MINISTRY OF EDUCATION

MANDALAY TECHNOLOGICAL UNIVERSITY

Department of Mechatronic Engineering

2018-2019Academic Year

Fourth Year **First Semester Examination**

McE-41077 Control Engineering I

Date: 5.4.2019(FRI) **Time: 1:00 to 4:00 pm**

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Attempt **ALL** Questions.

1. (a.) Using the speedometer, the driver calculates the difference between the measured speed and the desired speed. The driver uses the throttle knob or the brakes as necessary to adjust the speed is not too much over the desired speed, the driver may let the friction and gravity slow the motorcycle down. Describe the block diagram of the speed control system of a motorcycle with a human driver.

(10 .Marks)

1. (b.) Drive the transfer function of the armature-controlled DC motor. (10.Marks)

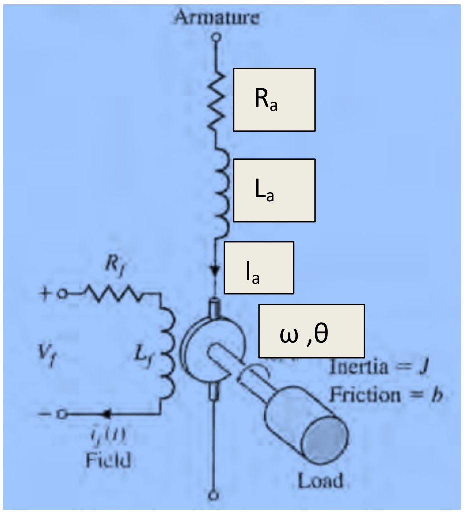

Figure 1.(b.) :A DC motor electrical diagram

2. (a.) Determine the transfer function $V_O(s) / V(s)$ for the op-amp circuit shown in Figure.

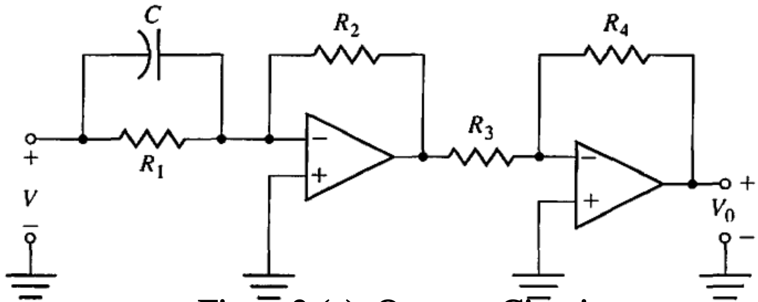

Figure2.(a): Op-amp Circuit

2. (a.)Let R_1=167 kΩ, R_2 = 250 kΩ, R_3 = 1 kΩ, R_4 = 200 kΩ, and C = 1 μ F. Assume an ideal op-amp. **(10.Marks)**

2. (b) Find the transfer function Y(s) / U(s) for the multivariable system in figure by using the block diagram reduction to simplify the block diagram below into a single block relating. **(10.Marks)**

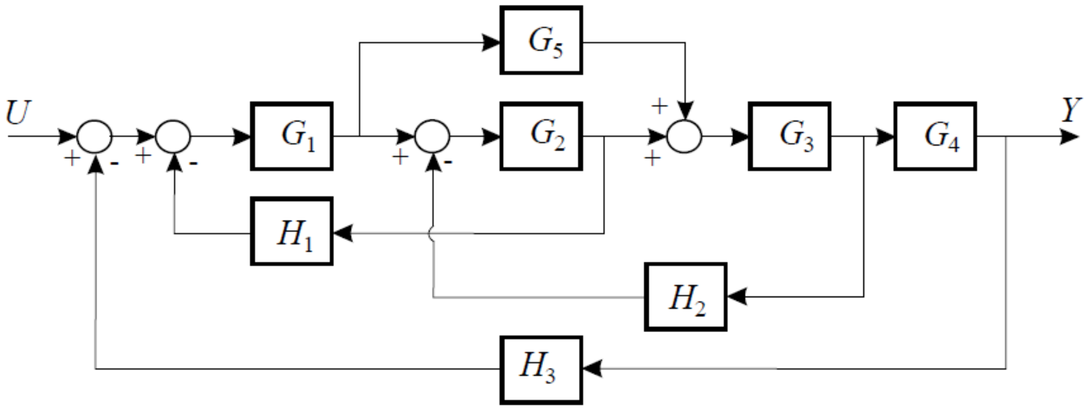

Figure 2.(a.) : Multiple-loop feedback control system

3. (a)A single-input, single-output system has the matrix equation:

$$\dot{x} = \begin{bmatrix} 0 & 2 \\ -3 & -4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u \quad \text{and} \quad y = [10 \quad 0]\, x$$

Determine the transfer function G(s) =Y(s)/U(s). **(10.Marks)**

3. (b.) A hovering vehicle control system is represented by two state variables, and

$$A = \begin{bmatrix} 0 & 6 \\ -3 & -5 \end{bmatrix}.$$

(i) Find the roots of the characteristic equation.

(ii) Find the state transition matrix $\phi(t)$. **(10.Marks)**

4. A magnetic disc drive requires a motor to position a read/write head over tracks of data on a spinning disk. The motor and head may be represented by

$$G(s) = \frac{10}{s(\tau s+1)}, \text{ where}$$

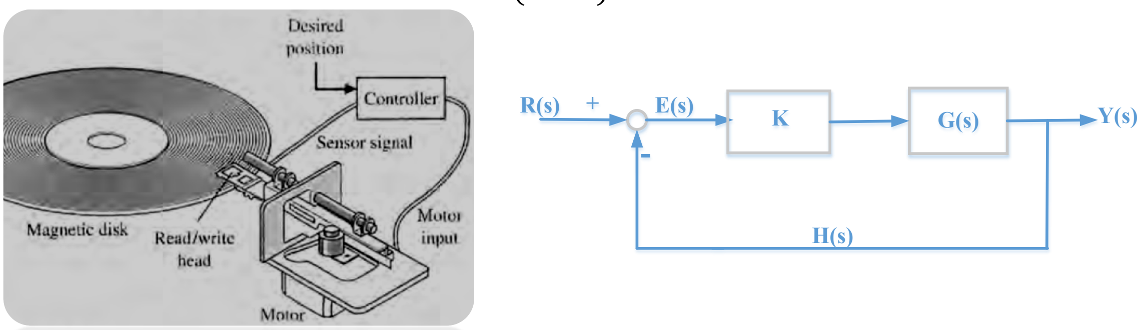

Figure: Disk drive control

4. τ = 0.001 second. The controller takes the differences of the actual and desired positions generate a error. This error is multiplied by an amplifier K. (a.) What is the steady state position error for a step change in the desired input? (b.) Calculate the required K in order to yield a steady state error of 0.1 mm for a ramp input of 20 cm/s. **(20.Marks)**

5. For the system shown in Figure(5), determine the values of gain K and velocity-feedback constant K_h so that the maximum overshoot in the unit-step response is 0.2 and the peak time is 1 sec. With these values of K and K_h, calculate the rise time and settling time. Assume that J=1 kg-m^2 and B=1 N-m/rad/sec.

(20.Marks)

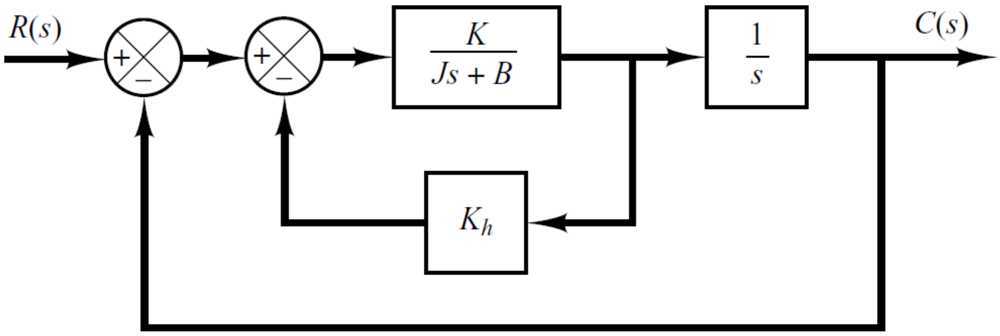

Figure. (5.): Closed-loop system

-- **End of the Questions**--