National University of Singapore

Department of Electrical & Computer Engineering

EE-1002:Introduction to Circuits and Systems

Tutorial - 9 (Linear and Rotational DC Machines)

Year 2013-14

Q.1 A linear DC machine as shown in Fig. 1 has a battery voltage,V_T of 120 V and an internal resistance, R_A of 0.3 Ω, length of the conductor, l is 10 m and a flux-density, **B** of 0.1 T (Wb/m^2) (into the page of the paper).

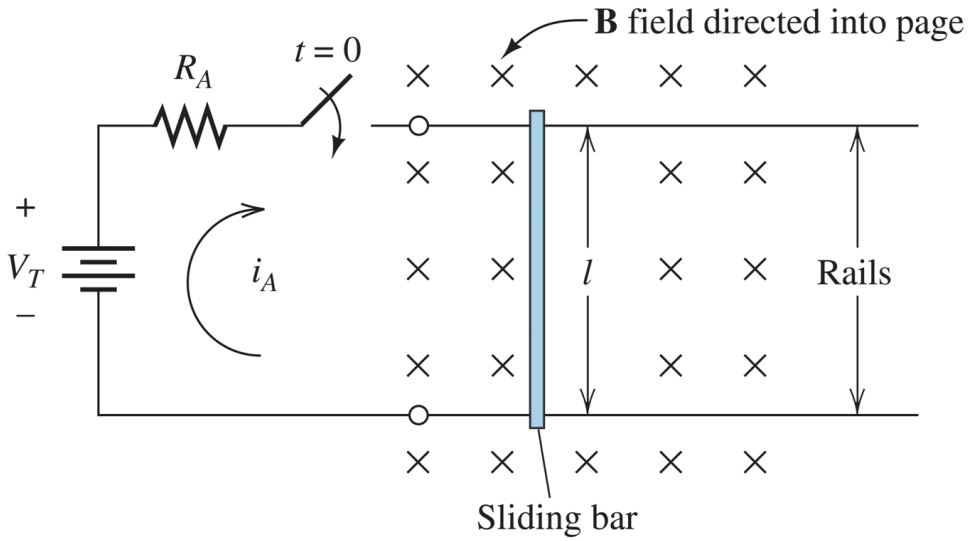

Figure 1: Q.2

(a) Determine the steady-state velocity of the bar at no-load.

(b) Suppose a 30 N force pointing to the left is applied to the bar, determine the corresponding new value of the steady-state speed. How much of power would the bar be producing or consuming? How much of power would the battery be delivering or consuming? Explain the difference between the two figures. Is the linear DC machine operating as a motor or generator?

(Ans. (a) 120 m/s and (b) 111 m/s.)

Q.2 A shunt dc motor has armature resistance of 0.1 Ω, and terminal voltage of 440 V. For an output power of 37.3 kW, we have the motor speed of 1500 rpm and the armature current of 103 A. The field current is maintained constant throughout. Determine

(a) the developed power;

(b) power lost in the armature resistance and

(c) the rotational losses.

(Ans. (a) 44.26 kW, (b) 1.06 kW and (c) 6.96 kW.)

Q.3 The armature supply voltage of a DC motor is 230 V. The armature current is 12 A, the armature resistance is 0.8 Ω, and the speed is 955 rpm. Determine

(a) the induced emf,

(b) the electromagnetic torque developed,

(c) the mechnical power developed by the armature and

(d) the armature copper loss.

(Ans. (a) 220.4 V (b) 26.45 N.m, (c) 2644.8 W and (b) 115.2 W.)

Q.4 A 220 V DC shunt motor has armature and field circuit resistances of 0.15 Ω and 110 Ω respectively. The motor draws a line current of 5 A while running at 1200 rpm on no-load. When driving a specific type of load, the input electrical power to the motor is 12 kW.

Determine

(a) the speed of the motor;

(b) the developed torque and

(c) the efficiency of the motor at this load.

(Ans. (a) 1158 rpm, (b) 91.8 N.m and (c) 87.25 %.)

Q.5 Consider a permanent magnet based DC motor that operates from a 12 V DC source with a no load speed of 1700 rpm. Neglect rotational losses. What average source voltage is needed in order to operate at a no-load speed of 1000 rpm? If this source voltage is to be obtained by using a MOSFET switch that would be chopping a source voltage of 12 V, determine the corresponding duty ratio, D.

(Ans. ~ 0.6)

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