (d) All are equally affected.
 - (iv) Plug setting of a relay can be changed by changing
(a) Air gap (b) Backstop position
(c) Number of ampere turns (d) Damping.
 - (v) Which among these is the most severe fault?
(a) Single line to ground fault (b) Double line to ground fault
(c) Line to line fault (d) Symmetrical fault.
 - (vi) The operator ' α ' rotates a vector in anticlockwise direction by an angle
(a) 90° (b) 120° (c) 60° (d) 180° .
 - (vii) A 500 MVA transformer has a reactance of 5%. Its reactance at 2000 MVA base is
(a) 5% (b) 4% (c) 20% (d) 10%.
 - (viii) The positive and negative sequence impedance of a transmission line are
(a) equal (b) unequal (c) 0 (d) infinite.

- (ix) What is the value of transient stability limit?
 (a) Higher than steady state stability limit
 (b) Lower than steady state stability limit
 (c) Equal to steady state stability limit
 (d) Depending upon the severity of load.
- (x) The equal area criteria of stability is used for
 (a) no load on the busbar
 (b) one machine and infinite busbar
 (c) more than one machine and infinite busbar
 (d) any number of machine and infinite busbar.

Group - B

2. (a) Draw and explain equivalent circuits of synchronous machine under subtransient, transient and steady state conditions. *[[CO1](Understand/LOCQ)]*
 (b) Fig. 1 shows a generating station feeding power to a 132 kV system. Determine the total fault current and fault level for a 3- phase fault at the receiving end bus. The line is 200 km long. *[[CO1](Evaluate/HOCQ)]*

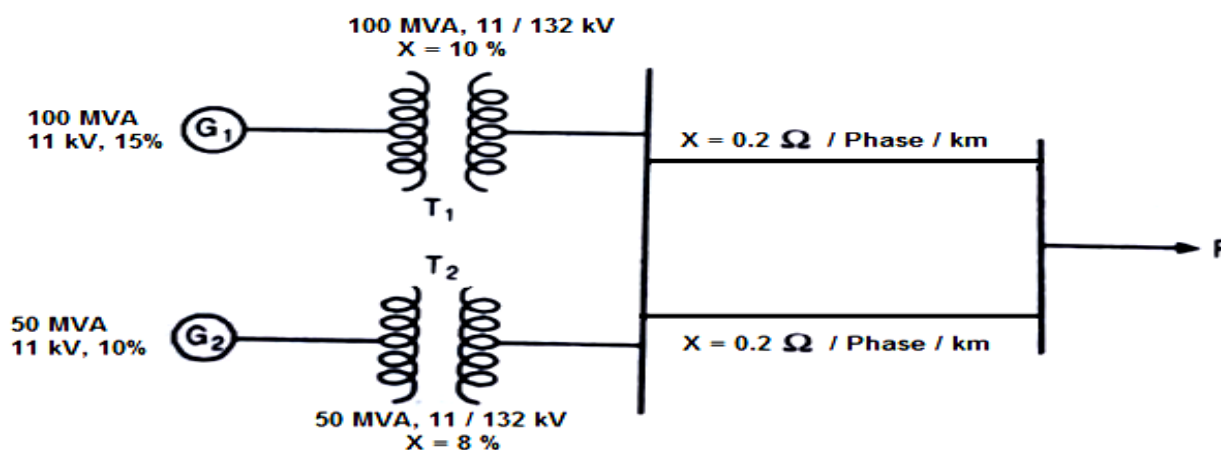


Fig.1

4 + 8 = 12

3. (a) What do you mean by zero sequence components of a 3 phase unbalanced phasors? Draw a general circuit, which can be used to determine the zero sequence network of a two winding transformer and hence draw the zero sequence network for the following three phase transformers. *[[CO1](Apply/IOCQ)]*



- (b) A 50 MVA, 11 kV three-phase alternator was subjected to different types of faults. The fault currents are as under:

3- phase fault = 2000A

Line - to - line fault = 2600A

Line - to - ground fault = 4200A

The generator is solidly grounded. Find the values of the three sequence reactance of the alternator. *[[CO1](Apply/IOCQ)]*

(2 + 3) + 7 = 12

Group - C

4. (a) Develop the swing equation of a synchronous machine swinging against an infinite bus. [[CO2](Apply/IOCQ)]
 (b) A two-pole, 50 Hz, 60 MVA turbo generator has a moment of inertia of $9 \times 10^3 \text{ kg-m}^2$. Calculate (i) the kinetic energy in MJ at rated speed, (ii) the inertia constants M and H and (iii) the inertia constant on 50 MVA base. [[CO2](Evaluate/HOCQ)]
6 + 6 = 12
5. (a) Explain the classification of different types of buses in power system for load flow analysis. [[CO2](Understand/LOCQ)]
 (b) Solve for the bus admittance matrix for the given 3-bus power system of Fig.2. (All the impedances and reactances are given in pu). [[CO2](Apply/IOCQ)]

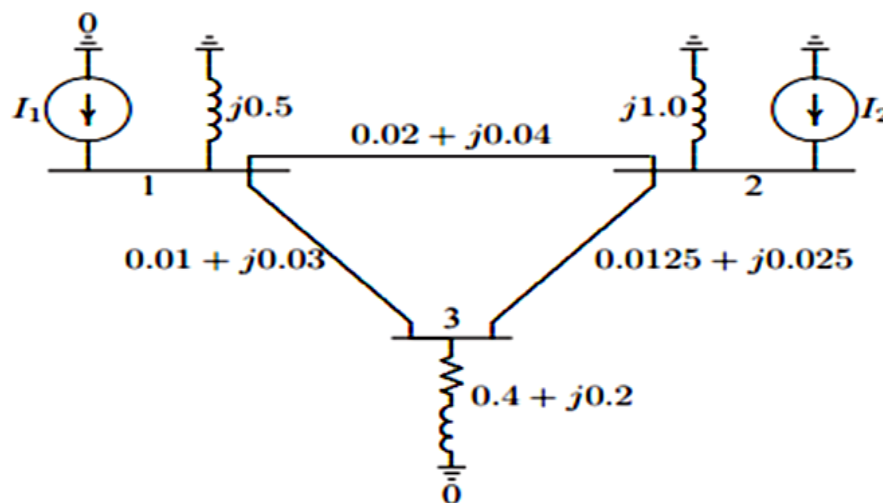


Fig.2

5 + 7 = 12**Group - D**

6. (a) Determine the time of operation of an Over current relay of current rating 5 A and having a relay current setting of 125%. Time setting is 0.9. It is connected to a supply circuit through a C.T. of 200/5 ratio. The fault current is 1000 A.

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

[[CO3](Evaluate/HOCQ)]

- (b) What is Universal Torque Equation? Using this equation derive and draw the operating characteristics of (i) Impedance relay and (ii) Reactance relay.

[[CO3](Apply/IOCQ)]**5 + 7 = 12**

7. (a) What is Universal Torque Equation? Using this equation derive the operating characteristics of
 (i) Impedance relay,
 (ii) Reactance relay,
 (iii) Mho relay.

[[CO3](Understand/LOCQ)]

- (b) In a 440 kV, 3-phase, 50 Hz long transmission line, synchronous impedance of alternator (Z_s) = 5Ω ; line impedance (Z_L) = 15Ω and load impedance (Z_{Load}) = 200Ω . If the current measured from CT be 40 kA, then determine whether the distance relay will operate or not. Also determine the location of fault.

[[CO3](Evaluate/HOCQ)]

6 + 6 = 12

Group – E

8. (a) Explain the following terms in a Circuit Breaker:
 (i) Restriking voltage
 (ii) RRRV. [[CO4](Understand/LOCQ)]
- (b) A circuit breaker is rated at 1200 amps, 1500 MVA, 66 kV, 3-sec 3-phase oil circuit breaker. Calculate
 (i) The normal rated current,
 (ii) The rated symmetrical breaking current,
 (iii) The rated asymmetrical breaking current assuming 40% direct current,
 (iv) The making current,
 (v) The short-time rating. [[CO4](Evaluate/HOCQ)]
- (2 + 2) + (1 + 2 + 2 + 1 + 2) = 12**
9. (a) Describe the following types of grounding in power system:
 (i) Arc suppression coil grounding,
 (ii) Delta-star transformer grounding. [[CO4](Understand/LOCQ)]
- (b) A 230 kV, 3-phase, 50 Hz transmission line 250 km long consists of three conductors of effective diameter 30 mm arranged in a vertical plane with 4 m spacing and regularly transposed. Determine the inductance and kVA rating of the arc suppressor coil. [[CO4](Apply/IOCQ)]
- (3 + 3) + 6 = 12**

<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	<i>26.04</i>	<i>39.59</i>	<i>34.37</i>

Course Outcome (CO):

After the completion of the course students will be able to

- To analyze different types of power system faults.
- To analyze the load flow problems and stability in power system.
- To discuss the basic principles of Power System relaying and the different protection schemes for various power system components.
- To discuss the basic principle of Circuit Breaking and grounding.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.