國立雲林科技大學
八十九學年度研究所碩士班入學考試試題
系所：電機系
科目：工程數學 (甲)

1. Solve the initial value problem:
   (a) $y''-6y'+9y=0,\quad y(0)=1, y'(0)=2.$ (10%)
   (b) $y''-y'-2y=e^{-x},\quad y(0)=2, y'(0)=2/3.$ (15%)
2. Using Laplace transforms to solve the following problem:
   $y''-y=t,\quad y(0)=1, y'(0)=1$ (15%)
3. Find the following convolution:
   $u(t-\pi)*\cos(t)$ where $u(t)=1$ if $t\geq 0$. (10%)
4. Find the Fourier transforms of the following function:

$$f(x)=\begin{cases} e^{x} & \text{if } x<0 \\ e^{-x} & \text{if } x>0 \end{cases}$$ (15%)

5. Find the Fourier series of the following function:
   $f(x)=x^2,\ (-\pi<x<\pi).$ (15%)
6. (a) Find the eigenvalues and the corresponding eigenvectors of the matrix $\begin{pmatrix} -1 & 2 \\ -3 & 4 \end{pmatrix}$ (10%)
   (b) The eigenvectors are orthogonal ? Find a matrix that diagonalizes the matrix. (10%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：電機系
科目：工程數學（乙）

(1) Find the general solution for the following differential equation. (10%)

$$(6x^2 - 3xy)\frac{dy}{dx} + 9xy - 2y^2 = 0$$

(2) Find the general solution for the following differential equation. (15%)

$$y\left(\frac{d^2y}{dx^2}\right) + 2\left(\frac{dy}{dx}\right) = \left(\frac{dy}{dx}\right)^2$$

(3) Use the Laplace transform to solve the following differential equation. (15%)

$$\frac{d^2y}{dt^2} + 2t\left(\frac{dy}{dt}\right) - 4y = 6; \qquad y(0) = \frac{dy}{dt}(0) = 0$$

(4) Find the inverse Laplace transform for the function $F(s) = ln\left(\frac{s^2+1}{s^2+s}\right)$. (10%)

(5) Give the definition or concept for the following terms.

(a) Linear dependence for the functions, $f_1(t), f_2(t), \cdots, f_n(t)$, where $f_i(t) \in \mathbf{R}^n$. (5%)

(b) Diagonalizable matrix. (5%)

(6) Find the Fourier transform for the following function. (10%)

$$f(t) = te^{-t}H(t), \quad \text{where } H(t) \text{ is Heaviside function.}$$

(7) Find the inverse Fourier transform (10%)

$$F(w) = e^{-|w+4|}cos(2w + 8)$$

(8) Show that the eigenvalues of a unitary matrix have absolute value 1. (10%)

(9) Let $\mathbf{A} = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 3 & 1 \\ 0 & 1 & 2 \end{bmatrix}$, find $e^{\mathbf{A}}$. (10%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：電機系
科目：線性代數與機率

1. (8%)Find the equation $y = a + bx$ of the least-squares line that best fits the data points (0,1), (1,1), (2,2), (3,2).

2. (8%)Prove that if $v_1, v_2, \cdots, v_r$ are eigenvectors that correspond to distinct eigenvalues $\lambda_1, \lambda_2, \cdots, \lambda_r$ of an $n \times n$ matrix A then the set $\{v_1, v_2, \cdots, v_r\}$ is linearly independent.

3. (a)(8%)Prove the *parallelogram law* for vectors u and v in R^n:

   $\|u+v\|^2 + \|u-v\|^2 = 2\|u\|^2 + 2\|v\|^2$. Do **not** use the Pythagorean theorem.

   (Hint: use inner product)

   (b)(10%)Use Pythagorean theorem to prove the *Best Approximation Theorem* which is stated as follow: Let W be a subspace of R^n, y be any vector in R^n, and y' be the orthogonal projection of y on to W determined by an orthogonal basis of W. Then y' is the closest point in W to y, in the sense that

   $$\|y - y'\| < \|y - v\|$$

   for all v in W distinct from y'.

4. (8%)Prove that if $S = \{u_1, \cdots, u_p\}$ is an orthogonal set of nonzero vectors in R^n, then S is linearly independent and hence is a basis for the subspace spanned by S.

5. (8%)The set $S = \{u_1, u_2, u_3\}$ is an orthogonal basis for R^3, where

   $$u_1 = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}, \quad u_2 = \begin{bmatrix} -1 \\ 2 \\ 1 \end{bmatrix}, \quad u_3 = \begin{bmatrix} -1/2 \\ -2 \\ 7/2 \end{bmatrix}$$

   Express the vector $y = \begin{bmatrix} 6 \\ 1 \\ -8 \end{bmatrix}$ as a linear combination of the vectors in S.

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：電機系
科目：線性代數與機率

6.(15%) Suppose that two dice are thrown and that the dice are distinguishable. An outcome of this experiment is denoted by (m, n), where m and n are the faces of the dice. Let A and B be the following events of this experiment:

$A = \{m + n = 11\}$,
$B = \{n \neq 5\}$.

(a) Find the probability of occurrence of the event A, $P[A]$. [4%]
(b) Find the probability of occurrence of the event B, $P[B]$. [4%]
(c) Show that $P[A, B] \neq p\{A\}P[B]$, [7%]
where $P[A, B]$ is the joint probability of events A and B.

7.(15%) A coin with $P[head]=p$, $P[tail]=q$, $p+q=1$ is tossed n times.
If $n \to \infty$, $p \to 0$, $np \to a$ (a finite value of the order of 1),
show that

$$P[k \text{ heads in } n \text{ tossings}] \cong \frac{a^k}{k!} e^{-a}.$$

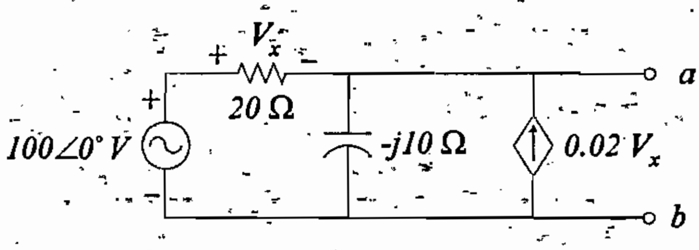
8.(20%) A device is put into service at time zero, and then we follow it until it fails. T is the random variable we use for the time of failure. We assume that the failure of electrical components is modeled by the exponential random variable with the *pdf* $f(t) = \lambda e^{-\lambda t}$ where λ is called a rate parameter because it has the units of inverse time.

(a) Reliability $R(t)$ is defined as the probability that a device will fail after time t.
Show that $R(t) = e^{-\lambda t}$. [7%]
(b) Show that the mean time to failure (*MTTF*) is given as
$MTTF = E[T] = 1/\lambda$. [7%]
(c) Show that the probability that a device will provide at least *MTTF* of use before it fails is e^{-1} (=0.368). [6%]

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

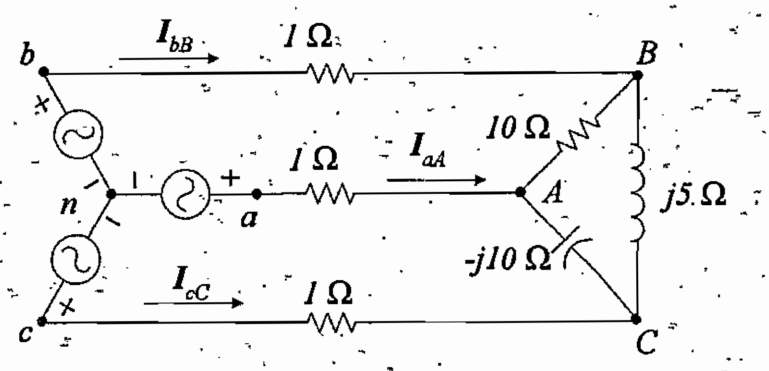
系所：電機系
科目：電路學

1. 戴維寧定理 參考圖一的交流電路，試求自 a, b 端點看入電路的戴維寧等效電路 V_{th} 及 Z_{th} 之值，請以極座標形式 (polar form) 表示 (20%) 。



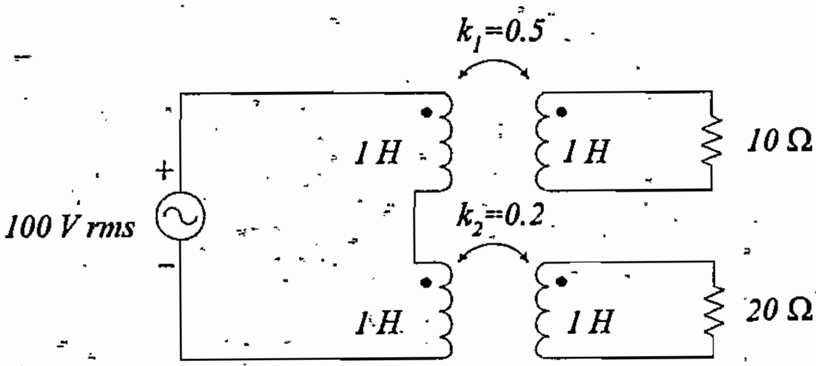
圖一

2. 三相交流分析 參考圖二之三相電路，平衡 Y 接三相電源 $V_{an}=120\angle 0^\circ$ V rms，$V_{bn}=120\angle -120^\circ$ V rms，$V_{cn}=120\angle 120^\circ$ V rms。求三相線電流 I_{aA}、I_{bB} 及 I_{cC}，請用極座標形式表示 (30%)。



圖二

3. 磁耦合電路 參考圖三之交流電路，設角頻率ω=100 rad/s，k_1 及 k_2 表示耦合係數，計算 (a) 10 Ω 電阻所吸收之有效功率 (10%)；(b)電源所提供的無效功率 (10%)。



圖三

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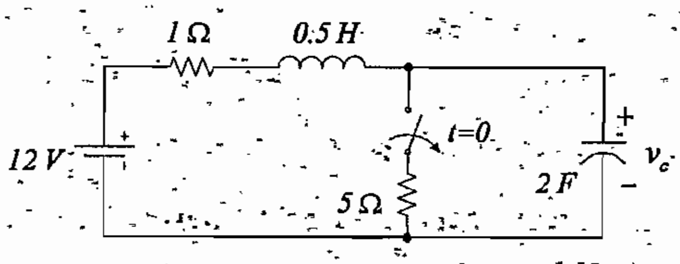
系所：電機系
科目：電路學

4. <u>暫態分析</u> 圖四所示電路的開關接通已有一段很長的時間，在 $t=0$ 時開關打開，試求 $t>0$ 時電容器兩端之電壓 $v_c(t)$ (30%)。



圖四

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系所：電機系
科目：電子學

1. For the amplifier circuit in Fig. 1, assume that V_s has a zero dc component and the BJTs have $\beta = 100$. Find V_o / V_s and R_{in}. (25%)
2. For the circuit in Fig. 2 in which the transistors have $V_{BE} = 0.7\text{V}$ and $\beta = 100$, find i_c, v_o / v_i, and R_{in}. (25%)
3. The NMOS transistors in the circuit of Fig. 3 have $V_t = 2\text{ V}$, $\mu_n C_{OX} = 20\ \mu\text{A/V}^2$, $\lambda = 0$; and $L_1 = L_2 = 10\ \mu\text{m}$. Find the required values of gate width for each of Q_1 and Q_2, and the value of R, to obtain the voltages and current values indicated. (25%)
4. The amplifier in Fig. 4 is biased to operate at $I_D = 1\text{ mA}$ and $g_m = 1\text{ mA/V}$. Neglecting r_o; find the midband gain. Find the value of C_S that places the corresponding pole at 10 Hz. What is the frequency of the transfer-function zero introduced by C_S? Give an expression for the gain function $V_o(s)/V_i(s)$. What is the gain of the amplifier at dc. (25%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：電機系
科目：電子學

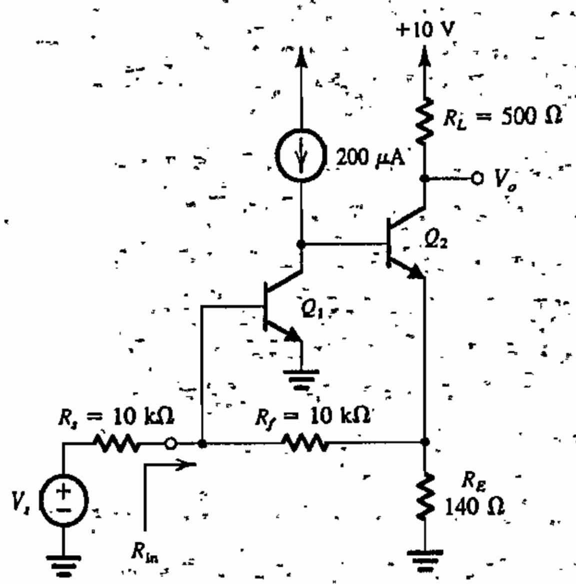

Fig. 1

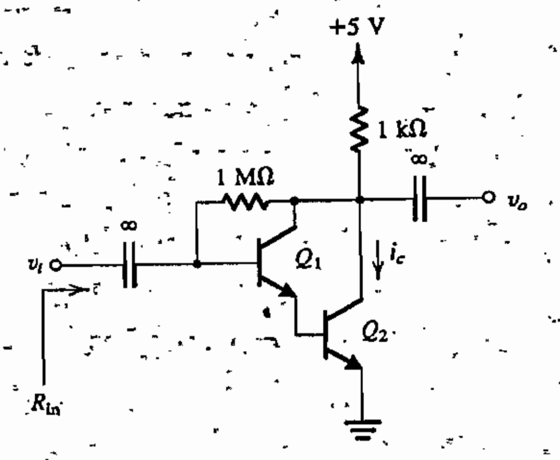

Fig. 2

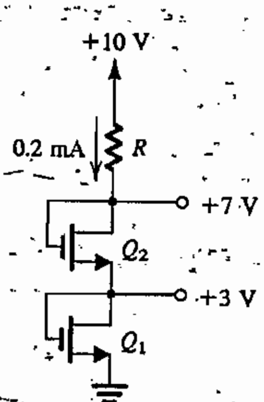

Fig. 3

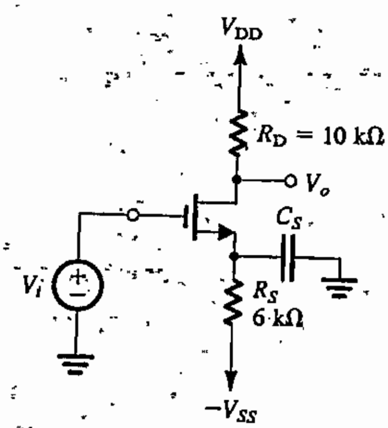

Fig. 4

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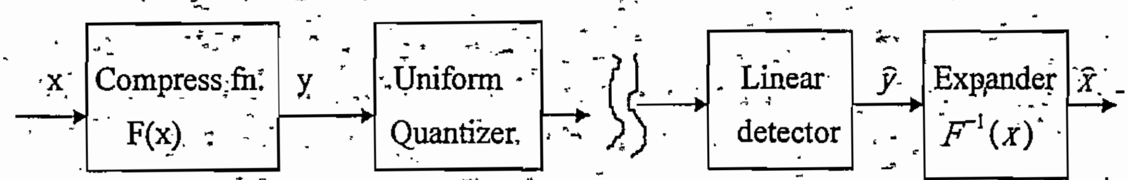
系所：電機系
科目：通信理論

(1) (25%) A signal *x(t)* of finite energy is applied to a system with output $y(t) = x^2(t)$. The spectrum of the *x(t)* is limited to the frequency interval $-W \le f \le +W$. Show that the spectrum of *y(t)* is limited to $-2W \le f \le +2W$.
Hint: Express y(t) as x(t) multiplied by itself.

(2) (25%) Given a signal $x(t) = \cos(\omega_0 t)$ which is sampled by an impulse train p(t) at $\omega_s = 2\pi/T = 600$; where T is the time interval between sampling impulses.
An ideal lowpass filter $H(j\omega)$ with gain T and cut-off frequency $\omega_c = 300$ (include 300) is used in the reconstruction process.
What is the reconstructed signal $x_r(t)$ at the following ω_0?
(a) $\omega_0 = 200$ (b) $\omega_0 = 400$
Explain your answer using sampling theorem and Fourier transform $X_r(j\omega)$

(3) 25%

A companding system is shown below.



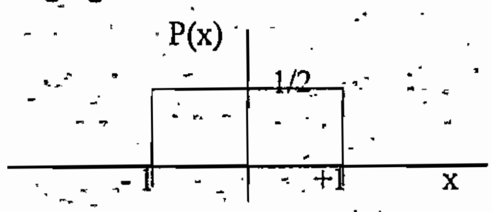
5% (A) Find the mean square error(MSE) for the uniform quantizer, assume that the step size is Δ.

10% (B) Describe why that the MSE of the above system can be approximated as

$$\bar{\varepsilon}_x \approx \frac{\Delta^2}{12}\int \frac{p(x)}{[F'(x)]^2}dx$$

where p(x) is the probability density function of the signal X.

10%(C) Now suppose we use 4-bit uniform quantizer and p(x) is given as the following figure.

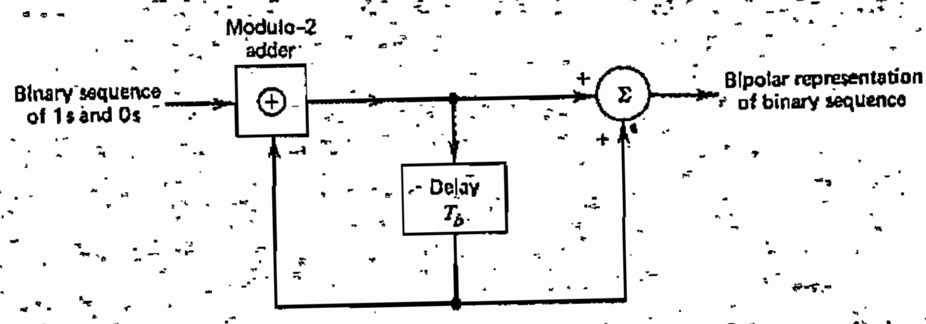


and F(x) is given as $F(x) = \ln(|x|)\,\text{sgn}(x)$. Find the SNR.

國立雲林科技大學 系所：電機系
八十九學年度研究所碩士班入學考試試題 科目：通信理論

(4) 15%

The scheme shown in the following figure may be viewed as a differential encoder (consisting of the modulo-2 adder and the 1-unit delay element) connected in cascade with a special form of correlative coder (consisting of the 1-unit delay element and summer). A single delay element is shown in this figure since it is common to both the differential encoder and the correlative coder. In this differential encoder, a transition is represented by symbol 0 and no transition by symbol 1.



5% (A) Find the frequency response and the impulse response of the correlative coder part of the scheme shown in the figure.

5% (B) Show that this scheme may be used to convert the on-off representation of a binary sequence (applied to the input) into the bipolar representation of the sequence at the output. You may illustrate this conversion by considering the sequence 010001101.

5% (C) Consider a random binary wave x(t) in which the 1s and 0s occur with equal probability, the symbols in adjacent time slots are statistically independent, and symbol 1 is represented by A volts and symbol 0 by zero volts. This on-off binary wave is applied to the circuit in the figure. Show the power spectral density of the bipolar wave y(t) appearing at the output of the circuit equals

$$S_Y(f)=T_b A^2 \sin^2(\pi f T_b)\,\mathrm{sinc}^2(\pi f T_b)$$

(5) 10%

5% (A) Please describe the advantages of using the GMSK modulation scheme.

5% (B) Draw a simple GMSK modulator and demodulator.

國立雲林科技大學　　　　系所：電機系
八十九學年度研究所碩士班入學考試試題　　科目：計算機組織

01. Explain the following terms briefly.
   (a) Hypercube (3%)
   (b) Fault Tolerance (3%)
   (c) RAID (3%)

02. Suppose that a certain magnetic hard disk drive has the following specifications:

Number of disks (recording surfaces)	14(27)
Number of tracks per recording surface	4925
Number of sectors on all recording surfaces	17,755,614
Storage capacity (formatted) of disk drive	9.09 GB
Disk-rotation speed	5400 rev/min
Average seek time	11.5 ms
Internal data-transfer rate	44 to 65 MB/s

   (a) What is the block size? (4%)
   (b) What is the average rotational latency? (4%)
   (c) What is the average block access time? (4%)

03. Design a counter with the following repeated binary sequence: 0, 1, 3, 7, 6, 4. Use T flip-flops. Treat the unused states as don't-care conditions. Analyze the final circuit to ensure that it is self-correcting. If your design produces a nonself-correcting counter, you must modify the circuit to make it self-correcting. (12%)

04. (a) How many 128×8 RAM chips are required to support a memory capacity of 2048 bytes? (2%)
   (b) How many lines of the address must be used to access 2048 bytes? How many of these lines are connected to the address inputs of all chips? (4%)
   (c) How many lines must be decoded for the chip select inputs? Specify the size of the decoder. (4%)

05. Design a parallel priority interrupt hardware for a system with four interrupt sources. (7%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：電機系
科目：計算機組織

06. The following binary word W=10001011 is stored in an 8-bit register. What is the decimal number represented by W if it is interpreted, as an integer in each of the following codes: (15%)
(a) Unsigned binary
(b) Signed binary (two's complement)
(c) Sign-magnitude

07. Analyze the three bus-arbitration methods (daisy chaining, polling, and independent requesting) with respect to communication reliability in the event of hardware failures. (15%)

08. Define each of the following IO control methods: programmed IO, DMA controllers, IOPs (input-output processor). List the advantages and disadvantages of each method with respect to program-design complexity, IO bandwidth, and interface hardware costs. (20%)

國立雲林科技大學
八十九學年度研究所碩士班入學考試試題

系所：電機系
科目：自動控制

1. 一系統之轉移函數為 $G(s)=\dfrac{1}{(s+1)(s+5)}$；求此系統對輸入 $u(t)=10\sin(2t+45^{\circ})$ 的穩態輸出響應。 (20%)

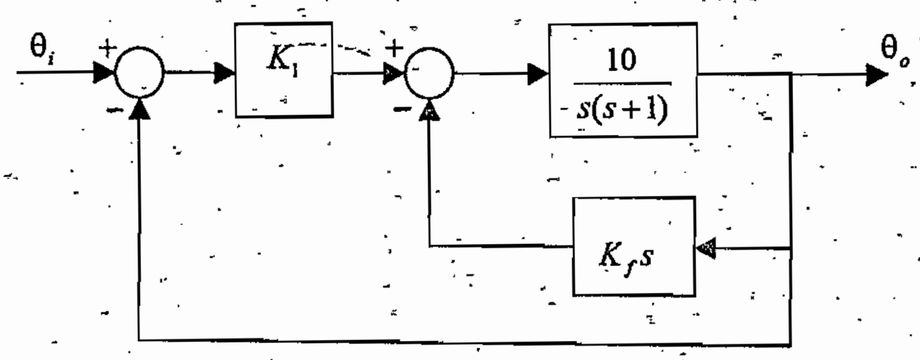
2. 一系統的轉移函數為 $G(s)=\dfrac{s^2+6s+8}{s^3+6s^2+11s+6}$，求此系統的狀態方程式與輸出方程式，使系統分別為

(a) 狀態可控制 (controllable)。 (10%)

(b) 狀態可觀測 (observable)。 (10%)

(c) 狀態可控制且可觀測 (controllable and observable)；若不能達到此要求，則解釋原因為何。 (10%)

3. 圖（一）所示的控制系統，試設計 K_1 與 K_f 值，使得當輸入為單位斜坡函數 (unit ramp function) $\theta_i(t)=t$ （$t\geq 0$） 時，閉迴路系統具有穩態誤差 (steady-state error) $e_{ramp}(\infty)=0.1$ 及阻尼比 (damping ratio) $\zeta=0.5$。 (20%)



圖（一）

4. 考慮圖（二）的回授控制系統，其中

$$G(s)=\frac{1}{(s+2)(s^2+2s+2)}$$

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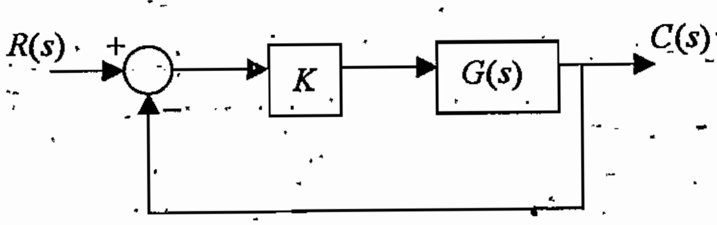
八十九學年度研究所碩士班入學考試試題　　科目：自動控制

(a) 應用奈奎氏準則 (Nyquist criterion) 決定系統穩定的 K 值範圍。 (10%)

(b) 試以羅斯－赫維茲 (Routh-Hurwitz) 法則驗證(a)小題中的答案。 (10%)

(c) 當 $K=6$ 時，求系統的增益邊際 (gain margin)。 (10%)



圖（二）