Menoufiya University
Faculty of Engineering Shebin El-kom
Course: Control of Electrical Machines Date: 26/ 5 /2015
Mark :70 Time: 3-Hour

Final-Term Exam

Answer the following questions:

Question (1) *20- Mark*

1-1) Derive an expression for minimizing the losses in a separately excited dc motor, and draw the block diagram of minimum loss control of a dc drive.

1-2) 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) *20-Mark*

2-1) Draw and explain the closed-loop speed with inner current loop and field weakening control of a dc motor.

2-2) A 40 KW ,220 V ,1100 rpm ,separately excited dc motor is to be used in a speed control system ,which may be represented by the block diagram in Fig.(1) . The field current is held constant at a value for which K_v I_f =1.95 V s/rad. Resistance R_a =0.089 Ω , and viscous friction factor *B*= 0.275 Nm-s/rad. The tachogenerator delivers 10 V/1000 rpm and the gain of the controller ,is K_1 =200.

(a) Determine the value of the reference voltage, V_r, required to drive the motor at rated speed at no load.

(b) If the reference voltage is unchanged, determine the speed at which the motor would runs at rated torque.

(c) If the motor is driven with constant armature voltage of 220 V, and without feedback, determine the no load and full load speed.

P.T.O.

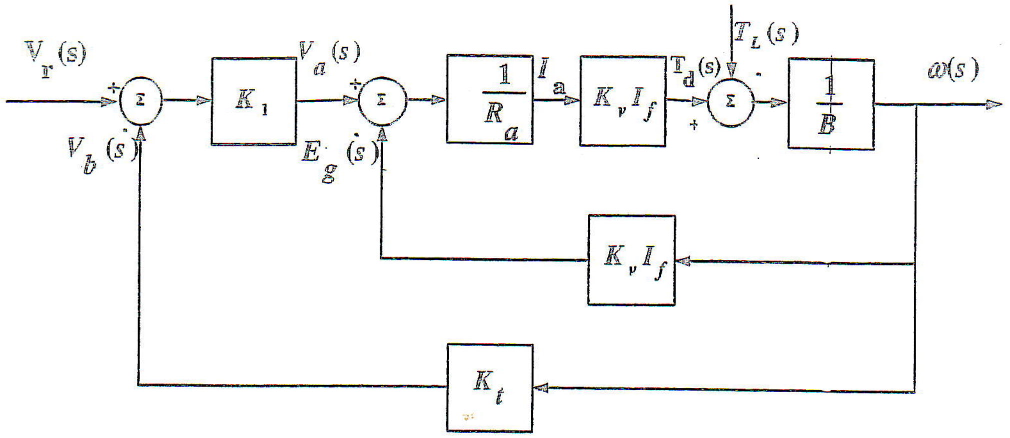

Figure (1) Steady- state closed-loop block diagram of a speed control system.

Question (3) ***20-Mark***

3-1) A thyristorized speed control scheme is shown in Figure(2). Make a model of the control system for studying the performance. The following values are known :

Moment of inertia of the load , J = 42.2 kg-m^2 ;
Torque constant of the motor, K_v = 4 .2 *Nm/amp.*;
Motor armature resistance, R_a = 0.035 Ω;
Motor armature inductance, L_a = 0.0077 H ;
Thyristor bridge is fed from 3-phase, 415 V, 50 c/s;
+ 5 V to the trigger circuit advances the pulses to give maximum output voltage; 0 V to the trigger circuit retards the pulses to give zero output voltage;
Tachogenerator constant, K_t = 10 V/1500 rpm ;
DC C.T. output K_r = 5 V/50 A ;
R_1 =one mega-ohm, R_2 = 50 K Ω, C_1 = 0 1 μF
R_3 = 500 KΩ , R_4 = 50 KΩ , C_2 = 0.04 μF.

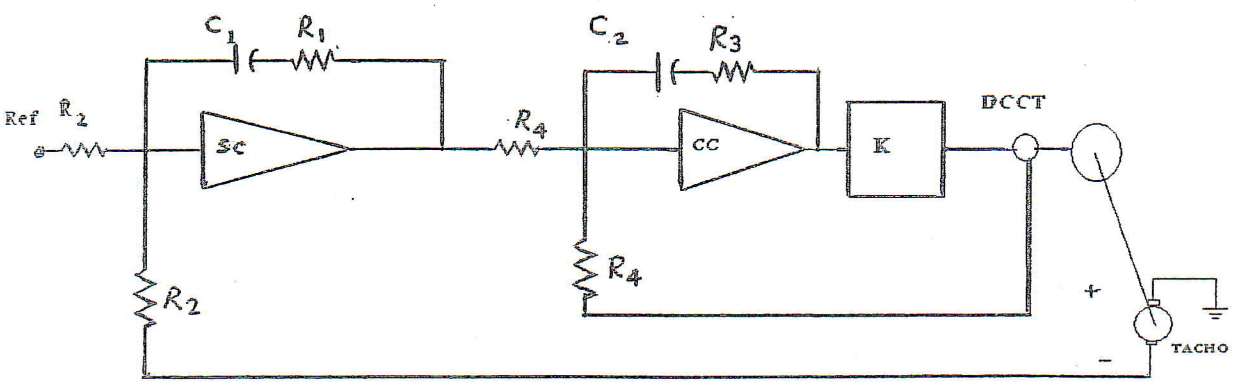

Figure (2) Feedback control system.

P.T.O.

3.2) A 2.5 *HP,* 100 V, 1500 rpm dc series motor is controlled by a class A chopper, which is considered as a linear converter of gain K_c=120 . The moment of inertia of the motor load J=0.065 Nm./rad/s, viscous friction constant B=0.004 Nm- sec/rad. Total armature circuit resistance, $R_m = 1\ \Omega$, and total armature circuit inductance (including series inductance), L_m = 0.32 m*H*. The back emf constant is K_v =0.034 V/A- rad/s.

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

Question (4) *10- Mark*

In control of induction motor drives, explain (with sketches) the concept of the Field Oriented Control (FOC).

Good Luck

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