Menoufiya University

Faculty of Engineering Shebin El-kom

Course: Control of DC Machines **Date:18 /1 /2014**

Mark: 100 **Time:3- Hour**

Post Graduate Students Exam.

Answer the following questions:

Question (1) ***25-Mark***

The speed of a separately excited dc motor is controlled by a single-phase full-converter. The field circuit is also controlled by a single-phase full converter and the field current is set to the maximum possible value. The ac supply voltage to the armature and field converters is single-phase,220 V,50 Hz. The armature resistance is R_a=0.25 Ω, the field circuit resistance is R_f=175 Ω, and the motor voltage constant is K_v=1.4 *V/A-rad/s*. The armature current corresponding to the load demand is I_a=45 A, the viscous friction and no-load losses are negligible. The inductances of the armature and field circuits are sufficient to make the armature and field currents continuous and ripple-free. If the delay angle of the armature converter is α_a=60 and the armature current is I_a=45 A. Determine the (a) Torque developed by the motor, T_d; (b)Speed, ω ;and (c) Input power factor of the drive, *PF*.

Question (2) ***25-Mark***

A 50-kW 220-V 1600-rpm separately excited dc motor is controlled by a converter as shown in the block diagram Fig.(1). The field current is maintained constant at I_f = 1.25A and the machine back emf constant is K_v = 0.9 V/A-rad/s . The armature at resistance is R_a = 0.1Ω and the viscous friction constant is B = 0.3 N m/rad/s . The transfer function of the speed sensor is K_t = 95 mV/rad/s, and the gain of the power controller is K_c = 80 .

(a) Determine the rated torque of the motor . (b) Determine the reference voltage V_r to drive the motor at the rated speed . (c) If the reference voltage is kept unchanged , determine the speed when the motor develops the rated torque . (d) If the load torque is increased by 10% of the rated value, determine the motor speed (e) If the reference voltage is increased by 10%, determine the motor speed .(f) If the load torque is increased by 10% of the rated value and reference voltage is increased by 10%, determine the motor speed . (g) If there was no feedback in an open-loop control ,determine the speed regulation for a reference voltage of V_r = 2 V . (h)Determine the speed regulation with a closed-loop control .

P.T.O

Question (3) *25-Mark*

3.1) Explain the classical configuration of Phase-Locked-Loop, (PLL), and determine the overall transfer function of a separately excited dc motor, $\frac{\omega(s)}{V_r(s)}$, when it is controlled by the PLL, using a passive low pass filter (considering $\tau_a = 0$).

3.2) Design and describe a circuit of speed control for a separately excited dc motor, using fuzzy logic controller (FLC).

Question (4) *25-Mark*

4.1) A step-down (class A) chopper fed dc series motor, in case of discontinuous current operation, derive an analytical expression for average motor current.

4-2) A 40 *HP*, 220 V, 3500 rpm dc series motor is controlled by a class A chopper, which is considered as a linear converter of gain K_c=100 . The moment of inertia of the motor load J=0.156 Nm./rad/s, viscous friction constant is negligible. Total armature circuit resistance, R_m =0.08 Ω , and total armature circuit inductance, L_m = 0.0 *H*. The back emf constant is K_v =0.34 V/A- rad/s.

(a) Obtain the open-loop transfer function $\frac{\omega(s)}{V_r(s)}$ *and* $\frac{\omega(s)}{T_L(s)}$ for the motor.

(b) Calculate the motor steady-state speed if the reference voltage, V_r=*1 V* and the load torque is 60% of the rated value.

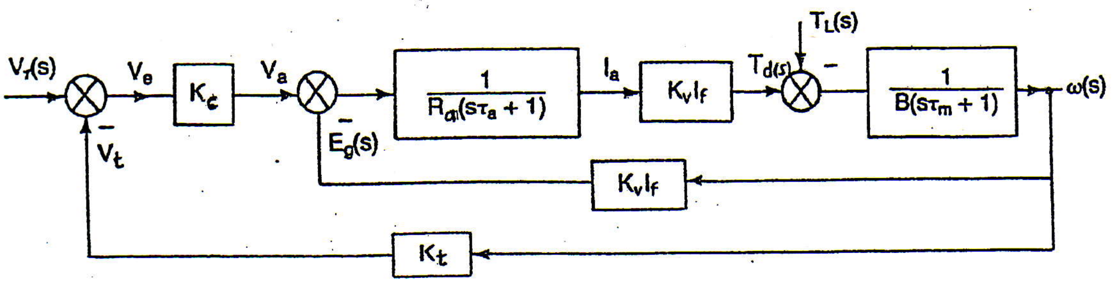

Figure (1) Block diagram for closed-loop control of separately excited dc motor.

Good Luck
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