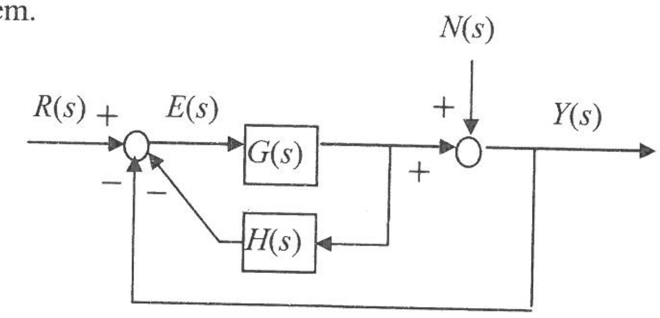
國立中正大學104學年度碩士班招生考試試題

系所別：電機工程學系-電力與電能處理甲組　　科目：控制系統

1. (20%) Figure shows the block diagram of a circuit control system. The signal $N(s)$ denotes the load torque at the circuit. (a) (10%) Find the transfer function $H(s)$ so that the output $Y(s)$ is not affected by the load $N(s)$. (b) (10%) With $H(s)$ as determined in part (a), find the value of K so that the steady-state value of $e(t)$ is equal to 0.1 when the input is a unit-ramp function, $r(t) = tu_s(t)$, $R(s) = 1/s^2$, and $N(s) = 0$. Apply the final-value theorem.



$$G(s) = \frac{K(s+3)}{s(s+2)(s+5)}$$

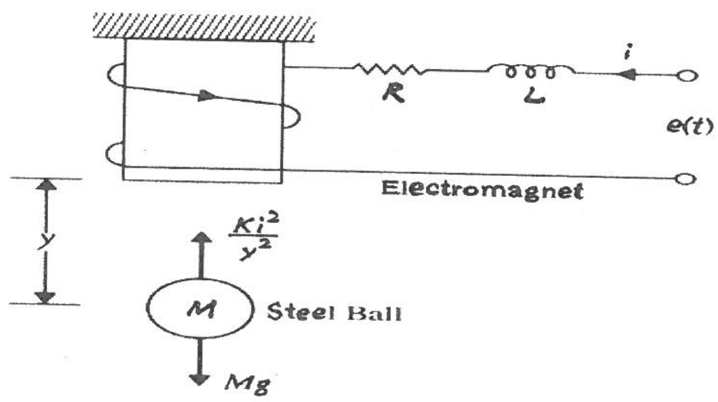
2. (20%) Figure shows the diagram of a magnetic-ball suspension system. The objective of the system is to control the position of the steel ball by adjusting the current in the electromagnet through the input voltage $e(t)$. The inductance is $L(y) = L/y(t)$, where L is a constant. The differential equations of the system are

$$M\frac{d^2y(t)}{dt^2} = Mg - \frac{Ki^2(t)}{y^2(t)}$$

$$e(t) = Ri(t) - \frac{L}{y^2}i(t)\frac{dy(t)}{dt} + \frac{L}{y}\frac{di(t)}{dt}$$

(a) (10%) Let us define the state variables as $x_1(t)=i(t)$, $x_2(t)=y(t)$, and $x_3(t)= dy(t)/dt$. Find the nonlinear state equations of the system.

(b) (10%) Linearize the system about the equilibrium point. Find the linear state equations of the system.



3. (30%) Consider a system represented in state –space

$$\dot{x} = \begin{bmatrix} -1 & 2 \\ 1 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$
$$y = \begin{bmatrix} 1 & -1 \end{bmatrix} x$$

(a) (10%) Determine the stability of the system. Check for the BIBO stability and asymptotic stability, respectively.

(b) (10%) Determine whether the system is controllable or observable.

(c) (10%) Design a state-feedback controller to place the closed-loop system poles at $s = -2 \pm j$.

4. (30%) The transfer function of a unity feedback control system is

$$G(s) = \frac{5K(s+1)}{s(1+0.1s)(1+0.2s)(1+0.5s)}$$

(a) (10%) Find the value of K so that the gain margin of the system is 10 dB.

(b) (10%) Find the value of K so that the phase margin of the system is 45°.

(c) (10%) Plot the root locus for $K \geqq 0$.