Tampere University of Technology
Electrical Engineering

Fundamentals of Electrical and Power Engineering DEE-23106 16.10. 2015

Anna Kulmala Programmable calculator allowed 5 questions/ á 6 pts

Question 1: Fig 1 shows a special circuit where the diode D denotes an ideal diode. The initial values of the circuit are zero. Compute the time-domain response of the voltage v_{C1} when a step change of 1 A is applied to its input current. Utilize the basic relation between the capacitor current and voltage for solving the problem. Sketch the waveform of v_{C1}.

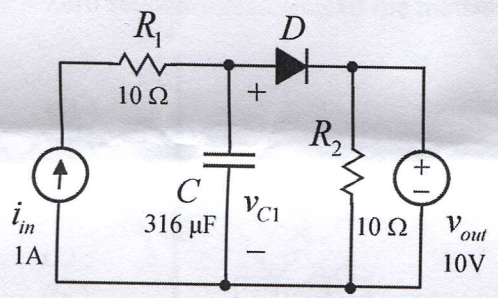

Fig. 1. The circuit of question 1.

Question 2: A three-phase load is fed through a three-phase feeder. The source phase voltage of phase a at the feeding end of the feeder is 325cos(377t+55°)V. The feeder is 1.5 km long, having parameters R = 1.3 Ω/km and X = 0.2 Ω/km. The load is a constant impedance load having impedance of (10+j4)Ω/phase.

a) Draw the single-line diagram of the network and calculate the phase currents. Draw the phasor diagram of the current and voltage of phase a.

b) Calculate the three-phase real power, reactive power, apparent power and power factor of the source.

c) Calculate the three-phase real power, reactive power, apparent power and power factor of the load.

Question 3: Fig. 2 presents an electric circuit and all the relevant parameter values are given on the figure.

a) Determine the nodal admittance matrix of the electric circuit.

b) Calculate the voltage at node 2.

c) Determine the powers injected by the two voltage sources at nodes 1 and 3.

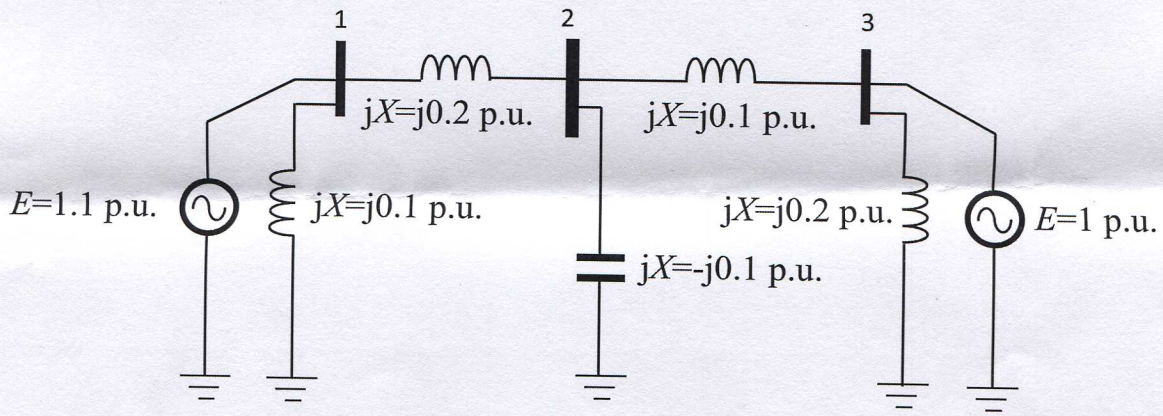

Fig. 2. The electric circuit of question 3.

Question 4: Draw the positive, negative and zero sequence impedance networks for the power system in Fig. 3. Use per unit values.
Generator 1 (G1): 25 MVA, 11 kV, X'' = 0.15, X2 = 0.1, X0 = 0.03 pu
Generator 2 (G2): 15 MVA, 11 kV, X'' = 0.2, X2 = 0.15, X0 = 0.05 pu
Synchronous motor 1 (M1): 25 MVA, 8 kV, X'' = 0.2, X2 = 0.2, X0 = 0.1 pu
Transformer 1 (T1): 50 MVA, 11/220 kV, X = 8 %
Transformer 2 (T2): 25 MVA, 220/8 kV, X = 10 %
Zero sequence reactance of the transmission line is 230 % of its positive sequence reactance.

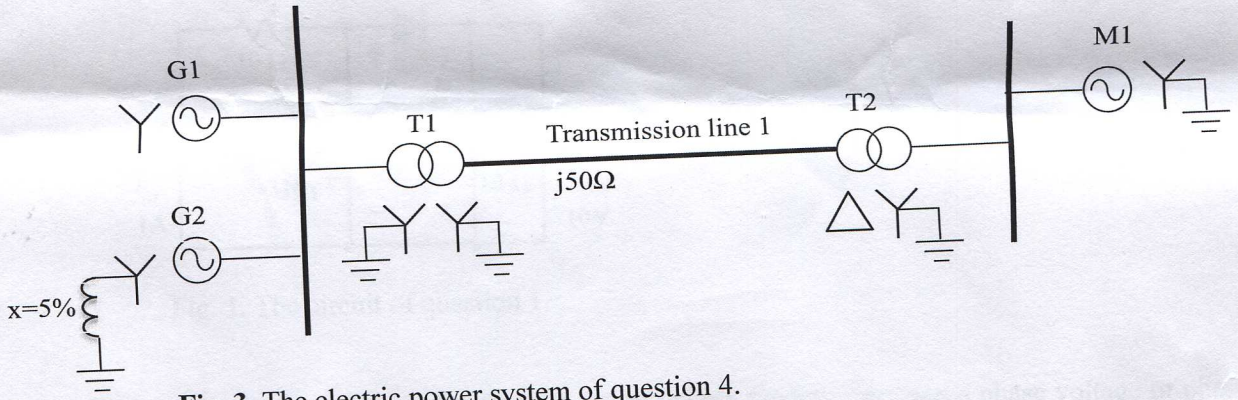

Fig. 3. The electric power system of question 4.

Question 5: Plan a high-pass filter using any passive circuit components.
a) Draw the circuit diagram and determine the transfer function between output and input voltages u_o/u_{in}.
b) Draw an approximate Bode diagram of your transfer function.
c) Determine such component values that the cutoff frequency of the filter is 350 Hz.