

EE 114 Power Engineering I

Assignment 4

Question 1) A 1.5 m long section of cable carrying current to a car starter motor makes an angle of 60° with the Earth's 5.50×10^{-5} T field. What is the current when the wire experiences a force of 5.00×10^{-3} N? If the wire is run between the poles of a strong magnet, subjecting 10.00 cm of it to a 2T field, what force is exerted on this segment of wire? (Ans. 70 A, 14 N)

Question 2) A jet airplane with a 100 m wingspan is flying at 320 m/s. What emf is induced between wing tips if the vertical component of the Earth's field is 3.00×10^{-5} T? (Ans. 0.96 V)

Question 3) A 10 cm long conductor is placed in a 2 T field and connected to a battery of 50 V through a 2Ω resistance. What will be the velocity of the conductor after applying an external force of 5N? What will be the power absorbed/generated in the battery after the force is applied? (Ans. 500 m/s, 1250 W)

Question 4) A permanent magnet DC motor has an armature resistance of 0.1Ω , and runs at 1600 rpm while taking an armature current of 100 A from a 230 V battery. The friction and windage loss is 300 W, no-load core losses are 1200 W. Find the efficiency of the motor. (Ans. 89.13%)

Question 5) A two pole DC generator has field winding with 1000 turns per pole. The radius and length of the rotor of the machine are 10 cm and 25 cm, respectively. The air gap between pole face and rotor body is 2 mm and the air-gap flux density is 1.0 T. The pole face covers 80% of the rotor circumference. The number of armature winding conductor is 20. If machine is running at 1000 rpm, find the following, if armature is wave wound.

- a) The field current
- b) Armature voltage
- c) Developed torque if armature current in 15 A. (Ans. a) 1.59 A, b) 20.93 V, c) 2.998 Nm)



Question 6) 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. Wave Winding $\rightarrow a = 2$
- b) Number of coils required for each machine. Lap Winding $\rightarrow a = P$
- c) kW rating of each machine.

(Ans. a). 120 V Lap winding, 240V- Wave winding, b). For both 120V & 240V: 120 coils, c). 2.4kW)

Question 7) 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 25 A. (Ans. a). 500V, b). 25kW)

Question 8) A dc machine (6 kW, 120 V, 1200 rpm) has the following magnetization characteristics at 1200 rpm

I_f (A)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1	1.2
E_a (V)	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 $I_f = 0.8 \, \text{A}$. 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

Load power = Power across the load
= Power across the resistor here.

(Ans. a). $0.907 \, \text{V rad./s}$, b). $E_a = 114 \, \text{V}$, $I_a = 51.82 \, \text{A}$, c). $T = 47 \, \text{Nm}$, $P = 5370.6 \, \text{W}$)