一.Consider the block diagram of a control system in Fig.1. (15%)

(a).Draw an equivalent signal flow graph.

(b).Find the transfer function $\frac{C(S)}{R(S)}$, $\frac{E(S)}{R(S)}$ and $\frac{Y_3(S)}{R(S)}$ by applying the gain formula directly to the block diagram.

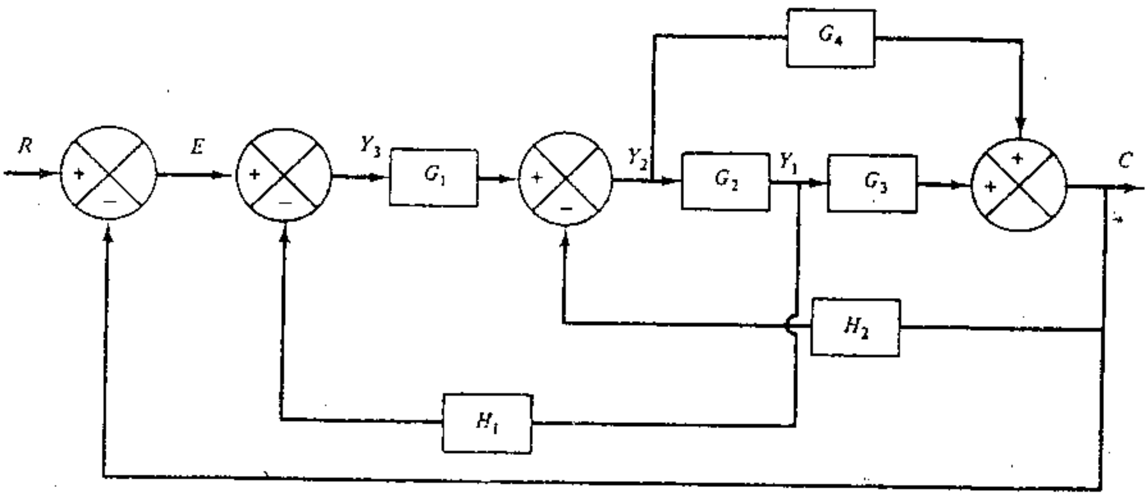

Fig. 1

二、For the mechanical system shown in Fig.2. (15%)

(a).Write the force equations from free-body diagram for the two masses.

(b).Write a set of the state equations by defining the following state variables:

$x_1 = y_1$, $x_2 = \frac{dy_1}{dt}$, $x_3 = y_2$, $x_4 = \frac{dy_2}{dt}$.

(c).Derive the transfer functions $\frac{Y_1(S)}{F(S)}$ and $\frac{Y_2(S)}{F(S)}$.

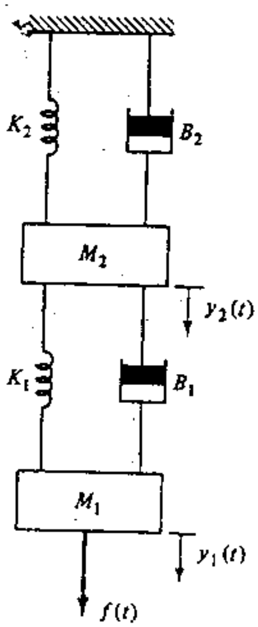

Fig. 2

(背面仍有題目,請繼續作答)

三、The circuit diagram of a separately excited dc motor is shown in Fig.3.Assume That the air-gap flux is proportional to the field current. (20%)

That is $\phi(t) = K_f i_f(t) = K_f I_f$ =constant,

And assume that the torque developed by the motor is proportional to the air-gap flux and the armature current;

Thus $T_m(t) = K_m \phi(t) i_a(t) = K_m K_f I_f i_a(t) = K_i i_a(t)$, (which $K_i = K_m K_f I_f$ =constant).

(a).Derive the dynamic equations.

(b).Write the state equations in vector-matrix form by defining the state variables θ_m, ω_m and i_a.

(c).Draw a block diagram of the system.

(d).Derive the transfer function between the motor displacement and the input voltage.

The following summary on the variables and parameters is given:

$e_a(t)$ = armature voltage
$e_f(t)$ = field voltage
R_a = armature resistance
$e_b(t)$ = back emf
R_f = field resistance
L_a = armature inductance
L_f = field inductance
$i_a(t)$ = armature current
$i_f(t)$ = field current
K_i = torque constant
K_b = back emf constant
$\phi(t)$ = magnetic flux
$T_m(t)$ = torque developed by motor
J_m = rotor inertia of motor
B_m = viscous frictional coefficient
$\theta_m(t)$ = rotor angular displacement
$\omega_m(t)$ = rotor angular velocity
$T_L(t)$ = load torque

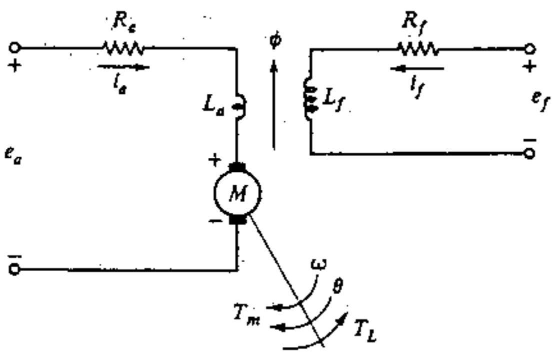

Fig. 3

prob. #4)

(25%)

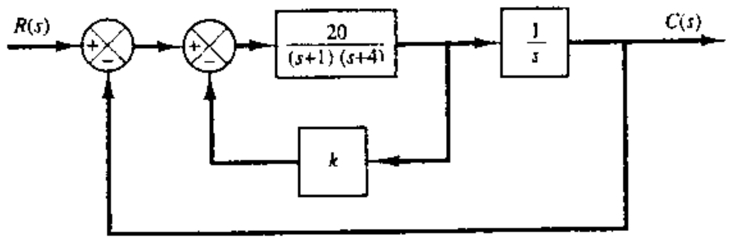

FiG. 4

Conder the system in FiG. 4

a) find the open-loop transfer function. (5%)

b) Draw a root-Locus diagram. (10%)

c) Determine the value of k such that the damping ratio of the dominant closed-loop poles is 0.4. (10%)

Prob. #5) Plot the Bode Plots of the following Cases:

(25%)

Case (a) $G_A(s) = \dfrac{20}{S(1+0.5S)(1+0.1S)}$ (10%)

Case (b) $G_B(s) = \dfrac{2S^2}{(1+0.4S)(1+0.04S)}$ (10%)

Calculate the magnitude (db) value and phase angle (degree) values at frequencies $W = 0.1$ rad/sec, $W = 1.0$ rad/sec, $W = 2.5$ rad/sec and $W = 25$ rad/sec respectively for Case (b).

(5%)