

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) The transient voltage that appears across the contacts at the instant of arc extinction is called
(a) recovery voltage (b) restriking voltage
(c) supply voltage (d) peak voltage.
- (ii) The most severe fault on the power system is
(a) three-phase short-circuit (b) line to line fault
(c) double line to ground fault (d) single line to ground fault.
- (iii) The zero-sequence current of a generator for line to ground fault is $j2.4$ pu. Then the current through the neutral during the fault is
(a) $j15$ pu (b) $j0.8$ pu
(c) $j7.2$ pu (d) $j0.24$ pu.
- (iv) The rating of a circuit breaker is usually determined on the basis of _____ fault.
(a) symmetrical (b) line to line
(c) single line to ground (d) double line to ground
- (v) Bus admittance matrix (Y_{Bus}) is a
(a) null matrix (b) unit matrix
(c) diagonal matrix (d) sparse matrix.
- (vi) Plug setting of a relay can be changed by changing
(a) air gap (b) backstop position
(c) number of ampere turns (d) damping.
- (vii) A 1000 kVA transformer has a reactance of 5%. Its reactance at 2000 kVA base is
(a) 5% (b) 4%
(c) 20% (d) 10%.

- (viii) In which type of fault positive, negative and zero sequence currents are equal to each other?
(a) Symmetrical fault (b) Single line-to-ground fault
(c) Double line-to-ground fault (d) Line-to-line fault.
- (ix) Transient stability limit is
(a) greater than steady state stability limit
(b) less than steady state stability limit
(c) equal to steady state stability limit
(d) may be greater or less than steady state stability limit.
- (x) Purpose of backup protection is
(a) to increase the speed (b) to increase a reach
(c) to leave no blind spot (d) to guard against failure of primary.

Group- B

2. (a) What are current limiting reactors? Explain how the classification of current limiting reactors can be done depending upon their location?
[[CO1](Remember/LOCQ)]
- (b) Two generating stations each having short circuit capacities of 1300 MVA and 900 MVA respectively are operating at 11 kV and are linked by an interconnected cable having a reactance of $0.55 \Omega/\text{phase}$. Determine the short-circuit capacity of each station.
[[CO1](Evaluate/HOCQ)]
(2 + 3) + 7 = 12
3. (a) What do you mean by positive, negative and zero phase sequence components of 3-phase unbalanced system?
[[CO1](Remember/LOCQ)]
- (b) Construct the zero sequence diagrams for the following three phase transformers:
(i) Y/Y (ii) Δ/Δ [[CO1](Apply/IOCQ)]
- (c) A synchronous generator is rated 25 MVA, 11 kV. It is star connected with the neutral point solidly grounded. The generator is operating at no load rated voltage. Its reactances are $X_1 = X_2 = 0.20 \text{ pu}$ and $X_0 = 0.08 \text{ pu}$. Solve for the fault currents for
(i) single line to ground fault
(ii) line to line fault
(iii) symmetrical three phase fault. [[CO1](Apply/IOCQ)]
3 + 3 + (2 + 2 + 2) = 12

Group - C

4. (a) Develop the swing equation of a synchronous machine swinging against an infinite bus.
[[CO2](Apply/IOCQ)]

- (b) A 50 Hz, four pole turbo-generator rated 100 MVA, 11 kV has an inertia constant of 8.0 MJ/MVA.
- (i) Determine the stored energy in the rotor at synchronous speed.
 - (ii) If the mechanical input is suddenly raised to 80 MW for an electrical load of 50 MW, determine rotor acceleration, neglecting mechanical and electrical losses.
 - (iii) If the acceleration calculated in part (ii) is maintained for 10 cycles, determine the change in torque angle and rotor speed in revolutions per minute at the end of this period. [[CO2](Evaluate/HOCQ)]
- 5 + (2 + 2 + 3) = 12**

5. (a) Develop static load flow equations (SLFE). [[CO2](Apply/IOCQ)]
- (b) What are the advantages of Newton-Raphson method over Gauss-Seidel method in load flow analysis? [[CO2](Remember/LOCQ)]
- (c) Solve for Y_{bus} matrix for the 3-bus power system shown in Fig.1. The line series impedances are given along with the transmission lines. [[CO2](Apply/IOCQ)]

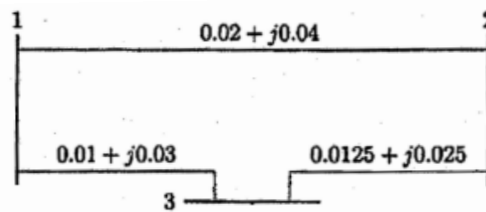


Fig.1

5 + 2 + 5 = 12

Group - D

6. (a) Determine the time of operation of an over current relay of rating 5 A and having a relay current setting of 125%. Time setting is 0.8. It is connected to a supply circuit through a C.T. of 400/5 ratio. The fault current is 4000 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 the operating characteristics of
- (i) impedance relay
 - (ii) Mho relay. [[CO3](Apply/IOCQ)]

5 + 7 = 12

7. (a) With a neat diagram explain the working of induction type directional over-current relay. What is meant by MTA of directional over-current relay? [[CO3](Apply/IOCQ)]
- (b) Explain clearly the basic principle of operation of a differential relay. What is meant by per cent bias? How is this achieved in practice in differential relay? [[CO3](Understand/LOCQ)]

(4 + 2) + (2 + 1 + 3) = 12

Group - E

8. (a) Explain the following terms in a Circuit Breaker:
 (i) Breaking current
 (ii) Making current
 (iii) Short-time rating. [[CO4](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.
[[CO4](Evaluate/HOCQ)]
(2 + 2 + 2) + 6 = 12
9. (a) Briefly describe the following types of grounding in power system:
 (i) Arc suppression coil grounding,
 (ii) Zig-zag transformer grounding. [[CO4](Understand/LOCQ)]
- (b) What do you mean by Step potential and Touch potential?
[[CO4](Remember/LOCQ)]
- (c) A 50 Hz overhead line has line to earth capacitance of 1.2 micro-farad. It is decided to use an earth fault neutralizer. Determine the reactance to neutralize the capacitance of (i) 100 % of the line length and (ii) 80 % of the line length.
[[CO4](Evaluate/HOCQ)]
(3 + 3) + 2 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	38.54	30.21

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