1.) Some tests are performed on a permanent magnet electric motor. The motor is found to act nearly ideally with practically 100% efficiency. The locked-rotor torque is found to be 0.5 Nm when 12 V is applied and the locked rotor current is 32.7 A. The no-load speed is found to be 10 000 RPM, also at 12 V applied. The motor is used to drive a small fan. The torque needed to drive this fan is $T = [2.222 \text{ nNm/(RPM)}^2]S^2$ where S is the speed of the fan in RPM. (The item in braces is 2.222 nano-newton-meters per revolution-per-minute-squared).

a.) If the fan is directly driven by this motor and, the motor is operated at 12 V, at what speed will the fan rotate?

b.) For the conditions of part (a), how much electrical power will the motor draw?

c.) If the fan is operated at 10 V instead of 12 V, at what speed will the fan rotate?

d.) For the conditions of part (b), how much electrical power will the motor draw?

2. Lin Engineering makes stepper motors. Use the Web to up the specifications and "torque curve" for a NEMA size 11 stepper motor with a step angle of 1.8 degrees, and choose specifically model number 211-13-01. On the top of the torque curve you will find the operating voltage and current. The current specified there only applies when the rotor is stationary. In most stepper motor applications the rotor is stationary most of the time, but as speed increases current decreases due to speed voltage, as we discussed in class. The ratio of the voltage and current at the top of the torque curve gives you the winding resistance.

a.) Extrapolate the locked rotor torque (also known as "running torque") and no-load speed from the torque vs. speed curve. Compare to the "Holding Torque" specification. Why is the holding torque larger? (See Jones, Figure 2.6)

b.) For a frictional load of 3 oz-in, what is the maximum speed in RPM? (Note: in RPM).