Note: The equation for electromagnetic torque shown on the handout was not correct; it should have been:

\[ Te = Km \cdot If \cdot Ia \]

1. A 12 volt DC motor has an input current of 20 amps, is operating at an efficiency of 74%, and is driving a load torque of 2 newton-meters. Find the speed of the motor in radians per second. (Answer = 88.8 rad/sec)

2. A 24 volt DC motor has an armature resistance of 0.2 ohms, a field resistance of 80 ohms, a motor constant (Km) of 0.73, and a no-load speed of 107 radians per second.
   a) Find the no-load input current (Answer = 3.135 amps)
   b) Find the friction torque (Answer = 0.6209 newton-meters)
   c) Find the output torque of the motor when the speed is zero (Answer = 25.66 newton-meters)
   d) Find the motor input power when the speed is zero (Answer = 2887.2 watts)

3. If the motor in problem 2 were driving a 5 newton-meter external load:
   a) Find the motor speed (Answer = 86.15 radians per second)
   b) Find the armature current (Answer = 25.67 amps)
   c) Find the copper losses (Answer = 139 watts)
   d) Find the friction loss (Answer = 53.49 watts)
   e) Find the output power (Answer = 430.75 watts)
   f) Find the motor efficiency (Answer = 69.1%)