

Problem 3 An elementary single phase equivalent circuit for a three-phase induction motor is shown in Figure 2

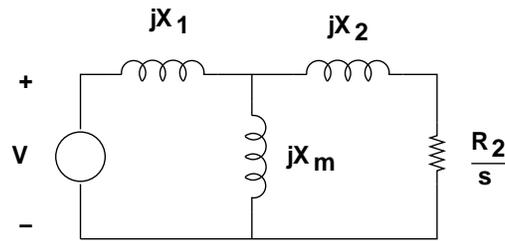


Figure 2: Equivalent Circuit

Terminal voltage is 200 Volts, RMS, per phase. The reactances are $X_1 = 2.5\Omega$, $X_2 = 2.0\Omega$, $X_m = 10\Omega$ and the rotor resistance is $R_2 = 1\Omega$. This is a kind of odd machine that has an electrical frequency $\omega = 200\text{Radians/second}$, or about 31.8 Hz. This is a four pole ($p = 2$) motor.

1. At what rotational speed does the motor achieve maximum (breakdown) torque? (Give this in radians/second.)

2. What IS that maximum torque?

Problem 4 This is about a synchronous generator meant for a power system with an electrical frequency of 400 Radians/second (or just about 63.7 Hz). It is a four pole machine, so its rotational speed is 200 Radians/second. This is a three-phase machine.

The machine is tested at its rated speed and, with a field current of 1000 Amperes, open circuit terminal voltage is measured to be 10,000 Volts, *Peak* in each phase.

With the terminals short circuited and operated at rated speed with a field current of 1000 Amperes, phase current is measured to be 1000 Amperes, *Peak*.

1. The machine is operated with a balanced three-phase current source that puts 1000 Amperes *Peak* in each phase winding. With 1000 Amperes DC in the field winding, what is the maximum torque the machine can produce?

2. Now the machine is operated with a balanced three-phase voltage source that puts 10,000 Volts *Peak* across each phase winding. What is the maximum torque the machine can produce if the field current is 1,000 A?

3. Now, operating as a generator with 10 kV terminal voltage across each phase winding and a current of 1,000 A *both Peak values*, and at unity power factor:
 - Draw a phasor diagram for this operation, showing internal voltage (E_{af}), terminal voltage and voltage across machine reactance.

 - What is the torque angle δ ?

 - What is the field current?

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