EE4010
Electrical and Electronic Power Supply Systems
<u>Test:- Teaching Period 2 – 2006/2007</u>

Name: ***Number:***

1. (a) Draw the equivalent circuit of an ideal transformer and write down the two equations which govern its operation.

[5]

1. (b) Three single-phase transformers are connected in a delta-delta configuration to step down a line voltage of 110 kV to a line voltage of 10 kV to supply a manufacturing plant. The plant draws a balanced three-phase power of 21.5 MW at a power factor of 0.86 lagging. The transformers may be assumed to be ideal.

Calculate (i) the apparent power drawn by the plant, (ii) the current in the HV lines, (iii) the current in the LV lines, (iv) the current in the HV phases and (v) the current in the LV phases.

[10]

1. (c) The one-line schematic diagram of a three-phase power transmission system is illustrated in Figure 1 below.

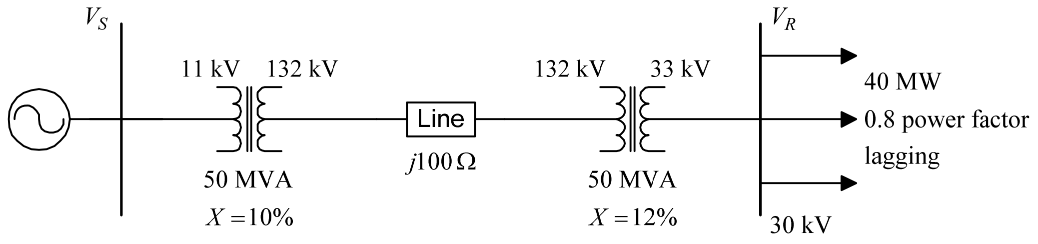

Figure 1: Power transmission system of Q.1(c).

The ratings and reactances of the various components are as shown together with the nominal line voltages. The specified per-unit values are based on the given ratings. The three-phase transformers are connected in delta on the low voltage side and in a grounded star on the high voltage side. A load of 40 MW at 0.8 power factor lagging is taken from the V_R busbar which is to be maintained at 30kV. Calculate the line voltage V_S at the terminals of the synchronous generator.

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2. (a) Draw the steady-state per-phase equivalent circuit of a three-phase, round-rotor, star-connected synchronous generator and note the significance of each of its constituent elements.

[5]

(b) Neglecting resistive losses, derive an expression for the real power delivered by this machine to a set of infinite busbars in terms of the terminal voltage V_t, the generated back-emf, E_f, the synchronous reactance X_s and the load angle δ. Deduce the steady-state stability limit governing this power transfer. **[10]**

(c) A 2.2 MVA, 3.3 kV, 50 Hz, three-phase, round-rotor, star-connected, synchronous generator has a per-phase synchronous reactance of $j0.75$ per unit based on its own ratings. The machine is connected to 3.3 kV infinite busbars and operates at full rated load and 0.85 power factor lagging.

(i) Calculate the excitation voltage of the generator.

(ii) If the prime mover power remains fixed and the field excitation current of the generator is slowly reduced to 45% of its original value, determine whether the machine will remain in synchronism or not.

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