國立中山大學九十學年度碩博士班招生考試試題

科目：工程數學（甲）【電機系碩士班】甲.丙選.丁.戊組

1. (10%) Let $x(t)$ be a rectangular pulse defined by $x(t)=1$, $|t|<1/2$ and $x(t)=0$, otherwise. The corresponding Fourier transform is denoted as $X(j\omega)$, i.e., $X(j\omega)=\int_{-\infty}^{\infty}x(t)\exp(-j\omega t)\,dt$. Find

   (a) $\int_{-\infty}^{\infty}X(j\omega)\,d\omega$

   (b) $\int_{-\infty}^{\infty}|X(j\omega)|^2\,d\omega$

2. (15%) Let $z(t)=x(t)*y(t)=\int_{-\infty}^{\infty}x(\tau)y(t-\tau)\,d\tau$.

   (a) Prove the area under $z(t)$ is the product of the areas under $x(t)$ and $y(t)$ over the interval $-\infty<t<\infty$. (10%)

   (b) Give an interpretation (5%)

3. (10%) For an arbitrary vector $\vec{A}(x,y,z)$

   (a) find an expression for the x component of $\nabla\times\nabla\times\vec{A}$

   (b) find an expression for the x component of $\nabla(\nabla\cdot\vec{A})$

4. (20%) Let's consider the vector space $C[-\pi,\pi]$ with inner product defined by

$$\langle f,g\rangle:=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)g(x)dx.$$

   (a) (3%) What is the dimension of $C[-\pi,\pi]$? (Explain your answer.)

   (b) (7%) Show that $\{\cos mx,\ m=1,2,\ldots;\ \sin nx,\ n=1,2,\ldots\}$ is an orthonormal set.

   (c) (10%) Let $\|\cdot\|_2$ be the norm induced from the inner product. Determine $\|\cos mx-\sin nx\|_2$.

5. (10%) Let $\alpha=[\alpha_1\cdots\alpha_n]^T$; $\beta=[\beta_1\cdots\beta_n]$. Define $A:=\alpha\cdot\beta$.

   (a) (5%) What is the rank of matrix A? (Explain or prove your answer as well.)

   (b) (5%) Find all eigenvalues of matrix A.

6. (15%) Find the general solution of the following differential equation:

   $(y + x^2y^4)dx + 3x\,dy = 0$

7. (20%) Use the Laplace transform to solve the following initial-value problem:

   $y'' - 4y' + 4y = \delta(t-1),\ y(0) = 0,\ y'(0) = 1$

國立中山大學九十學年度碩博士班招生考試試題

科目：電子學【電機系碩士班】　甲、乙、戊　組　

1. To form a single-stage IC MOS amplifier with active load, a MOS transistor is biased using a constant current source. This amplifier can be designed in three different configurations, viz. common source, common gate and common drain. (a)Please draw them respectively. (b)What is the other name of the amplifier designed in a common drain configuration? (c)Derive the small signal equivalent circuit of the common drain MOS amplifier including the body effect. (d) Please find out the voltage gain in (c) and explain its characteristic. (e) As in (c), how to determine the output resistance? (5% * 5)

2. Consider the circuit shown in Fig.2. Signals ϕ_1, and ϕ_2 are nonoverlaping clock signals. (a)Describe the operation of the circuit and (b)Derive the logic function implemented. (c) Discuss any possible relationship between the width-to-length ratios of the load and driver transistors for "proper"circuit operation. (5% *3)

3. For a nonideal inverting amplifier as shown in Fig.3, (a) Define the input bias current I_{bias}, and input offset current I_{OS}. (b)How to reduce the effects of the input bias and the offset currents by introducing a resistance R_3 in the circuit? (c) Derive the expressions of the output voltage V_o to explain the reducing. (5% *3)

4. For the circuit of shown in Fig.4., (a)What is the circuit? (b) Derive the loop gain of the oscillator included. (c)What will be the frequency of the oscillation? (d)To ensure that oscillations will start, what is the value of R_2/R_1 one should choose and set? (e)What are the values of the positive output peak and the negative output peak? (5% * 5)

5. For the circuit of Fig 5, the op amp has open-loop gain A_d = 10^4 V/V, differential input resistance R_{id} = 100kΩ, and incremental output resistance r_o. Please use the feedback method to find (a)the voltage gain V_o/V_s, (b)the input resistance R_i and (c)the output resistance R_o. (d)What is the configuration of the feedback amplifier? (5% *4)

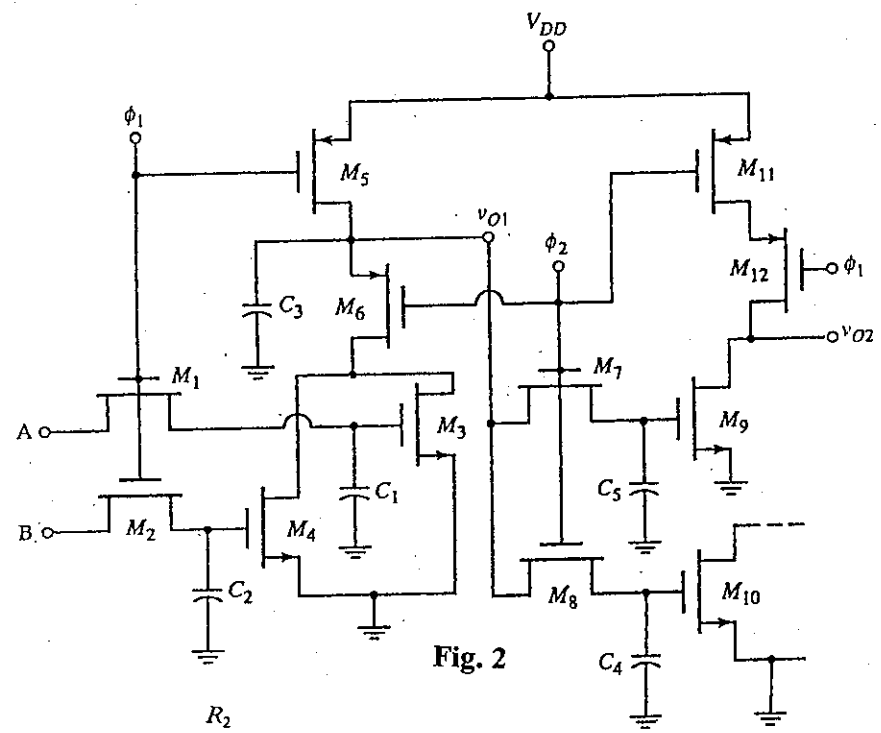


Fig. 2

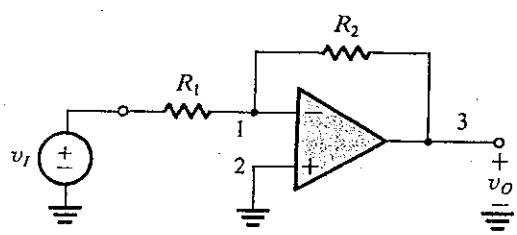


Fig. 3

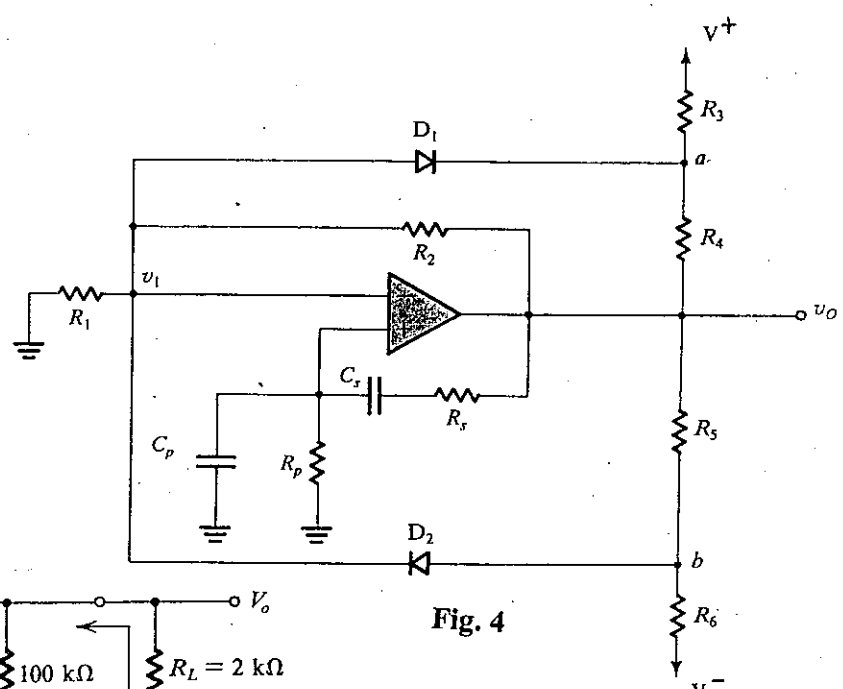


Fig. 4

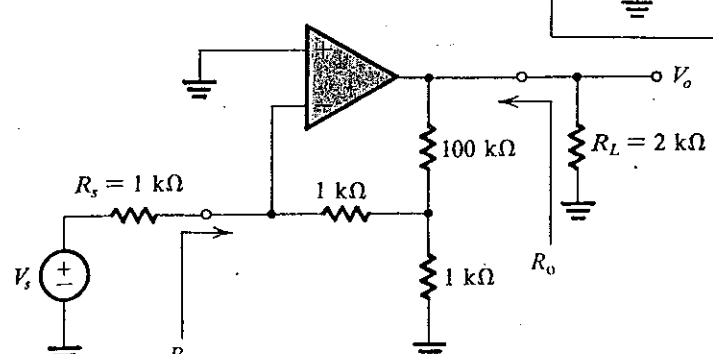


Fig. 5

國立中山大學九十學年度碩博士班招生考試試題

科目：半導體概論【電機系碩士班】甲組

1. Consider a germanium sample in which $N_d = 5 \times 10^{13}$ cm^{-3}. At T=300°K, the germanium sample has the following properties : E_g = 0.66 eV, and $n_i = 2.4 \times 10^{13}$ cm^{-3}. Calculate the electron and hole concentrations at T=300°K and T=350°K. (note: Boltzmann's constant k_B=8.62×10^{-5} eV/K) (16%)

2. An abrupt silicon pn junction at zero bias has dopant concentrations of N_a=10^{15} cm^{-3} and $N_d = 2 \times 10^{17}$ cm^{-3} at T = 300°K ($n_i = 1.5 \times 10^{10}$ cm^{-3},ϵ_s = 11.8 ϵ_o,$\epsilon_o = 8.85 \times 10^{-14}$ F/cm^2). Calculate (16%)

   (a) The build in voltage V_{bi}.

   (b) The depletion width W.

   (c) The maximum electric field ϵ_{max}.

3. Derive the current-voltage equation of the Schottky diode using the thermionic emission theory. (17%)

4. Derive the expression of the drain current I_d for the n-channel JFET in the linear region and the saturation region. The device has following parameters : channel length L, width W, and thickness $2a$. The mobility μ is assumed to be a constant. (17%)

5. Consider a pnp bipolar junction transistor with base width W_B, base doping N_B, and applied voltages V_{EB} and V_{CB}. Derive the general expression of the hole distribution in the base region. (17%)

6. The charge distribution in the oxide has an effect on the threshold voltage V_T. Find the threshold voltage variation ΔV_T due to a sheet of positive charge Q_{ox} per unit area within the oxide located x' below the metal gate (note: $x' < t_{ox}$). (17%)

國立中山大學九十學年度碩博士班招生考試試題

科目：工程數學（乙）【電機系碩士班】乙組

1. (10%) Let $x(t)$ be a rectangular pulse defined by $x(t)=1$, $|t|<1/2$ and $x(t)=0$, otherwise. The corresponding Fourier transform is denoted as $X(j\omega)$, i.e., $X(j\omega)=\int_{-\infty}^{\infty}x(t)\exp(-j\omega t)\,dt$. Find

   (a) $\int_{-\infty}^{\infty}X(j\omega)\,d\omega$

   (b) $\int_{-\infty}^{\infty}|X(j\omega)|^2\,d\omega$

2. (15%) Let $z(t)=x(t)*y(t)=\int_{-\infty}^{\infty}x(\tau)y(t-\tau)\,d\tau$.

   (a) Prove the area under $z(t)$ is the product of the areas under $x(t)$ and $y(t)$ over the interval $-\infty<t<\infty$. (10%)

   (b) Give an interpretation (5%)

3. (20%) Let's consider the vector space $C[-\pi,\pi]$ with inner product defined by

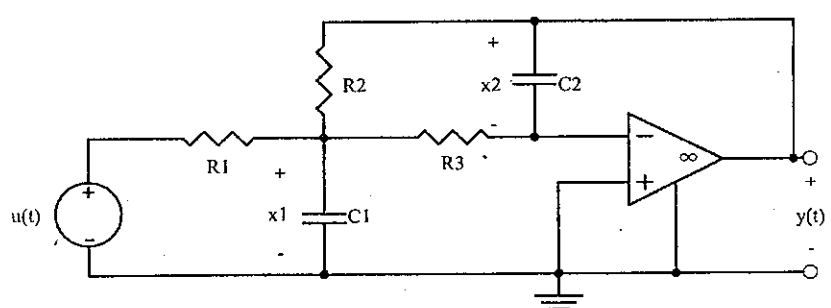
$$\langle f,g\rangle:=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)g(x)dx.$$

   (a) (3%) What is the dimension of $C[-\pi,\pi]$? (Explain your answer.)

   (b) (7%) Show that $\{\cos mx,\ m=1,2,\ldots;\ \sin nx,\ n=1,2,\ldots\}$ is an orthonormal set.

   (c) (10%) Let $\|\cdot\|_2$ be the norm induced from the inner product. Determine $\|\cos mx-\sin nx\|_2$.

4. (20%) Consider the RC op-amp circuit shown below, where the ideal op amp is assumed to be operating in its linear region and let the voltages across capacitors C_1 and C_2 be denoted as the state variables x_1 and x_2, respectively.



   (a) (10%) Find the parameters A,b,c,d in the dynamic equations

$$\dot{x}=Ax+bu$$
$$y=cx+du$$

   used to describe the circuit, where $x:=[x_1\ \ x_2]^T$.

   (b) (10%) Show that, no matter the initial value of $x(0)$, the zero-input response of the circuit will always die out asymptotically provided that all the resistances and capacitances are positive.

5. (15%) Find the general solution of the following differential equation:

$$(y+x^2y^4)dx+3x\,dy=0$$

6. (20%) Use the Laplace transform to solve the following initial-value problem:

$$y''-4y'+4y=\delta(t-1),\ y(0)=0,\ y'(0)=1$$

國立中山大學九十學年度碩博士班招生考試試題

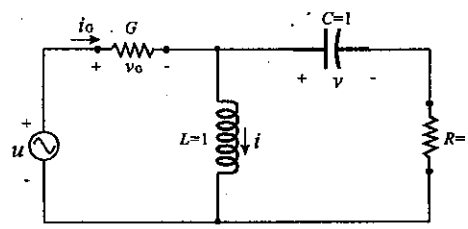
科目：控制系統【電機系碩士班】乙組

1.(a)(6%) The circuit shown below has a nonlinear conductance G such that $i_G = g(v_G) = v_G(v_G-1)(v_G-4)$, where i and v are the states and u is the input. Write the state differential equations of this circuit.

(b)(6%) Suppose that the state differential equations you obtained in Part (a) are

$$\begin{aligned} \frac{di}{dt} &= -i+v \\ \frac{dv}{dt} &= -i+g(u-v) \end{aligned}$$

Find the linearized model of the system about the equilibrium point $u=1$, $i=v=0$.



2. Suppose that the closed-loop transfer function $T(s)$ of a type 1 system is

$$T(s) = k\frac{(s-z_1)(s-z_2)\cdots(s-z_m)}{(s-p_1)(s-p_2)\cdots(s-p_n)}$$

The system error is defined as $E(s) \triangleq R(s) - Y(s)$, where $R(s)$ and $Y(s)$ are the transfer functions of the input signal and output signal respectively. Prove that,

(a)(4%) the DC gain of this system is unity, i.e., $T(0)=1$.

(b)(6%) by using Part (a), the steady-state error of this system (type 1) due to a unit ramp input is

$$e_{ss} = -\lim_{s\to 0}\frac{dT}{ds}\frac{1}{T} \triangleq \frac{1}{K_v}$$

(c)(6%)

$$\frac{1}{K_v} = \sum_{i=1}^{n}\left(-\frac{1}{p_i}\right) + \sum_{i=1}^{m}\frac{1}{z_i}$$

Hint: Use the result of Part (b).

3.(14%) Prove that the system with impulse response $h(t)$ is BIBO-stable if and only if the integral

$$\int_{-\infty}^{\infty}|h(\tau)|d\tau < \infty$$

4. Given a characteristic equation of a control system as

$$s^2(s+12)+k(s+1)=0, \qquad k \geq 0$$

Find the

(a)(3%) open loop poles and zeros,

(b)(2%) intersect of the asymptotes (Centroid),

(c)(2%) angles of asymptotes,

(d)(2%) departure angle of the point $s = 0$,

(e)(3%) intersection of the Root Loci with the imaginary axis and the value of k,

(f)(4%) breakaway point(s) and corresponding value(s) of k.

(g)(3%) Sketch the Root Loci for $k \geq 0$.

5. Consider a control system with the loop transfer function

$$L(s) = \frac{K(s-1)}{s(s+1)}, \qquad -\infty \leq K \leq \infty$$

(a)(5%) Sketch the Nyquist Plot of this system for $K > 0$.

(b)(6%) Using Nyquist criterion, determine the range of $K(> 0)$ such that the closed-loop system is stable. If the system is unstable due to the range of K, find the number of closed-loop poles in the right-half of $s-$plane.

(c)(6%) Using Nyquist criterion and the Nyquist plot of $K > 0$, determine the range of $K(< 0)$ such that the closed-loop system is stable. If the system is unstable due to the range of K, find the number of closed-loop poles in the right-half of $s-$plane.

6.(22%) Give answer true (T) or false (F) to each question shown below:

(a) If the numbers in the first column of Routh's tabulation turn out to be all negative, the equation for which the tabulation is made has at least one root not in the left half of the s-plane.

(b) When a row of Routh's tabulation contains all zeros before the tabulation ends, this means that the equation has roots on the imaginary axis of the s-plane.

(c) Linear and nonlinear frictions will generally degrade the steady-state error of a control system.

(d) The location of the roots of the characteristic equation in the s-plane will give a definite indication on the maximum overshoot of the transient response of the system.

(e) There is only one intersect of the asymptotes of the complete root loci.

(f) At the breakaway points on the root loci, the root sensitivity is finite.

(g) The intersect of the asymptotes must always be on the real axis.

(h) For a prototype second-order system, the value of resonance peak M_r of a closed-loop system depends solely on the damping ratio ζ.

(i) The slope of the magnitude curve of the Bode plot of $L(j\omega)$ at the gain crossover usually gives an indication of the relative stability of the closed-loop system.

(j) A Bode plot can be used for stability analysis for minimum- as well as nonminimum-phase transfer functions.

(k) Given the following characteristic equation of a linear control system, increasing the value of K will increase the frequency of oscillation of the system:

$$s^3 + 3s^2 + 5s + K = 0$$

（答題需將過程寫出，回答到要點與推導的嚴謹性爲評分考量）

1. (10%) Prove that $p \rightarrow (q \rightarrow r)$ $\quad$ $(p \wedge q) \rightarrow r$

2. (10%) Given a relation R as in the following matrix, where (X,Y) = 1 means node X precedes node Y:

$$\begin{pmatrix} 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{pmatrix}$$

   (a) Draw a directed graph to represent the relation.

   (b) Calculate the matrix of transitive closure of relation R.

3. (10%) Prove the two equations:

   (a) $1/(1-x) = 1 + x + x^2 + x^3 + \cdots$

   (b) $1/(1-x)^2 = 1 + 2x + 3x^2 + 4x^3 + \cdots$

4. (10%) Given a bag having a white ball and **x** number of balls with distinct colors, let us take a ball from the bag, record its color, put it back, and repeat for **n** times.

   (a) Calculate the number of possible distinct drawing runs with exactly **n-r** white balls and **r** balls of other colors being drawn in the run.

   (b) Use the result of (a) to prove $(1+x)^n = \Sigma^n_{r=0} C(n,r) * x^r$

5. (15%) Given the following recurrence equation, derive the function $\mathbf{A(n)}$ for a_n.

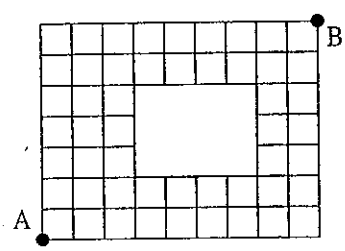
   $a_k = a_{k-1} + a_{k-2}$ if k is odd

   $a_k = 2 * a_{k-1}$ if k is even

   $a_1 = 1$

   $a_2 = 2$

6. (15%) A street map is shown in the following figure. Derive the number of minimum-distance paths to traverse from location A to location B.



7. (15%)Prove that the following two statements are equivalent:

   (a) A graph has all its vertices with even degrees.

   (b) A graph has Euler cycle(s).

8. (15%) Given a graph G(V,E) which is a forest (***k*** number of trees) and has ***n*** vertices and ***e*** edges, prove that $\boldsymbol{n = e + k}$.

國立中山大學九十學年度碩博士班招生考試試題

科目：資料結構【電機系碩士班】丙組選考

1.[12 分] 考慮下列運算式的前序（Prefix）、中序（Infix）及後序（Postfix）表示法，請寫出該式另外二種表示法：(假設使用 C 語言的優先權，其中$表示指數運算)

(a) a+(((b-c)*(d-e)+f)/g)$(h-j)

(b) ++a-*$bcd/+ef*ghi

(c) abcde-+$*ef*-

2.[8 分] 若 C(n,k)表示由 n 個人中選取 k 個人，組成一個委員會所有可能的組合數：

(a) 試證：C(n,k)=C(n-1,k)+C(n-1,k-1)。

(b) 寫一遞迴程式計算 C(n,k)，其中 n、k≥1。

3.[15 分] 下圖爲一 linked queue 儲存在記憶體的情形：

				rear ↓			front ↓	avail ↓		
位址	1	2	3	4	5	6	7	8	9	10
資料	38	70	19	56	79	18	2	66	30	43
連結	9	5	1	0	0	3	6	2	10	4

其中 front 表示指向 linked queue 之頭的指標；rear 表示指向 linked queue 之尾的指標；avail 表示下一個可存資料有效位址的指標。

(a) 請畫出該 linked queue。

(b) 由該 linked queue 中插入一個元素其值爲 99 後，請畫出記憶體儲存情形及所產生的 linked queue。

(c) 從(b)所產生的 linked queue 中，刪除值爲 38 的元素之後，請畫出記憶體儲存情形及所產生的 linked queue。（注意：經刪除之位址必須加入有效位址的連結裡。）

(d) 將原來之 linked queue 表示法改成雙向 linked queue，請畫出記憶體儲存情形及所產生的雙向 linked queue。

(e) 將(d)中之雙向 linked queue，刪除 18，再移去 30，再插入 80 後，畫出記憶體儲存情形及所產生的雙向 linked queue。

4.[10 分] 按照下列資料的順序做 AVL tree 的資料增加及資料刪除，請把每一步驟所產生的 AVL tree 詳細的畫出來。

(a) 資料增加：25, 20, 15, 10, 14, 30, 50, 35, 60, 40。

(b) 資料刪除：60, 25, 30, 14, 15, 10, 50, 35, 40, 20。

5.[20 分] Sorting: 25、57、48、37、12、92、86、33（請將每一步驟詳細畫出來）

(a) Insertion sort。

(b) Shell sort。

(c) Quicksort。

(d) Mergesort。

(e) Heapsort。

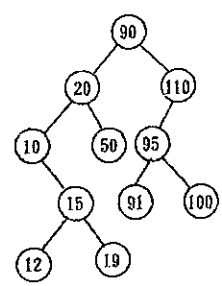
6. [8 分] 右圖爲一棵二元搜尋樹（Binary search tree），請把下列各種刪除情況的結果畫出來：

(a) 刪除 90。

(b) 刪除 91。

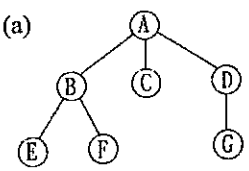
(c) 刪除 110。

(d) 刪除 10。

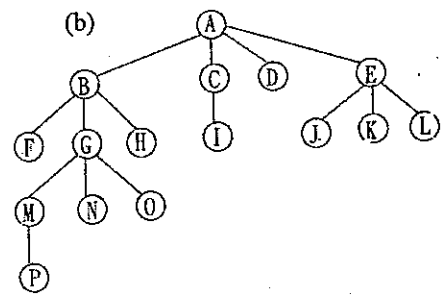


7.[4 分] 畫出下列各樹的相對應的二元樹。

(a)



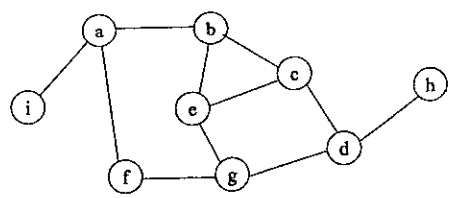
(b)



8.[4 分] 請由右圖中 a 點開始，找出（請詳細畫出每一步驟）：

(a) Depth-first search spanning tree。

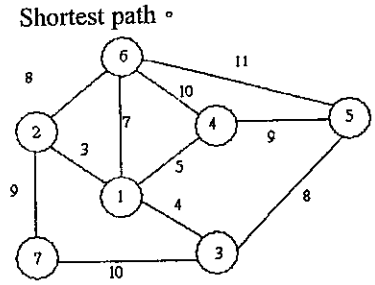
(b) Breadth-first search spanning tree。



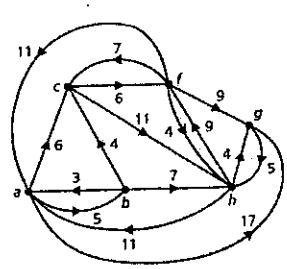
9.[10 分] 請詳細畫出下列各小題所要求之每一步驟：

(a) 利用 Prim's algorithm 找出下圖（a）之 Minimal spanning tree。

(b) 利用 Dijkstra's algorithm 找出下圖（b）中以 c 點爲起始點，到其他各點的 Shortest path。



圖（a）



圖（b）

10.[9 分] 將下列資料序列利用除法(modular arithmetic)進行雜湊(hashing)運算：

406, 727, 537, 425, 626, 508, 594, 603, 641, 347, 112

其中雜湊函數爲

h(**value**)= **value** mod **13**

並用下列三種方法解決雜湊碰撞(collision)問題：

(a) 線性探測(linear probing)。

(b) 重函數雜湊(rehashing)，重函數爲 rh(**value**)=(**value** + **2**) mod **13**。

(c) 鏈結法(chaining)（新增的資料插入串列尾端）。

請將所有資料完成運算後的雜湊表（hash table）（編號 0 到 12）畫出來。

國立中山大學九十學年度碩博士班招生考試試題

科目：數位電路【電機系碩士班】丙組選考

Problem 1 : Since the Gray code, $g_{n-1}, \ldots, g_2, g_1, g_0$, and the binary code $b_{n-1}, \ldots, b_2, b_1, b_0$, are two of the most popular codes used in logic designs, we hope to make it easier to be remembered and utilized. Your task are as follows.

1). Develop the recursive conversion formula to generate the g_i, $i = n-1, n-2, \ldots, 0$, if given $b_{n-1}, \ldots, b_2, b_1, b_0$.

2). Develop the recursive conversion formula to generate the b_i, $i = n-1, n-2, \ldots, 0$, if given $g_{n-1}, \ldots, g_2, g_1, g_0$.

(20%)

Problem 2 : Please design a clock generator given D-FF's, one clock source, and NAND and NOR gates to generate two clocks. Note that these two generated clocks, called $\phi_1(t)$ and $\phi_2(t)$, must satisfy the following two constraints.

1). $0 = \phi_1(t) \cdot \phi_2(t)$

2). They are exactly out of phase (i.e., phase shift = 180°).

(10%)

Problem 3 : MUXs are easily to be used to realize other Boolean functions. You are given a 8-to-1 MUX which has 3 selecting lines and 8 output lines. Please use it to implement the following Boolean equation :

$$Z(A, B, C, D) = \sum(0, 1, 4, 5, 9, 13, 15)$$

Note that you don't need to draw the internal design of the MUX. You simply use a block diagram to denote it. (10%)

Problem 4 : Is it possible to implement a JK flip-flop with a T flip-flop? If yes, then show your implementation step by step. (10%)

Problem 5 : You are given many 1-out-of-16 decoder standard ICs. However, you can not perceive its layout. Hence, it can be treated as a block. You are then asked to design a 1-out-of-256 decoder. Thus, how to arrange those standard decoders to achieve the goal? Please show your design as detailed as possible. Note that the address lines are $A_0, A_1, \ldots$. (10%)

Problem 6 : An asynchronous circuit that employs two-level AND-OR logic has the following next-state and output equations:

$$\begin{aligned} y_1^+ &= y_1 y_2 + y_1 x_1 + \bar{x}_1 \bar{x}_2 \bar{y}_1 \\ y_2^+ &= x_1 x_2 + \bar{x}_1 y_1 \bar{y}_2 + \bar{x}_1 \bar{x}_2 y_1 \bar{y}_2 \\ z &= y_1 y_2 + x_2 y_1 \end{aligned}$$

Construct a logic circuit and a state (flow) table for this circuit. (10%)

Problem 7 : Simplify the Boolean expression, $f(a,b,c,d,e) = (ab+c+d)(\bar{c}+d)(\bar{c}+d+e)$, such that you can use fewest number of gates to implement this function. You have to show
(a) the simplest expression
(b) the logic circuit with minimum number of gates
(10%)

Problem 8 : The microprocessor is the most powerful digital device in logic design, since it comprises many functional blocks, e.g., ALU, register file, etc. The software code, i.e., the assembly language, is the tool to drive such a powerful device. Referring to the following simple 8-bit 8086/88 microprocessor code, what is the function of the following sequence of instructions? Please explain it and add comment to each instruction.

```
MOV AX, [ASCII_DATA]
MOV BX, AX
MOV CL, 08H
ROR BX, CL
AND AX, 00FFH
AND BX, 00FFH
MOV [ASCII_CHAR_L], AX
MOV [ASCII_CHAR_H], BX
```

(10%)

Problem 9 : Given an adder of which the inputs are A_i, B_i and C_i, the outputs are S_i and C_o, please show how an adder can implement the following Boolean functions, respectively.
1). XOR
2). exclusive-NOR
3). AND
4). OR
(10%)

國立中山大學九十學年度碩博士班招生考試試題

科目：計算機結構【電機系碩士班】丙組

I. (25%) Bus Architectures

1. (10%) A hypothetical machine has an instruction format with **4-bit** OP code and **12-bit** Address/Operands.
   (a) (5%) How many memory locations and I/O locations, respectively, can be addressed by CPU, if memory-mapped I/O is used.
   (b) (5%) How many memory locations and I/O locations, respectively, can be addressed by CPU, if Isolated I/O is used.

2. (15%) A bus system consists of a multiplexed **32 bits** for transferring both address and data. There are **1 G** memory locations and **4** I/O modules to be referenced by CPU. A centralized arbitration scheme (**NO** Hidden Arbitration) with a clock rate of **40** MHz is used. Assuming that
   Memory latency time = **40 nsec**,
   Memory word length = **4 bytes**.
   CPU always requests data in a block of **4 words**, and it takes **2 bus cycles** for bus arbitration and **one bus cycle** for transferring address to main memory.
   (a) (5%) Calculate the *effective bus bandwidth* (in Mbytes/sec), if CPU accesses the **4 words** at the same time in a Block Data Transfer Mode.
   (b) (10%) Calculate the *effective bus bandwidth* (in Mbytes/sec), if CPU accesses the **4 words** one by one separately in a Read (Multiplexed) Operation Mode.

II. (25%) Memory Architectures

1. (10%) The average access time of a disk can be estimated by summing disk seek time, disk rotational delay and data transfer time. Disk seek time is the time it takes to position the head at the target track. Disk rotational delay is the time it takes for the beginning of the sector to reach the head. If there are 100 bytes to be transferred from the disk and assuming that disk seek time = 50 ms, 10,000 bytes per track , and the rotational speed is 3600 rpm (revolutions per minute). Calculate the average access time of the disk.

2. (15%) Applying **Hamming** single-error correction code to the code word 00111001 and assuming that the data bit M1 is the rightmost bit, and M8 is the leftmost bit.
   (a) (5%) Calculate the 4-bit Syndrome word.
   (b) (5%) If data bit M3 sustains an error and is changed from 0 to 1, Recalculate the Syndrome word.
   (c) (5%) Based on the two Syndrome words, how do you locate the position of bit error?

III. (25%) Computer System Performance

1. (10%) In a multiprogramming environment, since the system throughput (Ws) is too complicated to estimate, it is often use CPU throughput (Wp) to evaluate a computer performance.
   (a) (5%) Derive an equation for Wp, if given the following parameters.
   IC = Instruction count
   CPI = Cycles per Instruction
   T = CPU cycle time (nsec).
   (b) (5%) If Wp = MIPS × K, Find out K = ? Note that MIPS = Million Instructions per Second.

2. (15%) A linear pipeline system with K stages and cycle time = T. Assuming that
   N= total number of instructions of a program,
   P = the probability of conditional branch instructions,
   Q = the probability of branch taken, and
   B = the number of pipeline cycles wasted between a branch taken and its branch target.
   (a) (5%) Derive an equation for effective throughput for the linear pipeline.
   (b) (5%) Find out the maximum throughput of the linear pipeline.
   (c) (5%) If K = 10, T = 20 nsec, N = 10,000, P = 0.2, Q = 0.8, and B = 9,
   calculate the performance degradation factor D.

IV. (25%) Multiprocessor and Multicomputer Architectures

1. (10%) Multiprocessor architectures.
   (a) (5%) What is the main purpose to use **Fetch&Add operations** in a multiprocessor architecture with multistage interconnection network.
   (b) (5%) Design a method for a bus-based multiprocessor system with multiple caches to avoid cache inconsistency.

2. (15%) In a multicomputer network, the **network diameter** is defined as the maximum shortest path between any two nodes, and the **bisection width** is defined as the minimum number of edges along the cut for each half, if a network is cut into two equal halves.
   (a) (5%) For a binary-tree network with N nodes, find out its **network diameter**.
   (b) (5%) For a 2-D mesh network with N nodes, find out its **bisection width**.
   (c) (5%) For a hypercube network with N nodes, find out how many links in a hypercube.

國立中山大學九十學年度碩博士班招生考試試題

科目： 電路學【電機系碩士班】 丁組

1， Op-Amps 可以作爲加法器，描述其理由（說明 Op-Amps 的特性）。(10%)

2， 測一般物理場的 sensors 必須與 Pre-Amp 連在一起，其理由安在？二者若距一段距離會有什麼結果？(10%)

3， 描述 dual circuit 以及 equivalent circuit，其區別在哪裡？(10%)

4， 在 frequency-domain 中，含有電感以及電容的電路可以用類似電阻電路的方法解串聯以及並聯的等效電路，但在 time-domain 則無此功能，試述其理由。(10%)

5， 解電路時，常以「大小」以及「相位角」來表示阻抗(impedance)，這時候的阻抗是否爲 phasor？理由安在？(10%)

6， 描述電力系統中三相電路的優點（與單相電路比較）。(10%)

7， Find the magnitude of the balanced line voltage V_{AB}, V_{BC}, and V_{CA}(Fig.7) (15%)

8， Find the equivalent impedance Z(s) of the network shown in Fig. 8 (15%)

9， 在電感、電容、電阻三元件串聯的電路中，跨在電感或電容元件上的電壓是否可能比總電壓高？理由安在？(10%)

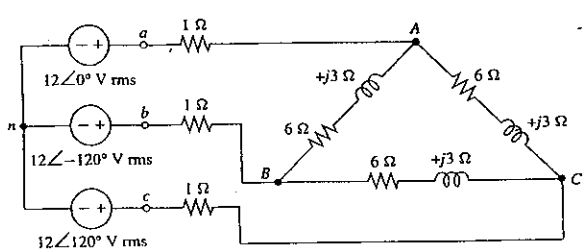


Fig.7

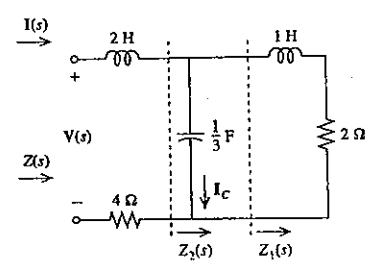


Fig.8

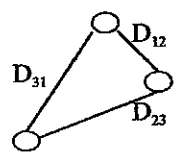
國立中山大學九十學年度碩博士班招生考試試題

科目：電力系統【電機系碩士班】丁組

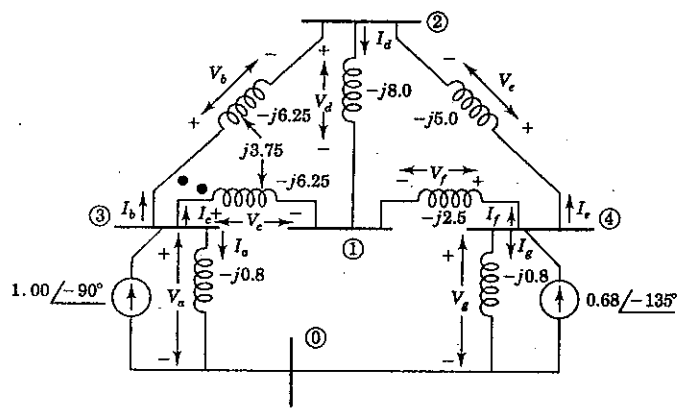
1. 說明配電系統產生過電流原因？電力系統裝置過電流保護電驛之目的及種類爲何？(20%)

2. 故障發生時斷路器偵測到等效電容及電感分別爲 800pF 及 4.0mH，試求當斷路器遮斷故障電流爲 200 安培時，斷路器接觸點兩側之再襲電壓（Re-striking Voltage）爲何？(20%)

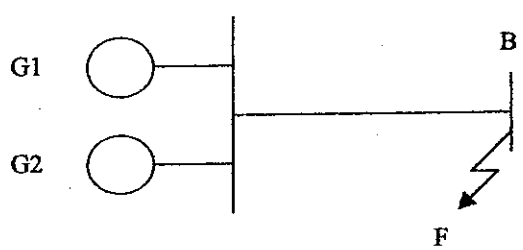
3. 電力輸送線配置如下圖所示，其中導線間距 $D_{12} \neq D_{31} \neq D_{23}$，試問每相平均電感如何求解？試導出計算公式。(20%)



4. 小型電力系統如下圖所示，所有電抗爲標么值，試計算出〔Y_{BUS}〕。(20%)



5. 兩部額定容量均爲 30MVA 之發電機經 33kV 輸送線將電力傳輸之 B 點，B 點發生單相接地故障，如下圖所示，(a)導出單相接地故障電流公式，（b）計算單相故障電流爲何？(20%)
   發電機：$X_1 = j\,0.2$p.u., $X_2 = j\,0.1$p.u., $X_0 = j\,0.05$p.u.
   輸送線：$X_1 = X_2 = j\,3\,\Omega$，$X_0 = j\,4\,\Omega$



國立中山大學九十學年度碩博士班招生考試試題

科目：電磁學【電機系碩士班】戊組

1. 請寫出 Poynting's Theorem，並說明其物理意義。(10%)
2. 一半徑為 a 之圓盤，其上有一均勻分佈之電荷密度 σ，若此圓盤繞著其中心軸，以 ω $(=2\pi f)$ 之角速度旋轉，則在中心軸上任何一點之磁場強度為何？(20%)
3. 一同軸導線，其內導體半徑為 a，外導體半徑為 b。計算此同軸導線內外導體間之單位長度電容值及電感值。(20%)
4. 均勻平面波可寫成 $\mathbf{E}(x,y,z)=\mathbf{E}_0\exp(-j\mathbf{k}\cdot\mathbf{R})$，$\mathbf{R}=\vec{a}_x x+\vec{a}_y y+\vec{a}_z z$，若其為 z 極化且行進方向與正 x 軸夾 30° (20%)
   (a) 寫出向量 $\mathbf{k}$ 之方向(不只一個可能性)
   (b) 若此一電磁波為 900 兆赫行動電話產生，寫出在空氣中 $\mathbf{k}$ 的大小
   (c) 若電場強度為 0.5 V/m，寫出向量 $\mathbf{E}_0$
   (d) 在前三個條件下此一電磁波所攜帶的平均功率密度為何($\mathrm{W/m^2}$)？
5. 一向 $+x$ 方向傳播導波其電磁場與 x 關係為 $\exp(-\gamma x)$。若 $E_x=0$，利用馬克斯威爾方程式將真空中之 E_y 以 H_x 表之。(10%)
6. 一沿 z 向無損耗傳輸線之特徵阻抗為 50 歐姆，在 $z=0$ 處接上一負載 Z_L。若線上之電壓分佈為 $V(z)=e^{-j\beta z}+e^{+j\beta z}(1+j\sqrt{3})/2$，其中 β 是相位常數 (20%)
   (a) 求負載 Z_L
   (b) 求向 $+z$ 方向傳送的平均功率

1. (15%) Let $\alpha=[\alpha_1\cdots\alpha_n]^T$; $\beta=[\beta_1\cdots\beta_n]$. Define $A:=\alpha\cdot\beta$.
   (a) (5%) What is the rank of matrix A? (Explain or prove your answer as well.)
   (b) (10%) Find all eigenvalues of matrix A.

2. (25%) Let $L: V\to W$ be a linear transformation between vector spaces V and W.
   (a) (6%) What are the definitions of L being (i) a one-to-one mapping, and (ii) an onto mapping?
   Let $A\in\Re^{m\times n}$. For $x\in\Re^n$, define a mapping $L_A: \Re^n\to\Re^m$ by $L_A(x):=A\cdot x$.
   (b) (7%) Show that L_A is a linear mapping.
   (c) (12%) What are the conditions on matrix A for mapping $L_A(\cdot)$ to be (i) one-to-one; (ii) onto; and (iii) one-to-one and onto, respectively? (Explain or prove your answer clearly as well.)

3. (15%) Suppose A is the matrix representation of the linear transformation $L:\Re^n\to\Re^n$ with respect to the standard basis. Let $\lambda_1,\cdots,\lambda_r$ be distinct eigenvalues of A with the corresponding eigenvectors $x_1,\cdots,x_r$, respectively. Let $x_{r+1},\cdots,x_n$ be chosen such that $X:=[x_1,\cdots,x_n]$ is an ordered basis for R^n. Let B denote the matrix representing L with respect to basis X.
   What is the form of B? (Explain your answer as clearly as possible.)

4. (20%)
   (a) (5%) What does the Cauchy-Schwarz inequality say?
   (b) (10%) Let's consider the vector space $V:=C[-\pi,\pi]$ with inner product defined by

$$\langle f,g\rangle:=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)g(x)dx$$

   and the induced norm $\|f\|:=\sqrt{\langle f,f\rangle}$. Use the Cauchy-Schwarz inequality to define an angle between any two nonzero vectors in V. Moreover, compute the angle between $f(x):=\cos mx$ and $g(x):=\sin nx$ where m and n are positive integers.
   (c) (5%) Compute $\|f-g\|$.

5. (25%) Let V be an inner product space and let S be its subspace spanned by an orthonormal basis $\{u_1,\cdots,u_\ell\}$. Let $v\in V$ be any vector and denote its projection onto S by p.
   (a) (10%) Derive the representation for p in terms of u_i's and v?
   (b) (5%) Suppose $V=\Re^n$ with $n>\ell$ and denote the matrix constructed from u_i's by U, i.e. let

$$U=[u_1\cdots u_\ell].$$

   What is the representation for p in terms of U and v?
   (c) (10%) Suppose $V=C[0,1]$ with the inner product $\langle f,g\rangle:=\int_0^1 f(x)g(x)dx$. Find the best least squares approximation to the vector e^{x+1} of V by a linear function of x.

國立中山大學九十學年度碩博士班招生考試試題

科目：機率【電機系碩士班】己組

1. Let $\mathbf{X}=(X_1,X_2,X_3)^T$ be a random vector with $\boldsymbol{\mu}=E[\mathbf{X}]$ given by $\boldsymbol{\mu}=(5,-5,6)^T$, and covariance matrix given by

$$\mathbf{K}=\begin{bmatrix} 5 & 2 & -1 \\ 2 & 5 & 0 \\ -1 & 0 & 4 \end{bmatrix} \qquad (15\%)$$

Calculate (a) the mean and (b) variance of $Y = \mathbf{A}^T\mathbf{X} + B$. Where $\mathbf{A}=(2,-1,2)^T$ and B=5.

2. Show that (a) $E[Y] = E[E[Y \mid X]]$ (8%). (b)$E[Z]=E[E[Z \mid X,Y]]$ (8%), and (c) $E[Z \mid X] = E[E[Z \mid X,Y] \mid X]$ (9%).

3. The probability that a teleohine call lasts no more than *t* minute is often described by an exponential cumulative distribution function (CDF), i.e.,

$$F_T(t)=\begin{cases} 1-e^{-at}, & t \geq 0 \\ 0 & ,otherwise \end{cases}$$

For a= 1/3 **(a)** What is the probability density function, f_T(t), of the duration in minutes of a telephone conversation. (5%) **(b)** What is the probability that a coversation will last between 2 and 4 minutes. (7%) **(c)** What is E[T] (*mean*) and $E[T^2]$. (8%) **(d)** The probability that the call duration is within 1 *standard deviation* of the *mean*. (5%)

4. Let X and Y be independent identical distribution (*i.i.d.*) with $X=N(0,\sigma^2)$ (*Gaussian* distribution with zero *mean* and *variance* σ^2) . What is the the probability density functions (p.d.f) of **(a)** $Z=(X^2+Y^2)^{1/2}$ (10%) and **(b)** $W= X^2+Y^2$ (10%).

5. Let $B=\{X \leq 10\}$. We wish to compute (a) $F(x \mid B)$ (10%) , and (b) $f(x \mid B)$ (5%).

國立中山大學九十學年度碩博士班招生考試試題

科目：通訊理論【電機系碩士班】己組

計分說明:

本題計分將採用一種新創的"市場需求調整計分法",即計分高低(價值)與獲解率(市場需求率之倒數，愈易獲解，市場上需求愈低)成反比。所以考生除了要把握多數人會的題目外，還要著重於自己獨特的能力，即別人不容易會的問題。 在入學徵才錄取率不高的情況下，希望考生能發揮出自己卓越的特點。

你的得分($S_1', S_2', S_3', \ldots$)公式計算如下：令$R_1, R_2, R_3, \ldots$爲小題各自原始分數給分範圍，$R_1', R_2', R_3', \ldots$爲依市場需求調整後的分數給分範圍，$M_1, M_2, M_3, \ldots$爲小題各自的原始平均得分，$S_1, S_2, S_3, \ldots$ 爲小題各自原始得分：

則 $S_1' = S_1 \times \frac{R_1'}{R_1}$

而 $R_1', R_2', R_3', \ldots$的計算，在 $M_1, M_2, M_3, \ldots$的各小題平均分數算出後，

依據 $R_1' : R_2' : R_3', \ldots = \frac{R_1}{M_1} : \frac{R_2}{M_2} : \frac{R_3}{M_3}, \ldots$ 得到，且 $R_1' + R_2' + R_3', \ldots = 100$

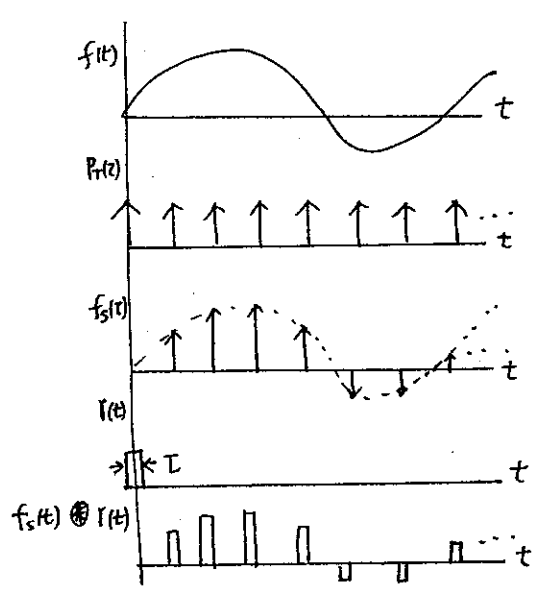
注意 $R_1, R_2, R_3, \ldots$的原始範圍可以任意設定，爲著讓考生易所依循，我仍可以做一次不必要的設定： $R_1 = R_2 = R_3, \ldots = \frac{100}{6}$ 。

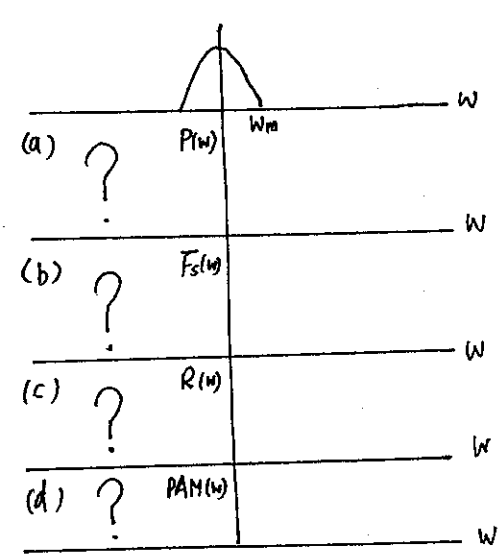
1. A system is described by the following equation:
   $y(t) = f(2t)$
   where y(t) and f(t) are the output and the input.
   Explain whether this system is
   (a) linear
   (b) time-invariant
   (c) causal

2. What are the equivalent noises in the demodulated output of the receivers for the following AM systems:
   (1) DSB-SC
   (2) DSB-LC
   (Hint: the bandpass noise can be expressed as $n_c(t)\cos w_c t - n_s(t)\sin w_c t$)

3. What is the difference between the instantaneous frequency and the Fourier frequency? How does the instantaneous frequency affect the Fourier frequency in FM? Please give the key derivation of the formula or results in your answer.

4. Please sketch the Fourier spectrums for the following signal processing procedures for PAM. You must sketch them in one column on the same scale as shown in the problem.





5. What is the difference between the digital communication and analog communication? Explain if there is any situation where the analog communication is better than the digital communication.

6. This problem is about bit error versus symbol error probabilities:
Assuming Pe is the average probability of symbol error and M is the total number of the symbols. Compute the bit error rate if all symbol errors are equally likely to occur for every symbol.