國立臺北科技大學 101 學年度碩士班招生考試

系所組別：1112 機電整合研究所甲組

第二節　自動控制　試題（選考）

注意事項：

1. 本試題共 5 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. (20%) Please step by step draw the Nyquist plot of the following open-loop transfer function and determine the range of K such that its close-loop system can be stable.

$$G(s)H(s) = \frac{K}{s(s+2)^2}$$

2. (20%) A unit feedback control system has feed-forward transfer function as

$$\frac{K}{s(s+2)(s^2+4s+8)}.$$

Please sketch the closed-loop root locus step by step as K varying from zero to infinity.

3. (20%) What is PID control law (4%)? Please write down its expressions and explain the advantages and disadvantages of each component (16%).

4. (20%) An armature controlled DC servomotor is used in a position control system as depicted in the following drawing. All the necessary parameters and variables are also listed. Other effects if not listed are negligible.
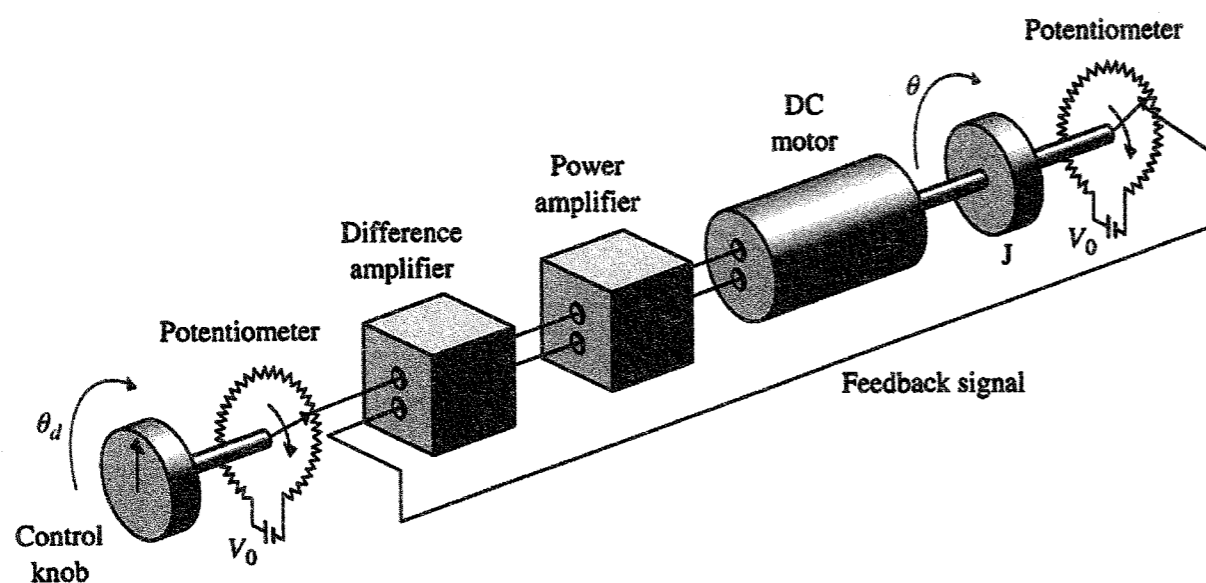
R_a = armature resistance
i_a = armature current
e_a = applied armature voltage
e_b = back emf
K_m = motor torque constant
K_b = motor back emf constant
K_a = power amplifier voltage gain
K_p = potentiometer voltage to angle proportional constant
θ = angular displacement of the motor shaft
θ_d = angular displacement of control knob
T = torque developed by the motor
J = equivalent moment of inertia in the motor shaft
b = equivalent viscous friction coefficient in the motor shaft
e = error signal

(1) List all the equations necessary for modeling (4%).
(2) Draw a block diagram showing every detail of the system (4%).
(3) Find the transfer function of $\Theta(s)/\Theta_d(s)$ (4%).
(4) Determine the damping ratio, ζ, and undamped natural frequency, ω_n, of the system (4%).
(5) Determine the unit step response of the system in terms of ζ and ω_n (4%).

5. (20%) A unit feedback system has its Nichols diagram as in the following. Please determine its (1) phase margin and gain margin (8%), (2) closed-loop peak resonance amplitude ratio and frequency (8%), (3) closed-loop bandwidth (4%).