Homework 4

EE-306 – Electromechanical Devices - Semester 171

Submission Deadline: ST Classes (21 Nov 2017)
: MW Classes (22 Nov 2017)

Note: You must submit this cover page along with your solution

Student Name	ID	Sr. #	Section

Total Marks Obtained	/

Problem 1

A four pole DC machine has a flux per pole of 15 mWb. The armature has 330 conductors connected as a **wave winding** such that the rated conductor current remains the same. The DC machine runs at 1150 rpm and it delivers a rated armature current of 250 A to a load connected to its terminals.

(a) Determine the machine constant, K_a

(b) Determine the generated voltage, E_a

(c) The conductor current, I_c

(d) Electromagnetic torque, T_e

(d) Power developed, P_{dev}, by the armature

Problem 2

Consider a self excited DC shunt generator (12 kW, 100 V, 1000 rpm) as shwon in Fig. 1. It has armature resistance $R_a = 0.1\ \Omega$, shunt field winding resistance $R_{fw} = 80\ \Omega$, and $N_f = 1200$ turns per pole. The rated field current is 1 A. The magnetization characteristic of the machine at 1000 rpm are shown in Fig. 2. Determine the following assuming that the generator is operating at no load (for clarity, a curve with field resistor line is also shown in Fig. 3):

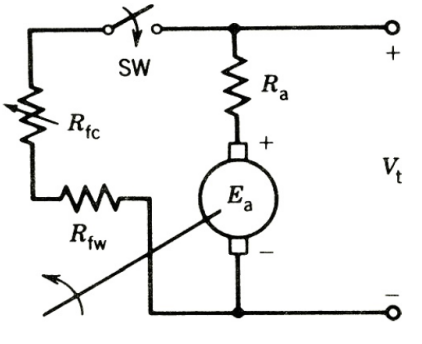

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Figure 1: A self excited (shunt) generator (Problem 2).

(a) The maximum value of the generated voltage

(b) The value of the field circuit control resistance (R_{fc}) required to generate rated terminal voltage

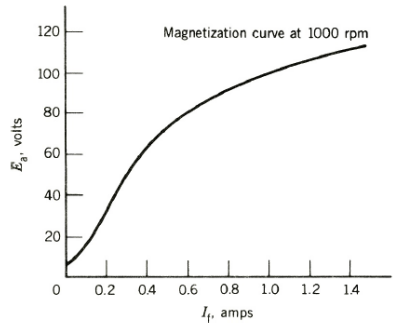

Figure 2: The mangentization curve of machine (Probem 2).

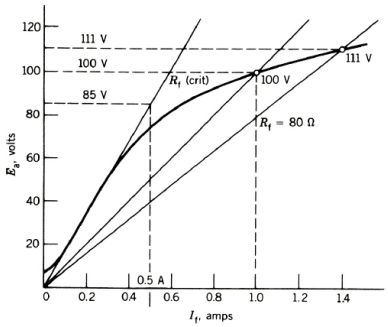

Figure 3: The mangentization curve of machine including field resistance lines (Probem 2).

Problem 3

A six poles short shunt compound DC generator running at 1200 rpm delivers 25 KW to a load resistance at a terminal voltage of 250 V. The resistance of the armature, shunt field resistance and the series field resistance are 0.12 Ω, 125 Ω and 0.05 Ω respectively. The efficiency of the machine at the given load is 82%.

(a) Draw the equivalent circuit

(b) Estimate the input power and the corresponding applied input torque

(c) Find the developed power and the corresponding developed torque

Problem 4

A 120 V DC shunt motor has armature and field resistances of 0.1 Ω and 120 Ω respectively, and a total brush voltage drop of 2V. The motor operates at rated load and draws a line current of 41 A at an angular speed of 200 rad/sec. Calculate

(a) The field and armature current

(b) The developed power and developed torque

Problem 5

Suppose a 600 V DC series motor with equal armature and field winding resistance of 0.5 Ω is opearimg at 500 rpm and taking 75 A when connected to a 600 V supply. If the load torque is reduced to half, determine the following:

(a) The armature current

(b) The speed at which it will operate

Problem 6

A 240 V DC shunt motor has an armature resistance of 0.3 Ω and a field resistance of 120 Ω. At no-load, the motor runs at 1000 rpm and it draws a line current of 9 A.

(a) Draw the equivalent circuit with proper labeling

(b) Find the efficiency of motor assuming that the input to the motor is 12 kW at full load conditions.

Problem 7

A DC shunt motor (see Fig. 4) has the following parameters:

$P_{rated} = 30$ hp, $V_T = 240$ V, $R_A = 0.19\ \Omega$, $R_F = 75\ \Omega$, $I_L(ratcd) = 110$ A

Magnetization curve of the given DC motor is shown in Fig. 5.

(a) If the resistor R_{adj} in Fig. 4 is adjusted to 175 Ω, what is the rotational speed of the motor at no-load conditions?

(b) Assuming no armature reaction, what is the speed of the motor at full load? What is the speed regulation of the motor?

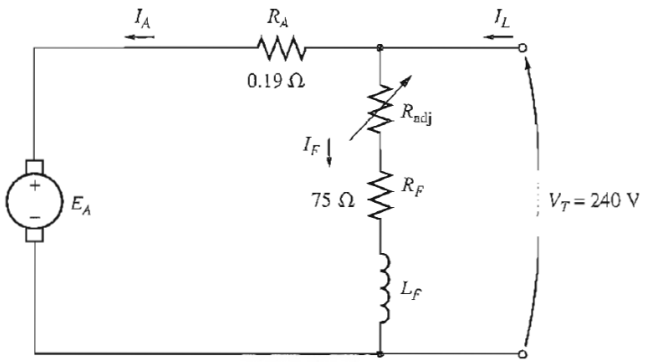

Figure 4: The equivalent circuit of the shunt motor (Problem 7).

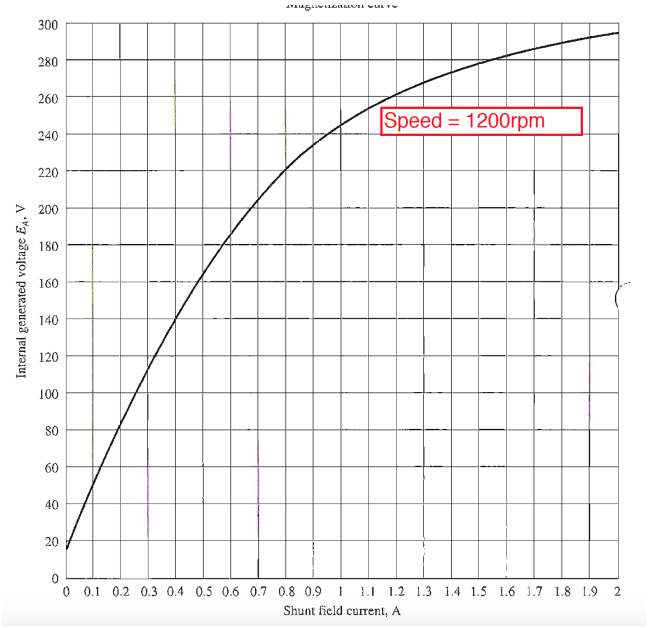

Figure 5: The magnetization curve for the DC motor (Problem 7).

!End of Homework Problems!