國立雲林技術學院　所別：電機工程技術研究所

八十六學年度研究所碩士班入學考試試題　科目：工程數學（乙組）

考試範圍：微分方程、拉氏轉換、線性代數、傅氏轉換。

1. Solve the following ordinary differential equations.

   (a) $\dfrac{dy}{dx}+1=4e^{-y}\sin(x)$ (10%)

   (b) $yy''+3(y')^2=0$ (15%)

2. Find the Laplace transform of the function

   $$f(t)=\int_0^t \tau\sin(3\tau)\sinh(\tau)\,d\tau$$ (10%)

3. Solve the following problem using the Laplace transform

   $$y''+8ty'-8y=0;\quad y(0)=0,\quad y'(0)=-4.$$ (15%)

4. The Fourier transform of a function f is defined to be

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

   Find the Fourier transform of the function.

   (a) $f(t)=3e^{-4|t+2|}$ (10%)

   (b) $f(t)=\dfrac{t}{4+t^2}$ (10%)

5. Let

   $$A=\begin{bmatrix}1 & -2 & 1 & 0\\ 2 & 1 & 1 & 2\\ 1 & -7 & 2 & -2\end{bmatrix}$$

   (a) Find a basis for the column space of A. (8%)

   (b) Describe the set of all vectors $\mathbf{b}=[a \quad b \quad c]^T\in R^3$ for which the linear system $A\mathbf{x}=\mathbf{b}$ is consistent (i.e. has a solution). (7%)

6. In R^4, let W be the subset of all vectors

   $$\mathbf{v}=\begin{bmatrix}a_1\\ a_2\\ a_3\\ a_4\end{bmatrix}$$

   that satisfy $a_4-a_3=a_2-a_1$.

   (a) Show that W is a subspace of R^4. (7%)

   (b) Show that

   $$S=\left\{\begin{bmatrix}1\\0\\0\\-1\end{bmatrix},\begin{bmatrix}0\\1\\0\\1\end{bmatrix},\begin{bmatrix}1\\1\\1\\1\end{bmatrix},\begin{bmatrix}0\\0\\1\\1\end{bmatrix}\right\}$$

   spans W. (8%)

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所別：電機工程技術研究所 科目：工程數學（甲組）

1. 用拉氏轉換解下列微分方程式：(20%)

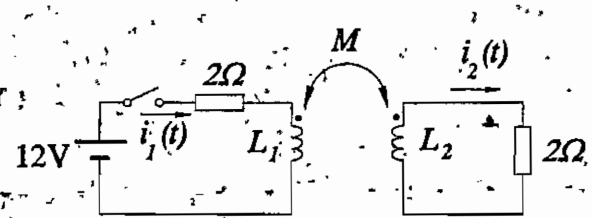
(a) $x''+3x'+2x=2,\quad x(0)=0,\quad x'(0)=0$

(b) $x''=2t+1,\quad x(0)=0,\quad x'(0)=1$

2. 圖一的電路中，電感 $L_1=3/2$ H，$L_2=1$ H，互感 $M=1/\sqrt{2}$ H，初時條件為 $i_1(0^-)=i_2(0^-)=0$。在 $t=0$ 時將開關閉合。(20%)

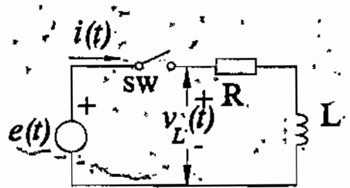
(a)寫出 $i_1(t)$ 及 $i_2(t)$ 之聯立微分方程式。

(b)依初時條件求出 $i_1(t)$ 及 $i_2(t)$ 之全響應。

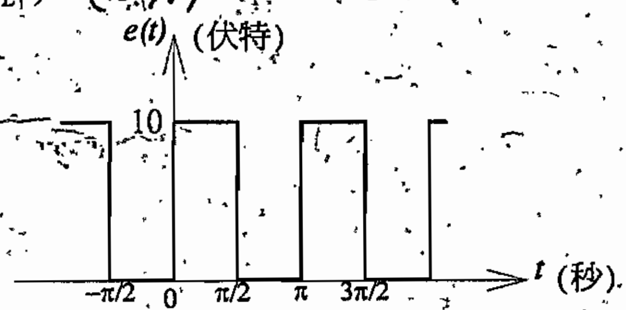


圖一 耦合電路

3. 若圖二中之交流電壓源 $e(t)$ 之波形如圖三所示，開關在 $t=0$ 時閉合，則 R-L 串聯支路之電壓 $v_L(t)$ 可表為 $v_L(t)=e(t)\,u(t)$，其中 $u(t)$ 表示單位步階函數 (*unit step function*)。求 $v_L(t)$ 之拉普拉斯變換 $v_L(s)$。(20%)



圖二 具有交流電源之 R-L 串聯電路



圖三 電壓源 $e(t)$ 之波形

4. 求下列函數之傅立葉係數 (20%)

$f(t)=t,\quad -\pi<t<\pi$ 且 $f(t+2\pi)=f(t)$

5. 求下列方程式之傅立葉轉換 (20%)

(a) $f(t)=e^{-a|t|},\ a>0$

(b) $f(t)=\begin{cases} e^{-2t}, & t>0 \\ e^{3t}, & t<0 \end{cases}$

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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. (15%) Three masses are connected by a series of springs between two fixed points as shown in the Figure 1. Assume that the springs all have the same spring constant and let $x_1(t)$, $x_2(t)$, and $x_3(t)$ represent the displacements of the respective masses at time t.
   (a) Derive a system of second-order differential equations which describes the motion of this system. [8%]
   (b) Solve the system if $m_1 = m_2 = \frac{1}{3}, m_3 = \frac{1}{4}, k = 1$, and
   $x_1(0) = x_2(0) = x_3(0) = 1$
   $x_1'(0) = x_2'(0) = x_3'(0) = 0$ [7%]

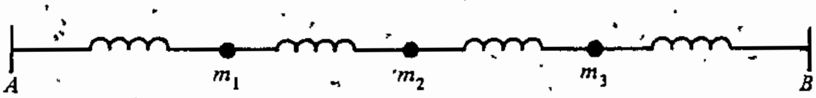

Figure 1

2. (15%) Let A be a diagonalizable matrix with characteristic polynomial
   $p(\lambda) = a_1\lambda^n + a_2\lambda^{n-1} + \cdots + a_{n+1}$
   (a) If D is a diagonal matrix whose diagonal entries are the eigenvalues of A, show that $p(D) = a_1 D^n + a_2 D^{n-1} + \cdots + a_{n+1} I = O$
   (b) Show that $p(A) = O$.
   (c) Show that if $a_{n+1} \neq 0$, then A is nonsingular and $A^{-1} = q(A)$ for some polynomial q of degree less than n.

3. (20%) Let

$$A = \left(\begin{array}{c|c} B & O \\ \hline O & C \end{array}\right)$$

where B and C are square matrices.
   (a) If λ is an eigenvalue of B with eigenvector $y = (y_1, y_2, \ldots, y_k)^T$, show that λ is also an eignvalue of A with eigenvector $z = (y_1, y_2, \ldots, y_k, 0, \ldots, 0)^T$. [7%]
   (b) If B and C are positive matrices, show that A has a positive real eigenvalue r with the property that $|\lambda| < r$ for any eigenvalue $\lambda \neq r$. [7%]
   (c) If $B = C$, show that the eigenvalue r in part (b) has multiplicity 2 and possesses a positive eigenvector. [6%]

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4.(10%) Two random variables X and Y are independent, find the density of $W = aX + bY$.

5.(17%) Show that if the random variables X and Y are independent, normal, with expected values m_1, m_2 and variances σ_1^2, σ_2^2, respectively, then

$$P[XY<0]=\frac{1}{2}-2erf\frac{m_1}{\sigma_1}erf\frac{m_2}{\sigma_2}$$

Hint: The general normal density is given by $f(x)=\frac{1}{\sigma\sqrt{2\pi}}e^{-(x-m)^2/2\sigma^2}$

and $erf(x)=\frac{1}{\sqrt{2\pi}}\int_0^x e^{-y^2/2}dy$, $erf(\infty)=\frac{1}{2}$, $erf(-x)=-erf(x)$

6.(23%) Consider a binary symmetric channel as shown in Fig. 2. Use this channel to communicate to a receiver the result of an experiment carried out by flipping a coin repeatedly. We wait until the coin has been flipped twice and transmit via the coding rules shown in Table 1. The receiver uses the decoding rules shown in Table 2 to decode the received message.

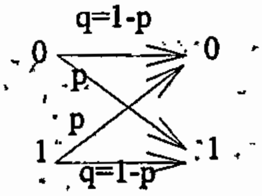

Figure 2

TABLE 1

Exp. result	Transmit codeword
HH	0 0 0 0
TH	1 0 0 1
HT	0 1 1 1
TT	1 1 1 0

TABLE 2

Received message	Decode message
0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0	0 0 0 0 (HH)
1 0 0 1 1 0 1 1 1 1 0 1 0 0 0 1	1 0 0 1 (TH)
0 1 1 1 0 1 0 1 0 0 1 1 1 1 1 1	0 1 1 1 (HT)
1 1 1 0 1 1 0 0 1 0 1 0 0 1 1 0	1 1 1 0 (TT)

(That is, if one of the first three bits is in error, the receiver still can decode the received message correctly.)

(a) find the probability of 4-bit received correctly. [5%]

(b) find the probability of one error among the first three bits. [5%]

(c) find the probability that the receiver gets both experiments false. [5%]

(d) find the probability that the reveiver gets one of the experiments false. [4%]

(e) show that the summation of above four probabilities is equal to 1. [4%]

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八十六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：電力系統

1. 對稱故障分析 (30%)
某電力系統包含三個匯流排，其以次暫態電抗計算而得之匯流排阻抗矩陣爲：

$$Z_{bus}=j\begin{bmatrix}0.12 & 0.08 & 0.04\\ 0.08 & 0.12 & 0.06\\ 0.04 & 0.06 & 0.08\end{bmatrix}\text{ 標么}$$

(a) 假設故障前各匯流排之電壓均爲 1.0 標么，且故障前之負載電流可予以忽略，在第二匯流排 (bus 2) 發生三相短路故障時，計算在故障期間之次暫態故障電流值及第一、第二及第三匯流排之電壓。
(b) 若將一電抗 Z_b=j0.7 標么 跨接在原有的第二匯流排及新的第四匯流排之間，並假設電抗 Z_b 與原有的電抗之間沒有耦合，計算新的匯流排阻抗矩陣。

2. 非對稱故障分析 (30%)
續上題，假設該電力系統之零相序、正相序及負相序匯流排阻抗矩陣分別爲：

$$Z_{bus\,0}=j\begin{bmatrix}0.10 & 0 & 0\\ 0 & 0.20 & 0\\ 0 & 0 & 0.10\end{bmatrix}\text{ 標么}$$

$$Z_{bus\,1}=Z_{bus\,2}=j\begin{bmatrix}0.12 & 0.08 & 0.04\\ 0.08 & 0.12 & 0.06\\ 0.04 & 0.06 & 0.08\end{bmatrix}\text{ 標么}$$

(a) 若在第一匯流排發生兩線直接短路 (*bolted line-to-line fault*)，計算故障電流及第二匯流排之電壓。
(b) 若在第一匯流排發生一線直接接地故障 (*bolted single line-to-ground fault*)，計算故障電流及第二匯流排之電壓。

3. 輸電線參數之計算 (40%)
(a) 試推導一半徑爲 r 之長直實心圓柱形導體，單位長度之內電感 (*internal inductance*)，以每米亨利表示。假設該導體之導磁係數 $\mu=\mu_0=4\pi\times10^{-7}$ H/m且電流均勻分佈於導體截面 (忽略集膚效應)。 [14%]
(b) 以兩根半徑分別爲 r_x 與 r_y 之長直實心圓柱形導體作爲單相輸電線，若兩根導體中心點之距離爲 D，試計算此單相輸電線單位長度之迴路電感值 (*loop inductance*)。同樣假設導體之導磁係數 $\mu=\mu_0$ 並忽略集膚效應。 [13%]
(c) 若考慮由 *60 Hz* 交流電流所引起的集膚效應，您認爲導體的內電感值會增加還是減少？用不超過 30 個中文字解釋您的理由。 [13%]

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電子與資訊工程技術研究所
科目：電子學

1. Figure 1 shows a circuit for a digital-to-analog converter (DAC). The circuit accepts a 4 bits input binary word $a_3a_2a_1a_0$ where $a_0, a_1, a_2,$ and a_3 take the values of 0 and 1, and it provides an analog output v_o proportional to the value of the digital input. Each of the bits of the input word controls the correspondingly numbered switch. For instance, if a_2 is 0 then switch s_2 connects the $20\ k\Omega$ register to ground, while if a_2 is 1 then s_2 connects the $20\ k\Omega$ register to the $+5V$ power supply. Show that v_o is given by

$v_o = -\frac{R_f}{16}[2^0 a_0 + 2^1 a_1 + 2^2 a_2 + 2^3 a_3]$. (25 %)

2. Figure 2 shows a transconductance amplifier with an infinite input resistance, a $10\ k\Omega$ output resistance, and a transconductance $G_m = 0.1\frac{A}{V}$. A $1\ M\Omega$ resistor R_f is connected from the output of the amplifier back to its input. The amplifier is fed with a source v_s having a source resistance R_s. Find R_{in}, v_o/v_i, and R_{out}. (25 %)

3. Provide a design for a voltmeter circuit similar to the one in Figure 3, which is intended to function at frequencies of $20\ Hz$ and above. It should be calibrated for sine-wave input signals to provide an output of $+10V$ for an input of $1V$ rms. The input resistance should be as high as possible. To extend the bandwidth of operation, keep the gain in the ac part of the circuit reasonably small. The design should be such as to reduce the size of the capacitor C required. The largest value of resistor available is $1\ M\Omega$. (25 %)

4. A logic inverter having the circuit of Figure 4 with $V^+ = 5V$ and $R_L = 1\ k\Omega$, and the switch having an on-resistance of $100\ \Omega$, is switched at a $10\ MHz$ rate. The load capacitance is $10\ pF$, and the input remains high an average of 75 % of the time. Calculate the static, dynamic, and total power dissipation in the gate. What is the power dissipated in the switch? (25 %)

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科目：電子學

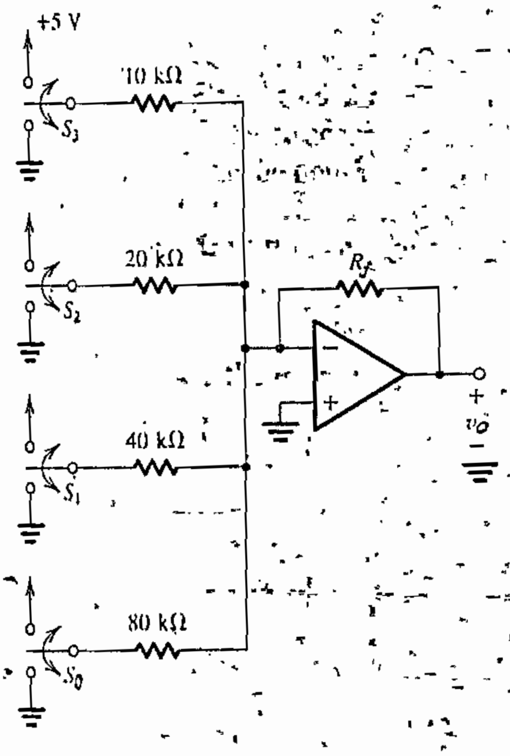

Fig. 1

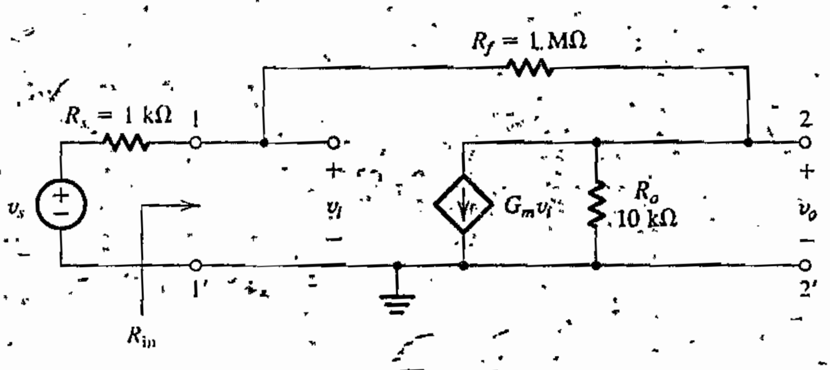

Fig. 2

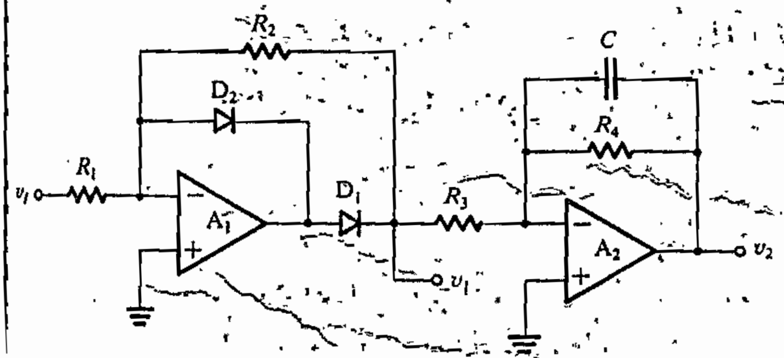

Fig. 3

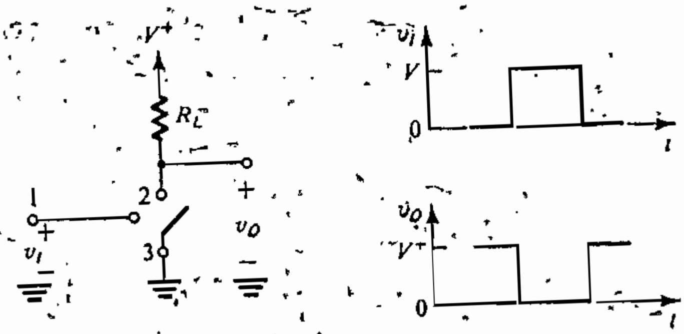

Fig. 4

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1. Answer the following question. (20%)

(a) Can the power MOEFET be used by parallel? Why?
(b) Can the power BJT be used by parallel? Why?
(c) Give the accurate definition of the power factor.(The input source may be nonsinusoidal.)
(d) What is the latchup problem for the IGBT?
(e) Give three possible PWM methods for the inverter.(20%)

2. derive the fourier series of the following waveform (20%)

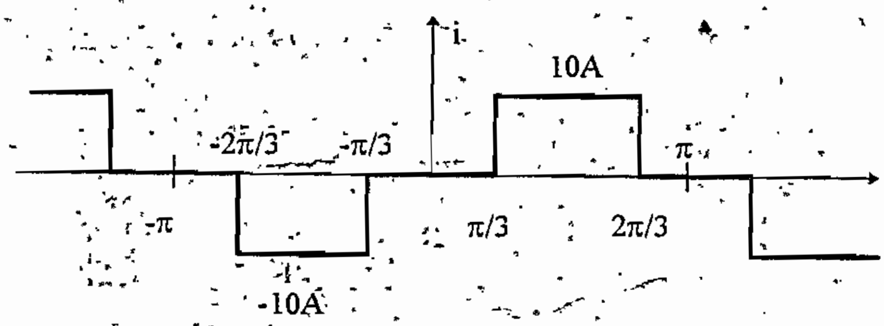

Fig. 1

3. (a) Give the circuits of the buck, boost, and buck-boost converters. [13%] (25%)
(b) Derive the Vo(output voltage)/Vi(input voltage) for the above three converters. (If the duty ratio is D.)(12%)

4. Please give some more detailed statements and control blocks of power electronic techniques apply to the industry products. (for examples, switching mode power supplies, UPS, power factor correction circuits, motor drive, electronic ballast, battery charge, active power filter, ...etc) (35%)

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八十六學年度研究所碩士班入學考試試題　　科目：自動控制

1. Please explain the following terminologies (20%)
   (a) linear time–invariant systems. (5%)
   (b) well–posed systems. (5%)
   (c) Resonant frequency. (5%)
   (d) uniform stable in the Lyapunov sense. (5%)

2. The bolck diagram of unity feedback control with a series controller $G_p(s)$ is shown in Fig. 1(a). The root locus of uncompensated system in Fig. 1(b). Design an ideal derivative compensator to yield a 16% overshoot (i. e. damping ratio $\zeta = 0.504$), with a threefold reduction in settling time (note: the settling time $t_s = \frac{4}{\zeta\omega_n}$). (15%)

3. Find the fundamental matrix and state transition matrix of the following equations (15%)

   (a) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-1 & e^{-t}\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$. (8%)

   (b) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-1 & 2\\ -1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$. (7%)

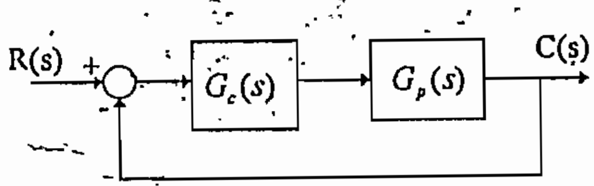

Figure 1 (a)

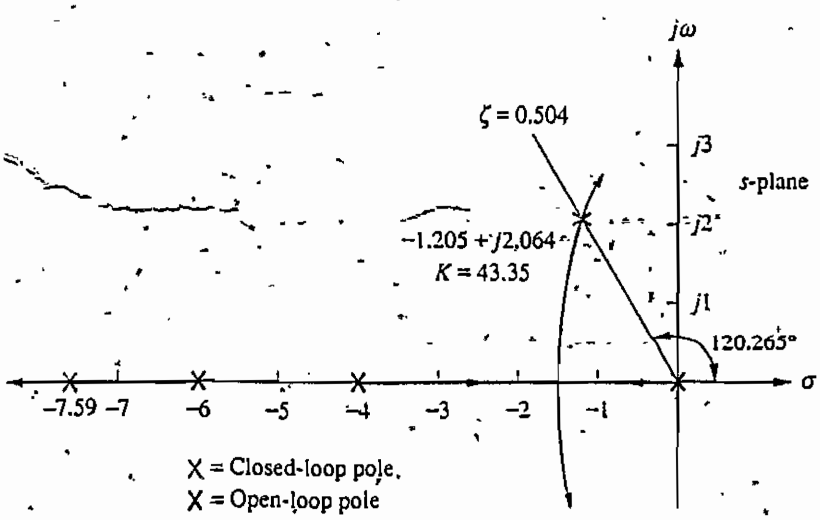

Figure 1 (b)

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4. Given a closed-loop system described by the dynamic equations

$$\dot{x}(t)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -2 & -2K & -3\end{bmatrix}x(t)+\begin{bmatrix}0\\ 0\\ K\end{bmatrix}u(t)$$

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

(a) Determine the range of k for which the system is stable. (5%)

(b) The gain k is set to the value that results in a marginally stable system. Find the frequency, ω_o, at which the system will oscillate. (5%)

(c) If $k=1$, find the steady-state value of $y(t)$ for a unit-step input. (5%)

5. Consider the system with the state diagram shown in Fig. 2.

(a) Write the system state equations. (5%)

(b) Find the roots of the system characteristic equation. (5%)

(c) Determine if the system is controllable. (5%)

(d) Determine if the system is observable. (5%)

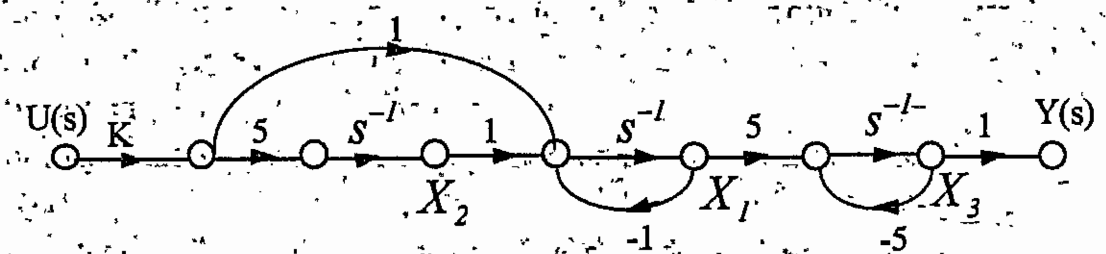

Fig. 2

6. Consider the sampled-data system shown in Fig. 3.

(a) Find the output $C(z)$ for a unit-step input. (5%)

(b) Find the system output $c(t)$ at $t=6$ sec. (5%)

(c) Find the system output $c(t)$ at $t=5$ sec. (5%)

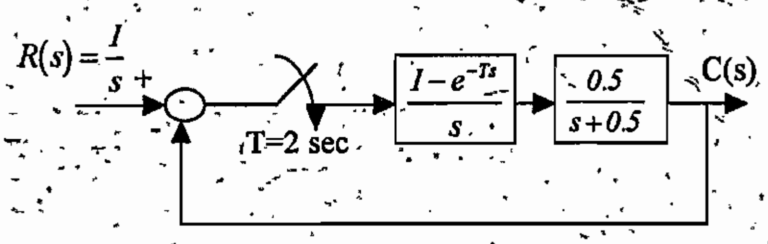

Fig. 3

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1. (15%) X(t) is a stationary process with power spectral density $S_X(f)$. This process passes through the system shown in Figure 1. Answer the following questions:
   (a) Is Y(t) stationary? Why?
   (b) What is the power spectral density of Y(t)?
   (c) What frequency components can not be present in the output process and WHY?

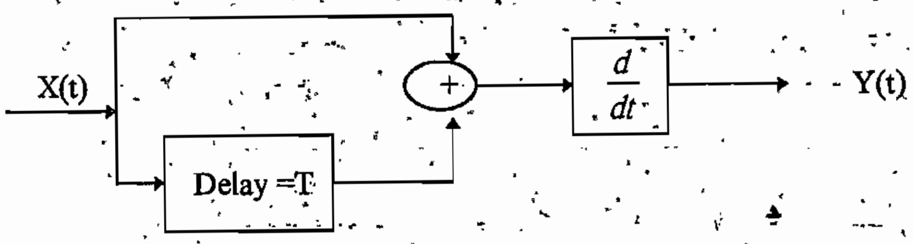

Figure 1

2. (15%) An SSB signal is generated by modulating an 800-kHz carrier by the signal $m(t) = \cos 2000\pi t + 2\sin 2000\pi t$. The amplitude of the carrier is $A_c = 100$.
   (a) Determine the Hilbert transform of $m(t)$.
   (b) Determine the (time domain) expression for the lower sideband of the SSB signal.
   (c) Determine the magnitude spectrum of the lower sideband SSB signal.

3. (20%) An angle modulated signal has the form

$$s(t) = 100\cos[2\pi f_c t + 4\sin 2000\pi t]$$

where $f_c = 10$ MHz.
   (a) Determine the average transmitted power.
   (b) Determine the peak-phase deviation.
   (c) Determine the peak-frequency deviation.
   (d) Is this an FM or PM signal? Explain.

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4. (a) (10%) Two networks with known noise figures (F_a=2.5dB, F_b=5dB) and power gains (G_a=10dB, G_b=20dB) are to be cascaded. Find out the minimal overall noise factor that you can achieve.

(b) (15%) Consider the front end of the receiver shown in Figure 2. The received signal power at the input to the first amplifier is -113 **dBm**, and the received noise power spectral density is -175 dBm/Hz. The bandpass filter has a bandwidth of B=10MHz, and power gains and noise figures are as shown. Determine the signal-to-noise ratio (**in dB**) at the input to the demodulator.

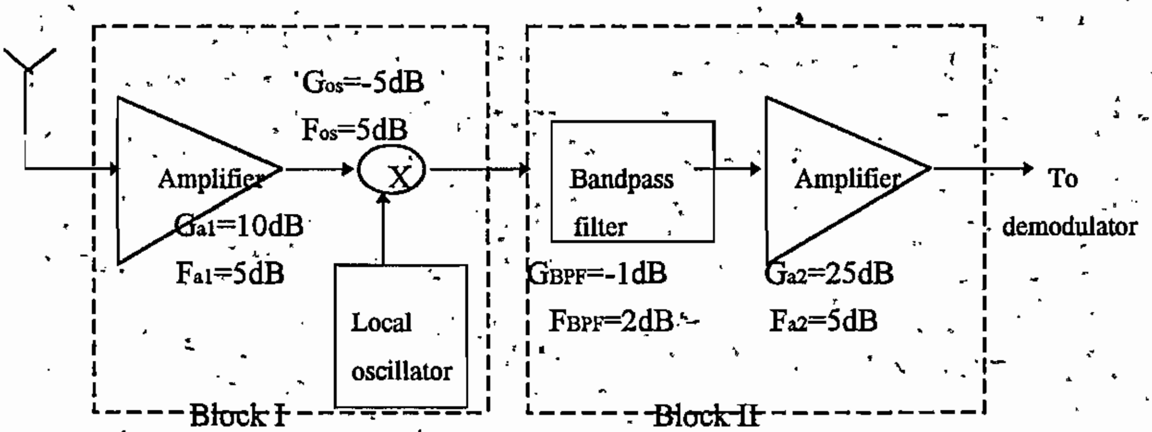

Figure 2

[Hint: (1) $SNR = \frac{P_{s,dem}}{P_{n,dem}}$. The signal power at the output can easily be obtained by finding the overall power gain (addition of each stage) first and then add with the input signal power. (You must be careful in discerning dB and dBm)

(2) To find the noise power at the input to the demodulator, you may first find the noise factors (F1, F2) of block I and block II respectively, then use F1 to compute the noise power density at the input to block II as follows.

$$S_{n,o}(f) = F_1 S_{n,i}(f) G_{a1} G_{os}$$

Thus, the noise power at the input to the demodulator can be computed as follows.

$$P_{n,dem} = S_{n,o} \cdot 2B \cdot G_{BPF} \cdot G_{a2} \cdot F_2$$

You have to be careful in using NOISE FIGURE formula.

Noise Figure=10log(Noise Factor)]

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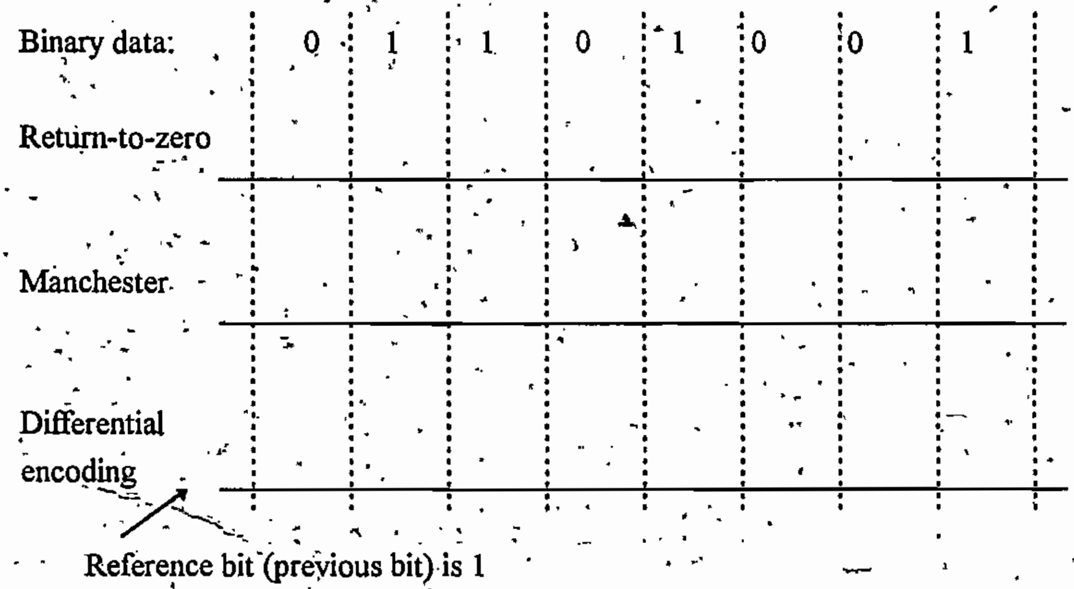
科目：通信理論

5. (10%) Please graphically illustrate the corresponding baseband coding output waveform for the following data stream.



6. (15%) In your opinion, compare the following modulation schemes in terms of power efficiency (such as error probability) and bandwidth efficiency (such as power spectra), respectively: BPSK, QPSK, OQPSK, and MSK.