國立政治大學 九十六學年度 碩士班暨碩士在職專班招生考試 命題紙

考試科目	計算機概論	所別 8141	資訊科學系	考試時間	三月十七日 星期六 第一節

一、 選擇題：每答對一題得兩分，每答錯一題得到負一分(也就是倒扣一分)；如果本大題得分為負，將不會從其他大題的得分減扣

1. 下列哪一個名詞跟資訊科學的學術研究沒有關連？(A) W3C (B) UDP (C) SOAP (D) ONTOLOGY (E) 以上皆非
2. 下列何種軟體必定參與個人電腦系統開機程序？(A) linking loader (B) relative loader (C) bootstrap loader (D) linkage editor (E) 以上皆非
3. 下列何者不包含在$(A^*|B^+)C$ 這一個 regular expression 所描述的字串集合中？(A) BC (B) AC (C) C (D) ABBC (E) 以上皆非
4. 程式語言的語法一般只要用下列哪一等級的文法來描述即可？(A) regular grammars (B) context free grammars (C) type-0 grammars (D) XML (E) 以上皆非
5. 下列何者不是編譯器技術的重要一環(A)LALR (B) LR (C) SLR (D) MAR (E) 以上皆非
6. 下列哪一個技術名詞跟電腦的運作時時刻刻都相關？(A) macro processors (B) linkers (C) fetch-decode-execute cycles (D) assemblers (E) compilers
7. 下列哪一個技術名詞跟電腦網路的研究和應用沒有關連？(A) 802.11 (B) 藍芽 (blue tooth) (C) ring topology (D) 代理人系統(agents) (E) 以上皆非
8. 相對而言，下列哪一個名詞跟資料庫系統(database systems)的研究關連性最低？(A) data flow analysis (B) functional data models (C) relational models (D) object-oriented databases (E) knowledge bases
9. 在問題本身有答案的條件之下，下列哪一種搜尋技術保證可以找到問題的答案？(A) depth first search (B) breadth first search (C) greedy search (D) bidirectional search (E) 以上皆非

二、 (兩分) 假定 C4 和 4C 是兩個以二的補數所表示的數字，假定在一個以八個位元(bits)表示整數的機器中，這兩個數的和是多少？

三、 (五分) 假定執行某一程序(process) 所需花費的 CPU 時間只能以機率分佈來描述。以(x,y)代表一個工作花費 x 分鐘的機率是 y。該程序若由 A 電腦來執行，所需的時間的機率分佈是(3, 0.3), (5, 0.4), (7, 0.3)；若由 B 電腦來執行，則所需的時間的機率分佈是(4, 0.2), (5, 0.6), (6, 0.2)。假設我們只會使用 A 電腦或是 B 電腦；且使用 A 電腦的機率是使用 B 電腦的機率的兩倍。在這一些假設之下，已知某一次執行該程序的時間多於四分鐘，請問該次工作由 A 電腦執行的機率是多少？

四、 依照本題末尾所列以 C 語言所寫的程式回答問題。

1.(四分)主程式(main)中標記為第一小題的輸出為何？
2.(八分)主程式(main)中標記為第二小題的輸出為何？

```
// ************************************************************
// 以下是第四大題的 C 程式
// ************************************************************
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#define WordLen 40
#define PathLen 100
#define VecSize 3
#define NumChoices 2
#define MALLOC(x) (x *)malloc(sizeof(x))
typedef struct _word {
char word[WordLen];
double weight;
} bfeature;
typedef struct _doc {
char filename[PathLen];
```

備考	試題隨卷繳交

命題委員： 057 （簽章） 96 年 2 月 26 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

國立政治大學圖書館

考試科目	計算機概論	所別 8141	資訊科學系	考試時間	三月十七日 星期六	第一節

```
bfeature vector[VecSize];
double norm1;
} doc;

typedef double (*choices)(doc*, doc*);
double cosine(doc*, doc*);
double euclidean(doc*, doc*);
double sim(doc*, doc*, double (*fun)(doc*, doc*));
void   switchvecw(doc, doc, int*, int*);

int main(int argc, char *argv[])
{
int i;
doc *d1, *d2;
int cos=1, euc=0;
choices item[NumChoices];

d1 = MALLOC(doc);
d2 = MALLOC(doc);
d1->norm1 = 0;
d2->norm1 = 0;
item[euc] = cosine;
item[cos] = euclidean;
for (i=0; i<VecSize; i++) {
   d1->vector[i].weight = (double)i/VecSize;
   d2->vector[i].weight = (double)(VecSize-i)/VecSize;
   d1->norm1 += d1->vector[i].weight*d1->vector[i].weight;
   d2->norm1 += d2->vector[i].weight*d2->vector[i].weight;
}
fprintf(stdout,"euclidean: %8.6f\n",sim(d1, d2, euclidean));  // 第 1 小題
switchvecw(*d1, *d2, &euc, &cos);
for (i=0; i<NumChoices; i++)
   fprintf(stdout, "hello: %8.6f\n", sim(d1, d2, item[i]));  // 第 2 小題
return(0);
}
//=============================================================================
double sim(doc *d1, doc *d2, double (*fun)(doc *dd1, doc *dd2))
{ eturn(fun(d1, d2));}
//=============================================================================
double cosine(doc *d1, doc *d2)
{
int i;
double value=0;
for (i=0; i<VecSize; i++)
   value += d1->vector[i].weight*d2->vector[i].weight;
return (value/d1->norm1/d2->norm1);
}
//=============================================================================
double euclidean(doc *d1, doc *d2)
{
int i;
double value=0, temp;
for (i=0; i<VecSize; i++) {
   temp = d1->vector[i].weight-d2->vector[i].weight;
   value += temp*temp;
}
return (value);
}
//=============================================================================
void witchvecw(doc d1, doc d2, int *a, int *b)
{
```

國立政治大學圖書館

備考	試題隨卷繳交

命題委員：058 （簽章） 96 年 2 月 26 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機概論	所別 8141	資訊科學系	考試時間	三月十七日 星期六 第一節

國立政治大學圖書館

```
    double temp;
    int i;
    for (i=0; i<VecSize; i++) {
    temp = d1.vector[i].weight;
    d2.vector[i].weight = temp;
    d1.vector[i].weight = d2.vector[i].weight;
    }
    i = *a;
    *a = *b;
    *b = i;
}
// ****************************************************************
// 以上是第四大題的 C 程式
// ****************************************************************
```

五、 依照本題末尾所列以 JAVA 語言所寫的程式回答問題。如果小題所描述之程式不可能執行，請答『問題定義錯誤』。每一個小題都跟其他小題無關，請分題回答。

1. （三分）將下列指令放在主程式(main)中『//程式加入位置』的下面，程式會印出什麼訊息？

```
System.out.println(bbb1.b1+" "+bbb1.a2);
System.out.println(bbb2.b1+" "+bbb2.a2);
```

2. （三分）將下列指令放在主程式(main)中『//程式加入位置』的下面，程式會印出什麼訊息？

```
System.out.println(bbb1.t2()+" "+bbb2.t2(3));
System.out.println(bbb1.t()+" "+bbb2.t(3));
```

3. （三分）將下列指令放在主程式(main)中『//程式加入位置』的下面，程式會印出什麼訊息？

```
System.out.println(bbb1.b1+" "+bbb2.a3);
```

4. （兩分）將下列指令放在主程式(main)中『//程式加入位置』的下面，程式會印出什麼訊息？

```
pparray<Integer> generics = new pparray<Integer>();
generics.insert(2);
generics.insert(5);
generics.insert(3);
generics.show();
```

5. （兩分）將下列指令放在主程式(main)中『//程式加入位置』的下面，程式會印出什麼訊息？

```
pparray<Character> g2 = new pparray<Character>();
g2.insert('A');
g2.insert('c');
g2.insert('B');
g2.show();
```

```
// ****************************************************************
// 以下是第五大題的 JAVA 程式
// ****************************************************************
public class grad07e {
  public int c1;
  public static void main(String argv[]) {
    grad07b bbb1 = new grad07b();
    grad07b bbb2 = new grad07b(3, 4);

    //程式加入位置 （各小題所應加入之指令，請放在這一行的下面）

  } //（各小題所應加入之指令，請放在這一行的上面）
}
//=================================================
public class grad07a {
  public int a1;
  protected int a2;
  private int a3;
```

備考	試題隨卷繳交

命題委員： 059 （簽章） 96 年 2 月 26 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

國立政治大學 九十六學年度 碩士班暨碩士在職專班招生考試 命題紙

考試科目	計算機概論	所別 8141	資訊科學系	考試時間	三月十七日 星期六 第一節

```
  grad07a() { a1 = 1; a2 = 2; a3 = 3; }
  grad07a(int x) { a1 = x; a2 = x; a3 = x; }
  public int t() { return a1+a2+a3;}
}
//=================================================
public class grad07b extends grad07a {
  public int b1;
  private int b2;

  grad07b() { super(); }
  grad07b(int x, int y) {
    super(x);
    b1 = y;
    b2 = y;
  }

  public int t2() { return b1-b2; }
  public int t2(int e) { return a1+b1+e; }
  public int t(int x) { return a2+x; }
}

//=================================================
public class pparray<T> {
  private int cap;
  private int size;
  private int cut;
  private int i;
  private T[] cont;

  public pparray() {
    cap = 100;
    size = 0;
    cont = (T[]) new Object[cap];
  }

  public int insert(T item) {
    if (size==cap)
      ; // 不相關的細節
    else
      cont[size++] = item;
    return size;
  }

  public void show() {
    for (T item : cont)
      if (item != null)
        System.out.println(item);
  }
}
// ****************************************************************
// 以上是第五大題的 JAVA 程式
// ****************************************************************
```

國立政治大學圖書館

備考	試題隨卷繳交

命題委員： 060 （簽章） 96 年 2 月 26 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機概論	所別 8141	資訊科學	考試時間	3 月 17 日 星期 六 第 一 節

說明：1. 請書寫必要之解題過程。過程正確但答案錯誤，可能有部分分數。如題目之解答非顯而易見者，僅書寫答案而缺乏必要之過程，亦無法獲得該題之滿分。

2. 可使用中文或英文作答。

國立政治大學圖書館

六. (18%, 每小題 2%) 是非題(True or False): (本大題僅回答 T 或 F 即可，不需理由)

(1) It takes constant time, O(1), in finding the minimum or maximum in a BST (Binary Search Tree.)

(2) Adjacency matrix is good for representing sparse graph.

(3) The minimum spanning tree of a n-node graph has O(log n) edges.

(4) $2^{2n} = O(2^n)$.

(5) Membership test in a linked list requires O(log n) time, in the worst case, for input size n.

(6) Both insert and delete operations of a queue take O(1) time.

(7) A binary tree can be used to represent a tree with more than 2 child nodes of a (parent) node.

(8) The worst case of insertion operation on a BST takes O(log n).

(9) Hashing is a technique to achieve an O(1) expected search time. However, its worst-case search time is O(log n).

七. (10%)

For the following binary tree

(1) (5%, 1% each) Write the nodes' ID in the order of "processed" (處理結束) according to the following algorithms: (僅列出結果，不必說明)

(a) inorder traversal,

(b) preorder traversal,

(c) postorder traversal,

(d) breadth-first-search, and

(e) depth-first-search.

(2) (a) (2%) Which algorithm has the "queue" property? (必須說明原因)

(b) (3%) Which algorithm has the "stack" property? (必須說明原因)

備考	試題隨卷繳交

命題委員： 061 96 年 3 月 4 日

命題紙使用說明：1. 試題將用原件印製，請勿以鉛筆作答（紅色不能製版請勿使用）。

2. 書寫時請勿超出格外 ~~以免印製不清~~。

3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機概論	所別 8141	資訊科學	考試時間	3 月 17 日 星期 六 第 一 節

國立政治大學圖書館

八、(12%)

(1) (1%) What is the lower bound of the comparison based sorting algorithms? (Just state the answer.)

(2) (4%) Prove that a tree with $n!$ leaves has $O(n \log n)$ height. (You must prove both the upper bound and the lower bound.)

(3) (2%) What is the time complexity of the radix sort, for n d-digit numbers in which each digit ranges from 0 to k? (The algorithm is given below.) (必須說明原因)

```
radix_sort (A, d)
  for i from 1 to d
      do use a stable sort to sort array A on digit i
```

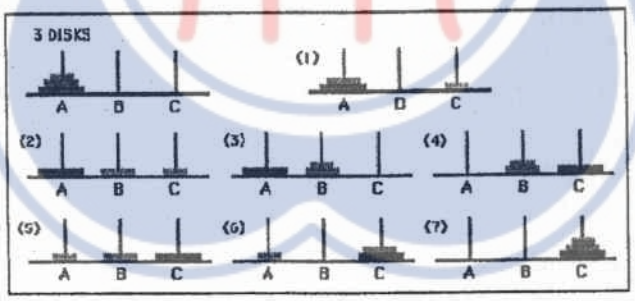
(4) (1%) Is the result in (3) conflict with the result in (1)? (回答 是 或 否)

(5) (4%) Justify your answer in (4). (必須說明原因)

九、(10%)

"Tower of Hanoi"(河內塔)相傳是一個與印度神廟相關的故事：

在東方古國印度的土地上，有一座神廟，廟裡有一塊黃銅板上插著三根柱子，就是有名的梵天塔(下圖為 3 片金環片的示意圖)。相傳天神在創造地球的時候，在梵天塔中的一根柱上放了六十四片圓型金環片。誰人能將梵天塔上六十四層的金環片，按照一定的方式(規則如下述)，由一根柱子移至另一根柱子，就可以昇天成仙(另有一說是完成後世界末日將到來)！幾千年來，成仙夢無人能圓，但這個神奇的遊戲卻流傳至今。



移動環片的規則：把一根柱子上所有的環片，以最少的步驟移至另一根柱子。 每次只能移動一片環片，而且移動的時候，較大的環片不能在較小的環片之上。

(1) (2%) 寫出解此題目的遞迴公式(recurrence equation)。

(2) (4%) 解出此公式。

(3) (1%) 如圓金環片數目為 12，根據此公式，完成此河內塔需要移動金環片的總次數為多少？

(4) (3%) 如圓金環片數目為 64，闡述何以完成時，世界末日將到來。(估計完成所需要的時間)

備考	試題隨卷繳交

命題委員： 062 96 年 3 月 4 日

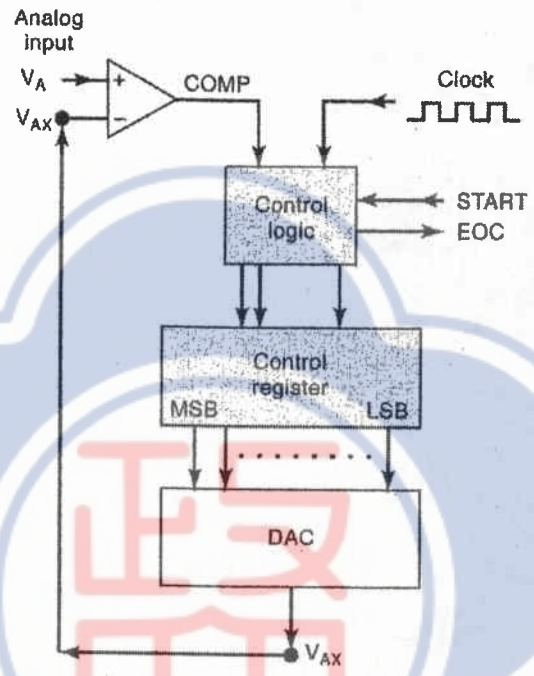
命題紙使用說明：1. 試題將用原件印製，敬請以正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機系統	所別	資訊科學系碩士班	考試時間	3月17日 星期六 第二節

國立政治大學圖書館

一、Computer Organization and Design

1. **[ADC]** The successive approximation converter is one of the most widely used types of ADC. Given the following simplified block diagram:
   - Explain how the control logic works using a flowchart. (6%)
   - Assume V_A=10.4V, use a simple four-bit converter with a step size of 1V to illustrate the conversion process. (4%)



2. **[Instruction Set Architecture, Cache, Performance]**
   - One of the differences between RISC architectures and CISC architecture is supposed to be the reduced types of instructions available. A student thinks it would be a good idea to simplify the instruction set even more to remove the special case instructions that take immediate operands such as "li", "addi", etc. Explain to him/her why this might not be such a good idea. (3%)
   - Explain how a memory system that pages to secondary storage depends on locality of reference for efficient operation. (3%)
   - Program A consists of 2000 consecutive add instructions, while program B consists of a loop that executes a single add instruction 2000 times. You run both programs on a certain machine and find that program B consistently executes faster. Explain. (4%)

備考	試題隨卷繳交

命題委員：063 （簽章） 96 年 3 月 5 日

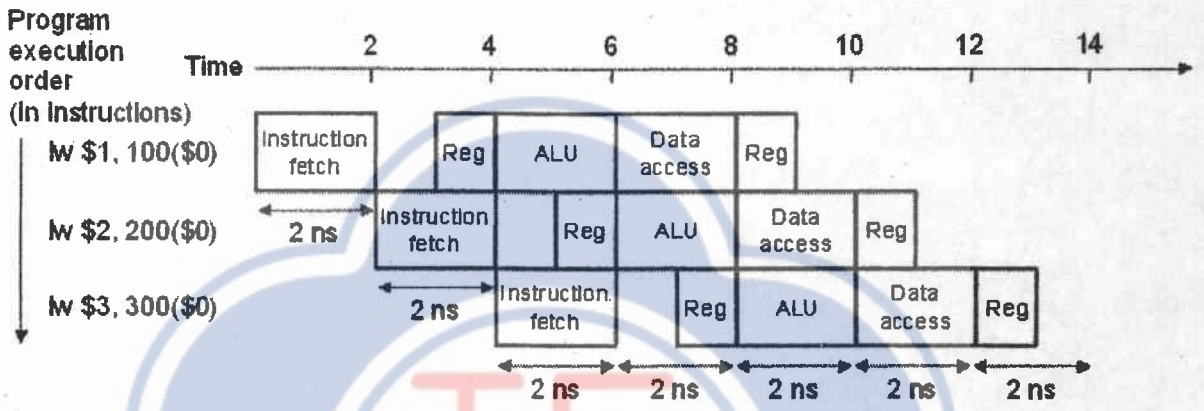
命題紙使用說明：1.試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2.書寫時請勿超出格外，以免印製不清。
3.試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機系統	系(組)別	資訊科學系碩士班	考試時間	3月17日 星期六 第二節

國立政治大學圖書館

3. **[Adder]** A half-adder takes two input bits A and B to produce sum (S) and carry (C_{out}) outputs.
   - Use basic logic gates to construct the circuits for a half adder. (6%)
   - Use exactly two half-adders and one OR gate to construct a full adder. (4%)

4. **[Pipelining]** Refer to the following figure, if the time for an ALU operation can be shortened by 25%; (a) Will it affect the speedup obtained by pipelining? If yes, by how much? Otherwise, why? (5%) (b) What if the ALU now takes 25% more time? (5%)



5. **[Memory]** Give a computer system that features:
   - a single processor
   - 32-bit virtual addresses
   - a cache of 2^{10} sets that are four-way set-associative and have 8-byte blocks
   - a main memory of 2^{26} bytes;
   - a page size of 2^{12} bytes.

   (1) Does this system cache virtual or physical addresses? (2%)
   (2) How many bytes of data from memory can the cache hold? (excluding tags) (2%)
   (3) In the cache, each block of data must have a tag associated with it. How many bits long are these tags? (2%)
   (4) How many comparators are needed to build this cache while allowing single cycle access? (2%)
   (5) At any one time, what is the greatest number of page-table entries that can have their valid bit set to 1? (2%)

備考	試題隨卷繳交

命題委員：064 (簽章) 96年3月5日

命題紙使用說明：1.試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2.書寫時請勿超出格外，以免印製不清。
3.試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機系統	所別	資訊科學	考試時間	3月17日 星期六 第2節

國立政治大學圖書館

二、Operating Systems

1. (5%) [Context switching] For each of the specified operations (a~e) below, indicate whether they must be performed (A) during a context switch between two processes, (B) during a context switch between two threads in the same process (address space), (C) during both kinds of context switches, and (D) during neither type of context switch. Assume that the threads are *kernel* managed (i.e., visible to the operating system).

(a) (1%) Modify the memory management unit to load the new process/threads's memory mappings.

(b) (1%) Save the registers of the process/thread being swapped out to its process/thread descriptor (control block).

(c) (1%) Save the top stack frame of the process/thread being swapped out to its process/thread descriptor (control block).

(d) (1%) Select the next process/thread to execute, based on priority information and other kernel internal state.

(e) (1%) Reset the "return register" (e.g., r0) to zero to indicate that the context switch occurred without any errors.

2. (9%) [CPU Scheduling] Consider a *multi-level feedback queue* in a single-CPU system. The first level (queue 0) is given a quantum of 8 ms, the second one a quantum of 16 ms, the third is scheduled FCFS. Assume six jobs (J1 ~ J6) arrive all at time zero with the following job times (in ms): 4, 7, 12, 20, 25 and 30. Show the *Gantt chart* for this system (3%) and compute the average waiting (3%) and turnaround time (3%).

3. (5%) [Deadlock] There are four conditions that are necessary for deadlock to occur: (A) mutual exclusion, (B) hold and wait, (C) no preemption, and (D) circular wait. With *deadlock prevention*, the system ensures that deadlock does not occur by preventing one of these conditions from holding. Match each of the following techniques with the one deadlock condition (A, B, C, or D) that it prevents.

(a) (1%) Impose a total ordering (or ranking) on how resources are acquired

(b) (1%) When a process requests a resource that is already held, force the process holding the resource to release it

(c) (1%) Only allow a process to request a resource when the process has none

(d) (1%) Allow all processes to access the resource simultaneously

(e) (1%) Require each process to grab all desired resources at once

4. (11%) [Miscellaneous topics]

(a) (4%) Assume that an inode-based file system has 2^{16} data blocks. For some reasons, the system designers have to trim down the size of an inode by reducing the number of direct pointers to 5 and keep only the single and double indirect pointers. The block size is also shrunk to 2Kbytes. What is the *maximum* file size in the trimmed system?

(b) (3%) Suppose each process spends 40% of its time in an I/O state. *How many* such processes are needed to bring the system CPU utilization to higher than 95%? Show your calculations. You will receive no credit if you only provide a number.

(c) (4%) Give *two specific factors* that we do NOT need to consider for the selection of disk scheduling algorithm when we decide to use RAM disk.

備考	試題隨卷繳交

命題委員：065 （簽章） 96 年 3 月 1 日

命題紙使用說明：1.試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2.書寫時請勿超出格外，以免印製不清。
3.試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機系統	所別	資訊科學	考試時間	3月17日 星期六 第2節

國立政治大學圖書館

5. (10%) [Synchronization and Deadlock] A family has three children, each of whom owns one piece of ski equipment (Bobby has boots, Suzy has skis, and Joey has poles). A child needs all three pieces of equipment to ski, and that the parents have a complete set of equipment that they lend to their children. Each day, the parents randomly choose one child to let ski, and place the pieces of equipment that they need outside the condo's front door. Each day, each child attempts to ski. We model this scenario with by using *semaphores* to pass signals between *four threads*: PARENTS, BOBBY, SUZY, and JOEY.

```
semaphore skis = 0, poles = 0, boots = 0, done = 0;
PARENTS: for (;;) { //thread
    who = random(BOBBY,SUZY,JOEY);//select one randomly
    if (who == BOBBY)       { V(skis); V(poles); }
    else if (who == SUZY)   { V(poles); V(boots); }
    else /* who == JOEY */ { V(boots); V(skis); }
    P(done); // Wait for child to finish
}
```

```
BOBBY: //thread
for (;;){
  P(skis);
  P(poles);
  ski();
  V(done);}
```

```
SUZY: //thread
for (;;){
  P(poles);
  P(boots);
  ski();
  V(done); }
```

```
JOEY: //thread
  for (;;){
    P(boots);
    P(skis);
    ski();
    V(done); }
```

(a) (5%) The program above is not deadlock free. Show a scenario where deadlock occurs using a step-by-step execution sequence table for the four threads.

(b) (5%) Show that two children can safely ski at the same (i.e., mutual exclusion is guaranteed.) using a step-by-step execution sequence table like the above one.

6. (10%) [Memory management] Consider the page replacement policies of OPT (Optimal algorithm), FIFO, and LRU. Which of the following statements (A~J) are true? Be careful to notice when the phrase states "better than or equal to" versus "strictly better than".

A. OPT always performs better than or equal to LRU.
B. OPT always performs strictly better than LRU.
C. LRU always performs better than or equal to FIFO.
D. LRU always performs strictly better than FIFO.
E. OPT with $n+1$ pages of physical memory always performs better than or equal to OPT with n pages.
F. OPT with $n+1$ pages of physical memory always performs strictly better than OPT with n pages.
G. FIFO with $n+1$ pages of physical memory always performs better than or equal to FIFO with n pages.
H. FIFO with $n+1$ pages of physical memory always performs strictly better than FIFO with n pages.
I. LRU with $n+1$ pages of physical memory always performs better than or equal to LRU with n pages.
J. LRU with $n+1$ pages of physical memory always performs strictly better than LRU with n pages.

備考	試題隨卷繳交

命題委員： 066 （簽章） 96 年 3 月 1 日

命題紙使用說明：1.試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2.書寫時請勿超出格外，以免印製不清。
3.試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

國立政治大學 九十六學年度 碩士班暨碩士在職專班招生考試 命題紙

考試科目	計算機數學	所別 8141	資訊科學	考試時間	3 月 17 日 星期 6 第 3 節

國立政治大學圖書館

I (離散數學部分; 共 9 題 60%)

1. [10%]True (mark 0) or false(mark x) questions:
   (a) If 2 + 2 = 5 then 1 + 1 = 3.
   (b) Let A, B, C, D be sets. Then (A - B) - (C - D) = (A - C) - (B - D).
   (c) $\forall x \exists y P(x,y)$ implies $\exists x \forall y P(x,y)$.
   (d) There are languages that cannot be recognized by any machine.
   (e) If a relation is irreflexive and transitive, then it is asymmetric.
   (f) The formula $(P \vee \sim Q) \wedge (\sim P \vee Q)$ is not satisfiable.
   (g) If A is not a tautology, then ~A must be satifiable.
   (h) If A, B and C are languages, then $A(B \cap C) = AB \cap AC$.
   (i) If A is a language, then $(A^*)^+ = A^+$.
   (j) There are context free languages that can be recognized by finite automata.

2. [3%]Which of the following formula is in conjunctive normal form and is logically equivalent to the formula : $(P \wedge S) \rightarrow (Q \wedge R)$
   (a) $\sim P \vee \sim S \vee (Q \wedge R)$ (b) $(\sim P \vee \sim S \vee Q) \wedge (\sim P \vee \sim S \vee R)$
   (c) $\sim(P \wedge S) \vee (Q \wedge R)$ (d) $(P \vee S) \wedge (\sim Q \vee \sim R)$

3. [3%]Suppose we have 4 algorithms designed to solve the same problem. If the running time of the 4 algorithms are expressed by divide-and-conquer recurrence relations as given below, then which algorithm would be asymptotically the best?
   (a) $f(n) = 10\, f(n/3) + 10\, n$
   (b) $f(n) = 5\, f(n/2) + 6\, n$
   (c) $f(n) = 9\, f(n/3) + 2n^2$
   (d) $f(n) = 20\, f(n/5) + 5\, n^2$

4. [3%]Which of the following sets of boolean operators is not functionally complete?
   (a) { or, not } (b) { →, 0 } (c) { xor, 1} (d) { nand }

5. [5%]There are _____ ways in which 6 jobs can be assigned to 3 employees so that each employee is assigned at least one job and the hardest job is assigned to the best employee.

備考	試題隨卷繳交
命題委員：	067 （簽章） 96 年 2 月 27 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機數學	所別 8141	資訊科學	考試時間	3月17日 星期6 第 3 節

國立政治大學圖書館

6. [9%]Answer the following questions about trees:
   (a) If T is a tree with 20 edges, then it has _____ vertices.
   (b) If T is a balanced full 3-ary tree of height 5, then it has at least _____ vertices.
   (c) If T is a full 4-ary tree with 82 leaves, then it has ____ internal vertices.

7. [5%] Solve the recurrence relation $a_n = 4\,a_{n-1} - 4\,a_{n-2}$ with the initial condition that $a_0 = 1$ and $a_1 = 6$. The solution is a_n = _____ for all $n \geq 0$.

8. [12%] Let $Q_n = (V_n, E_n)$ be a family of simple graphs where $n \geq 1$ and the set of vertices $V_n = \{a,b,c,d\}^n$ consists of all strings over the alphabet {a,b,c,d} of length n (,for instance, if n = 2, then V_2 = {aa,ab,ac,ad,ba,bb,…,dd},) and the set of edges E_n consists of all unordered pairs of members of V_n which differ in 1 position (, e.g., if n= 4, then aaab and acab are adjacent since they differs only in position 2.). The distance of two vertices in a graph is defined to be the number of edges of the shortest path between them and the diameter of a graph is defined to be the longest of all distances of all pairs of vertices of the graph.
   (a) There are _____ vertices in Q_n. [3%]
   (b) The degree of every vertex v in Q_n = _____ [3%]
   (c) There are _____ edges in Q_n. [3%]
   (d) Find all values of n under which Q_n has an Euler circuit [3%]

9. [10%] Show that a simple graph G with n vertices is connected if it has more than (n-1)(n-2)/2 edges.

備考	試題隨卷繳交
命題委員：	068 （簽章） 96 年 2 月 27 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機數學 (線性代數)	所別	8141 資訊科學	考試時間	3月17日 星期六 第三節

國立政治大學圖書館

10、(10%) 1. Please compute the QR-factorization of A.

$$A=\begin{bmatrix}1 & 0 & -1\\ 2 & -3 & 3\\ -1 & 2 & 4\end{bmatrix}$$

11、(10%) 2. By using orthogonal transformations, reduce the following quadratic forms to sums of squares.

(a) $2x_1^2 + x_2^2 - 4x_1x_2 - 4x_2x_3$

(b) $8x_1x_3 + 2x_1x_4 + 2x_2x_3 + 8x_2x_4$

12、(10%) 3. Please use Gaussian elimination to solve the given system of equations.

$$\begin{aligned} x + 3y + 2z &= 0\\ -x - 4y + 3z &= -1\\ 2x - z &= 3\\ 2x - y + 4z &= 2 \end{aligned}$$

13、(10%) 4. Please find the least-squares solution to the given system of equations.

$$\begin{aligned} x + y - z &= 90\\ 2x + y + z &= 200\\ x + 2y + 2z &= 320\\ 3x - 2y - 4z &= 10\\ 3x + 2y - 3z &= 220 \end{aligned}$$

備考	試題隨卷繳交

命題委員：069 (簽章) 96年2月16日

命題紙使用說明：1.試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2.書寫時請勿超出格外，以免印製不清。
3.試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算机數學與網路	所別	8141 資訊科學	考試時間	3月17日 星期六 第3節

國立政治大學圖書館

1. [Shannon's Theorem]

   Suppose that the spectrum of a voice channel is 64 kHz and the SNR (Signal to Noise Ratio) is 10 dB. Then:

   (a) (4%)Compute the theoretical limit of this channel's data rate based on the Shannon's Theorem?

   (b) (4%) How many signaling levels are required to achieve this data rate?

2. [Bandwidth and Latency]

   Calculate the total time required to transfer a 2.0 MB file in the following cases, assume an Round-Trip Time (RTT) of 100 ms, a packet size of 1 KB and an initial 2 × RTT of "handshaking" before data is sent.

   (a) (4%)The bandwidth is 100 $Mbps$, and data packets can be sent continuously.

   (b) (4%)The bandwidth is 100 $Mbps$, but after we finish sending each data packet we must wait one RTT before sending the next.

3. [Delay × Bandwidth]

   Please answer the following questions:

   (a) (4%)Why it is important to know the product of *delay* × *bandwidth* when constructing a high performance network?

   (b) (4%)Assume an RTT is 100 ms, please compute *delay* × *bandwidth* for T3 and FDDI?

4. [TCP Three-Way Handshake]

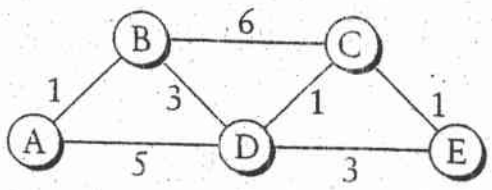
   (a) (4%)Please demonstrate how is the TCP three-way handshaking connection protocol established between a client process and a server process?

   (b) (4%)How the TCP three-way handshaking protocol works in case an old delayed duplicate SYN message from a client process was received by the server process?

5. [Routing Protocols]

   (a) (4%)What is the difference between RIP and OSPF routing protocols?

   (b) (4%)Use OSPF routing protocol to build the routing table for node A in the network shown in the following figure:



備考	試題隨卷繳交
命題委員：	070 （簽章） 年 月 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	計算機數學與網路	所別 8141	資訊科學	考試時間	3 月 17 日 星期 6	第 3 節

國立政治大學圖書館

(離散數學部分; 共 9 題 60%)

6. [10%]True (mark 0) or false(mark x) questions:

(a) If 2 + 2 = 5 then 1 + 1 = 3.

(b) Let A, B, C, D be sets. Then (A - B) - (C - D) = (A - C) - (B - D).

(c) $\forall x \exists y P(x,y)$ implies $\exists x \forall y P(x,y)$.

(d) There are languages that cannot be recognized by any machine.

(e) If a relation is irreflexive and transitive, then it is asymmetric.

(f) The formula $(P \vee \sim Q) \wedge (\sim P \vee Q)$ is not satisfiable.

(g) If A is not a tautology, then ~A must be satifiable.

(h) If A, B and C are languages, then $A(B \cap C) = AB \cap AC$.

(i) If A is a language, then $(A^*)^+ = A^+$.

(j) There are context free languages that can be recognized by finite automata.

7. [3%]Which of the following formula is in conjunctive normal form and is logically equivalent to the formula : $(P \wedge S) \rightarrow (Q \wedge R)$

(a) $\sim P \vee \sim S \vee (Q \wedge R)$ (b) $(\sim P \vee \sim S \vee Q) \wedge (\sim P \vee \sim S \vee R)$

(c) $\sim(P \wedge S) \vee (Q \wedge R)$ (d) $(P \vee S) \wedge (\sim Q \vee \sim R)$

8. [3%]Suppose we have 4 algorithms designed to solve the same problem. If the running time of the 4 algorithms are expressed by divide-and-conquer recurrence relations as given below, then which algorithm would be asymptotically the best?

(a) $f(n) = 10\, f(n/3) + 10\, n$

(b) $f(n) = 5\, f(n/2) + 6\, n$

(c) $f(n) = 9\, f(n/3) + 2n^2$

(d) $f(n) = 20\, f(n/5) + 5\, n^2$

9. [3%]Which of the following sets of boolean operators is not functionally complete?

(a) { or, not } (b) { →, 0 } (c) { xor, 1} (d) { nand }

10. [5%]There are _____ ways in which 6 jobs can be assigned to 3 employees so that each employee is assigned at least one job and the hardest job is assigned to the best employee.

備考	試題隨卷繳交
命題委員：	071 （簽章） 96 年 2 月 27 日

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

國立政治大學九十 二、學年度研究所 博/碩 士班入學考試命題紙

考試科目	計算机數學與網路	所別	資訊科學	考試時間	3 月 17 日 星期 二 第 3 節

國立政治大學圖書館

11. [9%]Answer the following questions about trees:
    (a) If T is a tree with 20 edges, then it has _____ vertices.
    (b) If T is a balanced full 3-ary tree of height 5, then it has at least _____ vertices.
    (c) If T is a full 4-ary tree with 82 leaves, then it has _____ internal vertices.

12. [5%] Solve the recurrence relation $a_n = 4\,a_{n-1} - 4\,a_{n-2}$ with the initial condition that $a_0 = 1$ and $a_1 = 6$. The solution is a_n = _____ for all $n \geq 0$.

13. [12%] Let $Q_n = (V_n, E_n)$ be a family of simple graphs where $n \geq 1$ and the set of vertices $V_n = \{a, b, c, d\}^n$ consists of all strings over the alphabet {a, b, c, d} of length n (,for instance, if n = 2, then V_2 = {aa, ab, ac, ad, ba, bb, ..., dd},) and the set of edges E_n consists of all unordered pairs of members of V_n which differ in 1 position (, e.g., if n= 4, then aaab and acab are adjacent since they differs only in position 2.). The distance of two vertices in a graph is defined to be the number of edges of the shortest path between them and the diameter of a graph is defined to be the longest of all distances of all pairs of vertices of the graph.
    (a) There are _____ vertices in Q_n. [3%]
    (b) The degree of every vertex v in Q_n = _____ [3%]
    (c) There are _____ edges in Q_n. [3%]
    (d) Find all values of n under which Q_n has an Euler circuit [3%]

14. [10%] Show that a simple graph G with n vertices is connected if it has more than (n-1)(n-2)/2 edges.

備考	試題隨卷繳交

命題委員： 072 （簽章） 96 年 2 月 27 日

命題紙使用說明：1. 試題將用原件印製；敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。