Problems for Module 3, MC Machines:

Textbook Chap. 4: Examples: 4.6 and 4.9 (ignore the parts related to the armature reaction)

Textbook Chap. 4: Problems: 4.30, 4.31, 4.32, 4.38, and 4.39.

EXAMPLE 4.6

The dc machine (12 kW, 100 V, 1000 rpm) of Example 4.2 is connected to a 100 V dc supply and is operated as a dc shunt motor. At no-load condition, the motor runs at 1000 rpm, and the armature takes 6 amperes.

(a) Find the value of the resistance of the shunt field control rheostat (R_{fc}).

(b) Find the rotational losses at 1000 rpm.

(c) Find the speed, electromagnetic torque, and efficiency of the motor when rated current flows in the armature.

- **(i)** Consider that the air gap flux remains the same as that at no load.
- **(ii)** Consider that the air gap flux is reduced by 5% when rated current flows in the armature because of armature reaction.

(d) Find the starting torque if the starting armature current is limited to 150% of its rated value.

- **(i)** Neglect armature reaction.
- **(ii)** Consider armature reaction, $I_{f(AR)} = 0.16$ A.

EXAMPLE 4.9

A 220 V, 7 hp series motor is mechanically coupled to a fan and draws 25 amps and runs at 300 rpm when connected to a 220 V supply with no external resistance connected to the armature circuit (i.e., $R_{ae} = 0$). The torque required by the fan is proportional to the square of the speed. $R_a = 0.6\ \Omega$ and $R_{sr} = 0.4\ \Omega$. Neglect armature reaction and rotational loss.

(a) Determine the power delivered to the fan and the torque developed by the machine.

(b) The speed is to be reduced to 200 rpm by inserting a resistance (R_{ae}) in the armature circuit. Determine the value of this resistance and the power delivered to the fan.

- **(ignore the parts related to the armature reaction)**

4.30 A permanent magnet dc motor drives a mechanical load requiring a constant torque of 25 N · m. The motor produces 10 N · m with an armature current of 10 A. The resistance of the armature circuit is 0.2 Ω. A 200 V dc supply is applied to the armature terminals. Determine the speed of the motor.

4.31 A dc shunt motor drives an elevator load that requires a constant torque of 300 N · m. The motor is connected to a 600 V dc supply and the motor rotates at 1500 rpm. The armature resistance is 0.5 Ω.

(a) Determine the armature current.

(b) If the shunt field flux is reduced by 10%, determine the armature current and the speed of the motor.

4.32 A dc shunt motor (50 hp, 250 V) is connected to a 230 V supply and delivers power to a load drawing an armature current of 200 amperes and running at a speed of 1200 rpm. $R_a = 0.2\ \Omega$.

(a) Determine the value of the generated voltage at this load condition.

(b) Determine the value of the load torque. The rotational losses are 500 watts.

(c) Determine the efficiency of the motor if the field circuit resistance is 115 Ω.

4.38 A dc motor is mechanically connected to a constant-torque load. When the armature is connected to a 120 V dc supply, it draws an armature current of value 8 A and runs at 1800 rpm. The armature resistance is $R_a = 0.08\ \Omega$. Accidentally, the field circuit breaks and the flux drops to the residual flux, which is only 5% of the original flux.

(a) Determine the value of the armature current immediately after the field circuit breaks (i.e., before the speed has had time to change from 1800 rpm).

(b) Determine the theoretical final speed of the motor after the field circuit breaks.

4.39 A 600 V dc series motor has armature and field winding resistance of 0.5 Ω. When connected to a 600 V supply, it operates at 500 rpm and takes 75 A. If the load torque is reduced to half, determine

(a) The armature current.

(b) The speed at which it will operate.

Assume that the flux is proportional to current and neglect armature reaction.