King Fahd University of Petroleum & Minerals
Electrical Engineering Department

EE 380 • CONTROL ENGINEERING

[MAJOR EXAMINATION # 1]

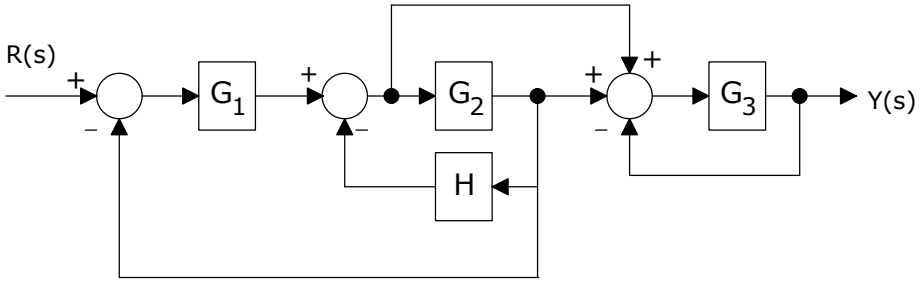
OCTOBER 13, 2003 Time 8:00 - 9:30 PM

Name:		
ID #:		
Section	02- (8:00 AM)	04- (10:00 AM)

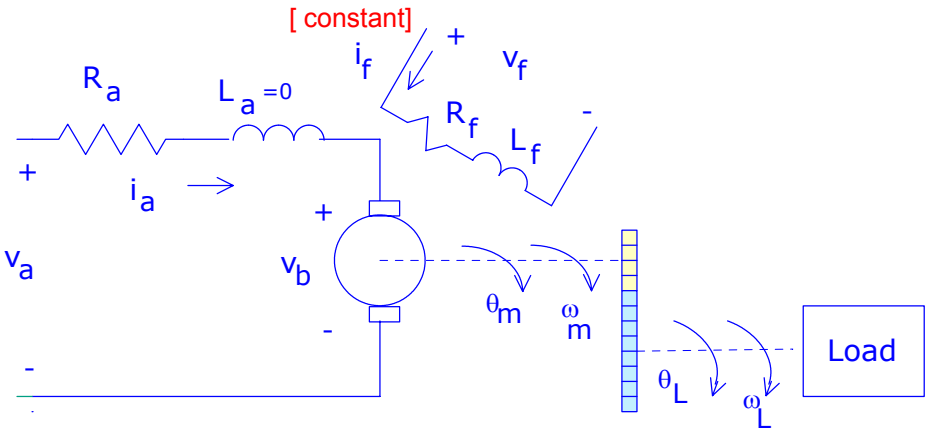
PROBLEM #	SCORE	MAXIMUM
1		20
2		30
3		25
4		25
TOTAL		100

Prof. Youssef Abdel-Magid

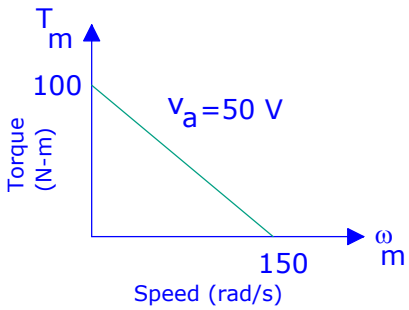
Q1. Reduce the block diagram to a single transfer function $\frac{Y(s)}{R(s)}$ using **block diagram reduction techniques**.



Q2. Consider the armature-controlled dc motor, and the torque-speed curve shown , find the transfer function that relates the output torque to the input armature voltage $\frac{T_L(s)}{V_a(s)}$.



$J_m = 2$ kg-m^2; $J_L = 18$ kg-m^2 ; $b_m = 2$ N-m s/rad ; $b_L = 36$ N-m s/rad ; $n = \frac{50}{150}$



Q4. A control system is described by the following state and output equations

$$\dot{\boldsymbol{x}}(t) = A\boldsymbol{x}(t) + Bu(t) = \begin{bmatrix} 0 & 2 \\ -1 & -3 \end{bmatrix} \boldsymbol{x}(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = C\boldsymbol{x}(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} \boldsymbol{x}(t)$$

(a) Find the transfer function of the system.

(b) If the input is zero, with $\boldsymbol{x}(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$, find the output $y(t),\ t \geq 0.$

Q3. Consider the closed-loop control system shown, and its signal-flow graph .

(a) Find the closed-loop transfer function $\frac{Y(s)}{R(s)}$ using Mason's Rule

(b) Find $G_c(s)$, the compensator transfer function, and $G_p(s)$, the plant transfer function directly from the signal-flow graph.

(c) Assign state variables on the signal-flow graph state diagram from right to left in ascending order.

d) Give **2 state variable representations** of the system based on (c) and in controller canonical form. .