**B.TECH/EE/6TH SEM/ELEC 3201/2019**

**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) For n-bus power system size of Ybus matrix is

(a) (n-1) × (n-1) (b) (n-2) × (n-2)

(c) n × n (d) (n-1) × (n-2).

 (ii) Which among the following reactance have a greater value?

(a) Sub transient reactance (b) Transient reactance

(c) Synchronous reactance (d) All of these.

 (iii) If a generator of 250 MVA rating has an inertia constant of 6 MJ/MVA, its inertia constant on a 100 MVA base is

(a) 15 MJ/ MVA (b) 10.5 MJ/MVA

(c) 6.0 MJ/MVA (d) 2.4 MJ/MVA.

 (iv) An impedance relay is

(a) voltage restrained overcurrent relay

(b) voltage restrained directional relay

(c) directional restrained overcurrent relay

(d) directional restrained overvoltage relay.

 (v) The method of neutral grounding affects the

(a) positive-sequence network

(b) negative-sequence network

(c) zero-sequence network

(d) both positive and zero sequence network.

 (vi) 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.

 (vii) Which of the following relays has inherent directional characteristics?

(a) Mho relay (b) Reactance relay

(c) Impedance relay (d) Differential relay.

 (viii) The arc voltage in a circuit breaker is

(a) in the phase with the arc current

(b) lagging the arc current by 90°

(c) leading the arc current by 90°

(d) lagging the arc current by 180°.

 (ix) 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.

 (x) Purpose of backup protection is

(a) to increase the speed

(b) to increase the reach

(c) to leave no blind spot

(d) to guard against failure of primary protection.

**Group – B**

2. (a) Discuss and explain the subtransient, transient and steady state reactances when a sudden 3-phase short circuit occurs at the generator terminals.

 (b) Two 11 kV generators G1 and G2 are connected in parallel to a bus-bar as shown in Fig.1. A 66 kV transmission line is connected to the bus-bar through 11kV/66 kV transformer. Calculate the short circuit MVA and the fault current when a three-phase short circuit occurs (a) at the high voltage terminal of the transformer and (b) at the load end of the transmission line. The ratings of the equipment are as given below:

Generator G1 : 11 kV, 8 MVA, $X\_{d}^{"}$ = 8%

Generator G2 : 11 kV, 4 MVA, $X\_{d}^{"}$ = 4%

Transformer T : 11 kV/66 kV, 4 MVA, $X\_{T}$ = 3.5%

Transmission Line : $Z\_{Line}$ = (5 + j20) Ω

|  |  |
| --- | --- |
| Assume the system to be operated under no load before the fault. | ***Fig.1*** |

**4 + (4 + 4) = 12**

3. (a) Derive the necessary equations to determine the fault current for L-L fault. Draw a diagram showing the interconnection of sequence networks.

 (b) Draw the zero sequence diagram of Υ/Δ transformer with star point grounded through the reactance of XN.

 (c) A synchronous generator has following reactances:

X1 = 60%, X2 = 25%, X0 = 15 %

(i) Calculate the percentage reactance to be added in the generator neutral such that the current for L-G fault does not exceed 1 pu.

(ii) Calculate the value of resistance to be connected in the neutral to achieve the same purpose.

**(3 + 2) + 2 + (2 + 3) = 12**

**Group – C**

4. (a) Derive the swing equation of a synchronous machine swinging against an infinite bus.

 (b) A 50 Hz, four pole turbo-generator rated 100 MVA, 11 kV has an inertia constant of 8.0 MJ/MVA.

(i) Find 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, find rotor acceleration, neglecting mechanical and electrical losses.

(iii) If the acceleration calculated in part (ii) is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of this period.

**6 + (2 + 2 + 2) = 12**

5. (a) Discuss classification of buses in a power system.

 (b) Determine Ybus matrix for the 4-bus system for which the line series impedances are as follows:

|  |  |
| --- | --- |
| Line (bus to bus) | Impedance (p.u.) |
| 1 – 2  | 0.25 + j 1.0 |
| 1 – 3 | 0.20 + j 0.8 |
| 1 – 4 | 0.30 + j 1.2 |
| 2 – 3 | 0.20 + j 0.8 |
| 3 – 4 | 0.15 + j 0.6 |

 (c) Compare G-S method and N-R methods of load flow solutions.

**4 + 6 + 2 = 12**

**Group – D**

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

 (b) Reference to Fig.2, given that

|  |  |
| --- | --- |
| Fault current = 2000 A; Relay-1 set on 100%; CT ratio = 400/5; Relay-2 set on 200%. For discrimination the time gradient margin between the relays in 0.84 second. | ***Fig.2*** |

(i) Determine the time of operation of the two relays assuming that both the relays have the characteristic as shown in the following table and the Relay-1 has a time multiplier setting = 0.4 .

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Plug setting multiplier | 2 | 2.5 | 3.9 | 5 | 8.4 | 10 | 12 | 15 | 20 |
| Time in seconds for a time multiplier of 1 | 10 | 8 | 6 | 3.9 | 3.15 | 2.8 | 2.6 | 2.2 | 2.1 |

(ii) Also determine the time multiplier setting of Relay-2.

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

7. (a) What are the fundamental requirements of protective relaying? Explain with sketches the construction and operation on the induction disc type over current relay. Also derive the torque equation on the induction disc type over current relay.

 (b) An over-current relay of current rating 5A and setting 200% is connected to the secondary of CT of ratio 400:5. Calculate the current in lines for which the relay picks up.

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

**Group – E**

8. (a) Explain the following terms in a Circuit Breaker:

(i) Restriking voltage (ii) Recovery voltage (iii) RRRV.

 (b) Explain current chopping phenomenon associated with air blast circuit breaker.

 (c) A three-phase circuit breaker is rated at 1250 A, 2000 MVA, 33 kV, 4- second. Find out

(i) the rated normal current (ii) making current

(iii) the rated symmetrical breaking current (iv) short-time rating.

**3 + 5 + 4 = 12**

9. (a) Briefly describe the arc suppression coil grounding in power system.

 (b) What is the difference between system earthing and equipment earthing? What is effectively grounded system? Explain.

 (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.

**3 + 5 + 4 = 12**