國立雲林技術學院　所別：電機工程技術研究所
八十四學年度研究所碩士班入學考試試題　科目：工程數學

1. Find the Fourier transforms of the following signals:

(a) $x(t)=\operatorname{sgn}(t)=\begin{cases}1, & t>0\\ -1, & t<0\end{cases}$ (5%)

(b) $x(t)=\operatorname{sin}c(t)\operatorname{sgn}(t)$

where $\operatorname{sin}c(t)=\dfrac{\sin t}{t}$ (5%)

2. Find the inverse Fourier transforms of the following functions:

(a) $\dfrac{\sin(3\omega)}{\omega(2+i\omega)}$ (5%)

(b) $e^{-3|\omega+4|}\cos(2\omega+8)$ (5%)

3. Define $T: M_{2\times 2}(\mathbf{R}) \to M_{2\times 2}(\mathbf{R})$ by

$$T\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right)=\begin{bmatrix} a+2b+3c-d & 2a+3b+2c+2d \\ 3a+c+5d & 4a+5b-2c+10d \end{bmatrix}$$

(a) Find bases for the null space and the range space of T. (10%)

(b) Dose $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ belong to the range space of T. (5%)

4. Determine whether the matrix

$$A=\begin{bmatrix} 0 & -2 & -3 \\ 1 & 3 & 3 \\ 0 & 0 & 1 \end{bmatrix}$$

is diagonalizable and ,if it is, find a diagonal matrix D and a matrix Q such that $Q^{-1}AQ=D$. (15%)

5. Solve the following differential equations:

(a) $\dfrac{2y^3+2x^2y-x}{x^2+y^2}dy+\dfrac{y}{x^2+y^2}dx=0$. (10%)

(b) $y''(x)-y'(x)-12y(x)=\sinh(4x)$. (10%)

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科目：工程數學

6. For the following differential equation, apply the method of Frobenius to find
   (a) the indicial equation (5%)
   (b) the recurrence relation (5%)

$$2xy''(x)+(2x+1)y'(x)+2y(x)=0.$$

7. Find the Laplace transform of the functions:
   (a) $f(t)=\frac{1}{t}\sin 2t.$ (5%)
   (b) $f(t)=\begin{cases}0 & \text{if } t<1\\ (t-1)(2-t) & \text{if } 1\le t<2\\ 0 & \text{if } t\ge 2\end{cases}$ (5%)

8. Find the inverse Laplace transform of the functions:
   (a) $F(s)=\frac{2s^2-2s+5}{(s+1)(s^2+1)}.$ (5%)
   (b) $F(s)=\frac{s}{(s^2+1)^2}.$ (5%)

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所別：電機工程技術研究所
科目：線性代數與機率

1. (17%) Given vectors u and v
   (a) (6%) How do you determine whether u and v are linearly independent?
   (b) (6%) u=(-4,6,-2), v=(2,-3,1), are they linearly independent?
   (c) (5%) $u=2-5t+6t^2-t^3$, $v=3+2t-4t^2+5t^3$, are they linearly independent?

2. (17%) Given matrix A

$$A=\begin{bmatrix} 2 & -1 & 1 \\ 4 & 1 & -3 \\ 2 & -1 & 3 \end{bmatrix}$$

(a) (9%) Evaluate Det A and Det A^{-1}.
(b) (8%) What is the relation between Det A and Det A^{-1}.

3. (16%) Solve the following system of equations by forming the matrix of coefficients and reducing it echelon form.

$$\begin{aligned} 3x + 2y - z &= 0 \\ x - y + 2z &= 0 \\ x + y - 6z &= 0 \end{aligned}$$

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所別：電機工程技術研究所
科目：線性代數與機率

4. (12%) A biased coin is tossed until a head shows. The probability that head shows in each toss is p. Let X be the number of tosses required for the appearance of the first head. Find the expected value of X.

5. (18%) A joint probability density function of random variables X and Y is

$$f_{XY}(x,y) = k(x+xy), \qquad 0<x<1, 0<y<4$$

and $f_{XY}(x,y)=0$, elsewhere.

(a) (3%) Find k.
(b) (5%) Determine if X and Y are independent.
(c) (5%) Evaluate the joint cumulative distribution function $F_{XY}(0.5,2)$.
(d) (5%) Find the conditional density function $f_{Y|X}(y|x)$.

6. (20%) The moment-generating function $M_X(t)$ of a random variable X is defined as the expected value of e^{tX}. Assume X has the probability density function

$$f(x) = ae^{-ax}u(x)$$

where $u(x)$ is the unit-step function.

(a) (5%) Determine $M_X(t)$.
(b) (15%) Use the moment-generating function to compute the variance of X.

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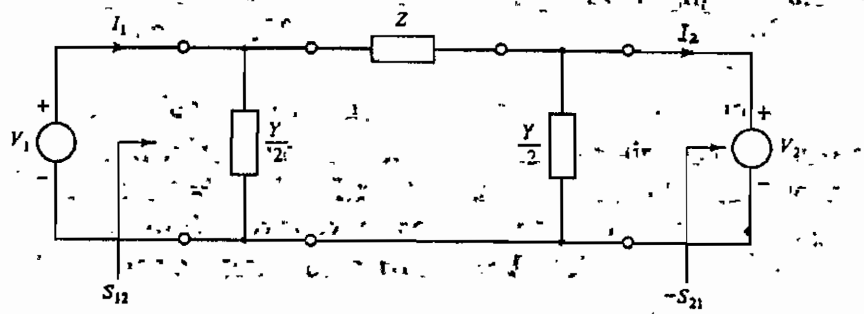
所別：電機工程技術研究所
科目：電機機械與電力系統

1. (a) Express S_{12} and $-S_{21}$ in terms of V_1, V_2, Z, and Y. (10%)

(b) If $|V_1|$=1.05 p.u., $|V_2|$=0.95 p.u., Z=0.1∠80° p.u., Y=0.05∠75° p.u..
Find $-P_{21\max}$. (10%)

(c) If $\theta_{12}=10^o$, what is the power loss in the system. (5%)



$V_1=|V_1|e^{j\theta_1}$
$V_2=|V_2|e^{j\theta_2}$
$\theta_{12}\triangleq\theta_1-\theta_2$

2. (a) Assume that we have the following fuel-cost curves for three generating units:

$$C_1(P_{G1})=300+8.0P_{G1}+0.0015P_{G1}^2$$
$$C_2(P_{G2})=450+8.0P_{G2}+0.0005P_{G2}^2$$
$$C_3(P_{G3})=700+7.5P_{G3}+0.0010P_{G3}^2$$

Neglecting line losses and generator limits, find the optimal dispatch and the total cost in dollars/hr when the total load, P_D, is 1000 MW. (10%)

(b) Repeat part (a), but this time introduce the following generator limits (in MW): (10%)

$$50\le P_{G1}\le 400$$
$$50\le P_{G2}\le 800$$
$$50\le P_{G3}\le 1000$$

(c) For the system in part (b) and calculate the approximate additional cost per hour of supplying one additional megawatt (i.e., P_D =1001 MW). (5%)

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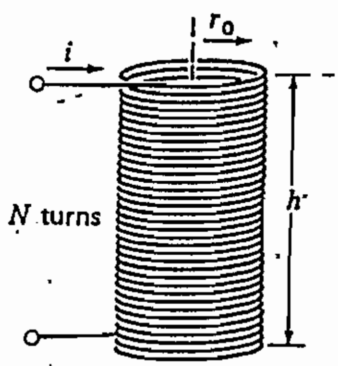
科目：電機機械與電力系統

3. A 1500-W 1.0-power-factor three-phase Y-connected 2300-V synchronous motor has reactances of X_d = 1.95 and X_q = 1.40 Ω/phase. Neglecting all losses, compute the maximum mechanical power in kilo-watts which this motor can deliver if it is supplied with electric power from an infinite bus at rated voltage and frequency and if its field excitation is constant at the value which would result in 1.00 power factor at rated load. The shaft load is assumed to be increased *gradually* so that transient swings are negligible and the steady-state power limit applies. (25%)

4. A long, thin solenoid of radius r_0 and height h is shown in the figure below. The magnetic field inside such a solenoid is axially directed and essentially uniform and equal to $H = Ni/h$. The magnetic field outside the solenoid is negligible. Calculate the *radial pressure* in newtons per square meter acting on the sides of the solenoid for constant coil current $i = I_0$. (25%)



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八十四學年度研究所碩士班入學考試試題　　科目：電路學與電力電子學

1. A half-wave, phase-controlled rectifier with resistive load - as shown in Figure 1 - has a load of 20Ω and a source voltage of 240V RMS, 60Hz. The circuit operates with $\alpha=60°$. Find: (a)average load voltage (5%) (b)RMS load current (7%) (c)power to the load. (8%)

2. Given the three-phase inverter line-to-neutral voltage as shown in Figure 2. Please express the three-phase instantaneous line-to-line voltage in a Fourier series form. (hint: $v_{ab}=\Sigma\ldots$, $v_{bc}=\Sigma\ldots$, $v_{ca}=\Sigma\ldots$) (15%)

3. (a) What is the meaning of Power Factor Correction. (5%) (b) How many power factor correction techniques or approaches are proposed right now? Please give some statements and draw some control circuit diagrams. (10%)

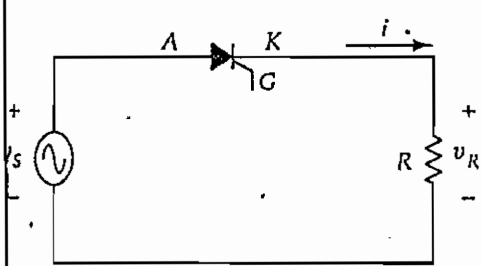
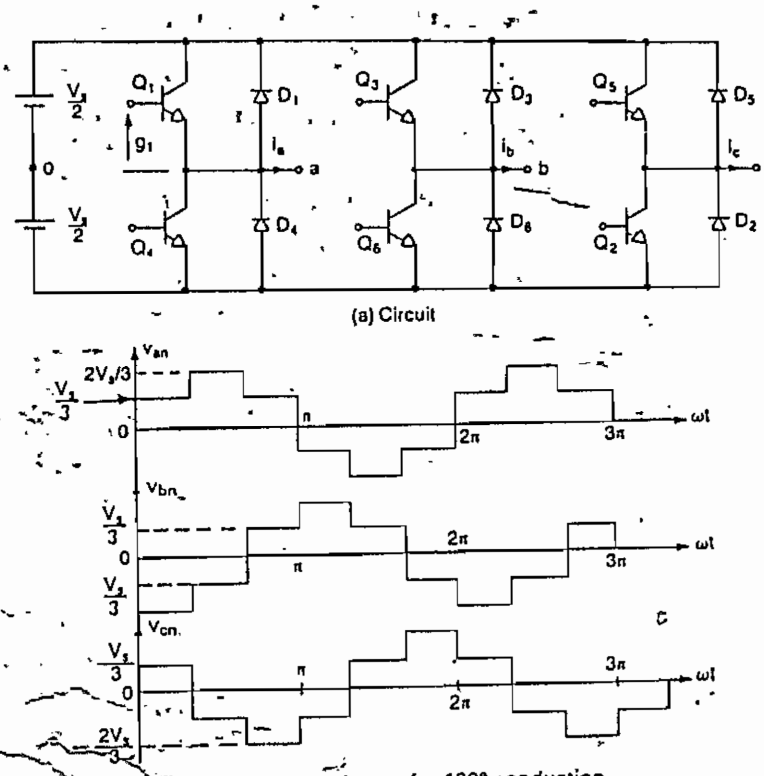


Figure 1



(a) Circuit

(b) Phase voltages for 180° conduction

Figure 2

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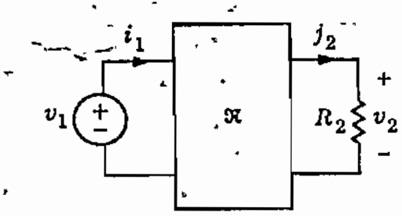
4. (a) Shown in Fig.3 is the resonance curve [Z(jw) in ohms versus w in rad/sec] of a parallel RLC circuit. Find R, L, and C.(5%)
   (b) The same resonance behavior is desired around a center frquency of 30 kHz. The maximum value of Z(jw) is to be 0.2$M\Omega$. Find the new values of R, L, and C. (5%)

5. Consider the linear time-invariant LC circuit shown in Fig.4. Before time t=0 the switch is open, and the voltage across the capacitors are v_1=2 and v_2=5 volts. The switch is close at time t=0 and remain in this condition for a time interval of 2π sec. The switch is opened at t=2π sec and remains open thereafter. What are the values of v_1 and v_2 for $t > 2\pi$ sec? Sketch the state trajectory in the $i_L v_c$ plane ($v_c = v_2 + v_1$). (15%)

6. The network $\mathfrak{N}$ shown in Fig.5 is made of n-2 linear time-invariant resistors. Voltage and current measurements were taken for two values of R2 and the input. The measurements are tabulated in the figure. Determine the value $\hat{v}_2$.(10%)

7. Find the zero-input response[that is, v_1(t) and v_2(t), for t ≥ 0] of the networks in Fig.6.(15%)



With R_2 = 1 Ω	With $\hat{R}_2$ = 2 Ω
v_1 = 4 volts	$\hat{v}_1$ = 6 volts
i_1 = 1 amp	$\hat{i}_1$ = 1 amp
v_2 = 1 volt	$\hat{v}_2$ = ?

Fig. 5

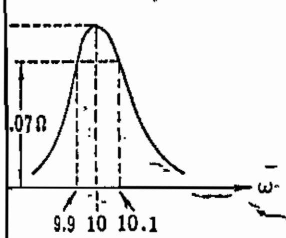
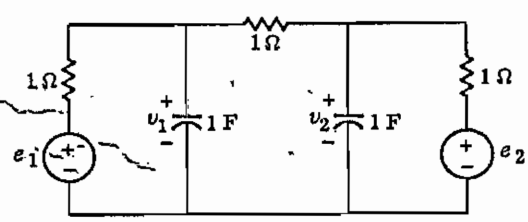
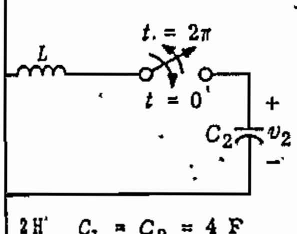


Fig.3



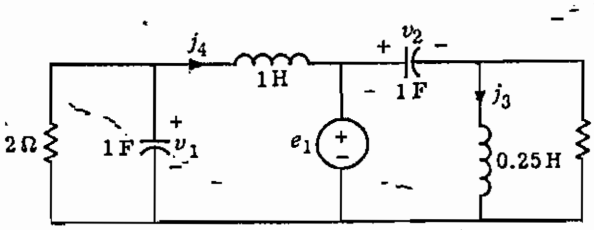
$v_1(0)$ = 2 volt
$v_2(0)$ = 2 volt

(a)



2H　C_1 = C_2 = 4 F

Fig. 4



(b)

$v_1(0)$ = 0　　$v_2(0)$ = 2 volts　　$j_3(0)$ = 5 amp　　$j_4(0)$ = 2 amp

Fig. 6

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八十四學年度研究所碩士班入學考試試題

所別：電機工程技術研究所
電子與資訊工程技術研究所
科目：電子學

1. (a) Explain how to classify power amplifiers of class A, class B, class AB, and class C? (8 %)

   (b) Give an example to illustrate the application of Miller's Theorem? (7 %)

2. (a) Consider the circuit shown in Figure 1(a), in which the devices are assumed to have $V_t = 1$ V, $K = 100\ \mu A/V^2$, and $V_A = 10$ V. If $I_{REF} = 100\ \mu$A and $V_{SS} = 0$ V, then what value of I_o will result? (10 %)

   (b) If the circuit in Figure 1(a) is modified to that in Figure 1(b), what value of I_o results? (5 %)

3. For each of the circuits shown in Figure 2:

   (a) Determine the value of feedback ratio β. (5 %)

   (b) Assume that the loop gain $A\beta$ approaches infinity. What is the gain of the amplifier? What values do the input and the output resistances approach (0 or infinity)? (15 %)

4. Figure 3 shows a circuit suitable for op amp applications. For all transistor $\beta = 100$, $V_{BE} = 0.7$ V, and $r_0 = \infty$.

   (a) For inputs grounded and output held at 0 V (by negative feedback) find the emitter currents of all transistors. (5 %)

   (b) Calculate the gain of the amplifier with a load of 10 kΩ. (5 %)

   (c) With load as in (b) calculate the value of the capacitor C required for a 3-dB frequency of 1 kHz. (5 %)

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科目：電子學

5. Consider the bandpass circuit shown in Figure 4. Let $C_1 = C_2 = C$, $R_3 = R$, $R_4 = R/4Q^2$, $CR = 2Q/\omega_0$, and $\alpha = 1$. Disconnect the positive input terminal of the op amp from ground and apply V_i through a voltage divider R_1, R_2 to the positive input terminal. Analyze the circuit to find its transfer function V_o/V_i. Find the voltage-divider ratio $R_2/(R_1 + R_2)$ so that the circuit realizes (a) an all-pass function and (b) a notch function. Assume the op amp to be ideal. (15 %)

6. An inverter that can be characterized by Figure 5 has $V^+ = 5$ V, $R_L = 1$ kΩ, and $R_{on} = 100$ Ω. It is loaded by a similar inverter whose switching threshold is at 2 V, by means of a connection whose capacitance to ground is 50 pF. If both switches exhibit a pure delay of 10 ns from the moment their input signal threshold is crossed, how long does it take for an input step to open the switch of the second inverter? to close it? (20 %)

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科目：電子學

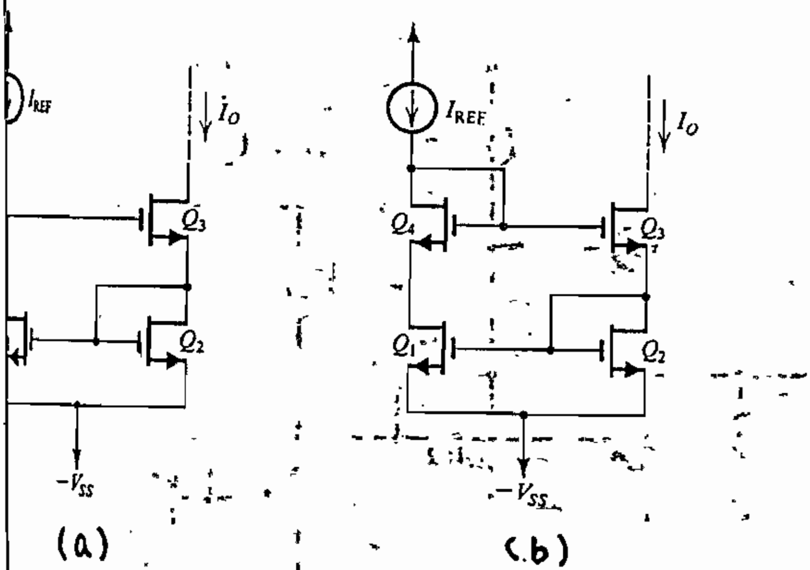

Figure 1

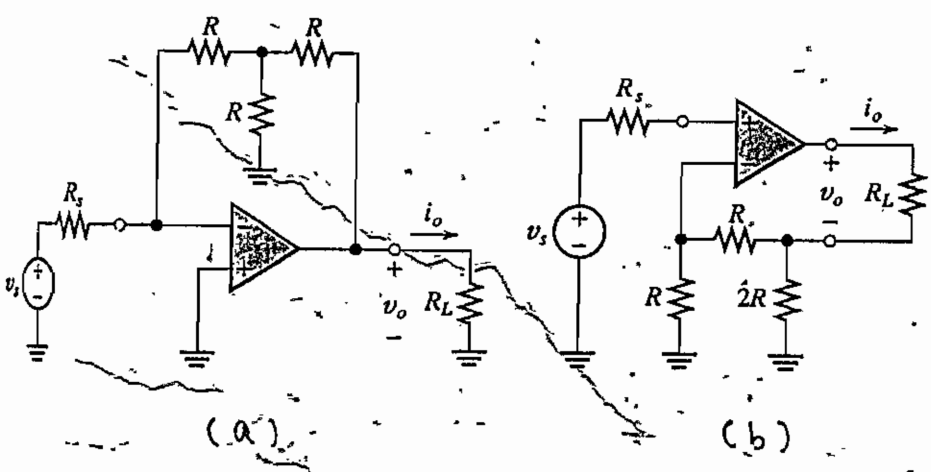

Figure 2

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所別：電機工程技術研究所、電子與資訊工程技術研究所

科目：電子學

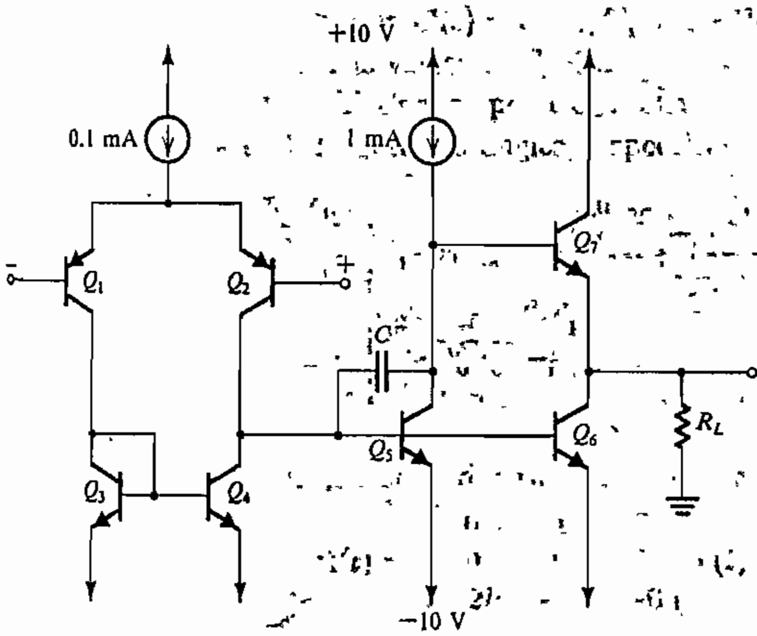

Figure 3

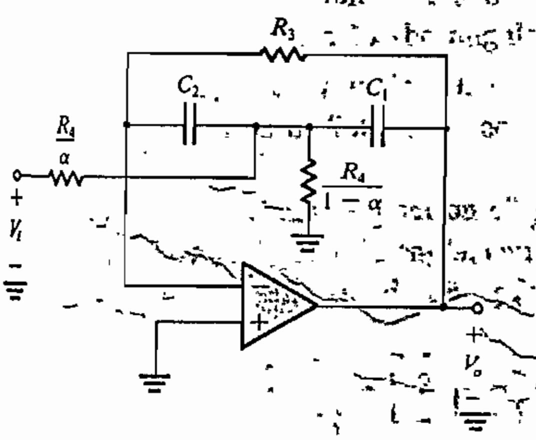

Figure 4

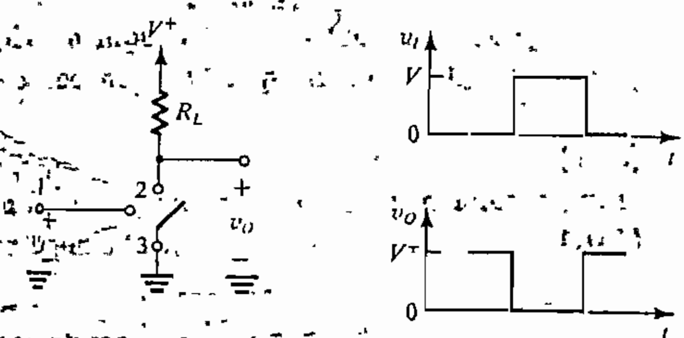

Figure 5

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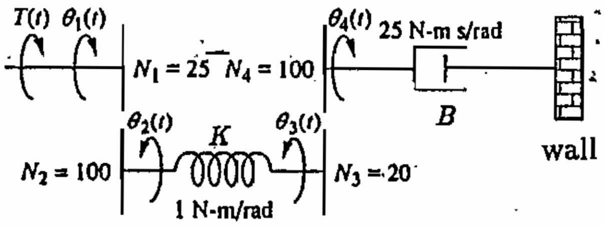
八十四學年度研究所碩士班入學考試試題

所別：電機工程技術研究所
科目：自動控制

1. Find the transfer function $G(s) = \theta_4(s)/T(s)$, for the rotational mechanical system shown in Figure 1. The values of T, K and B are the torque, spring constant and coefficient of viscous friction, respectively. The N_i and θ_i, $i = 1, \cdots, 4$ are the gears with N_i teeth and the rotation angles, respectively. (15%)



$B = 25$ N-m s/rad

$K = 1$ N-m/rad

Figure 1

2. Given the closed-loop system described by the dynamics equations

$$\dot{\mathbf{x}}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2k & -11 & -6 \end{bmatrix} \mathbf{x}(t) + \begin{bmatrix} 0 \\ 0 \\ k \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \mathbf{x}(t)$$

(a) Find the value of k and the frequency, w_o, of oscillation for the system is marginally stable ? (8%)

(b) Find the $x(t)$ when k=1 for the unit step input with $x(0) = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$? (7%)

3. Consider the position control system shown in Figure 2. The transfer function of the applied voltage to the angular displacement $\frac{k_m}{s(\tau_m s+1)}$ of a motor and load is obtained by measurement. If we apply an input of $u(t) = 110$ volt, the speed $\frac{dy}{dt}$ is measured as 34.7666 rad/sec at 0.5 seconds. The speed eventually reaches 55 rad/sec.

(a) Find the transfer function of $\frac{k_m}{s(\tau_m s+1)}$ (10%)

(b) If k_1 and k_2 is adjustable, can you find a k_1 and a k_2 so that the damping ratio equals 0.7 and the damping factor equals to 2. (10%)

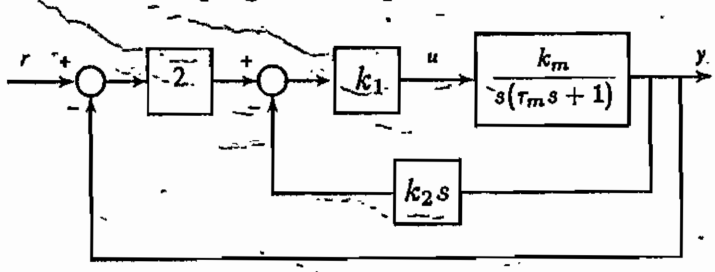


Figure 2

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所別：電機工程技術研究所
科目：自動控制

4. The block diagram of a control system with state feedback is shown in Fig. 3 Find the real feedback gains g1, g2, and g3 so that (10%)
- the steady-state error e_{ss} (e(t) is the error) due to a step input is zero, and
- the complex roots of the characteristic equation are at -1 + j and -1 - j.

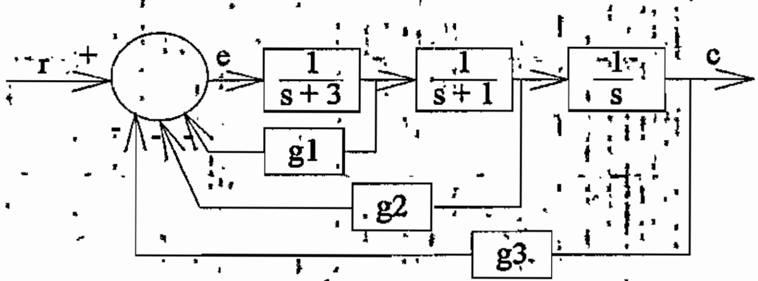

Fig. 3

5. The block diagram of a sampled-data control system is shown in Fig. 4 where data hold makes use of the zero-order hold (ZOH). The sampling period is T = 0.1 second.
(a) Find the values of K so that the system is asymptotically stable at the sampling instants. (15%)
(b) For K = 10, compute the unit-step response c(nT) for n = 0, 1, 2, 3. (10%)

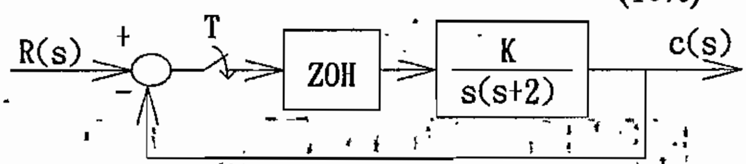

Fig. 4

6. Fig. 5 shows the block diagram of a unity-feedback control system with a series controller Gc(s). The Bode plots of the process Gp(s) is shown in Fig. 6. Design a single-stage phase-lag controller with the transfer function

$$Gc(s) = Kc\frac{1+aTs}{1+Ts} \quad a<1,\ Kc>0$$

so that the compensated system satisfies the following specifications; (15%)
- Ramp-error constant Kv = 20; or the magnitude of the steady-state error of the system due to a unit-ramp input, is 0.05 rad/rad/sec
- Phase margin PM ≥ 70°

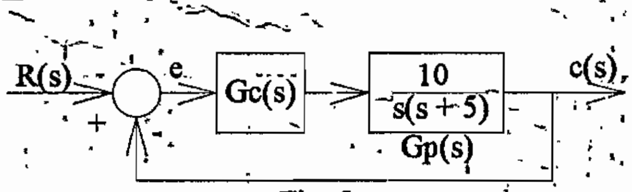

Fig. 5

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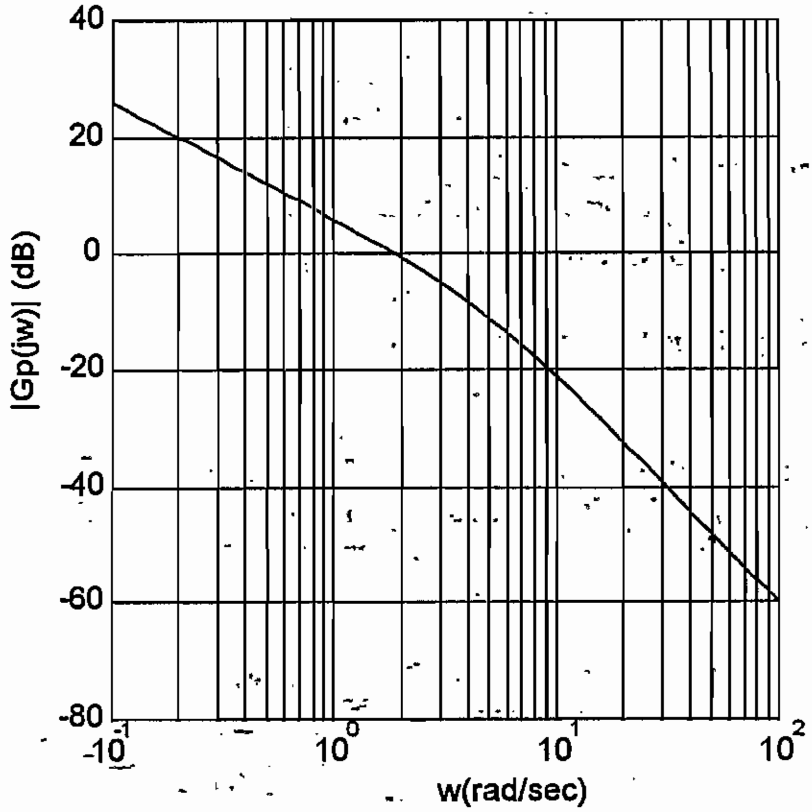
八十四學年度研究所碩士班入學考試試題 科目：自動控制



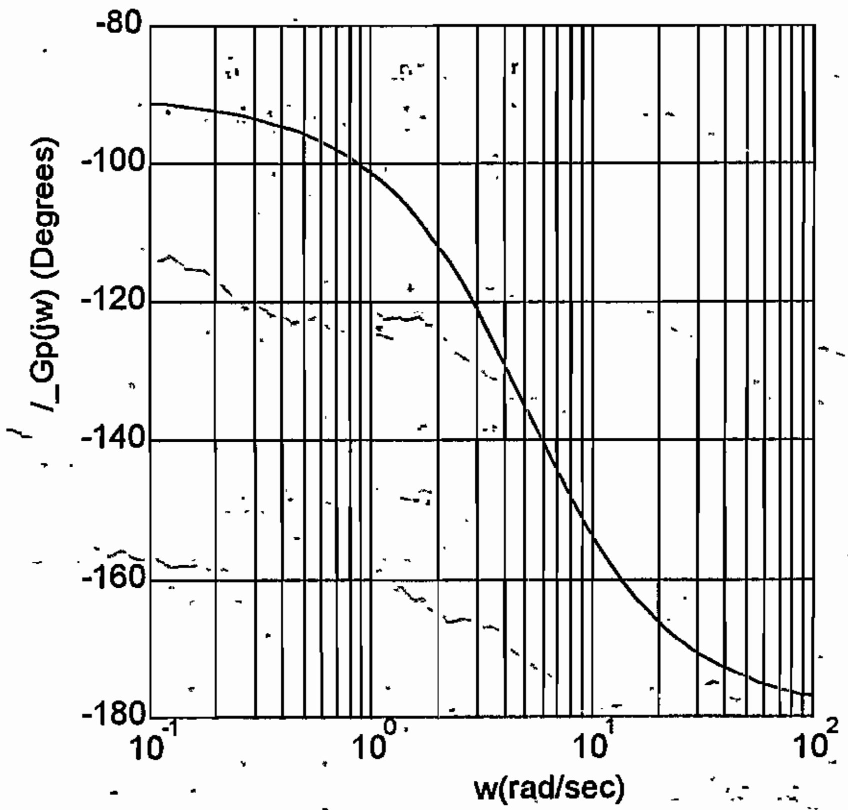


Fig. 6 Bode diagram of Gp(s) = 10/[s(s+5)]

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所別：電機工程技術研究所

科目：通信理論

(20%) QUESTION 1

4% (a) Explain the definition of noise figure.

4% (b) Explain what is ISI and why ISI occurs?

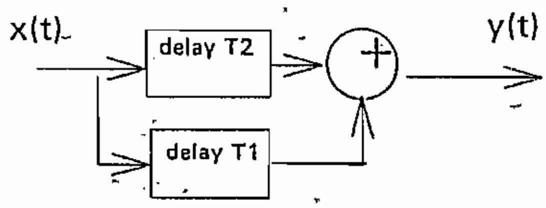
4% (c) Explain the frequency-selective fading effect in digital transmission. List methods which are usually used to overcome it.

4% (d) What is the definition of root-meam-squared bandwidth, and explain the time-bandwidth relation.

4% (e) Explain the difference between coherent and noncoherent demodulations.

(15%) QUESTION 2

A stationary random signal $X(t)$ has the power spectral density $S_x(f)$ and autocorrelation function $R_x(\tau)$. Suppose $X(t)$ is passed through the following system:



5% (a) Find the transfer function of the system.

5% (b) Find the autocorrelation function, $R_y(\tau)$, of the output $Y(t)$.

5% (c) Find the power spectral density, $S_y(f)$, of the output $Y(t)$.

(20%) QUESTION 3

5% (a) Derive the Hilbert transform of the signal $m(t) = \Pi(t/2)$, where Π is defined as follows.

$$\Pi(t) = \begin{cases} 1, & -1/2 \le t \le 1/2 \\ 0, & \text{otherwise} \end{cases}$$

5% (b) Express the SSB-modulated $m(t)$.

5% (c) Use the result obtained in part (a) to get the Hilbert transform of $M(t)$, where $M(t)$ is given as follows.

$$M(t) = \sum_{n=-\infty}^{\infty} (-1)^n \Pi\left(\frac{t}{2} - n\right)$$

5% (d) If $M(t)$ is transmitted by SSB-SC and the demodulator local oscillator has a phase error of θ degree, what is the demodulator output?

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(20%) QUESTION 4

A stationary random process x(t) is defined as

$$X(t) = A\cos(w_0 t + \Theta), \text{for } t \text{ is finite}$$

where Θ having the density function

$$f_\Theta(\theta) = \begin{cases} \frac{2}{\pi}, & 0 \le \theta \le \frac{\pi}{2} \\ 0, & \text{otherwise} \end{cases}$$

5% (a) Find the mean of $X(t)$.

5% (b) Find the variance of $X(t)$.

5% (c) Find the autocorrelation function of $X(t)$.

5% (d) Is it an ergodic random process? why?

(15%) QUESTION 5

A signal to be quantized is given by

$$s(t) = 20 \cos 100\pi t + 17 \cos 500\pi t$$

Assuming a uniform quantization error, how many bits of quantization are required so that the signal to quantization noise ratio is greater than 50dB?
[NOTE: The signal to quantization ratio is defined as the average signal power divided by the mean square quantization error.]

(10%) QUESTION 6

Consider phase-shift keying with a carrier component which can be written as

$$x_c(t) = A_c \sin[2\pi f_c t + d(t) \cos^{-1} a]$$

where $d(t)$ is binary data which is ±1-valued in contiguous T_b-second bit intervals. Find the ratio of powers in the carrier and in the modulation components.