CG1111 Engineering Principles and Practice I

Tutorial for Week 8

DC Motors and Operational Amplifier Basics

1. For a PMDC motor powered by a 12 V DC source, the no-load speed and stall torque are 3800 RPM and 30 mNm, respectively. If the motor is running at 2500 RPM, find

   a) Rotor current (I_m),

   b) Shaft torque (T_{shaft}),

   c) Back emf (E_b),

   d) Total electrical power consumed,

   e) Shaft power, and

   f) Power loss in rotor coil.

   Ans: a) 10.4 mNm, b) 346 mA, c) 7.85 V, d) 4.15 W, e) 2.72 W, f) 1.44 W

2. For the motor of Q3 with load condition unchanged, it is desired to spin it at 1500 RPM.

   a) What are the rotor current (I_m), and the required motor voltage (V_m)?

   b) What should be the PWM duty cycle if the DC source is still 12 V?

   c) Find the ON duration and OFF duration if the PWM frequency is 5 kHz.

   d) What is the total electrical power consumed?

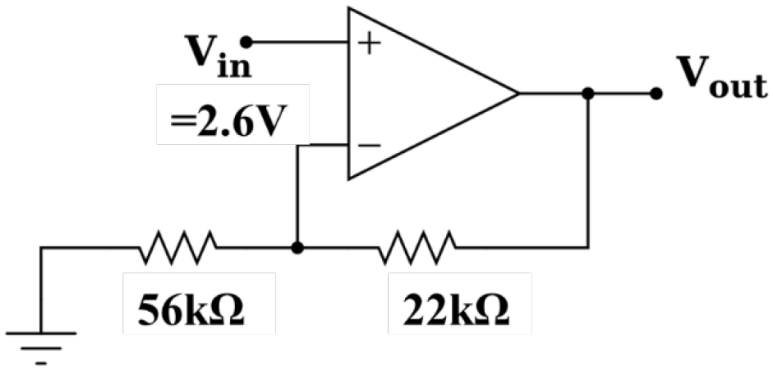
   e) What is the power loss in the rotor coil?

   Ans: a) 346 mA and 8.86 V, b) 73.8%, c) 147.6 μs and 52.4 μs, d) 3.07 W, e) 1.44 W

3. A PMDC motor is rigidly coupled to a fan; the fan load torque is described by the expression $T_L = 0.05\omega + 0.001\omega^2$, where the units of torque (T_L) and speed (ω) are Newton-meter and radians per second, respectively. The torque constant (K_t) of the motor is 2.42 N.m/A, and the rotor resistance is 0.2 Ω. If the motor is powered by a 50 V DC supply, what will be the speed of the motor and fan?

   Ans: 197 RPM

4. Calculate all the voltage drops and currents in the following circuit, complete with arrows for the current's direction and polarity markings for voltage polarity. Then, calculate the overall voltage gain of this amplifier circuit (A_V), both as a ratio, and as a figure in units of decibels (dB).



5. Calculate all the voltage drops and currents in the following circuit, complete with arrows for the current's direction and polarity markings for voltage polarity. Calculate the voltage gain for each stage of this amplifier circuit (both as a ratio and in units of decibels), then calculate the overall voltage gain.