國立中山大學八十八學年度碩博士班招生考試試題

科　目：離散數學（電機工程學系碩士班）　　共 1 頁 第 1 頁

考生請注意：必需寫出作答過程或說明，否則不予計分。

1. Let p, q, and r be primitive statements.
   (a) Complete the truth table in the following for $(p\rightarrow q)\wedge(\neg p\rightarrow r)$. (10%)

p	q	r	$p\rightarrow q$	$\neg p\rightarrow r$	$(p\rightarrow q)\wedge(\neg p\rightarrow r)$
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

   (b) Translate the statement in part (a) into words such that the word "*not*" does not appear in the translation. (For example, $(p\wedge q)\rightarrow r$ is translated into " If p and q then r". (5%)
2. For positive integers m, n, r, with $r\le\min\{m,n\}$, show that
$$\binom{m+n}{r}=\binom{m}{0}\binom{n}{r}+\binom{m}{1}\binom{n}{r-1}+\binom{m}{2}\binom{n}{r-2}+\cdots+\binom{m}{r}\binom{n}{0}=\sum_{k=0}^{r}\binom{m}{k}\binom{n}{r-k}.$$
   (10%)
3. Let A, B be sets with $|A|=m$, $|B|=n$,
   (a) How many relations can be defined from A to B? (5%)
   (b) How many functions can be defined from A to B? (5%)
   (c) How many functions in (b) are injective(one-to-one)? (5%)
   (d) How many commutative closed binary operations can be defined on A? (5%)
4. Let I, O be input and output alphabet respectively and I=O={0,1}. Please construct a state diagram for a finite state machine that recognizes each occurrence of 0110 in the string $x\in I^*$.(Overlapping is allowed.) (15%)
5. Derive the generating function for the sequence: 0^2, 0^2+1^2, $0^2+1^2+2^2$, $0^2+1^2+2^2+3^2$,⋯ from $1/(1-x)$. Hint: $1/(1-x)=\sum_{i=0}^{\infty}x^i$. (15%).
6. Prove that $K_{3,3}$ is nonplanar. (10%)
7. The Fundamental Theorem of Arithmetic says that every integer $n>1$ can be written as a product of primes uniquely, up to the order of the prime. Use this theorem to determine a number less than 6000 that has exactly 15 positive divisors. (15%)

國立中山大學八十八學年度碩博士班招生考試試題

科　目：線性代數與機率　(電機工程學系碩士班)　　共 1 頁 第 1 頁

1. LET

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

(a) Find a unitary matrix **U** that diagonalizes **A**. (10%)

(b) Please evaluate $\mathbf{U}^H \mathbf{A}\, \mathbf{U}$ where the superscript H is denoted as the Hermitian operator. (5%)

2. Consider the mapping L defined by

$$L(\mathbf{x}) = (x_1, -x_2)^T$$

for each $\mathbf{x} \in R^2$. Thus, if $\mathbf{x} = (x_1, x_2)$ and $\mathbf{y} = (y_1, y_2)$

(a) find L(ax + by) (10%)

(b) Please show that L is a linear operator. (5%)

3. Let V be an inner product space, and let $S = \{y_1, y_2, \ldots, y_n\}$ be a linear independent subset of V. Define $S' = \{x_1, x_2, \ldots, x_n\}$ which is constructed by the so-called Gram-Schmidt orthogonalization process. Now, if $\mathbf{V}=\mathbf{R}^3$ and $y_1 = (1,1,0)$, $y_2 = (2,0,1)$, $y_3 = (2,2,1)$, find $\{x_1, x_2, x_3\}$. (10%)

4. Consider n independent, identically, distributed r.v's $X_1, X_2, \ldots, X_n$ with PDF $F_{X_i}(x) \triangleq F(x)$. Let $Z \triangleq \min[X_1, X_2, \ldots, X_n]$. Compute the PDF of Z in terms of $F(x)$. (20%)

5. Compute the joint pdf of

$$Z \triangleq X^2 + Y^2$$
$$W \triangleq X$$

when

$$f_{XY}(x, y) = \frac{1}{2\pi\sigma^2} e^{-[(x^2+y^2)/2\sigma^2]}.$$

Compute $f_Z(z)$ from your results. (20%)

6. (a) Show that the conditioned distribution of X given the event $A = \{b < X \le a\}$ is

$$F_X(x \mid A) = \begin{cases} 0, & x \le b \\ \dfrac{F_X(x) - F_X(b)}{F_X(a) - F_X(b)}, & b < x \le a \\ 1, & x \ge a. \end{cases} \quad (10\%)$$

(b) Let $B \triangleq \{X \le 10\}$. We wish to compute $F(x \mid B)$. **(10%)**

1. Consider the ECL logic circuit shown in Figure 1. Neglect base currents and Assume that inputs v_x and v_y have the same values as the logic levels at v_{o1} and v_{o2}. (a)Determine the reference voltage V_R. (b) Find the logic 0 and logic 1 voltage values at each output v_{o1} and v_{o2}. (6%*3)

2. Figure 2 is a Class-AB output stage with V_{BE} multiplier bias circuit. Assume the circuit is biased at $V^+ = 15$V and $V^- = -15$V. The load is $R_L = 100\Omega$, transistor Q_n and Q_p are matched, with $I_S = 10^{-13}$A and $\beta = 50$, and $I_{S1} = 2 \times 10^{-14}$A for transistor Q_1. Assume the maximum output voltage is 10V, $I_{Bias} = 4$mA, $I_R = 0.2\ I_{Bias}$, and Q_n and Q_p are to be biased with quiescent collector currents of 5mA, Please determine the value of (a) R_1 and (b) R_2. (8%*2)

3. The circuit shown in Figure 3 is an alternative configuration of a phase-shift oscillator. (a)Assume that $R_1 = R_2 = R_3 = R_{A1} = R_{A2} = R_{A3} \equiv R$ and $C_1 = C_2 = C_3 \equiv C$. Derive the expression for the frequency of oscillation. (b)Assume equal magnitudes of gain in each amplifier stage. What is the minimum magnitude of gain required in each stage to sustain oscillation? (8%*2)

4. (a)Given inputs A, B, and C, please design a two stage clocked or domino CMOS logic circuit to implement the logic function $Y = AB + C$. (b)Determine the logic functions implemented by the circuits shown in Figure 4.a and 4.b. (8%, 4%*2)

5. A simple output stage for an NMOS op-amp (Operational Amplifier) is shown in Figure 5. Device M1 operates as a source-follower. Please derive the expressions for (a) the small-signal open-circuit voltage gain $A_v = v_O / v_I$ and (b) the output resistance of this output stage, with respect to g_{m1}, r_{o1} and r_{o2}. (8%*2)

6. The op-amp is the circuit shown in Figure 6 has an open-loop differential voltage gain of $A_d = 10^4$. Neglect the current into the op-amp, and assume the output resistance looking back into the op-amp is zero. Determine: (a) the closed-loop voltage gain $A_v = V_O / V_S$, (b) the input resistance R_{if}, and (c) the output resistance R_{of}. (6%*3)

Figure 1:

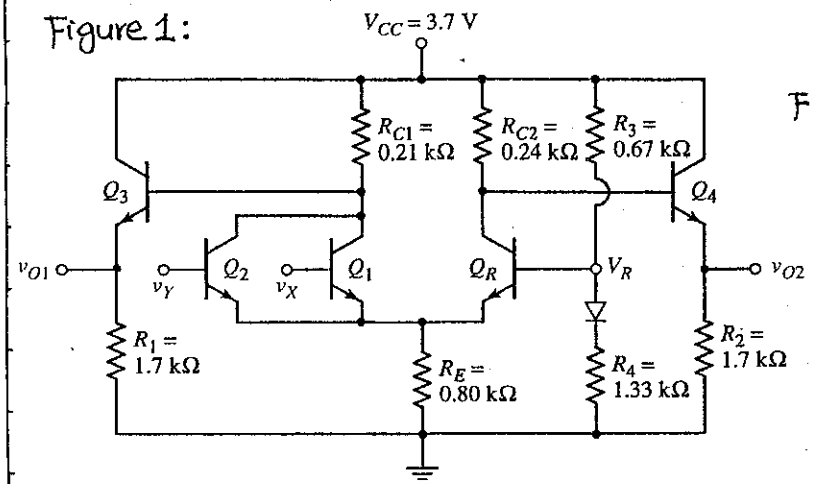


Figure 2:

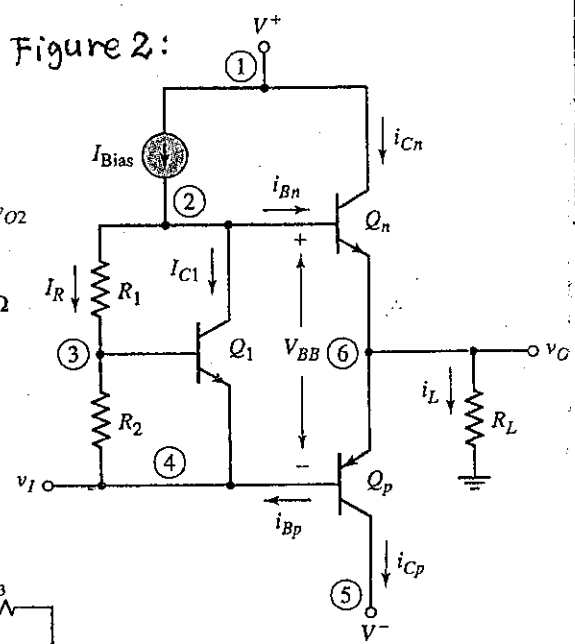


Figure 3:

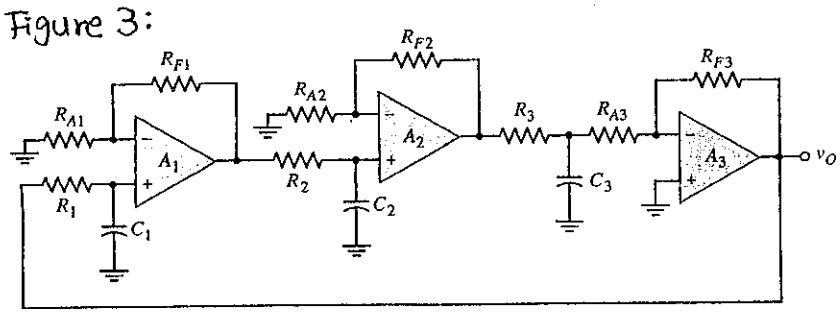
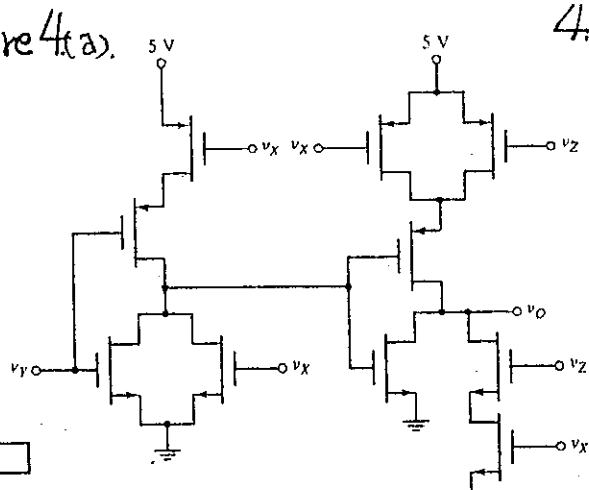


Figure 4(a).



4.(b).

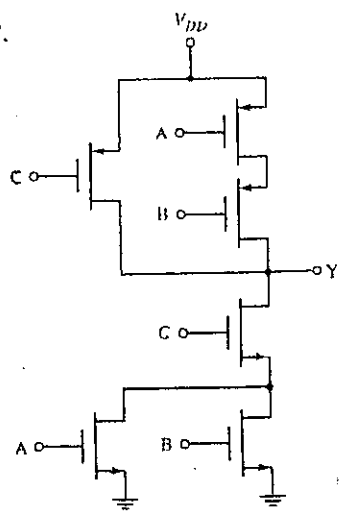


Figure 5:

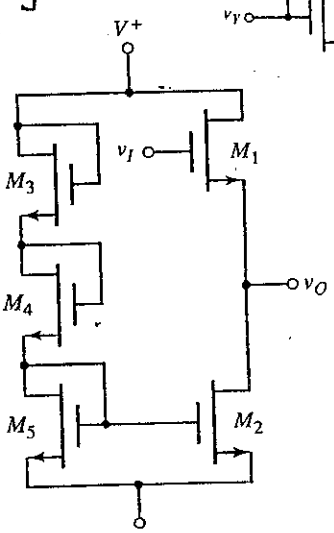
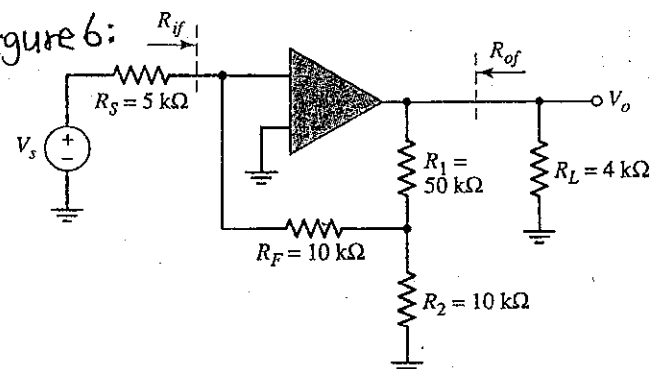


Figure 6:



國立中山大學八十八學年度碩✗士班招生考試試題

科 目：工程數學甲（電机所甲、丙、丁、戊組）

1. (15%) Let $T(x,y)=x^2+4y^2$ be a temperature field. We would like to evaluate the temperature variation around location (1,1).
   (a) By direct substitution and retain only the first-order terms to show that an infinitesimal increment of T from (1,1) to $(1+dx,1+dy)$ is $dT=2dx+8dy$.
   (b) Let $d\vec{r}\equiv\hat{x}dx+\hat{y}dy$ and write the result in (a) as $dT=d\vec{r}\cdot\vec{G}_T|_{(1,1)}$, where $\vec{G}_T|_{(1,1)}$ is a vector depending on T being evaluated at (1,1). Find $\vec{G}_T|_{(1,1)}$.
   (c) Repeat (a) for the increment of T from (x,y) to $(x+dx,y+dy)$ to obtain a general expression of $\vec{G}_T|_{(x,y)}$.
2. (10%) The Fourier series of a periodic signal $f(t)$ of period T can be written as
   $$f(t)=\sum_{n=-\infty}^{\infty}f_n e^{j2n\pi t/T}$$, where the n th coefficient $f_n=\frac{1}{T}\int_T f(t)e^{-j2n\pi t/T}dt$.
   (a) For a complex $g(t)=f(-t)$, express g_n in terms of the Fourier coefficients of $f(t)$.
   (b) Form an even function $e(t)=[f(t)+f(-t)]/2$. Express e_n in terms of f_n if $f(t)$ is real.
3. (15%) Use the upper-case function to denote the Fourier transform of the corresponding lower-case function as $F(f)\equiv\int_{-\infty}^{\infty}f(t)e^{-j2\pi ft}dt$, in which t and f are in second and hertz, respectively.
   (a) If $g(t)=f(t-1\times10^{-3})$, what would be the phase difference between $G(f)$ and $F(f)$ at $f=500$ Hz.
   (b) If $g(t)=f(t/5)$, find f_{100} such that $G(f_{100})$ corresponds to $F(100)$.
   (c) Following (b), will $F(100)$ and $G(f_{100})$ have the same strength? Why?
4. (15%) In the following three statements, first determine the correct one (or ones), and then prove the statement(s) which you choose.
   (a) Let $\mathcal{V}$ be a vector space, and let $X:=\{v_1,\ldots,v_n\}\subseteq\mathcal{V}$, with $v_1\neq0$. Then X is linearly independent if and only if there exists some $v_k\in\{v_2,\ldots,v_n\}$ such that $v_k\in\text{span}\{v_1,\ldots,v_{k-1}\}$.
   (b) Suppose that A is a linear transformation from vector space $\mathcal{V}$ to vector space $\mathcal{W}$. Then, for any $\omega\in\mathcal{W}$, the equation $A(v)=\omega$ has exactly one solution $v\in\mathcal{V}$ if and only if the null space of A is just $\{0\}$.
   (c) Let the dimensions of matrices A and B be such that both AB and BA are conformable. Then all eigenvalues, counting multiplicities, of matrices AB and BA are the same
   Note: Your score will be deducted for the wrong choice(s), and also the incorrect proof(s), up to the total 15 points.
5. (10%) Evaluate
   $$\int_0^{\infty}\frac{x^{-a}}{x+1}dx;\quad 0<a<1$$
   Note: You must give all the necessary details.

6. 7. 在第二頁

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

$$\cos y\,dx - 2(x-y)\sin y\,dy - \cos y\,dy = 0$$

7. (20%)Determine the Laplace transform of the function f(t) that is periodic and defined on one period as follow:

$$\sin t \qquad 0 \le t \le \pi$$

1. Choose and explain the corrective answer. (20%)

(a) In the energy band diagrams, for a gallium rich GaAs semiconductor, the Fermi energy level; E_F is located at (1) Close to E_C above E_i ; (2) Close to E_V below E_i ;(3) in the middle between E_C above E_V ;(4) none of above. (10%)

(b) Where is the site of intrinsic fermi level in the band gap; (1)$E_F > E_i$ (2) $E_F < E_i$; (3) $E_F = E_i$ (4) none of above. (10%)

2. Describe the comparison of the properties of the p-n diode and the Schottky diode.(10%)

3.The p-i-n diode is a three-region device with a middle region that is intrinsic (actually lightly doped) and relatively narrow. Assuming the p- and n- regions to be uniformly doped and N_D-N_A =0 in the I-region:

(a) Establish quantitative relationships for the charge density, electric field, and electrostatic potential and the p-and n- region depletion widths under equilibrium conditions.(10 %)

(b) What is the build-in voltage drop between the p- and n- regions? Justify your answer. (10%)

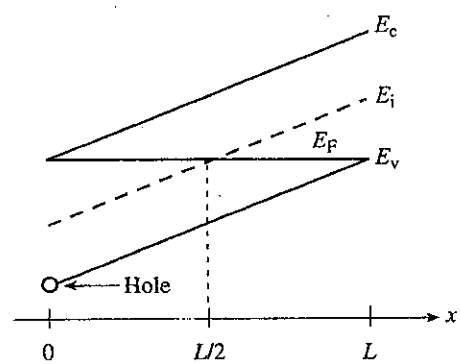
4.Derive and explain the passage of a particle through a potential barrier with (a) E>V (b) E<V (20%).
I. $x \le 0$; V=0; II. $0 \le x \le a$; V(x)=V ; III. $a \le x$; V=0

5.Interpretation of Energy band diagram;(15%)

(a) Sketch the electrostatic potential (V) inside the semiconductor as a function of x.(5%)

(b) Sketch the electric field (E) inside the semiconductor as a function of x. (5%)

(c) Roughly sketch n and p versus x. (5%).



6.Brief description on the development and trend of semiconductor industry in Taiwan. (15%)

國立中山大學八十八學年度碩博士班招生考試試題

科　目：控制系統 (電機系乙組)

20% 1. Please explain the following terms:

(a) Non-minimum phase zeros and their effects on the control system,

(b) Routh-Hurwitz stability criterion,

(c) Phase margin and Gain margin,

(d) Controllable and Observable,

(e) Phase lead and phase lag controller,

(f) Impulse response and transfer function.

15% 2.The block diagram of a control system is shown in Fig.1. Determine the range of K for stability using the Nyquist criterion when K_t has the following values:

(a) $K_t = 0$, (b) $K_t = 0.1$

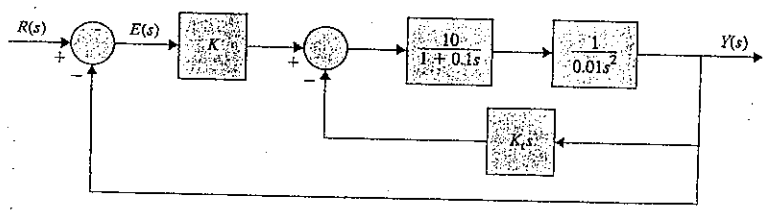


Fig.1

15% 3. The temperature $x(t)$ in the electric furnace shown in Fig.2 is described by the differential equation

$$\frac{dx(t)}{dt} = -2x(t) + u(t) + n(t)$$

where $u(t)$ is the control signal and $n(t)$ the constant distu bance of unknown magnitude due to heat loss. It is desired that the temperature $x(t)$ follows a reference input r that is a constant.

(a) Design a control system with state and integral control so that the eigenvalues of the closed-loop system are at -10 and 10

(b) Design a PI controller so that

$$G_c(s) = \frac{U(s)}{E(s)} = K_p + \frac{K_I}{s}$$

$$E(s) = R(s) - X(s) \text{ where } R(s) = R/s$$

Find K_p and K_I so that the characteristic equation roots are at -10 and 10.

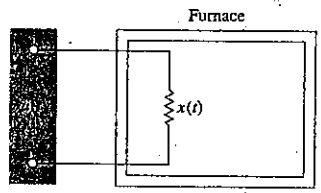


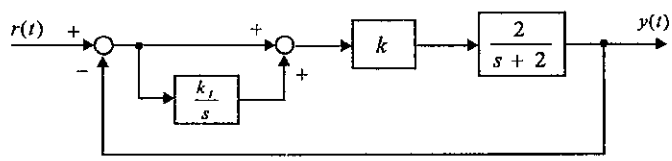
Fig. 2

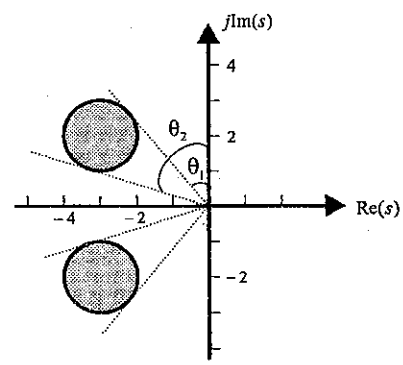
4. Suppose you are to design a unity feedback controller for a first-order plant, as shown in the following figure. You are to design the controller so that the closed-loop poles lie within the shaded regions as shown.

(a)(10%) Estimate the range of ω_n and ζ correspond to the shaded regions.

(b)(5%) Suppose that the answer you obtained in Part (a) are $0.6 \le \zeta \le 1$ and $6 \le \omega_n \le 16$. Find the range of k so that the poles of the closed-loop system lie within the shaded regions.

(c)(5%) If we set $k = 10$ in Part (b), find the range of k_I so that the poles of the closed-loop system lie within the shaded regions.





5. (a)(5%) How can you modify the Routh criterion so that it can apply the case where all the poles are to be to the left of $-\alpha, \alpha > 0$?

(b)(10%) Apply your method to the polynomial

$$s^3 + (6+k)s^2 + (5+6k)s + 5k = 0,$$

finding those values of k for which all poles have a real part less than -2.

6. The characteristic equation of a feedback control system is given by

$$s^3 + 12s^2 + ks + k = 0$$

where $0 \le k \le \infty$. Use Root-Locus Technique to find

(a)(3%) pole(s) of the closed-loop system for $k = 0$ and $k = \infty$.

(b)(3%) all the possible breakaway point(s).

(c)(2%) the intersections(centroid) of the asymptotes.

(d)(3%) the value of k at the point $(-8,\ 0)$, and

(e)(4%) sketch the root loci of the system.

國立中山大學八十八學年度碩博士班招生考試試題

科 目：工程數學乙（電机所乙組） 共一頁 第一頁

1. (15%) Let $T(x,y)=x^2+4y^2$ be a temperature field. We would like to evaluate the temperature variation around location (1,1).
   (a) By direct substitution and retain only the first-order terms to show that an infinitesimal increment of T from (1,1) to $(1+dx,1+dy)$ is $dT=2dx+8dy$.
   (b) Let $d\vec{r}\equiv\hat{x}dx+\hat{y}dy$ and write the result in (a) as $dT=d\vec{r}\cdot\vec{G}_T|_{(1,1)}$, where $\vec{G}_T|_{(1,1)}$ is a vector depending on T being evaluated at (1,1). Find $\vec{G}_T|_{(1,1)}$.
   (c) Repeat (a) for the increment of T from (x,y) to $(x+dx,y+dy)$ to obtain a general expression of $\vec{G}_T|_{(x,y)}$.

2. (10%) The Fourier series of a periodic signal $f(t)$ of period T can be written as
   $f(t)=\sum_{n=-\infty}^{\infty}f_n e^{j2n\pi t/T}$, where the nth coefficient $f_n=\frac{1}{T}\int_T f(t)e^{-j2n\pi t/T}dt$.
   (a) For a complex $g(t)=f(-t)$, express g_n in terms of the Fourier coefficients of $f(t)$.
   (b) Form an even function $e(t)=[f(t)+f(-t)]/2$. Express e_n in terms of f_n if $f(t)$ is real.

3. (30%) In the following four statements, first determine the correct one (or ones), and then prove the statement(s) which you choose.
   (a) Let $\mathcal{V}$ be a vector space, and let $X:=\{v_1,\ldots,v_n\}\subseteq\mathcal{V}$, with $v_1\neq 0$. Then X is linearly independent if and only if there exists some $v_k\in\{v_2,\ldots,v_n\}$ such that $v_k\in\text{span}\{v_1,\ldots,v_{k-1}\}$.
   (b) Suppose that A is a linear transformation from vector space $\mathcal{V}$ to vector space $\mathcal{W}$. Then, for any $\omega\in\mathcal{W}$, the equation $A(v)=\omega$ has exactly one solution $v\in\mathcal{V}$ if and only if the null space of A is just $\{0\}$.
   (c) Let the dimensions of matrices A and B be such that both AB and BA are conformable. Then all eigenvalues, counting multiplicities, of matrices AB and BA are the same.
   (d) Let's consider the set of $n\times m$ matrices with all entries being real, denoted by $R^{n\times m}$. Define $<A,B>:=\text{Tr}(A^TB)$, where $\text{Tr}(\cdot)$ stands for the trace of a matrix and A^T means the transpose of A. Then, $(R^{n\times m},<\cdot,\cdot>)$ is an inner product space.
   Note: Your score will be deducted for the wrong choice(s), and also the incorrect proof(s), up to the total 30 points.

4. (15%) Evaluate
   $$\int_0^\infty \frac{x^{-a}}{x+1}dx;\quad 0<a<1$$
   Note: You must give all the necessary details.

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

   cos y dx - 2(x-y)sin y dy - cos y dy = 0

6. (15%) Determine the Laplace transform of the function f(t) that is periodic and defined on one period as follow:

   sin t $0 \le t \le \pi$

I. (25%) Computer Performance Analysis

(1) (10%) Six computer performance factors are defined as below:

I = Total instruction count of a program.
D = CPU cycles needed for instruction decoding.
E = CPU cycles needed for instruction execution.
M = Number of memory references for one instruction.
K = CPU cycles for one memory reference.
T = CPU cycle time in ns.

Derive an equation for **CPU throughput** in programs/sec.

(2) (15%) Executing the following sequential Fortran program on a unit-processor system first and then the parallel Fortran program on a 16-processor system. Calculate the **speedup factor** and **efficiency** by assuming that **100** cpu cycles are needed for interprocessor communication and 10 cpu cycles are needed for arithmetic addition.

Sequential Fortran Program

```
      DO 10 I = 1, 4096
      A(I) = B(I) + C(I)
10    Continue
      SUM = 0
      DO 20 J = 1, N
      SUM = SUM + A(J)
20    Continue
```

Parallel Fortran Program

```
      DOALL K = 1, 16
          DO 10 I = L(K-1) + 1, KL
              A(I) = B(I) + C(I)
10        Continue
          SUM(K) = 0
          DO 20 J = 1, L
          SUM(K) = SUM(K) + A (L(K-1) + J)
20        Continue
      ENDALL
```

II. (25%) Computer Arithmetic and Cache Memory

(1) (10%) Express the following numbers in floating-point format
(a) (5%) **-1/32** (Use IEEE 32-bit floating point format)
(b) (5%) **1/64** (Use IBM's 32-bit floating-point format with **7-bit** Exponent and an implied base of **16**)

(2) (15%) Consider a **32-bit** microprocessor that has an on-chip **16 Kbytes four-way set associative cache**. Assume that the cache has a line (or block) size of **four 32-bit words**.
(a) (5%) Show the 32-bit physical address format (show how many Tag bits, Set bits, and Offset bits).
(b) (5%) Draw a block diagram of this cache showing its organization and how the different address fields are used to determine a cache hit or miss.
(c) (5%) Where in the cache (by indicating the **set number**) is the double word from memory location ABCDE8F8 mapped?

III. (25%) Pipeline Design

(1) (10%) A superpipelined superscalar processor of degree **(m, n)**. This machine executes **m** instructions every cycle with a pipeline cycle **1/n** of the base cycle. Assume there are **N** independent instructions and **K** pipeline stages. Calculate the **speedup factor** over the base machine with degree (1, 1)

(2) (15%) Consider the following pipeline reservation table:

(a) (5%) What are the forbidden latencies and the collision vector.

(b) (5%) Draw the state transition diagram.

(c) (5%) List all the Greedy cycles and determine the minimum average latency (**MAL**).

	0	1	2	3	4	5
Stage 1	X					X
Stage 2		X			X	
Stage 3			X			
Stage 4				X		
Stage 5		X				X

IV. (25%) Multiprocessor Architectures

(1) (10%) Answer the following questions related to a multistage interconnection networks (**MIN**).

(a) (5%) How many **permutation connections** and **legitimate states** are there in an **8x8** switch module. The permutation connections are defined as one-to-one connections, and the legitimate states are defined as one-to-one and one-to-many connections.

(b) (5%) What is the percentage of **one-pass permutations** as compared with the total number of permutations achievable in one or more passes through the network.

(2) (15%) Analyze the data dependencies by indicating the **Flow, Anti , Output, ALU and Storage dependencies** among the following statements in a given program.

S1:	Load R1, M(100)	/R1 <- Memory(100)/
S2:	Move R2, R1	/R2 <- R1/
S3:	Inc R1	/R1 <- (R1) + 1/
S4:	Add R2, R1	/R2 <- (R2) + (R1)/
S5:	Store M(100), R1	/Memory(100) <- (R1)/

Problem 1 : From time to time, we need to insert a node, *child*, as the left child of node *parent* in a threaded binary tree. The left child pointer of *parent* becomes the left child pointer of *child*. Please do the following tasks.

(1). Define the ADT of a node in a threaded binary tree. (5%)

(2). Write a paragraph of pseudo-code to illustrate how you are going to resolve such a problem. (5%)

(3). Write a C or C++ function, *insert_left*, to implement the desired function. (10%)

Problem 2 : Topological sort is an interesting sorting problem.

(1). Assume the number of edges and the number of nodes in a given graph is e and n, respectively, please analyze the time complexity of the topological sort. (10%)

(2). Does the following set of precedence relations (>) define a partial order on the elements 0 through 4? Explain your answer. (10%)

$$0 > 1; 1 > 4; 1 > 2; 2 > 3; 2 > 4; 4 > 0$$

Problem 3 : If given data is too large such that the sorting task can not be executed in limited main memories, then the secondary storage device, e.g., hard disks, might be required. It is called "external sorting."

(1). Prove that the time complexity of the 2-way merge sort algorithm is identical to that of the k-way merge sort algorithm. (10%)

(2). Practically speaking, one of the above algorithms will be a better one. Select your choice and explain why. (10%)

Problem 4 : Given a graph, G, please prove that $A^+ = A^* \times A$, where

A is the adjacency matrix of G;

A^+ is the transitive closure matrix;

A^* is the reflexive transitive closure matrix;

matrix multiplication is defined as :

$$a_{ij}^+ = \bigcup_{k=1}^{n} a_{ik}^* \bigcap a_{kj}$$

where $\bigcup$ is the logical *or* operation and $\bigcap$ is the logical *and* operation. (20%)

Problem 5 : We might utilize an extra field to record the next hash address that is to be checked next during a hash task. The hash table is assumed to be a circular table. The hashing function is $h(x) = x\%10$. The rehashing function is $rh(x) = (h(x) + 4)\%10$. The rehashing function is repeatedly used until one space is found. The input sequence is 333, 1678, 7809, 1243, 729, 918, 337, 780, 27, 7152. Please try your best to fill out the following table. If there is any unsolvable collision, please explain why. (20%)

bucket	slot 1	next address
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

1. (10 points) Suppose we have the following function:

$$z(a,b,c,d) = \sum(0,3,7,9,14) + \Delta(2,8,10,11,12,13,15)$$

where $\sum$ represents the sum of minterms and Δ represents the don't care minterms. Use Boolean algebra to convert $z(a,b,c,d)$ to a minimum-sized

   (a) SOP expression;

   (b) POS expression.

2. (10 points) Let $z(a,b,c,d,e) = (a+b)(c+d)e$. Implement z using

   (a) a current switching circuit;

   (b) a complementary switching circuit.

3. (10 points) Suppose we have the following function:

$$z(a,b,c,d) = \sum(0,6,7,8,9,14) + \Delta(1,5,11,15)$$

Use the K-map method to convert $z(a,b,c,d)$ to a minimum-sized

   (a) SOP expression;

   (b) POS expression.

4. (10 points) A carry-look ahead adder computes the carry bits in parallel with combinational circuits. Given two 4-bit binary numbers, $a_3a_2a_1a_0$ and $b_3b_2b_1b_0$, and initial carry-in c_0, derive the boolean equations of carry bits c_4, c_3, c_2, c_1, and draw the corresponding carry circuits.

5. (20 points) Use JK-type Flip-flop's to design a four-bit shift register which can perform hold value ($s_1s_0 = 00$), right shift ($s_1s_0 = 01$), left shift ($s_1s_0 = 10$), and load data ($s_1s_0 = 11$). The input signals include clock *clk*, two control lines s_1s_0, four parallel data inputs $d_Dd_Cd_Bd_A$, shift right serial input y_R, and shift left serial input y_L. The output signals include four parallel data outputs $q_Dq_Cq_Bq_A$. You need to draw the transition table, excitation table, K-maps, and the circuit.

6. (20 points) Consider the synchronous sequential circuit in Figure 1 which contains two JK flip-flops, and has a single primary input x and a single primary output z.

   (a) Derive transition table, state table, and state diagram for this circuit.

   (b) What is the output string z, given the input string $x = 1101101111$? Assume that at the beginning, both JK flip-flops are cleared.

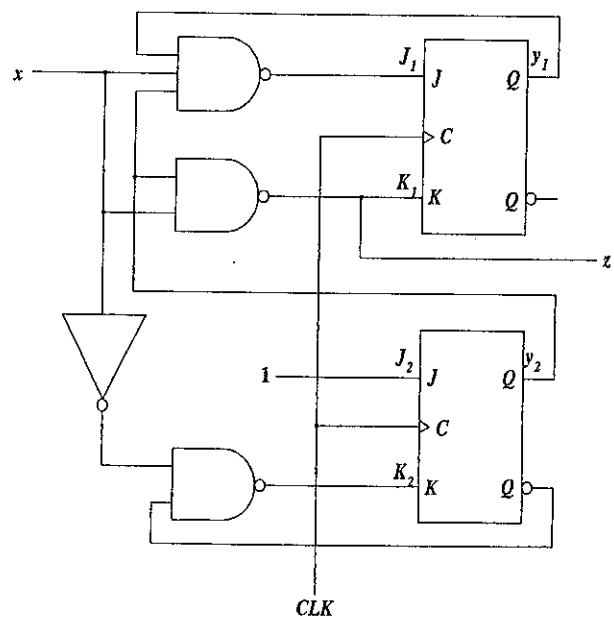


Figure 1: Figure for Problem 6.

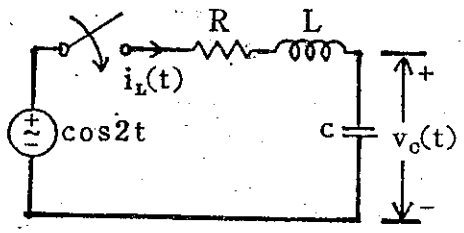
7. (20 points) A sequential circuit *MON* is to be designed that monitors the condition of a patient in a hospital bed. The input to *MON* is a binary number n that ranges in value from 1 to 7 and indicates the patient's condition. The expected value of n is 3, but values of 2 and 4 are not considered abnormal. A new value of n is sent to *MON* automatically every five seconds. If n goes below 2 or above 4 on two or more occasions, the machine should activate an alarm at a nurse's station. The nurse responds by administering medication to the patient and resetting the monitor. Using JK-type Flip-flops and NOR gates only, carry out the logic design of *MON*. You need to draw the state table, transition table, excitation table, K-maps, and the circuit.

國立中山大學八十八學年度碩士班招生考試試題

科　目：電路學　　電機系[丁組]　　

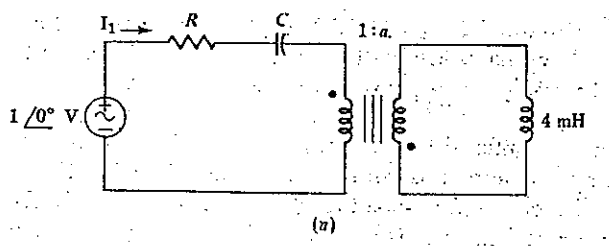
共 20 小題，選擇題每小題：對一題得 5 分，寫錯一題扣 3 分，沒寫得 0 分。
正確答案取最接近者；填充題每小題：對一題得 5 分，寫錯或沒寫得 0 分。

一、下圖所示：C=1F, R=1.5Ω, L=0.5H, 且 $i_L(0_-)=1A$, $v_C(0_-)=1V$, 求開關於 t=0 閉合：

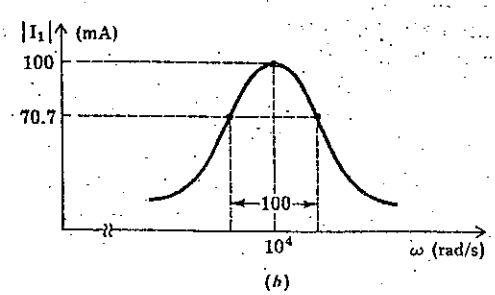


1. $t>0, i_L(t)=$_____
2. $t>0, v_C(t)=$_____
3. $t>0, v_R(t)=$_____
4. 自然頻率=?(a)-1,-2(b)-1,-3(c)-2,-3(d)-2,-4

二、下圖電壓及電流均爲有效值(RMS)，頻寬爲 100 rad/s, 爲得到圖(b), 試決定：



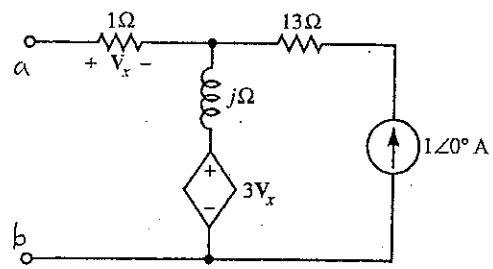
(a)



(b)

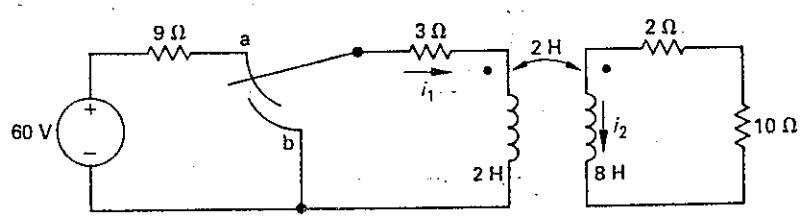
5. R=?(a)0.01Ω(b)0.1Ω(c)1Ω(d)10Ω
6. C=?(a)0.01μF(b)0.1μF(c)1μF(d)10μF
7. a=?(a)0.1(b)0.2(c)10(d)20
8. 共振時電路的品質因數 Q=?(a)10(b)100(c)0.1(d)0.01

三、下圖電壓及電流均爲有效值，端點 a,b 間之



9. 戴維寧等效阻抗=?(a)4+jΩ(b)-4-jΩ(c)4-jΩ(d)-4+jΩ
10. 戴維寧等效電壓=(a)1(b)0(c)j(d)以上皆非
11. a,b 間接上阻抗 z 可得最大平均功率，Z=?
(a)4+jΩ(b)-4-jΩ(c)4-jΩ(d)-4+jΩ
12. 最大平均功率=?(a) 125mW (b) 62.5mW (c)31.25mW(d) 15.625mW

四、下圖所示：開關在 a 已經有一段很長的時間後，t=0 時，開關瞬間移動至 b，求



13. $i_1(0_-)$=(a)2A(b)1A(c)0A(d)12A
14. $i_2(0_-)$=(a)0A(b)2.5A(c)5A(d)12A
15. t>0, $i_1(t)$=_____
16. t>0, $i_2(t)$=_____

五、線電壓有效值爲 230V 之平衡三相系統中，包含每相 12+j3Ω 之 Δ 接負載及每相 5+j1Ω 之 Y 接負載，求

17.線電流有效值=? (a)52.24A(b)30.16A(c)17.41A(d)90.48A
18.總負載之有效功率=?
(a)7.54KW(b)22.62KW(c)67.86KW(d)203.58KW
19.總負載之功率因數=?
(a)0.825 滯後(b) 0.875 滯後(c) 0.925 滯後(d) 0.975 滯後
20.假設要使總負載之功率因數提升爲 0.99 滯後，則須在負載端並聯 Q_c Kvar 之三相電容器，Q_c=(a)1.93KVAR(b)5.11KVAR(c)8.65KVAR(d)10KVAR

國立中山大學八十八學年度碩士班招生考試試題

科　目：電力系統（電機工程學系丁組）　　共 2 頁 第 1 頁

1. 三相 60Hz，345KV 超高壓輸送線，每相有三導體，其排列方式如圖 1 所示，導體 GMR 爲 0.0373ft，d = 45cm，全長 200 公里，試求（a）計算每相每公里之 X_L 爲多少歐姆，（b）以 100MVA 做基準，計算 X 之標么值。（本題答案務必正確，否則不予計分）

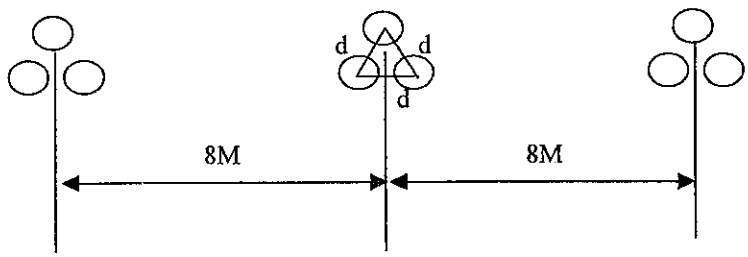


圖 1.

2. 如圖 2 所示之網路，所有標定值爲標么值
試（a）繪出消除互耦後之等效電路
（b）計算 Y_{Bus}
（c）寫出完整節點方程式

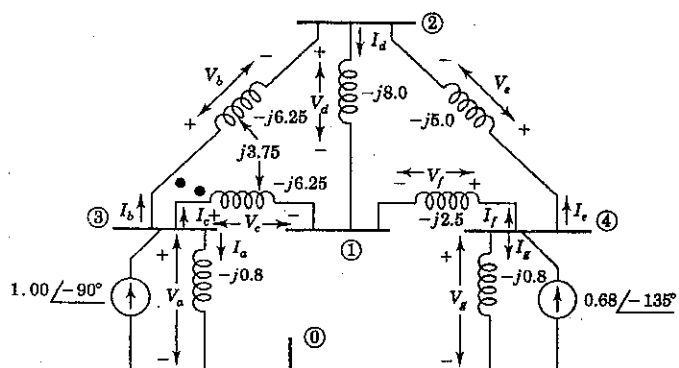
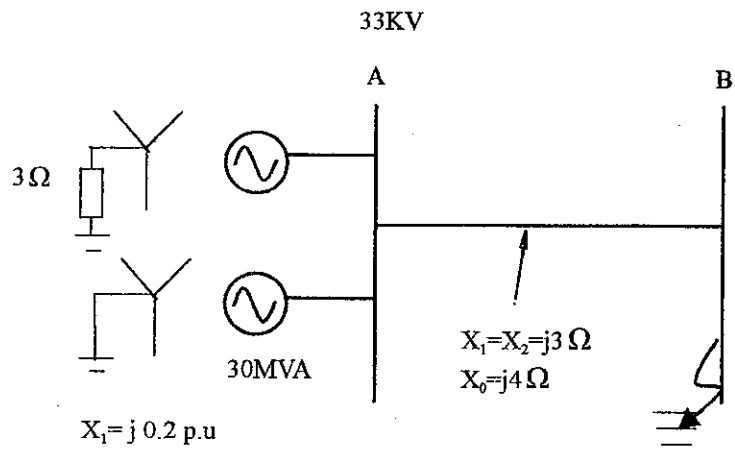


圖 2.

3. 試(a)說明潮流分析計算的兩種方法(Gauss-Seidel 及 Newton-Raphson 方法)
(b)潮流分析中，節點定義爲那幾種？每種節點已知參數及計算參數各爲何？

4. (a)短路故障電流成分爲何？試繪圖說明之。
(b)何謂平衡故障及不平衡故障？各包含哪些故障型態？
(c)計算下圖之單相接地故障電流及單相接地故障容量。(選擇 75MVA 及 33KV 爲基準)



X_1= j 0.2 p.u

X_2= j 0.1 p.u.

X_0= j 0.05 p.u.

(Base on 30MVA)

註：1. 上述參數為單一發電機參數。

2. 兩台發電機容量相同。

3. 下標 1, 2 及 0 分別代表正相序, 負相序及零相序。

※考試注意事項：1.每題以 25 分計，全四題共計 100 分。

2.計算題答案務必正確，否則不予計分。

1. (20%) The region between two concentric spherical conducting shells is filled with two different dielectrics, as shown in Fig. 1. Find the capacitance of the system.

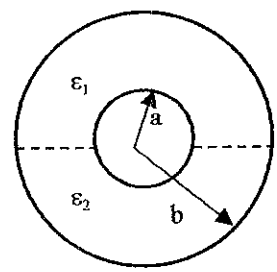


Fig. 1

2. (20%) A ground connection is made by burying a perfectly conducting hemispherical electrode of radius a in the earth, as shown in Fig 2. Assuming the earth's conductivity to be σ, find the resistance of the conductor to distant points in the ground (i.e., between the electrode and a concentric, perfectly conducting hemisphere of infinite radius).

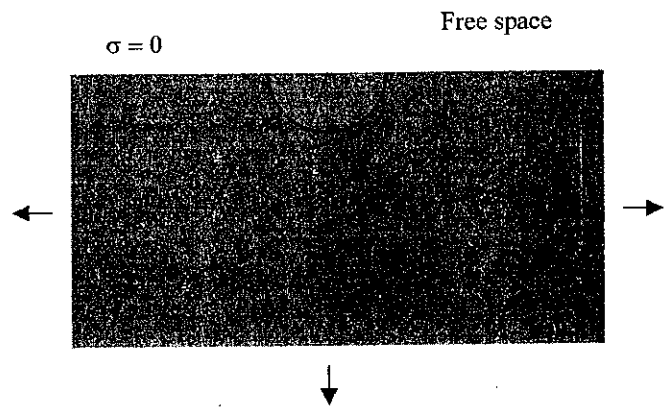


Fig. 2

3. Consider a plane wave propagating in a lossy dielectric medium for $z < 0$ is incident normally on a perfectly conducting plane at $z = 0$. Assume that the lossy medium is characterized by $\varepsilon = (5 - j2)\varepsilon_0, \mu = \mu_0$, and the frequency of the plane wave is 1 GHz, and let the incident electric field be $4\hat{x}$ V/m at $z = 0$.
   (a) (10%) Find the reflected electric field for $z < 0$.
   (b) (10%) Plot the magnitude of the totally electric field for $-0.5 \le z \le 0$.

4. A 50Ω transmission line is matched to a 10 W source, and feeds a load $Z_L = 100\Omega$. If the transmission line is 2.3λ long and has an attenuation constant $\alpha = 0.5$ dB/λ.
   (a) (5%) Find the input impedance to the transmission line.
   (b) (5%) Find the power that is delivered by the source.
   (c) (5%) Find the power that is lost in the transmission line.
   (d) (5%) Find the power that is delivered to the load.

5. Questions:
(a) (5%) What are the boundary conditions for electrostatic and magnetostatic fields at an interface of two lossless dielectric media? What are the boundary conditions for steady current density at an interface of two ohmic media with conductivities σ_1 and σ_2?
(b) (5%) Please define mathematically the gradient of a scalar field and the divergence of a vector field. And explain their physical meanings.
(c) (5%) What do we mean the quasi-static fields? Are they exact solutions of Maxwell's equations? Explain.
(d) (5%) Discuss the analytical procedure for studying the characteristics of TM and TE waves in a waveguide.

1. Explain the following terms: (a) Envelope Delay; (b) Quadrature-Carrier Multiplexing; (c) Random Process; (d) Slope-overload Distortion; (e) bandwidth efficiency. (15%)

2. Consider a periodical impulse train signal x(t) with period T_o, i.e. $x(t)=\sum_{m=-\infty}^{\infty}\delta(t-mT_o)$, determine its Fourier transform X(f). (10%)

3. Prove that $\int_{-\infty}^{\infty}|x(t)|^2dt=\int_{-\infty}^{\infty}|y(t)|^2dt$, where y(t) is a Hilbert transform of x(t). (10%)

4. For a single-tone wideband F. M. signal $s(t)=A_c\cos(2\pi f_c t+\beta\sin 2\pi f_m t)$, determine the amplitude spectrum S(f) of s(t). (10%)

5. Consider a white Gaussian noise w(t) of zero mean and power spectral density $N_o/2$ applied to a low-pass RC filter as shown in Fig. 1. Determine the autocorrelation function $R_N(\tau)$ of the filtered noise n(t). (10%)

6. An unmodulated carrier of amplitude A_c and frequency f_c and band-limited white noise are summed and then passed through an ideal envelope detector. Assume the noise spectral density to be of height $N_o/2$ and bandwidth 2W, centered about the carrier frequency f_c. Determine the output signal-to-noise ratio for the case when the carrier-to-noise ration is high. (10%)

7. A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of the system is equal to 50×10^6 b/s. Determine the maximum message bandwidth W for which the system operates satisfactorily with the Nyquist sampling rate. (10%)

8. Consider a signal s(t) shown in Fig. 2, determine the expressions of the matched filter output as a function of time. (15%).

9. Consider three signals $s_1(t)$, $s_2(t)$, $s_3(t)$ shown in Fig. 3, Express each of these signals in terms of a set of basis functions found by using the Gram-Schmidt orthogonalization procedure. (10%)

Fig. 1

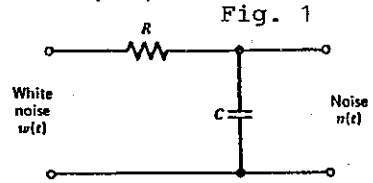


Fig. 2

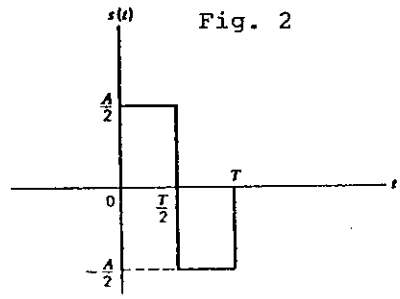


Fig. 3