國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班計算機組

科目：計算機概論

Part I: 概論及程式設計

壹、簡答題 (30%):

a. 若一數用Gray code表示為11011010，則若用binary code表示為何? (3%)

b. 若要班兩部電腦是否在同一C Class之網域上，則mask要設定為多少? (3%)

c. 在OOP中如何可做到呼叫函數時具cascading的功能?
   如可obj1.sethour(5).setminute(10).setsecond(25). (3%)

d. 在一OOP的class中constructor的功能為何? (3%)

e. 宣稱const有何用處? compiler如何判斷變數是否有違反const宣稱? (3%)

f. 解釋在C語言中此行 float (*f[5])(int, int) 的意義. (3%)

g. 解釋protected inheritance的繼承方式? (3%)

h. sequential access file和random access file在寫入時其格式有何不同? (3%)

i. static變數之特性為何? (3%)

j. 何謂function overloading? 電腦如何自動判斷以正確使用overloaded functions? (3%)

貳、下列C程式輸出結果為何? (4%):

```c
#include <stdio.h>

int main()
{
    int x;
    for (x = 1; x <= 30; x = x+4) {
        if (x == 3 || x == 9 || x == 21)
            continue;
        printf("%d", x);
    }
    return 0;
}
```

參、已知Karnaugh Map如下，求其minimized SOP (sum of product) expression. (4%):

<table>
<thead>
<tr>
<th></th>
<th>00</th>
<th>01</th>
<th>11</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>01</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

肆、利用任一程式語言寫一binary search 函數，並說明在主程式如何呼叫. (6%)

伍、利用任一程式語言寫一recursive函數stringlength，求出一字串的長度 (不含字串結束符號). (6%)

第 1 頁，共 2 頁
Part II: 資料結構

5% 1. Translate each of the following postfix expressions into prefix:
   a. ab+cd/-e+
   b. abc+de-.*

5% 2. Would it make sense to call a stack (a) a LILO structure? (b) a FILO structure?
   Would it make sense to call a queue (a) a LILO structure? (b) a FILO structure?

5% 3. What are the advantages and disadvantages of using an AVL tree?

5% 4. What is the range of possible heights of a binary tree with n=128 nodes?

5% 5. Please describe the merits and demerits of using a Binary Search tree?

5% 6. Please describe the difference between a queue and a priority queue?

5% 7. Please tell the merits and demerits of using a HashMap class compared to a
   TreeMap class?

5% 8. Why is the Bubble Sort so slow? Why are the O(n) sorting algorithms (Radix Sort
   and Bucket Sort) slower than the O(n \log n) sorting algorithms (Merge Sort, Quick
   Sort, and Heap Sort)?

5% 9. Please use Java (or C++) to write a Stack class, which must include constructor,
   the methods, push, pop, and isEmpty, and member variable(s). The member
   variable can be an object of Vector class in Java.

5% 10. Please tell the order of computing time of the following piece of program,
    makeSequence
        ```java
        private static void swap(List a, int i, int j) {
            Object tmp = a.get(i);
            a.set(i, a.get(j));
            a.set(j, tmp);
        }
        public static void makeSequence(int[] a)
        {
            for (int i=a.length-1; i>0; i--)
                for (int j=1; j<i; j++) if (a[j-1]>a[j]) swap(a, j-1, j);
        }
        ```
A. 計算機組織

1. Consider a 32-bit microprocessor that has an on-chip 16Kbyte four-way set-associative cache. Assume that the cache has a block size of four 32-bit words. Determine the number of set in the cache which the word from memory location ABCDE8F8 mapped? (10%)

2. A computer has a cache, main memory, and a disk used for virtual memory. If a referenced word is in the cache, 20 ns are required to access it. If it is in main memory but not in the cache, 60 ns are needed to load it into the cache, and then the reference is started again. If the word is not in main memory, 12 ms are required to fetch the word from disk, followed by 60 ns to copy it to the cache, and then the reference is started again. The cache hit ration is 0.9 and the main memory hit ratio is 0.6. What is the average time in ns required to access a referenced word on this system? (10%)

3. Suppose an 8-bit data word stored in memory is 11000010. Using the Hamming algorithm, determine what check bits would be stored in memory with the data word. Show how you got your answer. (10%) 

4. The following sequence of virtual page number is encountered in the course of execution on a computer with virtual memory: 3 4 2 6 4 7 1 3 2 6 3 5 1 2 3. Assume that a least recently used page replacement policy is adopted. Plot a graph of page hit ratio (fraction of page references in which the page is in main memory) as a function of main-memory page capacity n for 1 ≤ n ≤ 8. Assume that main memory is initially empty. (10%)

5. Based on the IEEE754 standard, show the binary floating-point representation for the decimal numbers, 21.125 and -13.375, in single precision. (10%)
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班計算機組

B. 作業系統

B1. 請解釋下列名詞。(10%)
   1) Spooling
   2) RAID
   3) I-node

B2. 假設有一作業系統採用動態分割(Dynamic Partition)的記憶體分配法，系統的記憶體共有 2560K 位元組，其中有 400K 位元組以分配給作業系統，剩下 2160K 位元組的可用空間，如下圖所示:

   ![圖示](image)

   另外，工作池(Job Pool)中現有 5 個行程，其所需要的記憶體空間及執行時間如下：

<table>
<thead>
<tr>
<th>行程</th>
<th>記憶體空間</th>
<th>執行時間</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>600K</td>
<td>10</td>
</tr>
<tr>
<td>P2</td>
<td>1000K</td>
<td>5</td>
</tr>
<tr>
<td>P3</td>
<td>300K</td>
<td>20</td>
</tr>
<tr>
<td>P4</td>
<td>200K</td>
<td>8</td>
</tr>
<tr>
<td>P5</td>
<td>500K</td>
<td>15</td>
</tr>
</tbody>
</table>

此系統所使用的工作排班法則為 FCFS，CPU 排班法則為循環式(round-robin)，時間分配(time quantum)為 1。若此系統採用的可用記憶體空間搜尋法為最先配合(First-fit)，請畫出當行程 P5 開始執行時的記憶體分配狀況。若採用最佳配合(Best-fit)，則當行程 P5 開始執行時的記憶體分配狀況又如何？若採最差配合(Worst-fit)，狀況又如何？(15%)
B3. 考慮下列的分頁參考字串(page reference string)：
   5, 4, 3, 2, 1, 4, 3, 5, 4, 3, 4, 1
   (a) 假設工作集合視窗(working set window)設為 4 次分頁參照，請寫出每一時間點的工作集合。(4%)
   (b) 假設記憶體的頁框數(page frame)為 3，請分別畫出當分頁取代法為 LRU 及 Clock 時，記憶體在每一時間點的分頁分配。(8%)

B4. 交換(Swapping)是作業系統中常見的處理動作，請舉出二種狀況下作業系統需執行交換的動作。(5%)

B5. 假設有一 200 磁軌的移動讀寫磁碟，從 0 編號至 199，目前磁頭位於第 125 磁軌，接下來要讀取第 143 磁軌。另外，假設行程上的要求以 FIFO 的順序如下排列：
   86, 147, 91, 177, 94, 150, 102, 175, 130
   請對下列磁碟排班法則，分別計算各需多少的讀寫頭移動總軌數。(8%)
   a. SSTF
   b. C-SCAN
A. **Discrete math**

1. Let us start at the point (0, 0) in the xy-plain and consider two kinds of moves:
   
   \[ R: (x, y) \rightarrow (x+1, y) \quad U: (x, y) \rightarrow (x, y+1) \]

   (a) (5%) Determine the number of paths from (0, 0) to (6, 6).
   
   (b) (5%) Determine the number of paths from (0, 0) to (6, 6), which may touch or lie below the line \( x = y \), but never rise above the line \( x = y \).

2. (10%) Prove that if 151 integers are selected from \( \{1, 2, 3, \ldots, 300\} \), then the selection must include two integers \( x, y \) where \( x \mid y \) (\( x \) divides \( y \)) or \( y \mid x \) (\( y \) divides \( x \)).

3. (10%) Let \( \phi \) be the input alphabet and \( \mathcal{B} \) be the output alphabet. Please draw the state diagram for a finite state machine with \( \phi = \mathcal{B} = \{0, 1\} \) that will recognize the occurrence of the sequence 1010 in an input string \( x \in \phi^* \). For example, if \( x = 10101001010 \), then the output will be 00010100001.

4. If \( A = \{u, w, x, y, z\} \)
   
   (a) (5%) determine the number of relations on \( A \) that are antisymmetric.
   
   (b) (5%) If \( R \) is the equivalence relation on \( A \) that induces the partition \( A = \{u, w\} \cup \{x, y\} \cup \{z\} \). What is \( R \)?

5. (5%) A proper coloring of a graph means that the two vertices of any edge in the graph will be colored with different colors. How many proper colorings are there for the graph given below, if six colors are available?

   ![Graph Diagram]

6. (5%) Verify the following argument (you must write each verification step):

   \[
   \begin{align*}
   &p \rightarrow (q \rightarrow r) \\
   &p \lor s \\
   &t \rightarrow q \\
   &\neg s \\
   \hline
   \neg r \rightarrow \neg t
   \end{align*}
   \]
B. Linearity Algebra

1. Determine whether the solution space of the system $Ax = 0$ is a line through the origin, a plane through the origin, or the origin only. If it is a plane, find an equation for it, and if it is a line find parametric equations for it.

(a) $A = \begin{bmatrix} 2 & -8 & 6 \\ -3 & 12 & -9 \\ 7 & -28 & 21 \end{bmatrix}$

(b) $A = \begin{bmatrix} 2 & 6 & 8 \\ 3 & 3 & 15 \\ 2 & 4 & 12 \end{bmatrix}$

2. Find the $QR$-decomposition of $A$ under the Euclidean inner product.

(a) $A = \begin{bmatrix} 1 & 1 \\ 1 & -2 \end{bmatrix}$

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

3. Consider the bases $B = \{u_1, u_2\}$ and $B' = \{v_1, v_2\}$ for $R^2$, where

$u_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$, $u_2 = \begin{bmatrix} 3 \\ 5 \end{bmatrix}$, $v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $v_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$.

(a) Find the transition matrix $P_{B', B}$ from $B$ to $B'$. 3%

(b) Find the transition matrix $P_{B, B'}$ from $B'$ to $B$. 3%

(c) Compute the coordinate matrix $[w]_{B'}$ where $w = \begin{bmatrix} 4 \\ 7 \end{bmatrix}$. 2%

(d) Use your answers to parts (b) and (c) to compute $[w]_B$. 2%

4. Use diagonalization to compute $A^{10}$ for $A = \begin{bmatrix} 5 & 3 & -7 \\ -1 & 1 & 1 \\ 3 & 3 & -5 \end{bmatrix}$. 10%

5. Let $T : R^3 \rightarrow R^3$ be the linear operator defined by $T(x_1, x_2, x_3) = (x_2 + x_3, x_1 + x_3, x_1 + x_2)$.

(a) Find the matrix $[T]_B$, where $B = \{v_1, v_2, v_3\}$, and $v_1 = (1, 1, 3)$, $v_2 = (1, 2, 0)$, $v_3 = (-1, 0, 1)$.

(b) Use the matrix from (a) to compute $T(1, 1, 1)$. 10%
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班 光電組

科目：電磁學

電機工程研究所碩士班入學測驗電磁學試題

一、請寫出 Maxwel's 電磁學方程式(微分式)，並說明其物理意義(25%)

二、有一材料截面積 A, 長度 L, 轉子濃度 n, 外加電壓 V, 請以自由電子模型(free
electron model)計算材料的電阻 R(resistance), (假設轉子的碰撞時間為 τ ),並
計算轉子的漂移速率 \( V_d \) (drift velocity). (20%)

三、請利用已知的電磁定律導出電磁輻射方程式(EM wave equation), 並求出真空
中的電磁波速率 \( \mu_0 = 4\pi \times 10^{-7} \text{H/m}, \epsilon_0 = 8.85 \times 10^{-12} \text{F/m} \) (20%)

四、請引證電磁定律說明導體(conductor)電荷集中於導體表面.(15%)

五、如下圖有一材料截面積 A=WxD, 長度 L, 通一電流 I, 若在垂直電流的方向施
一磁場 B, 則在垂直 LB 平面會產生一電壓 \( V_H \) (霍爾效應, Hall Effect), 請利用所
給的條件計算材料的轉子濃度 n.(20%)(轉子電荷量=\( e \))

\[ I \quad \begin{array}{c}
\uparrow \\
B
\end{array} \]

\[ \text{W} \quad \text{L} \]

\[ \uparrow B \quad \text{D} \]

第 页，共 页
A. 微分方程 (工程數學)

不可使用計算機，需按照題目順序作答。

10% 1. \[ \frac{dy}{dx} = \frac{y}{e^{2t} \ln y} \], solve y.

10% 2. \[ \frac{dy}{dx} = -\frac{2xy}{x^2 + y^2} \], solve y.

10% 3. \[ y'' + 2y' + y = 6, \quad y(0) = 5 \text{ and } y'(0) = 1 \], solve y.

10% 4. \[ y'' - 9y = 54 \text{ t sin (3t)} \], solve y.

10% 5. Solve the Laplace transformation \( L\{ f(t) \}(s) \).

a). \( L\{ \cos(kt) \} \)

b). \( L\{ e^{at} \ast \cosh (kt) \} \)
B. 線性代數

1. Determine whether the solution space of the system $Ax = 0$ is a line through the origin, a plane through the origin, or the origin only. If it is a plane, find an equation for it, and if it is a line find parametric equations for it.

   (a) $A = \begin{bmatrix} 2 & -8 & 6 \\ -3 & 12 & -9 \\ 7 & -28 & 21 \end{bmatrix}$

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   (a) $A = \begin{bmatrix} 1 & 1 \\ 1 & -2 \end{bmatrix}$

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

3. Consider the bases $B = \{u_1, u_2\}$ and $B' = \{v_1, v_2\}$ for $\mathbb{R}^2$, where

   $u_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$, $u_2 = \begin{bmatrix} 3 \\ 5 \end{bmatrix}$, $v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $v_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$.

   (a) Find the transition matrix $P_{B', B}$ from $B$ to $B'$. 3%

   (b) Find the transition matrix $P_{B, B'}$ from $B'$ to $B$. 3%

   (c) Compute the coordinate matrix $[w]_{B'}$ where $w = \begin{bmatrix} 4 \\ 7 \end{bmatrix}$. 2%

   (d) Use your answers to parts (b) and (c) to compute $[w]_{B}$. 2%

4. Use diagonalization to compute $A^{10}$ for $A = \begin{bmatrix} 5 & 3 & -7 \\ -1 & 1 & 1 \\ 3 & 3 & -5 \end{bmatrix}$.

5. Let $T : \mathbb{R}^3 \to \mathbb{R}^3$ be the linear operator defined by $T(x_1, x_2, x_3) = (x_2 + x_3, x_1 + x_3, x_1 + x_2)$.

   (a) Find the matrix $[T]_{B'}$ where $B = \{v_1, v_2, v_3\}$, and $v_1 = (1, 1, 3)$, $v_2 = (1, 2, 0)$, $v_3 = (-1, 0, 1)$.

   (b) Use the matrix from (a) to compute $T(1, 1, 1)$. 10%
A. 近代物理
不可以使用計算機，需按照題目順序作答。
1. The lifetime of muon particle is 2.2 μs when measured in a reference frame at rest with respect to the particles. While the muon particles were produced by the collision of cosmic radiation with atoms high in the atmosphere in earth, the speed of muon particles were 0.99C (C is the speed of light ). What is the lifetime measured in earth.(10%)

2. Solve the ground state wave function of a quantum well with potential well function \( U(x) = \frac{1}{2} m_0 \beta x^2 \). Find the energy (E) at ground state. (15%)

3. What is Compton effect? Derive the wavelength shift \( \Delta \lambda \) for a photon ( wavelength \( \lambda \) ) scattered by an electron ( effective mass \( m_e \) ) with scattered angle \( \theta \). (10%)

4. What is the distribution functions of photons, phonons and electrons.(15%)

B. 固態物理
不可使用計算機，需按照題目順序作答。
1. Can the (1 1 1) plane in the face centered cubic structure cause the constructive X-ray diffraction? How about the (1 2 3) plane? Why? (15%)

2. Calculate the packing faction in the fcc structure. (10%)

3. Is it possible for a material to have a low thermal conductivity and high electrical conductivity? Why? (15%)

4. Describe the following structures with angle \( \alpha, \beta, \gamma \) and axis a1, a2, a3. (10%)
   a) Cubic
   b) Hexagonal
   c) Tetragonal
   d) Orthorhombic
   e) Monoclinic
A. 機率

1. (Gambler’s Ruin Problem) Two gamblers play the game of “heads or tails,” in which each time a fair coin lands heads up, player A wins $1 from B, and each time it lands tails up, player B wins $1 from A. Suppose that player A initially has a dollars and player B has b dollars. If they continue to play this game successively, what is the probability that (a) A will be ruined; (b) the game goes forever with nobody winning?

2. Figure 1 shows an electric circuit in which each of the switches located at 1, 2, 3, 4, and 5 is independently closed or open with probabilities p and 1 – p, respectively. If a signal is fed to the input, what is the probability that it is transmitted to the output?

![Figure 1](attachment:image.png)

3. An urn contains n balls whose colors, red or blue, are equally probable. [For example, the probability that all of the balls are red is \((1/2)^n\).] If in drawing k balls from the urn, successively with replacement and randomly, no red balls appear, what is the probability that the urn contains no red balls?

4. A number \(t\) is said to be the median of a continuous random variable \(X\) if \(P(X \leq t) = P(X \geq t) = 1/2\). Calculate the median of the normal random variable with parameters \(\mu\) and \(\sigma^2\).

5. First, a point \(Y\) is selected at random from the interval (0, 1). Then another point \(X\) is chosen at random from the interval (0, \(Y\)). Find the probability density function of \(X\).
B. 線性代數

1. Determine whether the solution space of the system $Ax = 0$ is a line through the origin, a plane through the origin, or the origin only. If it is a plane, find an equation for it, and if it is a line find parametric equations for it.

   \[ (a) \ A = \begin{bmatrix} 2 & -8 & 6 \\ -3 & 12 & -9 \\ 7 & -28 & 21 \end{bmatrix}, \quad (b) \ A = \begin{bmatrix} 2 & 6 & 8 \\ 3 & 3 & 15 \\ 2 & 4 & 12 \end{bmatrix} \]

2. Find the $QR$-decomposition of $A$ under the Euclidean inner product.

   \[ (a) \ A = \begin{bmatrix} 1 & 1 \\ 1 & -2 \end{bmatrix}, \quad (b) \ A = \begin{bmatrix} 2 & 0 & 2 \\ 2 & 2 & -1 \\ 1 & -1 & -2 \end{bmatrix} \]

3. Consider the bases $B = \{u_1, u_2\}$ and $B' = \{v_1, v_2\}$ for $\mathbb{R}^2$, where

   \[ u_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \quad u_2 = \begin{bmatrix} 3 \\ 5 \end{bmatrix}, \quad v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad v_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \]

   (a) Find the transition matrix $P_{B',B}$ from $B$ to $B'$. 3%

   (b) Find the transition matrix $P_{B,B'}$ from $B'$ to $B$. 3%

   (c) Compute the coordinate matrix $[w]_{B'}$ where $w = \begin{bmatrix} 4 \\ 7 \end{bmatrix}$. 2%

   (d) Use your answers to parts (b) and (c) to compute $[w]_B$. 2%

4. Use diagonalization to compute $A^{10}$ for $A = \begin{bmatrix} 5 & 3 & -7 \\ -1 & 1 & 1 \\ 3 & 3 & -5 \end{bmatrix}$. 10%

5. Let $T : \mathbb{R}^3 \rightarrow \mathbb{R}^3$ be the linear operator defined by $T(x_1, x_2, x_3) = (x_2 + x_3, x_1 + x_3, x_1 + x_2)$.

   (a) Find the matrix $[T]_B$, where $B = \{v_1, v_2, v_3\}$, and $v_1 = (1,1,3)$, $v_2 = (1,2,0)$, $v_3 = (-1,0,1)$.

   (b) Use the matrix from (a) to compute $T(1,1,1)$. 10%
國立高雄大學九十三學年度研究所碩士班招生考試試題
系所組別：電機工程學系碩士班通訊組 科目：通訊系統

1. **Pseudo Noise Code Sequence (20 pts)**
   a) Figure 1 shows a four stage feedback shift register. The initial state of the register is 1000. Find the output sequence of the shift register.
   b) Find the PN sequence generated by the circuit in Figure 2 if the initial state is 10100.

![Figure 1](image1)

2. **Matched Filters (20 pts)**
   Consider the pulses pair in Figure 3a) that are orthogonal to each other over the interval \([0, T]\).
   a) Determine the impulse response of a matched filter to signal \(s_1(t)\) and \(s_2(t)\), respectively.
   b) Plot the matched filter outputs as a function of time.
   c) Form a two dimensional matched filter by connecting the two matched filters of \(s_1(t)\) and \(s_2(t)\) in parallel as shown in Figure 3b), show the following:
   c-1) When the pulse \(s_1(t)\) is applied, the response of the lower filter is zero.
   c-2) Find the peak value to the output of the lower part when \(s_2(t)\) is applied.

![Figure 2](image2)

![Figure 3](image3)

3. **Frequency Modulation (20pts)**
   For Frequency Modulation \(s(t) = A \cos(2\pi f_c t + 2\pi k \int_0^t m(\tau)d\tau)\), \(\beta = k \frac{|m(t)|_{\text{max}}}{f_m}\).
   a) Derive the equation for narrowband FM modulation (\(\beta << 1\), to simplify the problem use \(m(t) = \cos(2\pi f_c t)\)).
   b) The above equation for NBFM is similar to the DSB-LC signal; compare and show the similarity and difference between these two signals.
   c) Explain why the NBFM is better in noise resistance than DSB-LC signals.
4. **FSK (20pts)**
An FSK system transmits binary data at the rate of 2.5 Mbps. During the course of transmission, white Gaussian noise of zero mean and power spectral density $10^{-8}$ W/Hz is added to the signal. In the absence of noise, the amplitude of the received sinusoidal wave for digit 1 or 0 is 1 mV. Determine the average probability of symbol error for the following system configurations:
- a) Coherent binary FSK,
- b) Coherent MSK,
- c) Non-coherent binary FSK.

5. **Amplitude Modulation (20pts)**
- a) Explain how the DSB-SC amplitude modulation and demodulation schemes work.
- b) Following Figure 4, draw a figure to show the frequency response of modulated and demodulated signals. If $f_m=3000$ Hz, $f_1=50$ kHz, $f_2=200$ kHz, $f_3=250$ kHz and $A_1=0.5$, $A_2=1$, $A_3=2$.
- c) Following Figure 5, draw a figure to show the modulated and demodulated signals. If $f_m=50$ Hz, $f_1=900$ Hz, $f_2=950$ Hz, and $A_1=1$, $A_2=0.5$.

![Figure 4](image1)

![Figure 5](image2)
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班半導體組（積體電路）科目：微電子學

1. For the circuit shown in Fig. 1. Assume ideal op amp. (20%)
   (a) \( Z_{1}=R_{1}, Z_{2}=2R, Z_{3}=3R, Z_{4}=4R, v_{1}=v, v_{2}=0 \), please find the voltage gain and input resistance.
   (b) \( Z_{1}=2R, Z_{2}=R//C, Z_{3}=Z_{4}=0, v_{1}=v, v_{2}=0 \), please find the transfer function and what kind of this filter is it? And find the dc gain and 3dB frequency?
   (c) \( Z_{1}=R, Z_{2}=5R, Z_{3}=R, Z_{4}=2R, v_{1}=5e^{i\omega t}, v_{2}=-5e^{-i\omega t} \), please find the output of this circuit.
   (d) \( v_{1}, v_{2} \neq 0 \), please design an OP Amp \( \frac{\text{differentiator}}{Z_1Z_2Z_3Z_4} \) using \( Z_1, Z_2, Z_3, Z_4 \) and find this output voltage and voltage gain.

2. (a) For a circuit in Fig. 2(b), assume each diode is ideal, sketch the output for the input shown in Fig. 2(a). Label the most positive and negative output levels. Assume \( RC >> T \). (5%)
   (b) Design a limiter circuit using some diodes and a resistor to provide an output signal limited to the range from \(+0.7V \sim -0.4V\). Assume only two kind of diode with 0.5V and 0.3 drop when conducting, in respectively. (5%)

3. For the circuit in Fig. 3 (15%)
   (a) \( Z_{0}=100k\Omega, Z_{C}=2k\Omega, Z_{E}=0, V_{BB}=5.7V, v_{i}=v, V_{CC}=12V, V_{EE}=0V \) and \( \beta=100 \), assume Early effect is neglected, please find the transfer voltage gain. \( V_{T}=25mV \) at \( T=300K \).
   (b) \( Z_{0}=7.5k\Omega, Z_{C}=100k\Omega, Z_{E} \) is current source with \( I=1mA, v_{i}=v, V_{BB}=0, V_{CC}=10V, V_{EE}=-10V \) and \( \beta=100 \), Early effect cannot be neglected with \( V_{A}=100V \), please find \( R_{S}, A_{m} \) and \( A_{n}, R_{F} \).
   (c) \( Z_{0}=0, v_{i}=0, Z_{C}=3.8k\Omega, Z_{E}=3k\Omega, V_{BB}=6.7V, V_{CC}=9.2V \), assume Early effect is neglected, please find the minimum \( \beta \) to keep transistor in saturation.

4. For the circuit in Fig. 4 (15%)
   (a) \( V_{DD}=5V, V_{T}=1V, k(W/L)=1mA/V^{2} \), modulation length effect was neglected. If \( I_{D}=8mA \), please choose an appropriate \( Z_{1} \) and \( Z_{2} \) to find the largest \( Z_{0} \) for maintaining device in saturation-region?
   (b) For a CMOSFET with \( L=1\mu m, W_{g}=2\mu m, W_{p}=4\mu m, k_{n}=60\mu A/V^{2}, k_{p}=30\mu A/V^{2} \), \( V_{G}=V_{P}=1V \), \( V_{DD}=5V \), please find the noise margin \( N_{M} \) and \( N_{M} \).
   (c) Find the \( f_{T} \) for a MOSFET operating at \( I_{D}=1000\mu A \) and having \( \mu_{p}C_{ox}=5\mu A/V^{2}, W=10\mu m, L=10\mu m, \quad C_{B}=0.05pF, \quad C_{F}=0.5pF \).

5. Differential amplifier circuit in Fig 5, \( R_{C1}=R_{C2}=1k\Omega, R_{E}=4k\Omega, V_{DD}=4.7V, V_{EE}=-4.7V \) and \( \beta_{1}=\beta_{2}=100 \) (15%)
   (a) For \( v_{i1}=v_{i2}=v_{d} \), with zero average, find differential mode gain \( v_{s}=v_{d} \). \( V_{T}=25mV \) at \( T=300K \).
   (b) For \( v_{i1}=v_{i2}=v_{CM} \), please find the CMRR.
   (c) If this circuit with collector resistors that are matched 1%, please find input offset voltage \( V_{OS} \).

6. For the circuit in Fig 6, \( R_{E}=5k\Omega, R_{1}=R_{2}=10k\Omega, R_{C}=R_{L}=10k\Omega, V_{CC}=12V \), assume \( r_{i}=r_{o}=0, V_{T}=25mV \) at \( T=300K \). If \( I_{E}=0.25mA, \beta=100, C_{i}=C_{o}=1\mu F \) and \( C_{E}=10\mu F \). (10%)
   (a) Please find the midband gain.
   (b) Please find the \( f_{T} \) and frequency of the zero.

7. For the circuit in Fig 7.
   (a) For M is BJT, \( \beta_{1}=100, Z_{e}=7k\Omega, Z_{L}=1k\Omega, V_{CC}=4.7V \), Please find the voltage gain, \( R_{an} \), and \( R_{out} \). (7.5%)
   (b) For M is enhancement nMOSFET, \( Z_{e}=10k\Omega, Z_{L}=1M\Omega, Z_{C}=2k\Omega, V_{T}=1V, k_{n}W/L=1/3mA/V^{2}, V_{CC}=4V \), Please find the voltage gain, \( R_{an} \), and \( R_{out} \). (7.5%)
国立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班半導體組（積體電路）科目：微電子學
1. Consider a 32-bit microprocessor that has an on-chip 16Kbyte four-way set-associative cache. Assume that the cache has a block size of four 32-bit words. Determine the number of set in the cache which the word from memory location ABCDE8F8 mapped? (10%)

2. A computer has a cache, main memory, and a disk used for virtual memory. If a referenced word is in the cache, 20 ns are required to access it. If it is in main memory but not in the cache, 60 ns are needed to load it into the cache, and then the reference is started again. If the word is not in main memory, 12 ms are required to fetch the word from disk, followed by 60 ns to copy it to the cache, and then the reference is started again. The cache hit ration is 0.9 and the main memory hit ratio is 0.6. What is the average time in ns required to access a referenced word on this system? (10%)

3. Suppose an 8-bit data word stored in memory is 11000010. Using the Hamming algorithm, determine what check bits would be stored in memory with the data word. Show how you got your answer. (10%)

4. The following sequence of virtual page number is encountered in the course of execution on a computer with virtual memory: 3 4 2 6 4 7 1 3 2 6 3 5 1 2 3. Assume that a least recently used page replacement policy is adopted. Plot a graph of page hit ratio (fraction of page references in which the page is in main memory) as a function of main-memory page capacity n for $1 \leq n \leq 8$. Assume that main memory is initially empty. (10%)

5. Based on the IEEE754 standard, show the binary floating-point representation for the decimal numbers, 21.125 and -13.375, in single precision. (10%)

6. Consider an instruction sequence of length $n$ that is streaming through the instruction pipeline. Let $p$ be the probability of encountering a conditional or unconditional branch instruction, and let $q$ be the probability that execution of a branch instruction I causes a jump to a nonconsecutive address. Assume that each such jump requires the pipeline to be cleared, destroying all ongoing instruction processing, when I emerges from the last stage. Please calculate the total time $T_k$ required to execute all $n$ instructions and the speedup factor $S_k$ for the instruction pipeline compared to execution without the pipeline. (10%)
7. Use 4-bit carry lookahead adders to design a 16-bit carry lookahead adder. You should give the block diagram of the 16-bit adder and describe how carry signals, generate signals, and propagate signals are passed between 4-bit carry lookahead adders. (15%)

8. Please depict a 4-bit twos-complement adder-subtractor using 1-bit adder and some logic gates. The twos-complement adder-subtractor can compute the three quantities $X+Y$, $X-Y$, and $Y-X$, as well as overflow and zero flags. (10%)

9. Given $x=0101$ and $y=1010$ in twos complement notation, compute the product $p = x \times y$ with Booth’s algorithm. Show how you got your answer. (15%)
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班半導體組(積體電路) 科目：工程數學

A. 微分方程(工程數學)

不可使用計算機，需按照題目順序作答。

10% 1. \[ \frac{dy}{dx} = \frac{y}{e^{2x} \ln y} \], solve y.

10% 2. \[ \frac{dy}{dx} = -\frac{2xy}{x^2 + y^2} \], solve y.

10% 3. \[ y'' + 2y' + y = 6 \], y(0) = 5 and y'(0) = 1, solve y.

10% 4. \[ y'' - 9y = 54 \sin (3t) \], solve y.

10% 5. Solve the Laplace transformation \( L\{ f(t) \}(s) \).
   
   a). \( L\{ \cos(kt) \} \)
   
   b). \( L\{ e^{at} + \cosh(kt) \} \)
線性代數

1. Determine whether the solution space of the system \( Ax = 0 \) is a line through the origin, a plane through the origin, or the origin only. If it is a plane, find an equation for it, and if it is a line find parametric equations for it.
   \[
   a) \ A = \begin{bmatrix} 2 & -8 & 6 \\ -3 & 12 & -9 \\ 7 & -28 & 21 \end{bmatrix}, \quad \text{b) } A = \begin{bmatrix} 2 & 6 & 8 \\ 3 & 3 & 15 \\ 2 & 4 & 12 \end{bmatrix}
   \]

2. Find the QR-decomposition of \( A \) under the Euclidean inner product.
   \[
   a) \ A = \begin{bmatrix} 1 & 1 \\ 1 & -2 \end{bmatrix}, \quad \text{b) } A = \begin{bmatrix} 2 & 0 & 2 \\ 2 & 2 & -1 \\ 1 & -1 & -2 \end{bmatrix}
   \]

3. Consider the bases \( B = \{u_1, u_2\} \) and \( B' = \{v_1, v_2\} \) for \( \mathbb{R}^2 \), where
   \[
   u_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \quad u_2 = \begin{bmatrix} 3 \\ 5 \end{bmatrix}, \quad v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad v_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}
   \]
   (a) Find the transition matrix \( P_{B', B} \) from \( B \) to \( B' \). 3%
   (b) Find the transition matrix \( P_{B, B'} \) from \( B' \) to \( B \). 3%
   (c) Compute the coordinate matrix \( [w]_{B'} \) where \( w = \begin{bmatrix} 4 \\ 7 \end{bmatrix} \). 2%
   (d) Use your answers to parts (b) and (c) to compute \( [w]_B \). 2%

4. Use diagonalization to compute \( A^{10} \) for \( A = \begin{bmatrix} 5 & 3 & -7 \\ -1 & 1 & 1 \\ 3 & 3 & -5 \end{bmatrix} \).
   10%

5. Let \( T : \mathbb{R}^3 \to \mathbb{R}^3 \) be the linear operator defined by \( T(x_1, x_2, x_3) = (x_2 + x_3, x_1 + x_3, x_1 + x_2) \).
   (a) Find the matrix \( [T]_B \) where \( B = \{v_1, v_2, v_3\} \), and \( v_1 = (1, 1, 3), v_2 = (1, 2, 0), v_3 = (-1, 0, 1) \).
   (b) Use the matrix from (a) to compute \( T(1, 1, 1) \).
Semiconductor Devices

(1-4: semiconductor devices, 5-8: electromagnetics)

Physical constants
Boltzmann constant \( k = 1.38066 \times 10^{-23} \text{ J/K} \)
Permittivity in vacuum \( \varepsilon_0 = 8.85418 \times 10^{-14} \text{ F/cm} \)
Relative dielectric constant Si: 11.9 GaAs: 12.4 SiO_2: 3.9
Lattice constant Si: 5.43 Å GaAs: 5.65 Å
Effective density of state in conduction band Si: 2.86x10^{19} GaAs: 4.7x10^{17} cm\(^{-3}\)
Effective density of state in valence band Si: 2.66x10^{19} GaAs: 7.0x10^{18} cm\(^{-3}\)
Intrinsic carrier concentration Si: 9.65x10^9 GaAs: 2.25x10^6 cm\(^{-3}\)

1. (a) What is “Early voltage”? (b) What is "EEPROM"? (c) Find the number of atoms per square centimeter in silicon in the (110) plane. (15%)

2. For a silicon one-sided abrupt junction with \( N_A=2x10^{19} \text{ cm}^{-3} \) and \( N_D=5x10^{15} \text{ cm}^{-3} \), calculate the junction capacitance at reversed bias of 3V. \( T=300K \). (10%)

3. For an n-channel n\(^+\)-polysilicon-SiO\(_2\)-Si MOSFET with \( N_A=10^{17} \text{ cm}^{-3} \), \( \phi_m=-0.98 \text{V} \), \( Q_f/q=10^{12} \text{ cm}^{-2} \) and the gate oxide is 5nm. (a) Calculate \( V_{FB} \). (b) Calculate \( V_T \). (c) What is the boron ion dose required to increase \( V_T \) to 0.8V? Assume that the implanted acceptors form a sheet of negative charge at the Si-SiO\(_2\) interface. (15%)

4. The n-channel GaAs MESFET has a barrier height \( \phi_B=1 \text{V} \), \( N_D=2x10^{17} \text{ cm}^{-3} \), the thickness of epitaxial layer \( a=0.15 \mu \text{m} \), the gate length \( L=0.5 \mu \text{m} \), the gate width \( Z=10 \mu \text{m} \). (a) Find the width of depletion layer at zero bias, (b) find the threshold voltage. (10%)

5. A spherical capacitor consists of an inner conducting sphere of radius \( R_i \) and outer
conductor with a spherical inner wall of radius \( R_o \). The space in between is filled with a dielectric of permittivity \( \varepsilon \). Determine the capacitance. (10%)

6. Assume that the space between the inner and outer conductors of a long coaxial cylindrical structure is filled with an electron cloud having a volume density of charge \( \rho = A/r \) for \( a < r < b \), where \( a \) and \( b \) are, the radii of the inner and outer conductors, respectively. The inner conductor is maintained at a potential \( V_o \), and the outer conductor is grounded. Determine the potential distribution in the region \( a < r < b \) by solving Poisson's equation. (15%)

7. An air coaxial transmission line has a solid inner conductor of radius \( a \) and a very thin outer conductor of inner radius \( b \). Determine the inductance per unit length of the line. (15%)

8. The magnetic field in free space is \( \mathbf{H} = a_y H_0 \cos(\omega t - \beta z) \). Determine the corresponding electric field from Ampere’s law. (\( \sigma = 0, \ J = 0, \ \varepsilon = \varepsilon_0 \) in free space). (10%)
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班半導體組（元件） 科目：微電子學

1. For the circuit shown in Fig. 1. Assume ideal op amp. (20%)
   (a) \( Z_1=R, Z_2=2R, Z_3=3R, Z_4=4R \), \( v_1=v_2=0 \), please find the voltage gain and input resistance.
   (b) \( Z_1=2R, Z_2=R/C, Z_3=Z_4=0 \), \( v_1=v_2=0 \), please find the transfer function and what kind of this filter is it? And find the dc gain and 3dB frequency?
   (c) \( Z_1=R, Z_2=5R, Z_3=2R, Z_4=5e^{5\text{rad}}, v_1=5e^{5\text{rad}}, v_2=5e^{5\text{rad}}, \) please find the output of this circuit.
   (d) \( v_1, v_2 \neq 0 \), please design an OP Amp differentiator using \( Z_1, Z_2, Z_3, Z_4 \) and find this output voltage and voltage gain.

2. (a) For a circuit in Fig. 2(b), assume each diode is ideal, sketch the output for the input shown in Fig. 2(a).
   (b) Design a limiter circuit using some diodes and a resistor to provide an output signal limited to the range from +0.7V to -0.4V. Assume only two kind of diode with 0.5V and 0.3 drop when conducting, in respectively. (5%)

3. For the circuit in Fig. 3 (15%)
   (a) \( Z_{in}=100k\Omega, Z_c=2k\Omega, Z_e=0, V_{BB}=5.7V, v_i=v, V_{CC}=12V, V_{EE}=0V \) and \( \beta=100 \), assume Early effect is neglected, please find the transist voltage gain. \( V_T=25mV \) at \( T=300K \).
   (b) \( Z_{in}=7.5k\Omega, Z_c=100k\Omega, Z_e \) is current source with \( I=1mA, v_i=v \), \( V_{BB}=0, V_{CC}=10V, V_{EE}=10V \) and \( \beta=100 \), Early effect cannot be neglected with \( V_A=100V \), please find \( R_i, A_v, A_n, A_e \).
   (c) \( Z_{in}=0, v_i=0, Z_c=3.8k\Omega, Z_e=3k\Omega, V_{BB}=6.7V, V_{CC}=9.2V \), assume Early effect is neglected, please find the minimum \( \beta \) to keep transistor in saturation.

4. For the circuit in Fig. 4 (15%)
   (a) \( V_{DD}=5V, |V_{I}|=1V, k(W/L)=1m\Omega/V^2 \), modulation length effect was neglected, If \( I_D=8mA \), please choose a appropriate \( Z_1 \) and \( Z_2 \) to find the largest \( Z_3 \) for maintaining device in saturation-region?
   (b) For a CMOSTET with \( L=1\mu m, W_e=2\mu m, W_p=4\mu m, k_e=60\mu mA/V^2, k_p=30\mu mA/V^2 \), \( V_m=|V_{Gm}|=1V, V_{DD}=5V \), please find the noise margin \( N_{MH} \) and \( N_{ML} \).
   (c) Find the \( f_I \) for a MOSFET operating at \( I_D=1000\mu A \) and having \( \mu_C=5m\Omega/V^2, W=10\mu m, L=10\mu m, C_{gs}=0.05pF, \) and \( C_{gd}=0.05pF \).

5. Differential amplifier circuit in Fig 5, \( R_{CT}=R_{CT}=1k\Omega, R_{e}=4k\Omega, V_{DD}=4.7V, V_{EE}=-4.7V \) and \( \beta_1=\beta_2=100 \) (15%)
   (a) \( v_{B1}=v_{B2}, v_{D1}=v_{D2}, v_t \) with zero average, find differential mode gain \( V_{d}/V_{t} \). \( V_T=25mV \) at \( T=300K \).
   (b) \( v_{B1}=v_{B2} = v_{CM} \). Please find the CMRR.
   (c) If this circuit with controlled resistors that are matched 1%, please find input offset voltage \( V_{OS} \).

6. For the circuit in Fig 6, \( R_1=5k\Omega, R_1=R_2=10k\Omega, R_e=R_c=R_e=10k\Omega, V_{CC}=12V \), assume \( r_e=r_c=0, V_T=25mV \) at \( T=300K \). If \( I_e=0.25mA, \beta=100, C_1=C_2=1\mu F \) and \( C_E=10\mu F \) (10%)
   (a) Please find the midband gain.
   (b) Please find the \( f_i \) and frequency of the zero.
   (c) For M is BJT, \( \beta=100, Z_e=7k\Omega, Z_c=10k\Omega, V_{CC}=4.7V \), Please find the voltage gain, \( R_{in} \) and \( R_{out} \) (7.5%)
   (d) For M is enhancement nMOSFET, \( Z_e=10k\Omega, Z_c=1M\Omega, Z_c=2k\Omega, V_{CC}=1V, k_nW/L=1/3 m\Omega/V^2, V_{CC}=4V \), Please find the voltage gain, \( R_{in} \) and \( R_{out} \) (7.5%)

第1页，共2页
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班半導體組（元件） 科目：微電子學

图1

图2(a)

图2(b)

图3

图4

图5

图6

图7
線性代數

1. Determine whether the solution space of the system $Ax = 0$ is a line through the origin, a plane through
the origin, or the origin only. If it is a plane, find an equation for it, and if it is a line find parametric
equations for it.

   (a) $A = \begin{bmatrix} 2 & -8 & 6 \\ -3 & 12 & -9 \\ 7 & -28 & 21 \end{bmatrix}$

   (b) $A = \begin{bmatrix} 2 & 6 & 8 \\ 3 & 3 & 15 \\ 2 & 4 & 12 \end{bmatrix}$

2. Find the $QR$-decomposition of $A$ under the Euclidean inner product.

   (a) $A = \begin{bmatrix} 1 & 1 \\ 1 & -2 \end{bmatrix}$

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

3. Consider the bases $B = \{u_1, u_2\}$ and $B' = \{v_1, v_2\}$ for $R^2$, where

   $u_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$, $u_2 = \begin{bmatrix} -3 \\ 5 \end{bmatrix}$, $v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $v_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

   (a) Find the transition matrix $P_{B', B}$ from $B$ to $B'$. 3%

   (b) Find the transition matrix $P_{B, B'}$ from $B'$ to $B$. 3%

   (c) Compute the coordinate matrix $[w]_{B'}$ where $w = \begin{bmatrix} 4 \\ 7 \end{bmatrix}$. 2%

   (d) Use your answers to parts (b) and (c) to compute $[w]_B$. 2%

4. Use diagonalization to compute $A^{10}$ for $A = \begin{bmatrix} -5 & 3 & -7 \\ -1 & 1 & 1 \\ 3 & 3 & -5 \end{bmatrix}$. 10%

5. Let $T : R^3 \to R^3$ be the linear operator defined by $T(x_1, x_2, x_3) = (x_2 + x_3, x_1 + x_3, x_1 + x_2)$.

   (a) Find the matrix $[T]_{B'}$, where $B = \{v_1, v_2, v_3\}$, and $v_1 = (1, 1, 3)$, $v_2 = (1, 2, 0)$, $v_3 = (-1, 0, 1)$.

   (b) Use the matrix from (a) to compute $T(1, 1, 1)$. 10%
國立高雄大學九十三學年度研究所碩士班招生考試試題

系所組別：電機工程學系碩士班半導體組（元件）

科目：工程數學

A. 微分方程（工程數學）
不可使用計算機，需按照題目順序作答。

1. \( \frac{dy}{dx} = \frac{y}{e^{2x} \ln y} \), solve \( y \).

2. \( \frac{dy}{dx} = -\frac{2xy}{x^2 + y^2} \), solve \( y \).

3. \( y'' + 2y' + y = 6 \), \( y(0) = 5 \) and \( y'(0) = 1 \), solve \( y \).

4. \( y'' - 9y = 54 \sin(3t) \), solve \( y \).

5. Solve the Laplace transformation \( L \{ f(t) \} \).
   a). \( L \{ \cos(kt) \} \)
   b). \( L \{ e^{at} \ast \cosh(kt) \} \)