3-phase systems and two-port networks critical thinking example

Technology, Internet

3-Phase Systems

For a star connection, Vline= 3Vphase

Vline= 400+10ϕV where ϕ= 2. Therefore, phase voltage = 4203= 242. 48 V

Iphase= VphaseZphase= 242. 4820L37°= 12. 124L-37° A

For a star connection, Iline= Iphase= 12. 124L-37° A

Since the loads are identical in terms of impedance and phase, the net current at the neutral point would be zero. Therefore, the current in the neutral wire is also zero.

Power dissipated = Iphase2Rphase= 12. 124×12. 124×20= 2. 939 kW

Apparent power S= 3 VlineIline= 8. 81 kW

Reactive power Q= 3 VlineIlinesinθ= 5. 31 kW

Power factor of the load = cosϕ= cos37°= 0. 79

Right now, ϕ= tan-1x= 37° which implies x= 0. 75. Impedance offered by capacitor = 12π50C= 0. 75. This gives C= 4. 2 mF

When the fuse in Vc supply line blows, the line current through that line now flows through the neutral = 12. 124L-37° A

Two-Port Networks: Task 1

1.

Figure 1: Given network

Figure 1 shows the given network which is of the “ π” model, as represented in Figure 2. Let’s transform analyze this network in terms of Y parameters, to verify the design criteria.

Figure 2: “ π” Model Representation

2. Corresponding equations for the model are:

This means that:

Finally,

3. Using the above equations, we can calculate the input current and output voltage as follows:

Output Voltage – I1 represents the input current. From the given network specifications, Z1 = 1592. 35Ω, Z2 = 10 kΩ and Z3 = 1 kΩ. Therefore, correspondingly, Y1 = 0. 628 mS, Y2 = 10 mS, and Y3 = 1 mS. Now, substituting these values in the model, Y11 = 1. 628 mS, Y12 = Y21 = -1 mS, and Y22 = 11 mS.

Now using this in the other equations for the model, with V1 = 4. 5 V, we get I2 = V2/(input impedance of load) = V2/50 = (Y21 x V1) + (Y22 x V2). This gives, V2 = 0. 5 V.

4. Direct circuit analysis, without using admittance parameters, yields more or less the same results.

5. The specification of output voltage being at least 2. 5 V is not met.

6. For maximum power transfer, the load impedance should be equal to the output impedance of the network by maximum power transfer theorem. Thus load = 50 Ω.

Figure 3 gives the attenuator circuit, while Figure 4 gives the “ t” model for z parameters for the network.

Figure 3: Attenuator system

Figure 4: “ t” model z parameters

Below are the corresponding impedance parameter equations to design the network.

Using the above equations and given specifications,

V1 = 2 V; maximum V2 = 100 mV

I1 = 0. 02 A; maximum I2 = 2 mA

This gives 0. 02 Z11 + 0. 002 Z12 = 2 and 0. 02 Z21 + 0. 002 Z22 = 100 m.

But Z12 = Z21 and assume this is equal to 10 Ω. This gives Z11 = 99 Ω and Z22 = -50 Ω.

Corresponding components can be used in the design, which have been tested using TINA simulation software.