國 立 清 華 大 學 命 題 紙

九十一學年度 電机工程 系（所） 乙 組碩士班研究生招生考試

科目 控制系統 科號 2405 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. Find the optimal feedback control u which yields a minimum value for

   $J = \int_0^\infty x^2 + u^2 dt$ where $\dot{x} = -x + u$, with initial condition $x(0) = 1$.

   (20%)

2. (a) For $\dot{x} = f(x)$ with $f(0) = 0$, state the Lyapunov stability theorem for the origin as a stable equilibrium point.
   (b) If the system is linear and time invariant, derive a Lyapunov equation for the same stability condition. (20%)

3. Please give the following meanings (30%)
   1. State Observer
   2. Stability margin
   3. Frequency response
   4. Observer-based state feedback control
   5. Sensitivity function
   6. PID control

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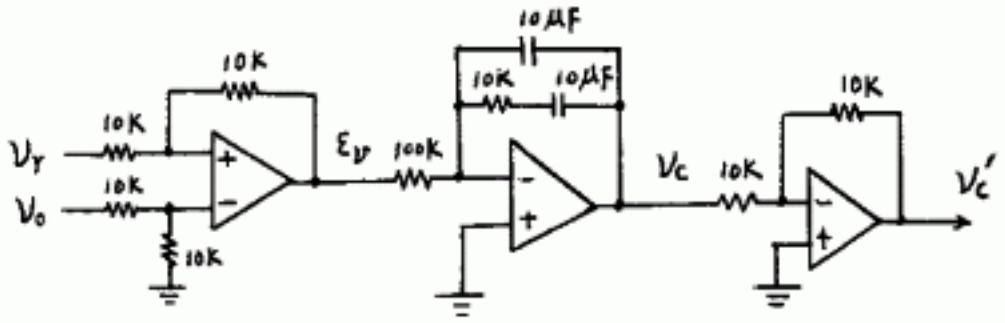
4. (1) Sketch the approximate Bode plots (magnitude and phase) of the transfer function: (15%)

$$H_p(s)=\frac{s}{(1+0.1s)(1+0.01s)}$$

(2) (a) Draw the control system block diagram corresponding to the following circuit; (b) Give the transfer functions of all blocks; (c) Describe the type of the controller.



5 (1) If the discrete-time plant model is: (15%)

$$G_p(B)=\frac{k_v TB}{(1-B)}$$

where B denotes back-shift operator, i.e., $Bx(n)=x(n-1)$. Find the controllers to obtain the following desired closed-loop tracking controls:

(a) Dead-beat response, i.e.,

$$G_{dr}(B)\overset{\Delta}{=}\frac{c_n}{r_n}=B$$

(b) First-order response:

$$G_{dr}(B)=\frac{(1-\delta)B}{1-\delta B}$$

(2) For a digital control system, the aliasing problem can be prevented by filtering the high frequency noises contaminated in the feedback signal. If the sampling time is chosen to be T=0.002s, give the cut-off frequency of the low-pass filter.