**Power Engineering 2**

**DC Machines Tutorial Sheet**

**Hints:**

(i) For all questions try to get into the habit of drawing the relevant DC machine circuit and writing down the characteristic equations for each. Applying these equations with the known parameters from the question will allow you to solve the problems.

(ii) You can always assume the machine is operating on the linear part of the B-H curve, so that

, and thus the expressions for EA and Torque can be expressed in terms of .

(iii) For power flow and efficiency calculations look at slides 27 & 28. Generally you can assume iron losses are negligible, so the main electrical losses will be Joule loss. If you are not told the friction loss in the question, then assume it is zero.

**Questions**

1) A shunt excited DC generator has armature resistance 1Ω and the shunt field resistance is 200Ω. The generator operates without load at 200V and the rotor speed is 600rpm. Calculate the rotor speed if the load absorbs 15.5A at 200V.

2) In a compound series-shunt DC motor part of the field resistance is in series with the armature and the other part is in the shunt part of the circuit. The DC machine has nominal characteristics: VDC=240V, POUT=9400W, at a speed of 1250rpm. The armature resistance is, RA=0.3Ω, the series field resistance, RFseries = 0.13Ω and the shunt field resistance, RFshunt=230Ω. The motor operates at nominal load and absorbs nominal armature current, IA=44A. If the friction losses are equal to 0.8% of the output power, calculate the following:

a) The back-EMF, EA, and the friction losses at nominal load.

b) The electromagnetic torque and the mechanical torque at nominal load.

c) The efficiency at nominal load.

(Hint: draw the circuit with the additional field resistance in the series part , and the rest of the field resistance in the shunt part, and then analyse in the normal way. For the power flow look at slides 27 & 28 in the lecture).

3) A series excited DC generator has nominal values of VDC=100V, POUT(elec)=10kW , RA=0.1Ω and RF=0.005Ω. The generator operates under nominal voltage and supplies an electrical load which is 80% of the nominal output power. If the prime mover mechanical power inputted to the generator is 8950W, calculate:

a) The generator efficiency and b) The back EMF, EA.

4) A separately excited dc motor with constant field current has an armature resistance of 5 Ω, and the back EMF is 120 V at 1500 rpm.

If the applied voltage VDC=130 V, calculate the load current (IA) and the torque developed at 1000 rpm.

5) A separately excited dc motor has armature and field resistances 0.5 Ω and 50 Ω respectively. The armature is supplied from a variable voltage source with a maximum output of 200 V dc, and the field from a variable voltage source with a maximum output of 100 V dc.

(a) If both sources are set at maximum, the armature current is, IA=50 A and the speed is 1000 rpm, calculate the back EMF EA and the shaft torque.

(b) What should the operator adjust, and by how much, to achieve a speed of 100 rpm with the same load torque as in part (a)?

(c) What should the operator adjust, and by how much, to achieve a speed of 1500 rpm with the same load power as in part (a)?