國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：工程數學

1. Find the general solution of the following differential equation:

$a) x^2y'' - xy' - 8y = x^4 - 3\ln x$. (8%)

$b) y'' + 3y' + 2y = \frac{1}{1+e^x}$. (8%)

c) If $y(x) = ax^b$ is one solution form of the Riccati equation ,please find the initial value problem: $y' = e^{2x}y^2 - 2y - 9e^{-2x}; y(0) = 4$. (9%)

2. Let $y(x) = \int_1^x \int_1^t \frac{\ln z}{z^2} dz dt$

a) determine $y''(x)$ by using the fundamental theorem of calculus and get a nonhomogeneous differential equation satisfied by y. (2%)

b) evaluate the value of $y(1)$ and $y'(1)$. (2%)

c) find the initial value problem of the differential equation from (a)and (b). (6%)

3. Given a Bernoulli equation $P(x)y' + Q(x)y = R(x)y^\alpha$, α is a constant; let $u(x,y) = f(x)y^b$ is an integrating factor of the differential equation ,please find the u(x,y). (10%)

4. a) If $K_1 = \begin{bmatrix} 4 \\ 1 \\ -1 \end{bmatrix}$, $K_2 = \begin{bmatrix} 1 \\ 0 \\ 4 \end{bmatrix}$, and $K_3 = \begin{bmatrix} 1 \\ -4 \\ 0 \end{bmatrix}$ are eigenvectors for the symmetric matrix $A = \begin{bmatrix} 7 & 4 & -4 \\ 4 & -8 & -1 \\ -4 & -1 & -8 \end{bmatrix}$ then find the corresponding eigenvalues. (4%)

b) Find a set of three mutually orthogonal eigenvectors for the matrix A in part (a). (6%)

國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　科目：工程數學

5. Consider the bases $B=\{u_1, u_2, u_3\}$ and $C=\{v_1, v_2, v_3\}$ for R^3, where

$$u_1=\begin{bmatrix}-3\\0\\-3\end{bmatrix}, u_2=\begin{bmatrix}-3\\2\\-1\end{bmatrix}, u_2=\begin{bmatrix}1\\6\\1\end{bmatrix}$$

$$v_1=\begin{bmatrix}-6\\-6\\0\end{bmatrix}, v_2=\begin{bmatrix}-2\\-6\\4\end{bmatrix}, v_2=\begin{bmatrix}-2\\-3\\7\end{bmatrix}$$

a) Find the transition matrix from B to C. (5%)

b) Find the transition matrix from C to B. (5%)

c) Given the coordinate matrix $[w]_B=\begin{bmatrix}1\\1\\1\end{bmatrix}$, compute $[w]_C$. (5%)

6. a) Find the number of additions and multiplications required to compute A^k by direct multiplication if A is an n×n matrix. (7%)

b) Determine the number of additions and multiplications required to find A^{-1} by reducing [A|I] to [I|A]. (7%)

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

a) Find an LU-decomposition of A. (5%)

b) express A in the form $A=L_1DU_1$, where L_1 is lower triangular with 1's along the main diagonal, U_1 is upper triangular, and D is a diagonal matrix. (5%)

c) Express A in the form $A=L_2U_2$, where L_2 is lower triangular with 1's along the main diagonal and U_2 is upper triangular. (6%)

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：計算機概論

1. Explain the following terms (10 pts).
   a. overflow (3 pts)
   b. stack frame pointer (3 pts)
   c. assembler directives (4 pts)

2. Translate the following C expression into assembly codes. You must define the operation of each instruction used, otherwise no points will be given. State the assumption about your code. (10 pts)

   if (i == j) a = b + c else a = b - c;

3. Do a floating pointing addition on 0.1 and - 0.0111 (both are binary number). (10 pts)

4. Which of the following logic elements are combinational? (10 pts)
   a. flip flop b. register c. ALU d. memory e. program counter
   f. NAND gate

5. A B C define the 3 inputs and P Q define 2 outputs. Determine the output function for P and Q respectively from the following true table. (10 pts)

A	B	C	P	Q
0	x	1	1	0
1	0	x	1	1
1	x	0	0	1
0	1	0	1	0

6. Decode the following bit patterns using the floating-point format as follows: bit 7: sign, bit 6-4: exponent using the 3-bit excess method, bit 3-0: mantissa
   (a) 01001010 (2 pts)
   (b) 01101101 (2 pts)
   (c) 00111001 (2 pts)
   (d) 11011100 (2 pts)
   (e) 10101011 (2 pts)

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：計算機概論

7. (a) Sort the list 47, 62, 33 12, 41 step-by-step using the quick sort. (4 pts)
(b) When sorting a list of 16 elements, how many comparisons are required in the following three cases ?
(b.1) the best case (2 pts)
(b.2) the average case (2 pts)
(b.3) the worst case (2 pts)

8. What is printed by the following program, assuming (a) call-by-reference (3 pts), (b) call-by-name (3 pts), (c) copy-restore linkage (push order: from left to right) (4 pts) ?

```
procedure PROC(X, Y, Z);
begin
    Y:=Y+1;
    Z:=Z+X;
end PROC;
begin
    A:=2;
    B:=3;
    PROC(A+B, A, A);
    print A
end
```

9. Transform the following infix expressions into prefix and postfix expressions.
(a) a + b * c / d (3 pts)
(b) a - c * d + b ↑ e (3 pts)
(c) x ↑ (y * z + w) (4 pts)

10. The language generated by a grammar G is defined as follows.
Please show the productions of G, assuming that S is the start symbol.
(a) $L(G)=\{a^j b^n c^n \mid n \geq 1, j \geq 0\}$ (5 pts)
(b) $L(G)=\{a^n b a^m \mid n, m \geq 1\}$ (5 pts)

國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：微分方程

1. Solve the following initial value problem: (15%)

$y''+4y'+6y=0, \quad y(0)=2, \; y'(0)=5$

2. Find a general solution for the following equation: (15%)

$y'''-3y'+2y=8e^{x}+4x+1$

3. Find a solution of the equation $\dfrac{\partial^2 u}{\partial x^2}-\dfrac{\partial^2 u}{\partial t^2}=x\cos t$

satisfying the conditions $u(0,t)=0$ and $u(2,t)=0$,

where $u(x,t)=f(x)g(t)$, (20%)

4. Solve the following differential equations

a. $y'+2y=x^2y^3$ (10 %)

b. $(D^2+D+1)\,y=x^2\cos(x)$ (10 %)

5. Solve the following system of differential equations (15%)

$(D^2-3)\,x-8y=\exp(t)$

$x+(D^2+3)\,y=0$

6. Solve the following differential equation (15%)

$x^2y'''+3xy''+y=[\,x\ln(x)\,]^{-1}$

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：離散數學

In 1-4, each question scores 15 points. In 5-8, each question scores 10 points.

1. Determine the coefficient of x^9y^5 in the expansion of (a) $(x+y)^{14}$, (b) $(3x+y)^{14}$, and (c) $(3x-4y)^{14}$.

2. For any positive integer n, show that
$$\binom{n}{0}+\binom{n}{2}+\binom{n}{4}+\ldots=\binom{n}{1}+\binom{n}{3}+\binom{n}{5}+\ldots$$

3. Give the steps and reasons to validate the argument
$[(p\rightarrow q)\wedge(\neg r\vee s)\wedge(p\vee r)]\rightarrow(\neg q\rightarrow s)$.

4. For sets $A,B,C\subseteq Universal\ Set$, prove or disprove each of the following:
   (a) $A\cap C=B\cap C\Rightarrow A=B$. (5 points)
   (b) $A\cup C=B\cup C\Rightarrow A=B$. (5 points)
   (c) $[(A\cap C=B\cap C)\wedge(A\cup C=B\cup C)]\Rightarrow A=B$. (5 points)

5. The integers from 1 to 100, inclusive, are randomly placed around the circumference of a circle. Prove that no matter how the integers are positioned there must be four of these integers, forming three overlapping pairs on the circumference, whose sum is 202 or more.

6. Prove $\sqrt{3}$ is irrational.

7. Write a regular expression that define the following language:
   All strings of 0's and 1's such that the first third position from right end is 1.

8. Statement the principle and purpose of Big-Oh notation.

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：信號與系統

[Note] The following notation is used: ω is the frequency variable for continuous-time signals, and Ω is the frequency variable for discrete-time signals.

1. (20%) We define the following set of signals:

$$\amalg(t) = \sum_{n=-\infty}^{\infty} \delta(t-n), \qquad \Pi(t) = \begin{cases} 1, & |t| < \frac{1}{2}, \\ 0, & otherwise. \end{cases}$$

(a) Find $\Pi(t) * \Pi(t) = ?$ (10%)

(b) Find $\amalg(t) * \Pi(t) = ?$ (10%)

2. (20%) Given a system

$$y(n) = \sum_{i=-\infty}^{n+1} x(i)$$

where $x(n)$ and $y(n)$ are the system input and output, respectively. Determine whether the system has the following properties:

(a) Time-invariance (4%)

(b) Linearity (4%)

(c) Causality (4%)

(d) Stability (4%)

(e) With or without memory (4%)

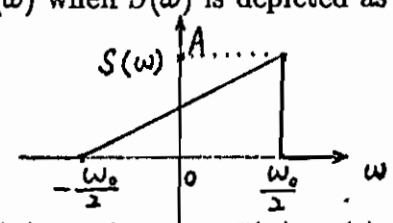
You must give the correct explanation to get your credit.

3. (20%) The Fourier transform (spectrum) of a signal $s(t)$ is defined by $S(\omega) = \int_{-\infty}^{\infty} s(t)e^{-j\omega t}dt$. We have another signal $p(t) = cos(\omega_0 t)$ whose Fourier transform is denoted as $P(\omega)$.

(a) For a signal $r(t) = s(t)p(t)$, find its Fourier transform $R(\omega)$ in terms of $S(\omega)$ and ω_0. (5%)

(b) For a signal $y(t) = r(t)p(t)$, find its Fourier transform $G(\omega)$ in terms of $S(\omega)$ and ω_0. (5%)

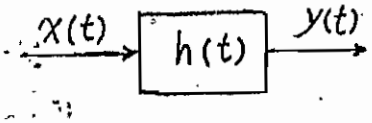
(c) Sketch the spectrum $R(\omega)$ when $S(\omega)$ is depicted as follows: (5%)



(d) Sketch the spectrum $G(\omega)$ for the same $S(\omega)$ in (c). (5%)

國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：信號與系統

4. (20%) We have a set of sinc functions given by $h_m(t) = \frac{sin(\pi a_m t)}{\pi t}$, $m = 1, 2, \ldots, M$, where $0 < a_1 < a_2 < \ldots < a_M < 1$. We consider the following linear time-invariant (LTI) system:



The impulse response of this LTI system is $h(t) = h_1(t) * h_2(t) \ldots * h_M(t)$.

(a) If $x(t) = \delta(t)$, find $y(t)$. (10%)

(b) If $x(t) = cos(2\pi t)$, find $y(t)$. (10%)

5. (20%) Suppose a continuous-time signal $x(t)$ is discretized by a sample-and-hold (zero-order hold) circuit to obtain $x_s(t)$. What is the relation between $X(\omega)$ and $X_s(\omega)$, where $X(\omega)$ is the Fourier transform of $x(t)$ and $X_s(\omega)$ is the Fourier transform of $x_s(t)$?

國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：數位邏輯

注意：一、本試卷共六題，共 100 分。須標明題號並依序寫在答案卷上，否則不予計分。
二、書寫答案卷時，由第一頁起採自左而右橫寫，不得倒反。

(15pt) Please explain the following terms
a. glitch b. static hazard c. dynamic hazard
d. critical race e. noncritical race (3pt each term)

(15pt)
a. Prove that any combinational function can be expressed by only using gates in the set {AND, EXCLUSIVE-OR}. (5pt)
b. Given a function $f(A,B,C,D)=\sum m(5,7,8,9,12,13,14,15)$, where m represents the minterm, please design a circuit in which the output is derived from an EXCLUSIVE-OR gate and the inputs are connected to AND gates.(5pt)
Note: use the minimum number of gates
c. Show that we can only use the EXCLUSIVE-OR gates to implement the circuit that converts a 4-bit binary number into its corresponding 4-bit reflected Gray code. (5pt)

(15pt) Assume we have three 3-bit operands, i.e. $A=a_2a_1a_0$, $B=b_2b_1b_0$ and $C=c_2c_1c_0$,
a. Please use full adders (FA's) and half adders (HA's) to implement a three operands adder which adds A, B and C and produces a sum S. (9pt)
b. Assume a full adder's delay time is t_{FA} and a half adder's delay is t_{HA}, please calculate the longest path delay of your design. (6pt)
Note: You should try to minimize both the number of adders and the delay time.

(15pt)
a. Find a minimal product-of-sum expression for the five variable function $f(A,B,C,D,E)=\sum m(0,1,2,5,8,9,17,25)$, where m represents the minterm. (7pt)
b. A prime implicant covering problem yields the following covering proposition:
$P=(A+F)(A+B+D)(A+B+C+E+F)(C+D)(C+F)(E)(E+F)(A+D)$
Suppose that prime implicants A,B and C have literal cost 3, and prime inplicants D,E and F have literal cost 2. Evaluate this proposition to find a minimum cost cover. (8pt)

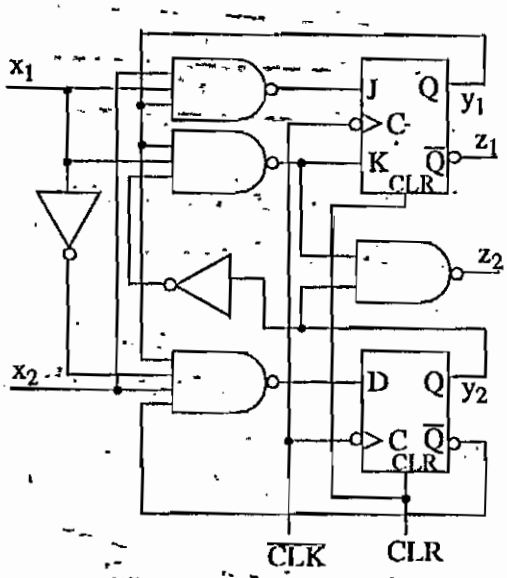
國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：數位邏輯

5. (20pt) Given the following parameters for various delays

T: clock period	t_{FF}: Flip-Flop propagation delay
t_c: propagation delay in the combinational circuit	
t_{su}: setup time for the FF	t_h: hold time for the FF

a. Please show the timing constraints for correct operation of edge-triggered, clocked sequential circuits. (10pt)

b. Construct the state transition diagram of the circuit shown as follows. (10pt)



Q6. (20pt) For the Huffman model of the positive-edge-triggered D FF whose behavior is illustrated in the following table

a. Construct a reduced state table. (10pt)

Present state		Present input Clk, Din			
		00	01	11	10
Y=0	A	A, 0	B, 0	-, -	C, 0
	B	A, 0	B, 0	H, -	-, -
	C	A, 0	-, -	D, 0	C, 0
	D	-, -	B, 0	D, 0	C, 0
Y=1	E	E, 1	F, 1	-, -	C, -
	F	E, 1	F, 1	H, 1	-, -
	G	E, 1	-, -	H, 1	G, 1
	H	-, -	F, 1	H, 1	G, 1

b. Give a state assignment for this state table that is free of critical races. (10pt)

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：計算機結構

1.(25%) Given that

Instruction class	CPI
A	1
B	4
C	2

	Instruction counts		
Code sequence	A	B	C
1	2	4	3
2	2	2	3

(a) which code sequence is faster? (13%)

(b) Which code sequence has larger CPI ? (12 %)

ANS:

(a) CPU clock cycles 1 =

CPU clock cycles 2 =

(b) CPI 1=

CPI 2 =

2. (25%) Use CPI in the table of the problem 1 above. We measure the code for the same program from two different compilers and obtain the following data:

	Instruction counts (In Millions) for each instruction class		
Code sequence	A	B	C
Compiler 1	5	1	1
Compiler 2	10	1	1

Assume that machine's clock rate is 100 MHz. For each code sequence what are the

(a) MIPS ? (9%)

MIPS 1 =

MIPS 2 =

(b) CPI ? (8%)

CPI 1 =

CPI 2 =

(c) CPU time? (8%)

CPU time 1 =

CPU time 2 =

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：計算機結構

3. (25%) In order to achieve pipeline control, a control unit generates 9 control lines (RegDst, ALUop0, ALUop1, ALUsrc, Branch, MemRead, MemWrite, RegWrite, MemtoReg). Show how these 9 lines are used up in each of the ID/EX, EX/MEM and MEM/WB stages.

4. (25%) We run a program on a machine with separate caches for instruction and data. We found that the instruction cache miss rate is 3% and data cache miss rate is 10%. Each miss causes penalty 40 cycles and the clock cycle is 12. We also found that there is one load/store instruction out of 2 instruction in the program. The machine has CPI=6.

(a) perfect cache is how much better than this cache (7%)

(b) reduce the CPI from 6 to 3, what happens in (a)? (6%)

(c) double the clock rate, what happens in (a)? (6%)

(d) explain these cases? (6%)

國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：系統程式

(20%)
1.Suppose a one-pass macro processor is applied to the following source code.
(a)Show the resulting NAMTAB. (5%)
(b)Show the resulting DEFTAB. (5%)
(c)Show the program after the macros have been expanded. (10%)

```
M1  MACRO
M2  MACRO  &P1
    CLEAR  X
    IF (&P1 EQ 1)
M3  MACRO  &P2
    CLEAR  A
    IF (&P2 NE 2)
    CLEAR  X
    ENDIF
    ENDM   /* end of M3 */
    ENDIF
    IF (&P1 EQ 2)
M3  MACRO  &P2
    CLEAR  X
    IF (&P2 NE 2)
    CLEAR  A
    ENDIF
    ENDM   /* end of M3 */
    ENDIF
    ENDM   /* end of M2 */
    ENDM   /* end of M1 */
    M1
    M2  2
    M3  1
    END
```

(10%)
2.(a)Why most assemblers are designed to be two-pass? (5%)
(b)What constraints does a two-pass assembler have? (5%)

(10%)
3.Eliminate the left-recursion from the following grammar:
S → (L) | a
L → L, S | S

國立雲林技術學院 所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題 科目：系統程式

(10%)
4.Explain the four types of Chomsky grammar. Most programming languages with BNF notation belong to what type of grammar?

(10%)
5.UNIX is often said to be a poor real-time system. Describe some of UNIX's real-time problems and solutions.

(20%)
6.In the context of Dijkstra's Banker's Algorithm discuss whether each of the following states is safe or unsafe. If a state is safe, show how it is possible for all processes to complete. If a state is unsafe, show how it is possible for deadlock to occur.

State A

	Current loan	Maximum need
User(1)	4	8
User(2)	3	9
User(3)	5	8
Available	2	

State B

	Current loan	Maximum need
User(1)	2	6
User(2)	4	7
User(3)	5	6
User(4)	0	2
Available	1	

(10%)
7.Show that if the P and V operations are not executed indivisibly, then mutual exclusion may be violated.

(10%)
8.Write an algorithm to implement semaphores using:
(a) The Swap instruction (5%)
(b) The Test-and-Set instruction (5%)

國立雲林技術學院　　所別：電子與資訊工程技術研究所
八十五學年度研究所碩士班入學考試試題　　科目：電磁學

說明：本試卷共六大題，總分共計１００分。

(15分) 一、有一無限長直導線中之電流強度爲 I, 設距該導線 r_0 處爲向量磁位（vector magnetic potential）之零參考點, 求距該導線任一點上 r 處之向量磁位？

(10分) 二、設在眞空中一電磁波之電場強度（electric field intenisty）爲 $\mathbf{E}(z,t) = 10\cos(\omega t - \beta z)\,\hat{a}_y$ volt/m, 其中 $\omega = 3\pi \times 10^6$ rad/s, 求

(5分) (a) 波長？

(5分) (b) 磁場強度（magnetic field intensity, H）？

(20分) 三、設一無限長均勻線電荷密度（linear charge density, ρ_ℓ）放置於 z 軸上，A 點（2, 0, 0）之電位爲 V_A = 30volt, B 點（$\frac{1}{2}$; 0, 0）之電位爲 60volt, 試求 C點（1, 0, 0）之電位？

(15分) 四、設有一點電荷 +q位於平面導體上方高度 h 處，試求

(8 分) (a) 導體平面感應電荷（induced charges）的面電荷密度（surface charge denstiy）？

(7分) (b) 由積分方法求出感應之總電荷量（total charges）？

(25分) 五、如圖A所示，半徑 a 之金屬球上帶有總電量 Q，其外覆以厚度爲 (b - a) 之介電質，其相對容電係數（relative permittivity）爲 ε_r，試求

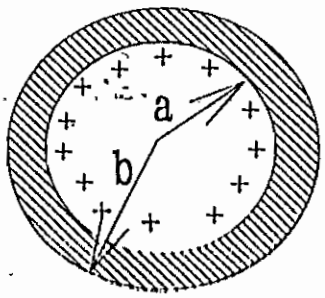


圖 A

(5分) (a) 金屬球內之電場強度？

(10分) (b) 介電質內部任一點之電場強度？

(10分) (c) 金屬球之電位？

(15分) 六、已知一磁場之磁通量密度（magnetic flux density）$\mathbf{B} = B_0 \exp(at)\,\hat{a}_Z$（圓柱座標系統），此處 B_0 及 a 爲常數，試求空間中感應之電場強度？

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電子與資訊工程技術研究所
科目：半導體元件

1. (a) Show the energies of an electron confined in a one-dimensional box of length L. (5%)
(b) If a hydrogen atom is modeled as a one-dimensional box with length equal to Bohr radius, what is the energy (in eV) of the ground level of the electron? (5%)
(c) If we assume Neutron in a nucleus size box with 5×10^{-15} m, what is the lowest energy level of the Neutron? (5%).

2. Please describe and sketch the position of Fermi level as a function of temperature and for various doping concentrations of (a) n-type and (b) p-type semiconductors (7%) (8%)

3. Consider a semiconductor that is uniformly doped with $N_d = 10^{14}$ cm^{-3} and $N_a = 0$, with an applied electric field of $E = 100$ V/cm. Assume that μ_n=1000 cm^2/V-sec and μ_p=0, also assume

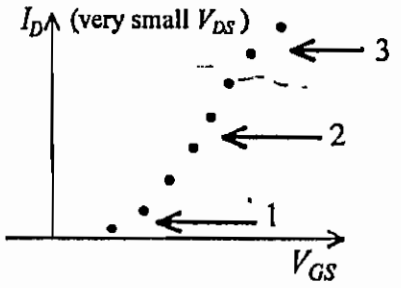
$$Eg = 1.1 \text{ eV}$$
$$Nc = 2\times10^{19}(T/300)^{3/2} \text{ cm}^{-3}$$
$$Nv = 1\times10^{19}(T/300)^{3/2} \text{ cm}^{-3}$$

(a) Calculate the electric current density at $T = 300$ K. (10%)
(b) At what temperature will this current increase by 5 percent. (Assume the mobilities are independent of temperature.) (10%)

4. An ideal, long silicon abrupt pn junction has a uniform cross section and constant doping on both sides. If the n-region has a resistivity of 2 ohm-cm, and the ratio of depletion width in the n-region to that in the p-region is 1:2, determine (a) N_a, N_d, and (b) the built-in potential barrier V_{bi}. ($T = 300$ K.)

5. A metal-silicon junction forms a Schottky barrier. The metal work function is $\phi_m = 4.7$ volts and the n-type silicon is doped to $N_d = 5\times10^{15}$ cm^{-3}. Calculate (a) the theoretical Schottky barrier height, and (b) the built-in potential barrier height at $T = 300$ K. (8%)

6. The I_D-V_{GS} curve of an n-channel MOSFET is measured and plotted below. (a) State which part of the curve should be used to obtain the threshold voltage. (10%) (b) Calculate the threshold voltage and the inversion carrier mobility from the following data. (10%)



W = 20 μm
L = 2 μm
$C_{ox} = 5\times10^{-8}$ F/cm^2
$V_{DS} = 0.1$ V
$I_D = 30$ μA at $V_{GS} = 1.5$ V
$I_D = 60$ μA at $V_{GS} = 2.0$ V

Physical constants	
Avogadro's number	$N_A = 6.02 \times 10^{23}$ atoms per gram molecular weight
Boltzmann's constant	$k = 1.38 \times 10^{-23}$ J/K $= 8.62 \times 10^{-5}$ eV/K
Electronic charge (magnitude)	$e = 1.60 \times 10^{-19}$ C
Free electron rest mass	$m_o = 9.11 \times 10^{-31}$ kg
Permeability of free space	$\mu_o = 4\pi \times 10^{-7}$ H/m
Permittivity of free space	$\varepsilon_o = 8.85 \times 10^{-14}$ F/cm $= 8.85 \times 10^{-12}$ F/m
Planck's constant	$h = 6.625 \times 10^{-34}$ J-s $= 4.135 \times 10^{-15}$ eV-s
	$\frac{h}{2\pi} = \hbar = 1.054 \times 10^{-34}$ J-s
Proton rest mass	$M = 1.67 \times 10^{-27}$ kg
Speed of light in vacuum	$c = 2.998 \times 10^{10}$ cm/s
Thermal voltage ($T = 300°K$)	$V_t = \frac{kT}{e} = 0.0259$ volt
	$kT = 0.0259$ eV

Silicon, gallium arsenide, and germanium properties ($T = 300°K$)

Property	Si	GaAs	Ge
Atoms (cm^{-3})	5.0×10^{22}	4.42×10^{22}	4.42×10^{22}
Atomic weight	28.09	144.63	72.60
Crystal structure	Diamond	Zincblende	Diamond
Density (g/cm^3)	2.33	5.32	5.33
Lattice constant (Å)	5.43	5.65	5.65
Melting point (°C)	1415	1238	937
Dielectric constant	11.7	13.1	16.0
Bandgap energy (eV)	1.12	1.42	0.66
Electron affinity, χ, (volts)	4.01	4.07	4.13
Effective density of states in conduction band, N_c, (cm^{-3})	2.8×10^{19}	4.7×10^{17}	1.04×10^{19}
Effective density of states in valence band, N_v, (cm^{-3})	1.04×10^{19}	7.0×10^{18}	6.0×10^{18}
Intrinsic carrier concentration (cm^{-3})	1.5×10^{10}	1.8×10^{6}	2.4×10^{13}

Property	Si	GaAs	Ge
Mobility ($cm^2/V\text{-}s$)			
Electron, μ_n	1350	8500	3900
Hole, μ_p	480	400	1900
Effective mass, $\left(\frac{m^*}{m_o}\right)$			
Electrons	$m_l^* = 0.98$	0.067	1.64
	$m_t^* = 0.19$		0.082
Holes	$m_{lh}^* = 0.16$	0.082	0.044
	$m_{hh}^* = 0.49$	0.45	0.28
Effective mass (density of states)			
Electrons, $\left(\frac{m_n^*}{m_o}\right)$	1.08	0.067	0.55
Holes, $\left(\frac{m_p^*}{m_o}\right)$	0.56	0.48	0.37

Other semiconductor parameters

Material	E_g (eV)	a (Å)	ϵ_r	χ	n_i
Aluminum arsenide	2.16	5.66	12.0	3.5	2.
Gallium phosphide	2.26	5.45	10	4.3	3.
Aluminum phosphide	2.43	5.46	9.8		3.
Indium phosphide	1.35	5.87	12.1	4.35	3.

Properties of SiO_2 and Si_3N_4 ($T = 300°K$)

Property	SiO_2	Si_3N_4
Crystal structure	[Amorphous for most integrated circuit applications]	
Atomic or molecular density (cm^{-3})	2.2×10^{22}	1.48×10^{22}
Density ($g\text{-}cm^{-3}$)	2.2	3.4
Energy gap	≈9 eV	4.7 eV
Dielectric constant	3.9	7.5
Melting point (°C)	≈1700	≈1900

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電機工程技術研究所
電子與資訊工程技術研究所
科目：電子學

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

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

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

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

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

國立雲林技術學院
八十五學年度研究所碩士班入學考試試題

所別：電機工程技術研究所
電子與資訊工程技術研究所
科目：電子學

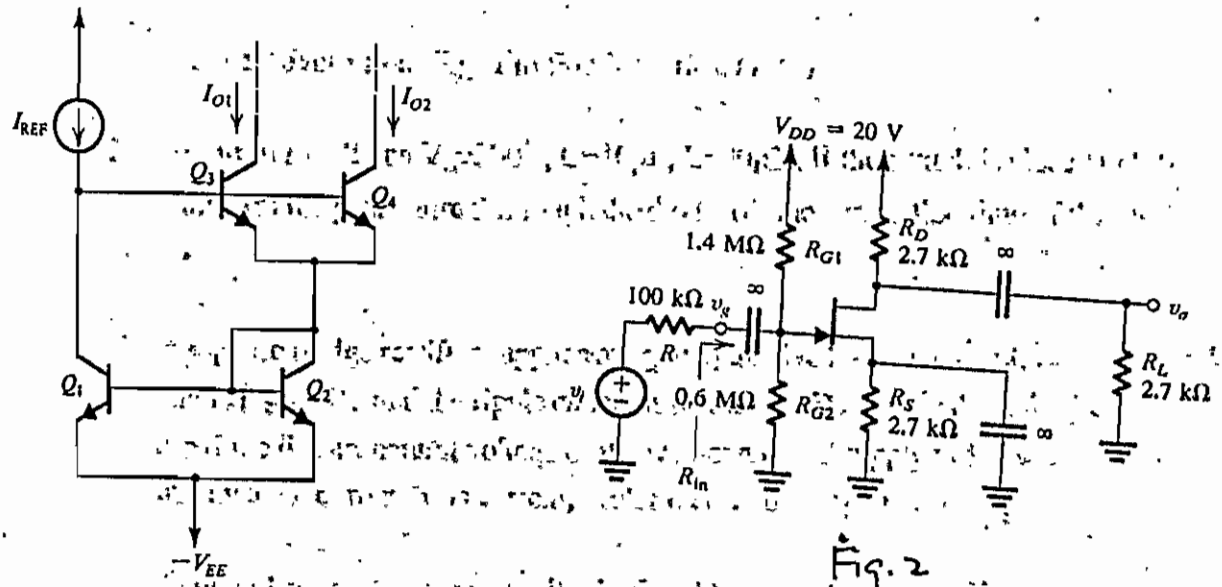


Fig. 1

Fig. 2

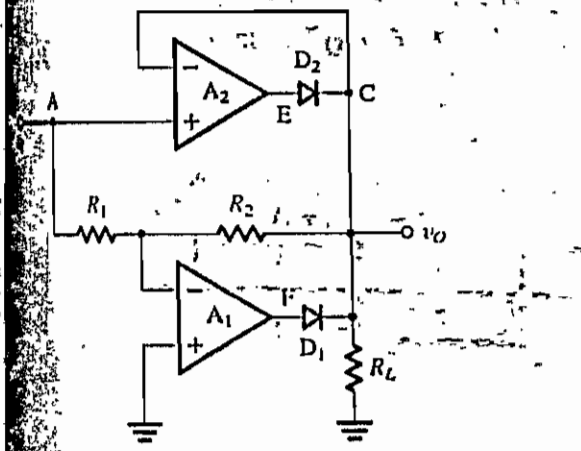


Fig. 3

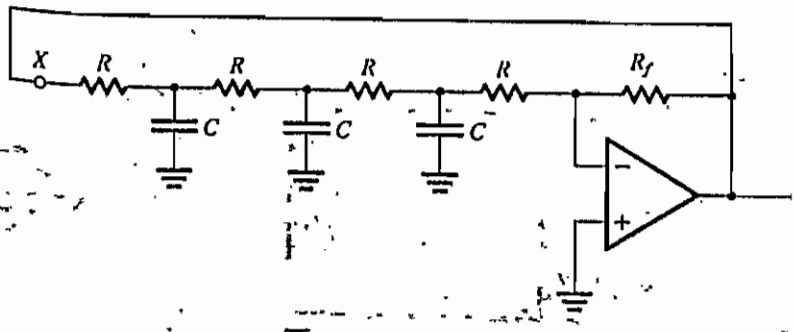


Fig. 4

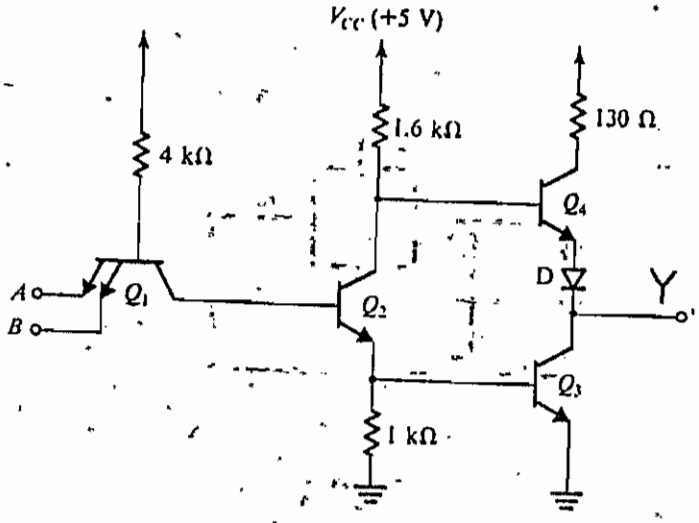


Fig. 5