ECE 3600   homework # DC1

1. A shunt-connected dc motor operates from 24 V and has an armature resistance of 0.30. The armature current is 10 A, the field current is 1 A, and the speed is 1200 rpm. The rotational losses are 5% of the output power.

   a) Find the input power.
   b) Find the output power in horsepower.
   c) Find the efficiency of this motor.
   d) Find the machine constant Kϕ.
   e) Find the no-load speed in rpm, assuming rotational losses remain approximately the same as at full load..
   f) Find the approximate no-load speed in rpm, assuming rotational losses are zero (I_A = 0). Is this a good estimate of the actual no-load speed?

2. A shunt-excited dc motor has the following nameplate information: 1.5 hp, 1750 rpm, 180 V, 7.3 A armature current, l.05-Ω armature resistance, 0.55 A field current. Assume constant rotational losses in this problem. $V_T := 180 \cdot V$

   a) Find the rotational losses. (Since they are assumed to be constant, calculate at nameplate operation.)
   b) Find the developed torque at full load.
   c) Determine the no-load speed.
   d) If the field winding connection malfunctioned so that the field flux dropped to a residual value of 15% of the original value, what would be the new no-load shaft speed. Is this speed likely to damage the motor?

ECE 3600   homework # DC2

1. A separately excited, dc motor has the following nameplate information: 1.5-hp, 2500 rpm, Armature: 150 V, 9 A, R_A = 0.8 Ω, L_A = 12 mH; Field: V_F = 150 V , and R_F = 250 Ω. Assume rotational losses are constant. Consider the motor to be shunt connected to 150 V for parts a) through e).

   a) Find the total losses of the motor at nameplate operation.
   b) Find the rotational losses at nameplate operation

   c) Find the the developed power if the load drops to 1.2 hp.
   d) Find the required current if output power is 1.2 hp.
   e) Find the shaft speed if output power is 1.2 hp.

   f) Find the required Input voltage for a no-load speed of 2800 rpm. V_T = ??

   g) Can you attain a no load speed of 2800 rpm by some other method with V_T = 150 V.
     (Note: You may assume that the field flux is proportional to the field current.) V_F = ??

2. A 5-hp, separately excited, 160-V dc motor has 0.25-Ω armature resistance and 90-W rotational loss at the nameplate speed of 600 rpm. The field is also connected to 160 V and its current is 0.5 A.

   a) What is the developed torque at the nameplate output power of 5 hp?
   b) What is the efficiency at 5 hp out, including field losses?

   c) If the load torque and rotational loss torque are both constant (not dependent on speed), find the shaft speed when the motor armature is hooked to half the rated voltage, 80V. (Field is left connected to 160V.)

   d) If the load torque and rotational loss torque are both proportional to speed, find the shaft speed when the motor armature is hooked to half the rated voltage, 80V. (Field is left connected to 160V.)

Answers

1. a) $264 \cdot W$ b) $200 \cdot W = 0.268 \cdot hp$ c) $75.6 \cdot \%$ d) $0.167 \cdot V \cdot sec$ e) $1364 \cdot rpm$ f) $1371 \cdot rpm$ yes

2. a) $139 \cdot W$ b) $6.86 \cdot N \cdot m$ c) $1820 \cdot rpm$ d) $12133 \cdot rpm$ The rotor may fly apart.

DC2

1. a) $321 \cdot W$ b) $167 \cdot W$ c) $1.06 \cdot kW$ d) $7.37 \cdot A$ e) $2523 \cdot rpm$ f) $161 \cdot V$ g) Reduce V_F to 140 V

2. a) $60.8 \cdot N \cdot m$ b) $92 \cdot \%$ c) $288 \cdot rpm$ d) $300 \cdot rpm$

ECE 3600   homework # DC1 and DC2