國立臺北科技大學 103 學年度碩士班招生考試

系所組別：2130 電機工程系碩士班丙組

第二節　控制系統　試題

注意事項：

1. 本試題共 4 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Consider the following DC motor system in Figure 1. Assume that the rotor with load has inertia J and viscous friction coefficient b. The input voltage, the torque on the rotor, and the back emf voltage are denoted by u, T, and v_b, respectively. Torque and back emf constants are denoted by k_t and k_b, respectively.

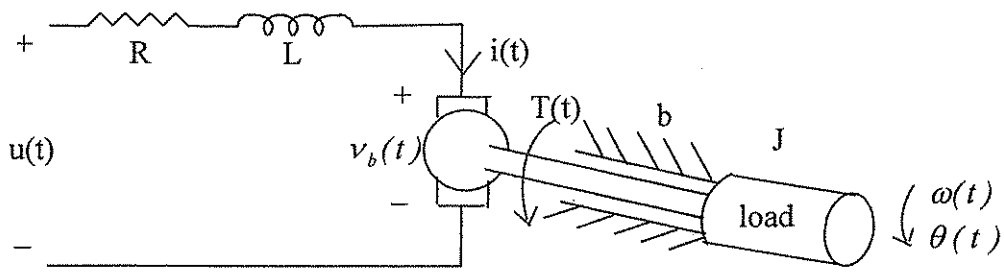

Figure 1. A DC motor system.

a. Determine the differential equation describing the motor driving circuit. (5%)

b. Determine the differential equation describing the rotational motion for the rotor with load. (5%)

c. Determine the transfer functions from input voltage U(s) to angular velocity $\Omega(s)$ and input voltage U(s) to angular position $\theta(s)$, respectively. (10%)

2. Determine the transfer function of the system from R to Y in Figure 2. (20%)

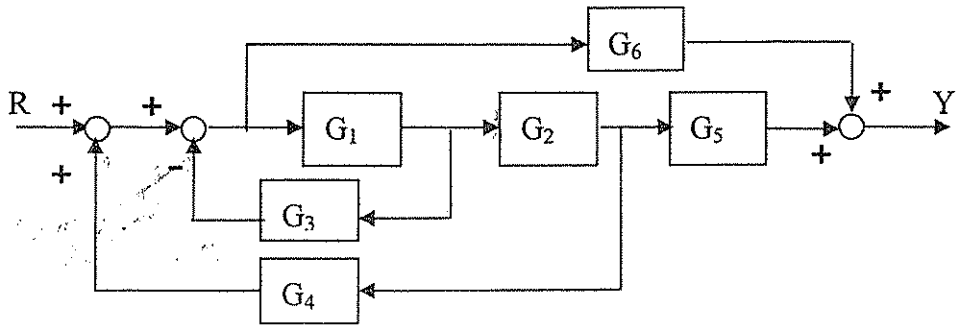

Figure 2. A feedback control system.

3. Use root locus technique to determine the range of parameter k such that the system in Figure 3 is stable.

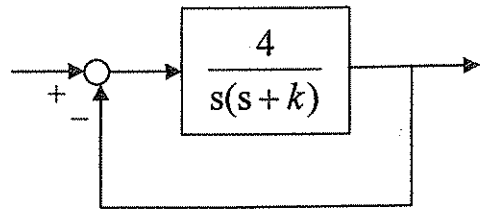

Figure 3. A feedback control system.

a. Draw the root locus of the feedback control system for $0 \le k < \infty$. Be sure to identify and determine all related features of the root locus. (15%)
b. Based on the root locus in 3a, determine the range of parameter k such that the system is stable. (5%)
c. Determine the range of the parameter k such that the closed-loop poles of the system satisfying the following time-domain specifications simultaneously. Be sure to mark the part of root locus corresponding to the range of the parameter k. (10%)
   (a) Damping ratio $\zeta \ge 0.5$
   (b) Rise time $t_r \le 1.125$ seconds
   (c) Settling time $t_s \le 3.68$ seconds (1% criterion)

4. Consider the following system with $G(s) = \dfrac{10}{s(s^2 + 0.4s + 4)}$.

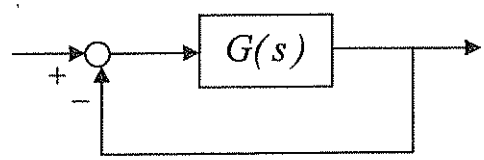

Figure 4. A feedback control system.

a. Give the definition of system type with respect to command tracking and then determine the system type for the system in Figure 4. (5%)
b. Draw the Bode plot of $G(s)$. (15%)
c. According to the magnitude plot in 4a, compute the velocity error constant K_v and then determine the stead-state error for a ramp input signal. (10%)