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6.061 / 6.690 Introduction to Electric Power Systems
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Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science
 6.061/6,979 Introduction to Power Systems

Quiz 2

Closed Book: Two Handwritten Crib Sheets Allowed

Please put your answers in the spaces provided on the quiz. You may, if you wish, turn in your work on additional sheets of paper. Hopefully you will get all the answers correct so I don't have to look at those sheets.

Problem 1: Two resistors are connected, line-line, to an otherwise balanced three-phase voltage source as shown in Figure 1. Assume both resistors are 10Ω and that the voltage sources all have **RMS** amplitude of 100 V.

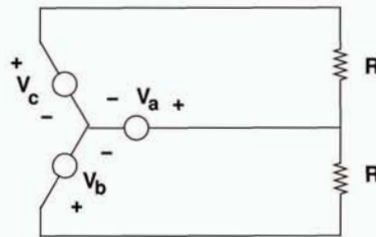


Figure 1: Source and Load

1. Find real and reactive power **out** of each of the three voltage sources:

$$P_a = \quad Q_a =$$

$$P_b = \quad Q_b =$$

$$P_c = \quad Q_c =$$

2. Find positive, negative and zero sequence currents, **out** of the three-phase source.

$$I_1 =$$

$$I_2 =$$

$$I_0 =$$

Problem 2: A DC motor is known to have armature (plus brush) resistance of 1Ω and, when running 'light' (no mechanical load) with a terminal voltage of 100 V turns at 100 Radians per second.

1. How fast does it turn with a torque load of 10 N-m?

2. Ignoring all losses besides armature resistance, what is the indicated efficiency of the motor with this load?

Problem 3 A three-phase, two-pole, round-rotor synchronous machine has a field to phase mutual inductance of 200 mHy and a synchronous inductance of 20 mHy. Assume a rotational speed of 500 radians/second and a field current of 10 A.

1. If the machine is driven at its armature terminals by a *balanced* current source with *peak* amplitude of 100 A, what is the maximum torque it can produce?

2. Now assume the machine is driven by a *balanced* voltage source with *peak* phase voltage of 600 V, (line-neutral if the machine is connected line-neutral). What is the peak torque the machine can produce?

3. If the machine's terminals are shorted, and ignoring any armature resistance, what is the armature current when field current is 10 A?

Problem 4 Figure 2 shows the single-phase equivalent circuit for an induction motor. Assume the parameters of the motor are, at its operating frequency:

$$\begin{aligned}X_{\phi} &= 10\Omega \\X_1 &= 2.5\Omega \\X_2 &= 2.0\Omega \\R_2 &= 1.0\Omega\end{aligned}$$

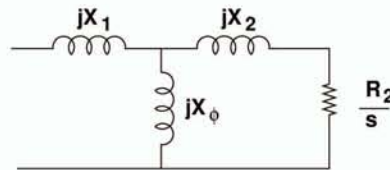


Figure 2: Induction Motor Equivalent Circuit

For the purposes of this problem we will ignore armature resistance. Assume this is a two-pole machine and that it is driven by a voltage source of 1,250 V, *Peak*, phase-neutral. Also, perhaps improbably, the excitation is at a frequency of 500 Radians/second.

1. What is the *breakdown* torque for this machine?
2. At what slip does the machine reach breakdown torque?
3. Running light (zero torque), what current does the motor draw from the source?