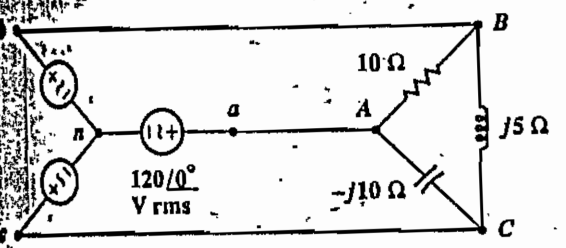
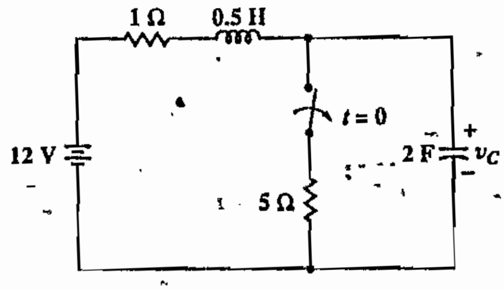
國立雲林技術學院　　所別：電機工程技術研究所

八十五學年度研究所碩士班入學考試試題　　科目：電路學

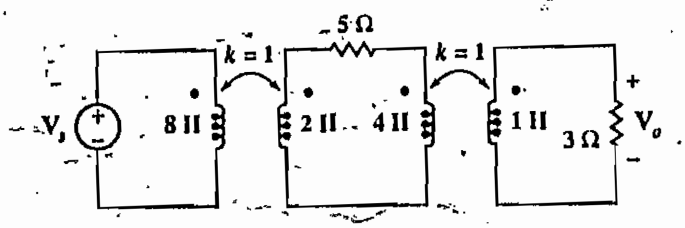
1. 圖一中之三相電壓源爲平衡且爲正相序，試求 (a) I_{aA} (8%)，(b) I_{bB} (8%)；(c) 電源所提供之總複數功率 (complex power) (9%)。
2. 圖二所示電路的開關接通已有一段很長的時間，而在 $t=0$ 時開關打開，試求 $t>0$ 時之 $v_C(t)$ (25%)。
3. 圖三所示電路之中，試求 $H(s)=V_o/V_s$ (25%)。
4. 某理想電壓源的電壓波形如圖四所示，若有一簡單之 R-L 串聯電路 (R=4Ω，L=2H) 以此電壓源供電時，試計算電源電流第五次諧波電流之有效值 (rms value) (25%)。



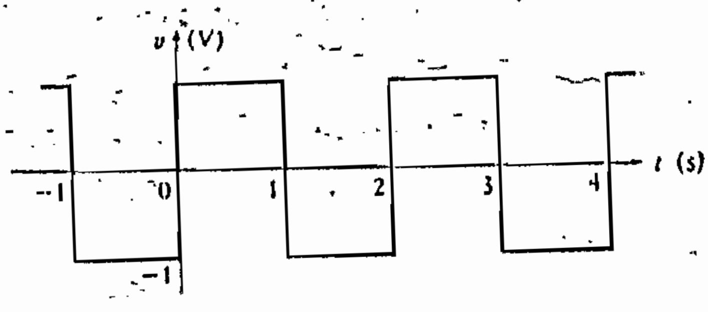
圖一



圖二



圖三



圖四

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1. Find the general solutions of the following equations

(a) $y' = \dfrac{y-x}{y+x}$ (10%)

(b) $x^3y''' - 3x^2y'' + 6xy' - 6y = x^4\ln(x)$ (15%)

2. Use the Laplace transform to solve the differential equation

$y'' + 2ty' - 4y = 1, \quad y(0) = y'(0) = 0$ (15%)

3. Solve the initial value problem

$$\begin{cases} 2y_1' - y_2' - y_3' = 0 \\ y_1' + y_2' = 4t + 2 \\ y_2' + y_3 = t^2 + 2 \end{cases}$$ (10%)

$y_1(0) = y_2(0) = y_3(0) = 0$

4. Consider the following ordinary differential equation:

$y'' + 0.02y' + 25y = r(t)$

where

$$r(t) = \begin{cases} t + \dfrac{\pi}{2} & \text{if } -\pi < t < 0 \\ -t + \dfrac{\pi}{2} & \text{if } 0 < t < \pi \end{cases}$$

and $r(t + 2\pi) = r(t)$

(a) Find the complex-Fourier series of $r(t)$. (5%)

(b) Find the steady-state solution $y(t)$. (8%)

5. The Fourier transform of a function f is defined by

$$F(j\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}\,dt$$

Find the Fourier transforms of the following functioms.

(a) $f(t) = \begin{cases} te^{-t} & \text{if } t > 0 \\ 0 & \text{if } t < 0 \end{cases}$ (5%)

(b) $f(t) = e^{-at^2} \quad (a > 0)$ (7%)

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Let

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

(a) Find an orthonormal basis for the column space of A. (5%)

(b) Find a basis for the orthogonal complement of column space of A. (5%)

(c) Find the orthogonal projection of the vector

$$\begin{bmatrix}1\\ -1\\ 0\\ 2\end{bmatrix}$$

on the column space of A which is a subspace of R^4. (5%)

Let

$$B=\begin{bmatrix}1 & -1\\ -4 & 4\end{bmatrix}$$

Define a linear operator on the space $M_{2\times2}(R)$ by $T(A)=BA$. (10%)

Find the nullity of T and a basis for the range space of T.

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1.(24%) Given matrix $A=\begin{bmatrix}2 & 2 & -1\\ 1 & 3 & -1\\ -1 & -2 & 2\end{bmatrix}$ with eigenvalues $\lambda=5,1$.

(a) For the eigenvalues, find the corresponding eigenvectors.

(b) Diagonalize matrix A.

(c) Find $A^{4.5}$.

2.(12%)

(a) Find an othornormal basis of the subspace spanned by the vectors below.

$$\begin{bmatrix}2\\ -5\\ 1\end{bmatrix},\quad \begin{bmatrix}4\\ -1\\ 2\end{bmatrix}$$

(b) Let $A=\begin{bmatrix}1 & -1\\ -1 & 2\\ 0 & 3\\ 2 & 5\end{bmatrix}$ and $\underline{b}=\begin{bmatrix}3\\ 1\\ -4\\ 2\end{bmatrix}$, find a least-squares solution of $A\underline{x}=\underline{b}$, and compute the associated least-squares error.

3.(14%)

(a) (5%) Find a spanning set for the null space of the matrix below.

$$\begin{bmatrix}1 & 5 & -4 & -3 & 1\\ 0 & 1 & -2 & 1 & 0\\ 0 & 0 & 0 & 0 & 0\end{bmatrix}$$

(b) (5%) Let V and W be vector spaces and let $T:V\rightarrow W$ be a linear transformation. Given a subspace U of V, let $T(U)$ denote the set of all images of the form $T(\underline{x})$, where $\underline{x}$ is in U. Show that $T(U)$ is a subspace of W.

(c) (4%) If A is a 6×8 matrix, what is the smallest possible dimension of $Nul\,A$?

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科目：線性代數與機率

4.(15%) If a random variable X is continuous, the mean square is given by the expectation

$$E[X^2] = \int_{-\infty}^{\infty} x^2\, p(x)dx$$

For any k > 0, show that $\text{prob}\{\,|X| \geq k\,\} \leq E[X^2]/k^2$

5.(15%) For the Poisson arrival process, let ti be the time of the ith arrival and suppose that Y time units have elapsed before the arrival of the next customer, as shown in Fig. 1. The probability that the next customer will arrive within r units of time is given by

$P[\,R \leq r \mid X \geq Y\,]$, where R = X - Y represents the remaining time until the next arrival. Show that $P[\,R \leq r \mid X \geq Y\,]$ is independent of Y.

(Hint: For the Poisson process

$$F_X(x) = 1 - e^{-\lambda x},\ x \geq 0$$

$$f_X(x) = F'_X(x) = \lambda e^{-\lambda x},\ x \geq 0$$

where λ represents the average arrival rate of customers)

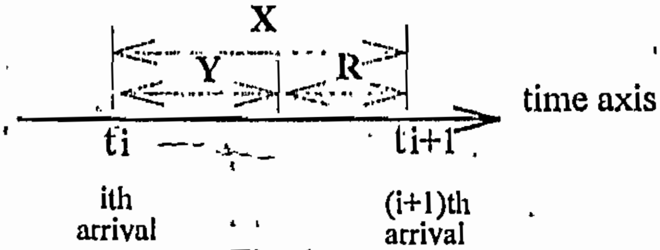

Fig. 1

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6.(20%) Let f(x) be a probability density function bounded by M and have a finite range, say $a \le x \le b$, as shown in Fig. 2. Let us generate pairs of random decimal numbers (R1, R2) between 0 and 1. Then

$X1 = a + (b - a)\,R1,$

is a random number in [a, b]. Whenever we encounter a pair (R1, R2) that satisfies the relationship

$M \cdot R2 \le f(X1),$

we accept X1 and reject otherwise. The probability density function of accepted X1's will then be f(x).

Let the number of trials before a successful pair is found is a random variable n,

(a) find the probability distribution of n (denoted by p[n]),

(b) find the mean value of n (denoted by E[n]).

(Hint: Try to find the acceptance ratio for one trial.)

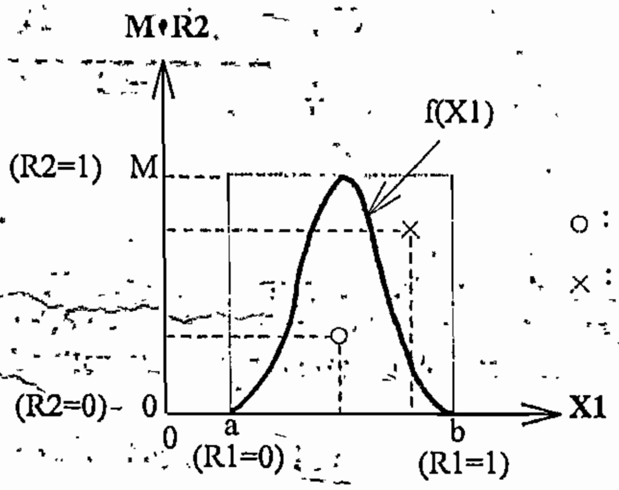

Fig. 2

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1. If a balanced three-phase load is connected to a balanced three-phase source. Show that the instantaneous power delivered to the load is constant. (5%)

2. In Fig.1 with the following notation

$V_1 = |V_1|e^{j\theta_1}$, $V_2 = |V_2|e^{j\theta_2}$, $\theta_{12} \triangleq \theta_1 - \theta_2$,
assume that $|V_1| = 1.05$, $|V_2| = 0.95$, $Z_{line} = 0.1\angle 85^o$.
Find (a) $P_{12\,max}$.
(b) θ_{12} at which we get $P_{12\,max}$.
(c) $-P_{21\,max}$.
(d) θ_{12} at which we get $-P_{21\,max}$.
(e) Active power loss in the line when $\theta_{12} = 10^o$. (10%)

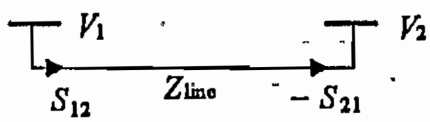

Fig.1

3. In Fig.2, assume that $V_1 = 1\angle 0^o$, $Z_{line} = 0.01 + j0.1$, $S_{D1} = S_{D2} = 0.5 + j0.5$
Pick Q_{G2} so that $|V_2| = 1$. In this case what are Q_{G2}, S_{G1}, and $\angle V_2$? (10%)

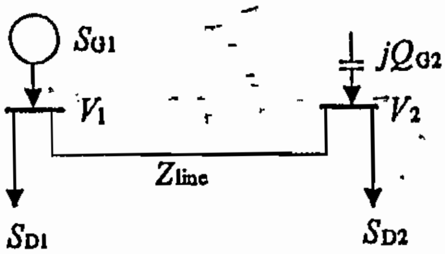

Fig.2

4. Given a 138 kV three-phase line with series impedance $z = 0.17 + j0.79$ Ω/mi and shunt admittance $y = j5.4 \times 10^{-6}$ mho/mi, find the characteristic impedance Z_c, the propagation constant γ, the attenuation constant α, and the phase constant β. (5%)

5. Given a transmission line described by

$$\begin{cases} V_1 = V_2 \cosh\gamma l + Z_c I_2 \sinh\gamma l \\ I_1 = I_2 \cosh\gamma l + \frac{V_2}{Z_c}\sinh\gamma l \end{cases}$$

we perform two tests and obtain the following results.
1. Open-circuit test ($I_2 = 0$): $Z_{oc} = \frac{V_1}{I_1} = 800\angle -89^o$
2. Short-circuit test ($V_2 = 0$): $Z_{sc} = \frac{V_1}{I_1} = 200\angle 77^o$

Find the characteristic impedance Z_c and find γl. (10%)

6. Consider a system with the one-line diagram shown in Fig.3. The 3ϕ and line-line ratings are given below.

Generator : 30 MVA, 13.8 kV, $X_s = 0.10$ p.u.
Motor : 20 MVA, 13.8 kV, $X_s = 0.08$ p.u.
T_1 : 20 MVA, 13.2-132 kV, $X_l = 0.10$ p.u.
T_2 : 15 MVA, 138-13.8 kV, $X_l = 0.12$ p.u.
Line : $20 + j100\ \Omega$ (actual)

(a) Draw an impedance diagram for the system. Pick the generator ratings for the bases in the generator section.

(b) Using the impedance diagram in part (a), assume that the motor voltage is 13.2 kV when the motor draws 15 MW at a power factor of 0.85 lagging. Find the following quantities in per unit: motor current, transmission-line current, generator current, generator terminal voltage, sending-end transmission-line voltage, and complex power supplied by generator.

(c) Convert the per unit quantities found in part (b) into actual units (i.e., amperes, volts, and volt-amperes). (15%)

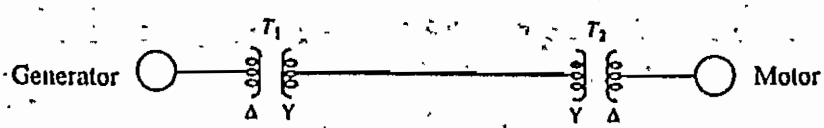

Fig.3

7. In Fig.4, all the transmission links are the same and each is modeled by the Π-equivalent circuit shown; the element values are impedances. Find the bus admittance matrix Y_{bus}. (5%)

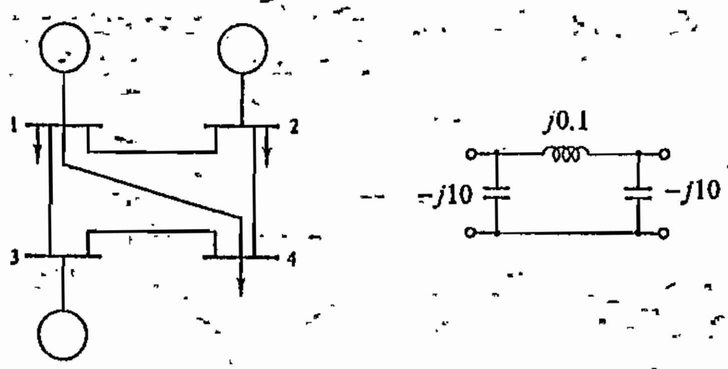

Fig.4

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8. We are given the system shown in Fig.5 and the following equations for bus powers:

$$S_1 = j19.98|V_1|^2 - j10V_1V_2^* - j10V_1V_3^*$$
$$S_2 = -j10V_2V_1^* + j19.98|V_2|^2 - j10V_2V_3^*$$
$$S_3 = -j10V_3V_1^* - j10V_3V_2^* + j19.98|V_3|^2$$

Do one step of Gauss-Seidel iteration to find V_2^1 and V_3^1. Start with $V_2^0 = V_3^0 = 1\angle 0^o$. (10%)

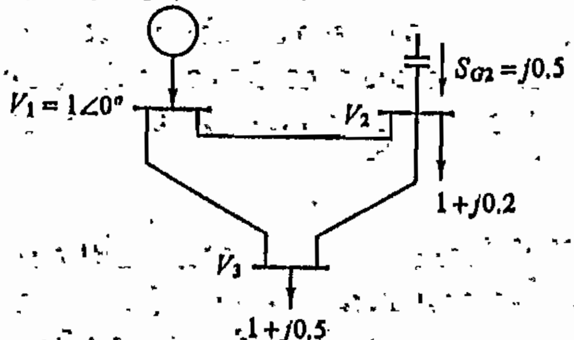


Fig.5

9. Two generating units supply a system.

Incremental costs: $IC_1 = 0.012P_{G1} + 8.0$ dollars/MWh
$IC_2 = 0.018P_{G2} + 7.0$ dollars/MWh

Generator limits: $100\text{ MW} \le P_{G1} \le 650\text{ MW}$
$50\text{ MW} \le P_{G2} \le 500\text{ MW}$

(a) Find the system λ for optimal operation when $P_{G1} + P_{G2} = P_D = 600$ MW. Find P_{G1} and P_{G2}.

(b) Suppose that P_D increases by 1 MW (to 601 MW). Find the extra cost in dollars/hr. (10%)

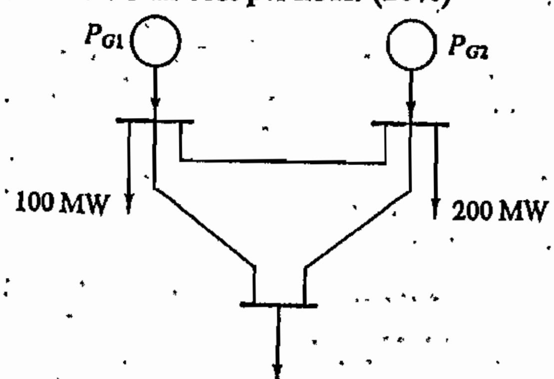
10. Consider the system shown in Fig.6, given that

Incremental costs: $IC_1 = 0.007P_{G1} + 4.1$ dollars/MWh
$IC_2 = 0.007P_{G2} + 4.1$ dollars/MWh

Loss coefficients: $B_{11} = 0.1 \times 10^{-2}$ MW^{-1}
$B_{12} = B_{21} = -0.005 \times 10^{-2}$ MW^{-1}
$B_{22} = 0.13 \times 10^{-2}$ MW^{-1}

(a) Find the optimal dispatch P_{G1} and P_{G2} in MW.

(b) Suppose that with optimal dispatch, $P_D = P_{D1} + P_{D2} + P_{D3}$ is increased by 1 MW. Find the additional cost per hour. (20%)



$$P_L = \sum_{i=1}^{2}\sum_{j=1}^{2} B_{ij}P_iP_j$$

Fig.6

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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

1.(a) For the circuit in Fig. 1, find I_{O1} and I_{O2} in terms of I_{REF}. Assume all transistors to be matched with current gain β. (10 %)
(b) Use this idea to design a circuit that generates currents of 1, 2, and 4 mA using a reference current source of 7 mA. What are the actual values of the current generated for $\beta = 40$. (10 %)

2. The JFET in the amplifier circuit in Fig. 2 has $V_p = -4$ V and $I_{DSS} = 12$ mA, and $I_D = 12$ mA, the output resistance $r_o = 25$ kΩ.
(a) Determine the dc bias quantities V_G, I_D, V_{GS}, and V_D. (10 %)
(b) Determine the value of g_m (you can use the same formula as for the enhancement MOSFET). Also determine r_o. (10 %)
(c) Find the overall voltage v_o/v_i. (10 %)

3. For the circuit in Fig. 3, let $R_1 = R_2 = R_L = 10\,k\Omega$, and assume that the op amps to be ideal except for output saturation at ± 12 V. When conducting a current of 1 mA each diode exhibits a voltage drop of 0.7 V, and this voltage changes by 0.1 V per decade of current change. Find the values of v_o, v_E and v_F corresponding to $v_I = 0.1$ V. (20 %)

4. For the circuit in Fig. 4, if $R = 10\,k\Omega$, find the values of C and R_f to obtain sinusoidal oscillation at 10 kHz. (20 %)

5. Find the logic function implemented by the circuit shown in Fig. 5. (10 %)

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八十五學年度研究所碩士班入學考試試題　科目：電子學

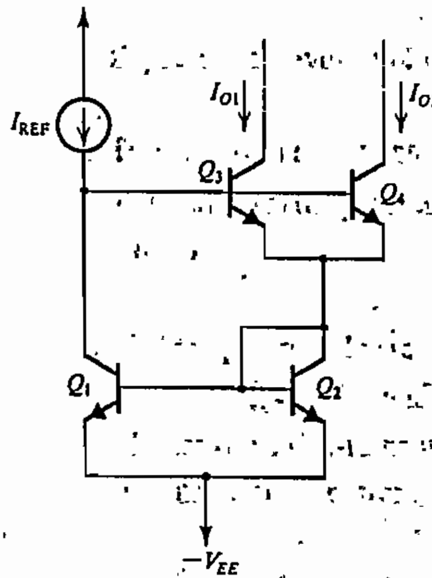

Fig. 1

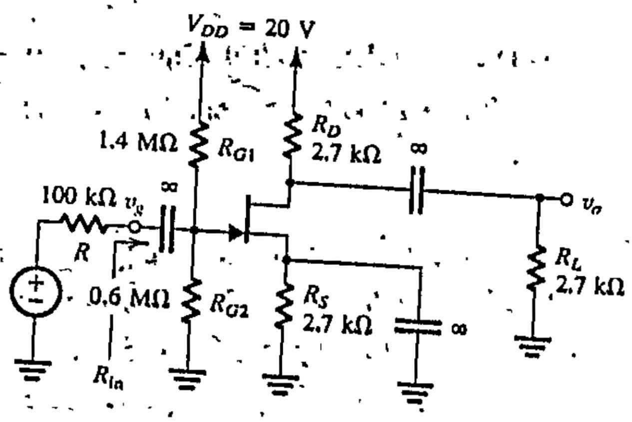

Fig. 2

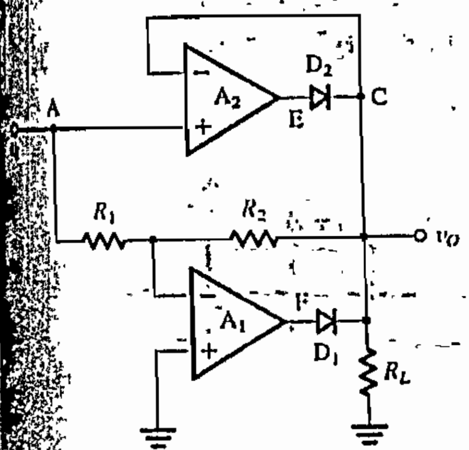

Fig. 3

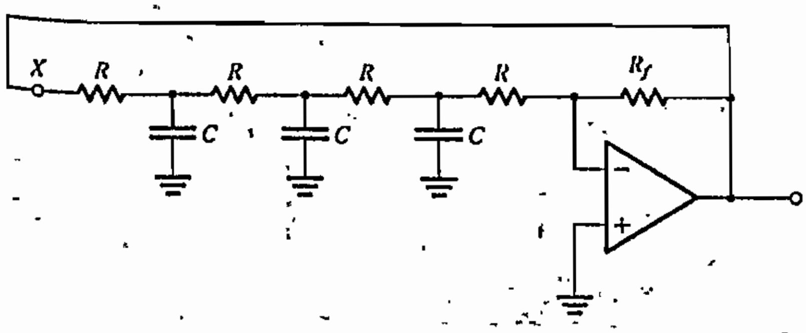

Fig. 4

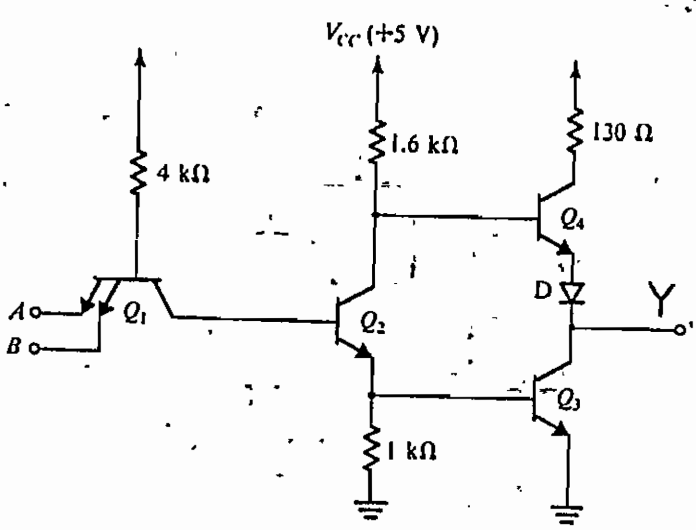

Fig. 5

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所別：電機工程技術研究所
科目：電力電子學

1. Express the waveform in Fig. 1 in Fourier series. (10%)

2. The circuit in Fig. 2 has V_0=300V, C=10μF, L=40μH. If the switch is closed at t=0, determine (a) the peak current through the diode, (b) the conduction time of the diode. (10%)

3. A three-phase bridge rectifier supplies a highly inductive load such that the average load current is I_{dc}= 45A and the ripple cintent is negligible. Determine the ratings of the diodes if the line-to-netural voltage of the wye-connected supply is 120V at 60Hz. (Hints: average current, rms current, peak inverse voltage) (15%)

4. The single-phase ac voltage controller in Fig. 3 has a resitive load of R=10Ω and the input voltage is V_s=120V,60Hz. The delay angle of thyristors is $\alpha=\pi/3$. Determine V_o(rms output voltage), PF(input power factor), I_R(rms current of T_1), I_A(average current of T_1). (15%)

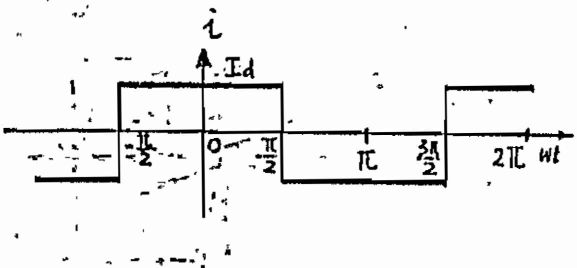

Fig. 1

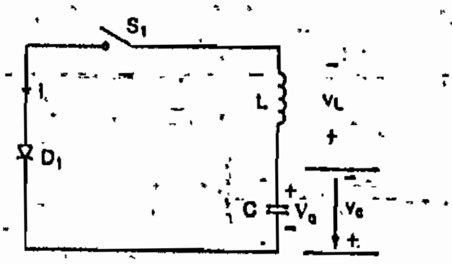

Fig. 2

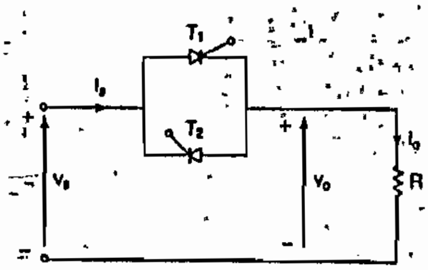

Fig. 3

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5. Figure 4 shows the reverse recovery characteristics of junction diode, if trr=3us and di/dt=20A/us. Determine the (a) storage charge Qrr(5%) (b) I_{RR} (5%) (If t_b is negligible as compared to t_a.)

6. Two MOSFETS which are connected in parallel similar to Fig. 5 carry a total current of I_T=20A. The drain-to-source voltage of switch S1 is V_{DS1}=2.5V and that of switch S2 is V_{DS2}= 3V. Determine the drain current of each switch and difference in current sharing if the current sharing resistances are (a) Rs1=0.2Ω and Rs2=0.3Ω.(8%) (b) Rs1=Rs2=0.6Ω.(7%)

7. About the pulse-width modulation scheme of the inverter(as shown in Figure 6) :
The amplitude modulation ratio m_a is defined as $m_a=\frac{\hat{V}_{control}}{\hat{V}_{tri}}$, where $\hat{V}_{control}$: peak amplitude of the control signal, $\hat{V}_{tri}$: amplitude of the triangular. The frequency modulation ratio m_f is defined as $m_f=\frac{f_s}{f_1}$, where fs: the switching frequency of the triangular, f1:the frequency of the $V_{control}$.
(a) What is the relation between f1 and the frequency of the inverter output?(5%) (b)Give the relation of the fundamental-frequency component $(v_{AO})_1$ and the input Vd (for $m_a \le 1$). (10%)
(c) Draw the diagram of $\frac{(\hat{v}_{AO})_1}{(\frac{Vd}{2})}$ vs. m_a.(10%)

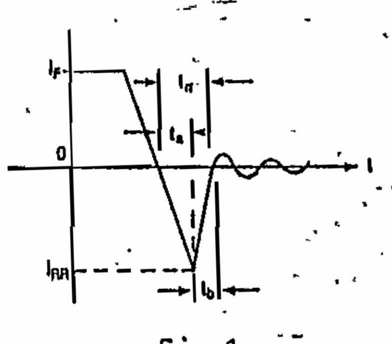
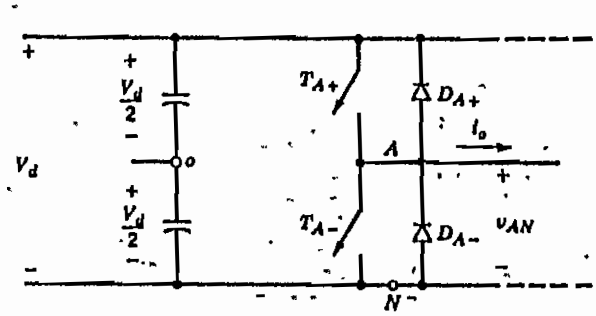


fig. 4



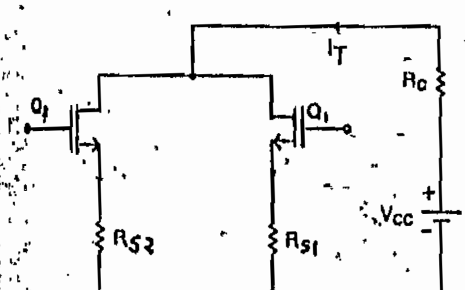


fig. 5

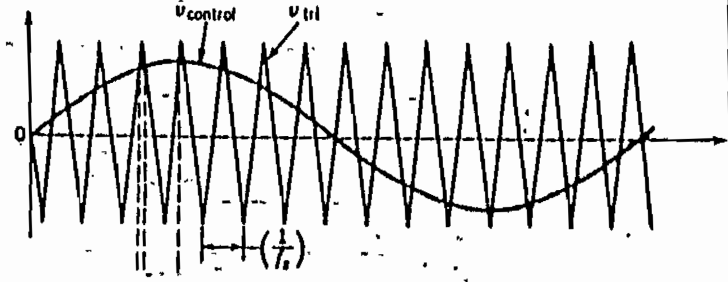


fig. 6

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1. A linear translational system is shown in Figure 1. (15%)
   (a) Write the dynamical equation (5%)
   (b) Draw the state diagram. (5%)
   (c) Find the transfer function from the state diagram. (5%)

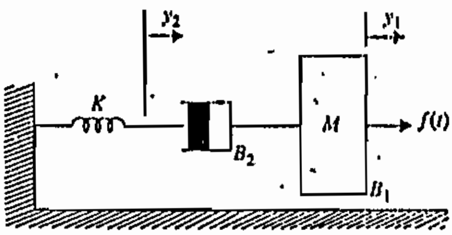

Figure 1

2. Given a dynamical system as follows: (15%)

$$\dot{x}(t) = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & 0 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u(t), \quad y(t) = [\,1 \;\; 3 \;\; 1\,]\, x(t).$$

   (a) Is the zero state asymptotically stable ? Why ? (5%)
   (b) Is the zero–state BIBO stable ? Why ?(5%)
   (c) Is the system total stable ? Why ?(5%)

3. (a) Give the concept of gain margin and phase margin. (10%)
   (b) Given the unity feedback system with $M(s) = 10k/[(s+2)(s+4)(s+5)]$ and the Bode diagram in Figure 2, determine the stable region. (5%)
   (c) As $k = 10$, find the gain margin. (5%)

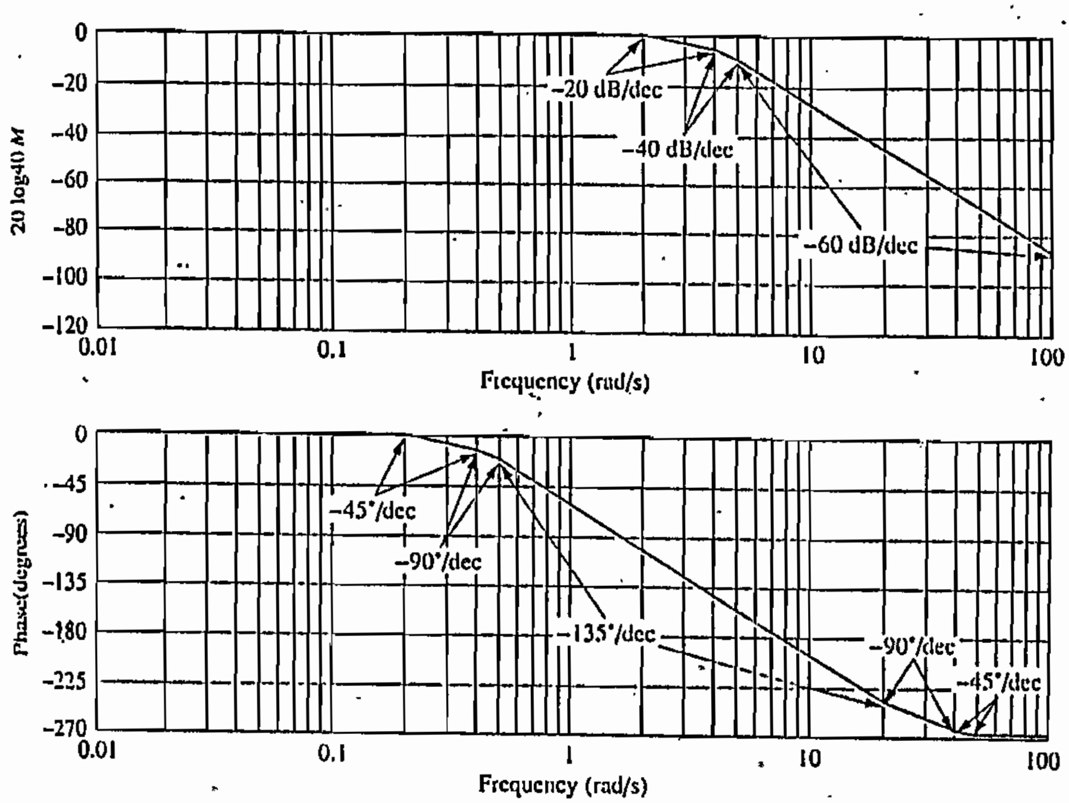

Figure 2

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4. The block diagram of a unity-feedback control system is shown in Figure 3. (20%)
   (a) When $k=1$, determine the maximum time delay T_d in seconds for the closed-loop system to be stable. (10%)
   (b) When the time delay $T_d = 0.3$ sec., find the maximum value of k for system stability. (10%)

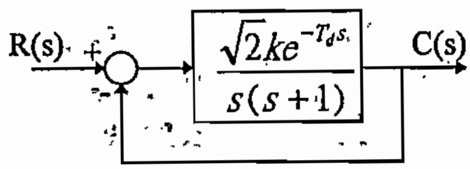

Figure 3

5. A regulator system has the input-output transfer function

$$\frac{Y(s)}{U(s)} = \frac{20}{(s+1)(s+2)(s+3)}$$

Define state variables as

$$x_1(t) = y(t)$$
$$x_2(t) = \dot{x}_1(t)$$
$$x_3(t) = \dot{x}_2(t)$$

and state vector $X(t) = [x_1(t) \quad x_2(t) \quad x_3(t)]^T$. By use of the state feedback control $u = -KX(t)$, where $K = [k_1 \quad k_2 \quad k_3]$, it is desired to place the closed-loop poles at $s = -2 \pm j4$, $s = -10$.

(a) Write the state equations of the system. (5%)
(b) Determine the state feedback gain matrix K. (10%)

6. Figure 4 shows the block diagram of a unity-feedback control system with a series controller $G_c(s)$. The transfer function of the controlled processor is

$$G_p(s) = \frac{400}{s(s^2+30s+200)}$$

The frequency response of this function is given in Table 1. Design a phase-lead controller with the transfer function

$$G_c(s) = K_c \frac{1+aTs}{1+Ts} \quad a>1,\ K_c>0$$

so that the following specifications are satisfied: (15%)

- velocity error constant, $K_v = 10$ sec^{-1}.
- phase margin, PM≥42°.

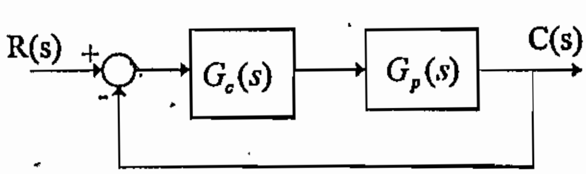

Figure 4

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Table 1 Frequency Response for $G_p(s)$

ω(rad/sec)	$\lvert G_p(j\omega)\rvert$(dB)	$\angle G_p(j\omega)$(deg)	ω(rad/sec)	$\lvert G_p(j\omega)\rvert$(dB)	$\angle G_p(j\omega)$(deg)
0.1000	26.0201	-90.8594	9.2000	-16.7520	-157.3165
0.2565	17.8353	-92.2041	9.6690	-17.4658	-159.8373
0.4806	12.3724	-94.1281	10.2400	-18.3110	-162.7918
0.6579	9.6339	-95.6481	11.2300	-19.7204	-167.6300
0.9006	6.8861	-97.7245	12.3000	-21.1725	-172.4801
1.2328	4.1208	-100.5552	13.1034	-22.2190	-175.8822
1.9540	-0.0019	-106.6364	14.1400	-23.5192	-179.9918
2.3101	-1.5354	-109.5965	15.1991	-24.7940	-183.8909
3.1623	-4.5006	-116.5335	20.8057	-30.7945	-200.4605
4.3288	-7.6515	-125.6195	28.4804	-37.4775	-215.5749
5.9255	-11.1062	-137.1521	38.9860	-44.7047	-228.4556
7.4940	-13.9799	-147.3889	53.3670	-52.3158	-238.8427
8.1113	-15.0182	-151.1223	73.0527	-60.1715	-246.8944

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Note: There are six problems in the test. You may find the following identities useful:

$$\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y$$
$$\cos(x \pm y) = \cos x \cos y \mp \sin x \sin y$$

1. (20%) Consider a flat-topped PAM wave produced by the modulating signal $m(t) = A_m \cos(2\pi f_m t)$ assuming a modulating frequency $f_m = 0.25$ Hz, sampling period $T_s = 1$ s, and pulse duration $T = 0.45$ s.

(a) (5%) Assume the modulating signal is sampled at $t = \ldots, -1, 0, 1, \ldots$ s. Sketch the modulated signal.

(b) (15%) Find the Fourier transform of the PAM wave.

2. (15%) Consider the SSB-SC signal

$$v(t) = \sum_{i=1}^{N} [\sin(2\pi f_c t)\cos(2\pi f_i t + \theta_i) - \cos(2\pi f_c t)\sin(2\pi f_i t + \theta_i)],$$

where f_c is the carrier frequency. Assume $f_i << f_c$, for $i = 1, \ldots, N$.

(a) (3%) Is it the lower or upper sideband?

(b) (6%) Obtain the expression for the DSB-SC signal.

(c) (6%) What is the original message signal?

3. (15%) Consider a narrowband FM signal $v(t) = \cos[2\pi f_c t + \beta \sin(2\pi f_m t)]$, with $\beta << 1$ and $f_m << f_c$.

(a) (5%) Find the approximate bandwidth of $v(t)$.

(b) (5%) Let $v(t)$ be applied as the input to a device whose output is $v^2(t) + v(t) + 1$. Determine the expression for the output of the device.

(c) (5%) How can we get another FM signal that has twice the frequency deviation of $v(t)$.

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4. (15%) A zero-mean Gaussian white noise that has the spectral density $N_0/2$ W/Hz is passed through an ideal lowpass filter with transfer function $H(f) = 1$, for $|f| \le B$.

(a) (5%) Find the autocorrelation function of the output.

(b) (5%) Write the probability density function (pdf) of the output at time t_0, where t_0 is arbitrary.

(c) (5%) Write the joint pdf for the output at times t_0 and $t_0 + 1/(2B)$.

5. (15%) A binary wave uses on-off signaling to transmit symbols 1 and 0; symbol 1 is represented by a rectangular pulse of amplitude A and duration T_b. The additive white Gaussian noise (AWGN) at the receiver input has zero mean and power spectral density $N_0/2$. Assuming that symbols 1 and 0 occur with equal probability.

(a) (7%) Determine and sketch the optimal receiver structure.

(b) (8%) Find an expression for the average probability of error at the receiver output.

6. (20%) Consider a (7,4) cyclic code. Assume that (1101000) is already known to be one of the codewords.

(a) (7%) Find all of the codewords of this code.

(b) (6%) Determine the minimum distance and error correcting capability of this code.

(c) (7%) If (1011010) is received at the receiver, determine the decoder output.