Code : 031814

B.Tech 8th Semester Exam., 2019

POWER SYSTEM DESIGN

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Question No. 1 is compulsory.

1. Choose the correct answer (any *seven*) : 2×7=14

(a) What will be the per unit impedance of a synchronous motor having a rating of 100 kVA, 13·2 kVA and having a reactance of 75 Ω / ph?

(i) 0·043 p.u.

(ii) 0·057 p.u.

(iii) 0·036 p.u.

(iv) 0·298 p.u.

(b) By using which component can the transient stability limit of a power system be improved?

(i) Series resistance

(ii) Series capacitor

(iii) Series inductor

(iv) Shunt resistance

(c) What is the expression for fault current in line-to-line fault?

(i) $I_f = \sqrt{3} * (E_a / Z_1 + Z_2)$

(ii) $I_f = 3 * (E_a / Z_1 + Z_2)$

(iii) $I_f = \sqrt{3} * (E_a / Z_1 + Z_2 + Z_0)$

(iv) $I_f = 3 * (E_a / Z_1 + Z_2 + Z_0)$

(d) What are the types of unsymmetrical faults?

(i) Single-line to ground fault

(ii) Double-line to ground fault

(iii) Line-to-line fault

(iv) Both *(i)* and *(ii)*

(e) What is the value of the zero sequence current?

(i) 3 times the current in the neutral wire

(ii) 1/3 times the current in the neutral wire

(iii) √3 times the current in the neutral wire

(iv) Equal to the current in the neutral wire

(f) Which among the following methods are generally used for the calculation of symmetrical faults?

(i) Norton theorem

(ii) Thevenin's theorem

(iii) Kirchhoff's laws

(iv) Both (ii) and (iii)

(v) All of the above

(g) Why is load flow studies carried out?

(i) To study of stability of the system

(ii) For fault calculations

(iii) For planning the power system

(iv) All of the above

(h) The stability of the power system is not affected by which among these?

(i) Generator reactance

(ii) Line losses

(iii) Excitation of generators

(iv) All of the above

(i) Which among the following buses constitutes the maximum number in a power system?

(i) Slack bus

(ii) *PQ* bus

(iii) *PV* bus

(iv) All of the above

(j) Which among the following is the main assumption to solve a load flow problem by GS method?

(i) All the buses are to be considered as *PQ* bus including the slack bus

(ii) All the buses are to be considered as *PV* bus including the slack bus

(iii) All the buses are to be considered as *PQ* bus excluding the slack bus

(iv) All the buses are to be considered as *PV* bus excluding the slack bus

2. (a) Why is one of the buses taken as slack bus in load flow studies? 4

(b) Explain different buses used in load flow study. 2

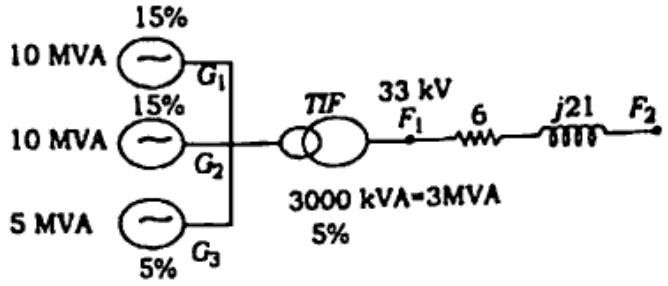
(c) Write down the general equation resultant from Gauss-Seidel load flow method that needs to be solved during each iteration. Define each term used in the expression. 8

3. (a) List the advantages of using per unit values in power system calculations. 6

(b) A three-phase transmission line operating at 33 kV and having a resistance and reactance of 6 ohm and 21 ohm respectively, is connected to the generating station bus-bar through a 3000 kVA step-up transformer which has a reactance of 5%. Three alternators are connected to the bus-bar, two alternators are of 10 MVA with a reactance of 15% and the third alternator is of 5 MVA with a reactance of 5%. Figure shown below. Assuming base quantities as 10 MVA, 33 kV.

(i) Draw the reactance diagram.

(ii) Calculate the Thevenin's impedance in p.u. for fault occurs at F1. 8



4. (a) Explain all types of reactance of synchronous machine under no load condition. Also draw the approximate circuit model for a short circuit under different conditions. 7

(b) The bus bar of each of the two alternators of 15% reactance each, are interconnected through tie-bar reactors of 15% each. What should be the value in p.u. for the equivalent impedance to fault current for three-phase fault in any alternator bus-bar? 7

5. (a) Determine the positive sequence component of the three currents $I_a = 10\angle 0$ A, $I_b = 10\angle 230$ A and $I_c = 10\angle 130$ A. 7

(b) Derive the complex power in terms of symmetrical components. 7

6. *(a)* Draw the sequence network for all types of asymmetrical fault with fault impedance (Z_f) and neutral impedance (Z_s). 7

(b) A 20 MVA, 12 kV alternator with solidly grounded neutral has is sub-transient reactance of 0·25 p.u. The negative and zero-sequence reactance are 0·3 and 0·5 p.u. respectively. A single line to ground fault occurs at the terminals of an unloaded alternator, determine the fault current in kA? 7

7. *(a)* Define and derive swing equation for a finite machine connected to an infinite bus. 8

(b) A 50 Hz, 4-pole Turbo-generator rated 22 MVA, 13·2 kV has an inertia constant of $H = 9$ kW-sec/kVA.

(i) Determine the kinetic energy stored in the rotor at synchronous speed.

(ii) The acceleration if the input less than the rotational is 25000 HP and the electric power developed is 15000 kW. 6

8. *(a)* Derive and plot the power angle equation for a synchronous machine connected to infinite bus. 8

(b) A synchronous generator with a synchronous reactance of 1·3 p.u. is connected to an infinite bus for voltage is 1 p.u. through and equivalent resistance of 0·2 p.u. for maximum output of 1·2 p.u. What should be the value of alternating EMF? 6

9. Write short notes on the following : 7+7=14

(a) Factor-affecting transient stability and methods of its improvement

(b) Z-bus build block algorithm

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