EE114 Power Engineering - I
Assignment 07

- **Question 1:** Two dc machines of the following rating are required:
  DC machine 1: 120 V, 1500 rpm, four poles
  DC machine 2: 240 V, 1500 rpm, four poles
  Coils are available that are rated at 4 volts and 5 amperes. For the same number of coils to be used for both machines, determine the

  a. Type of armature winding for each machine.

  b. Number of coils required for each machine.

  c. kW rating of each machine

- **Question 2:** A four-pole dc machine has a wave winding of 300 turns. The flux per pole is 0.025 Wb. The dc machine rotates at 1000 rpm.

  a. Determine the generated voltage.

  b. Determine the kW rating if the rated current through the turn is 25A.

- **Question 3:** A dc machine (6 kW, 120 V, 1200 rpm) has the following magnetization characteristics at 1200 rpm.

I_f	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.2
E_a	5	20	40	60	79	93	102	114	120	125

  The machine parameters are $R_a = 0.2\Omega$, $R_{fw} = 100\Omega$. The machine is driven at 1200 rpm and is separately excited. The field current is adjusted at $I_f = 0.8$ A. A load resistance $R_L = 2\Omega$ is connected to the armature terminals. Neglect armature reaction effect.

  a. Determine the quantity $K_a\phi$ for the machine.

  b. Determine E_a and I_a.

  c. Determine torque T and load power P_L.

- **Question 4:** The dc machine in Problem 3 has a field control resistance whose value can be changed from 0 to 150Ω. The machine is driven at 1200 rpm. The machine is separately excited, and the field winding is supplied from a 120 V supply.

  a. Determine the maximum and minimum values of the no-load terminal voltage.

  b. The field control resistance (R_{fc}) is adjusted to provide a no-load terminal voltage of 120 V. Determine the value of R_{fc}. Determine the terminal voltage at full load for no armature reaction and also if $I_{f(AR)} = 0.1$ A.

- **Question 5:** The dc machine in Problem 4 is self-excited.

  a. Determine the maximum and minimum values of the no-load terminal voltage.

  b. R_{fc} is adjusted to provide a no-load terminal voltage of 120 V. Determine the value of R_{fc}.

     (i) Assume no armature reaction. Determine the terminal voltage at rated armature current. Determine the maximum current the armature can deliver. What is the terminal voltage for this situation?

     (ii) Assume that $I_{f(AR)} = 0.1$ A at $I_a = 50$ A and consider armature reaction proportional to armature current. Repeat part (i).

- **Question 6:** A dc shunt machine (24 kW, 240 V, 1000 rpm) has $R_a = 0.12\Omega$, $N_f = 600$ turns/pole. The machine is operated as a separately excited dc generator and is driven at 1000 rpm. When $I_f = 1.8$ A, the no-load terminal voltage is 240 V. When the generator delivers full-load current, the terminal voltage drops to 225 V.

  a. Determine the generated voltage and developed torque when the generator delivers full load.

  b. Determine the voltage drop due to armature reaction.

  c. The full-load terminal voltage can be made the same as the no-load terminal voltage by increasing the field current to 2.2 A or by using series winding on each pole. Determine the number of turns per pole of the series winding required if I_f is kept at 1.8 A

- **Question 7:** A 240 V separately exited dc motor has an armature resistance of $R_a = 0.06\Omega$. When it is connected to a 240 V supply, it draws 90 A from the supply and rotates at 1200 rpm.

  a. Find the torque developed by the motor at this operating condition.

  b. If the torque developed is 280 Nm for the same excitation and same supply voltage, then find the speed and armature current.

- **Question 8:** A dc machine is connected across a 240-volt line. It rotates at 1200 rpm and is generating 230 volts. The armature current is 40 amps.

  a. Is the machine functioning as a generator, or as a motor?

  b. Determine the resistance of the armature circuit.

  c. Determine power loss in the armature circuit resistance and the electromagnetic power.

  d. Determine the electromagnetic torque in newton-meters.

  e. If the load is thrown off, what will the generated voltage and the rpm of the machine be, assuming

     (i) No armature reaction.

     (ii) 10% reduction of flux due to armature reaction at 40 amps armature current