國立政治大學 九十七學年度 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	資訊科學系 碩士班 8141	考試時間	3 月 15 日 星期 六 第 1 節

可用中文或英文回答。

1. **(10%) True or False** (Please write **T** or **F** as an answer to each of the following statements.)
   1) The width of a data bus could be two times larger than the size of a register in a computer system.
   2) The size of virtual memory is limited by the width of MAR.
   3) You should pass the parameters of a function *by value* in order to change their values.
   4) The LRU (Least Recently Used) page replacement policy replaces a page that is used least frequently.
   5) Loader is the program for initiating the execution of a program.
   6) In general, a complier has a better chance to do global optimization than local optimization.
   7) If we can find a symbol manipulation task that no Turing machine can perform, then there is no algorithm for this task.
   8) Duplicated labels in an assembly language will be discovered during the first pass to the assembler.
   9) The principle of locality can be used for code optimization.
   10) Ethernet technology is used for local area network (LAN) but not for wide area network (WAN).

2. **(12%) Single Selection**
   1) Which of the following concepts or technologies adopts the same principle as a web proxy server?
   (a) cache memory (b) time sharing (c) pipeline (d) virtual memory
   2) What does the following C statement print when two's complement notation is used?
   `printf("%d", (unsigned char) (-2+1));`
   (a) -1 (b) 1 (c) 3 (d) 255
   3) Which of the following network protocols is below the session layer in the OSI 7-layer model?
   (a) HTTP (b) FTP (c) SMTP (d) UDP
   4) Which of the following network devices cannot be used for "microsegmentation" in LAN (Local Area Network)?
   (a) bridge (b) hub (c) switch (d) router
   5) Which of the following strings cannot be produced by the BNF rules below?
   <index> ::= <letter><num>
   <num> ::= <digit>|<num><digit>
   <letter> ::= i|j
   <digit> ::= 0|1|2|3|4|5|6|7|8|9
   (a) i (b) i1 (c) j01 (d) j9876
   6) What is the prefix notation of the following expression? (assuming '*' has precedence over "+")
   `((A+B)*C+D*(E+F)*G)+H`
   (a) * + + A B C * * D + + E F G H
   (b) + * + + A B C * * D + E F G H
   (c) + + * + A B C * * D + E F G H
   (d) * + + + A B C * * D + E F G H

備考	試題隨卷繳交

命題委員： （簽章） 97 年 3 月 7 日

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考試科目	計算機概論	所別	資訊科學系 碩士班 8141	考試時間	3 月 15 日 星期 六	第 1 節

3. **(7%) Number System:**
Consider an 8-bit number with the following bit pattern: 10101010_2
(a) What is the decimal number if the bit pattern is in excess-128 notation?
(b) What is the decimal number if the bit pattern is in 2's complement notation?
(c) What is the number if the bit pattern represents a floating number of the following format: SEEEMMMM (S: sign, E: exponent, M: mantissa). The sign is 0 for positive and 1 for negative, exponent is stored in excess-4 notation, and the implied binary point is to the left of the mantissa.

4. **(4%)** What are the roles of the following registers in retrieving a machine instruction from the main memory: PC, IR, MAR, MDR? (Explain how they are used.)

5. **(6%)** Please list three main characteristics of an object-oriented programming language. Use the terminologies of an object-oriented programming language you are familiar with (please specify) to give an example for each of the three characteristics you identify. (No need to write code.)

6. **(3%)** Please give at least three main characteristics of Web 2.0 applications.

7. **(8%) C Programming:**
(a) (6%) Please write a *recursive* function called "reverse" in C (or C++) to reverse a string of arbitrary length in place. For example, "apple" will be reversed to "elppa" after calling this function. The prototype of the function is defined as follows.

```
void reverse(char *str);
```

The reversed string should replace the original string and be stored in the same space. You are not allowed to dynamically allocate memory in this function.
(b) (2%) Are there any potential problems of using the above recursive function?

備考	試題隨卷繳交

命題委員： （簽章） 97 年 3 月 7 日

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考試科目	計算機概論	所別	資訊科學	考試時間	3 月 15 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。

8. (16%, 2% for each problem) 是非題(True or False): (本大題僅回答 T 或 F 即可，不需理由)

(1) Hashing is a technique to achieve an O(1) expected search time. However, its worst-case search time is O(log *n*).
(2) Adjacency matrix is good for representing a sparse graph.
(3) $2^{2n} = O(2^n)$, where O is the notation for asymptotic upper bound.
(4) Membership test in a linked list requires O(log n) time, in the worst case, for input size n.
(5) We need two pointers to implement either queue or stack using linked lists.
(6) The best case time complexity of a selection sort algorithm is the same as that of a insertion sort algorithm.
(7) The worst case of insertion operation on a BST takes O(log n).
(8) The minimum spanning tree of a n-node graph has O(log n) edges.

9. (6%)

The recurrence equation, $T(n) = aT(n/b) + f(n)$, can be used to analyze the complexity of divide and conquer methods. Referring to this equation, explain
(a) (3%) the role of the function $f(n)$, and
(b) (3%) the restriction on b. (You must give the reason on why we need this restriction.)

10. (12%)

For the following problems, assume the input size is n.
(a) (4%) Formulate the recurrence equation for Quicksort. (Explain every parameter you used.)
(b) (4%) Using the recurrence equation, find the best case time complexity of Quicksort.
(c) (4%) Using the recurrence equation, find the worst case time complexity of Quicksort.

備考	試題隨卷繳交

命題委員： （簽章） 97 年 3 月 6 日

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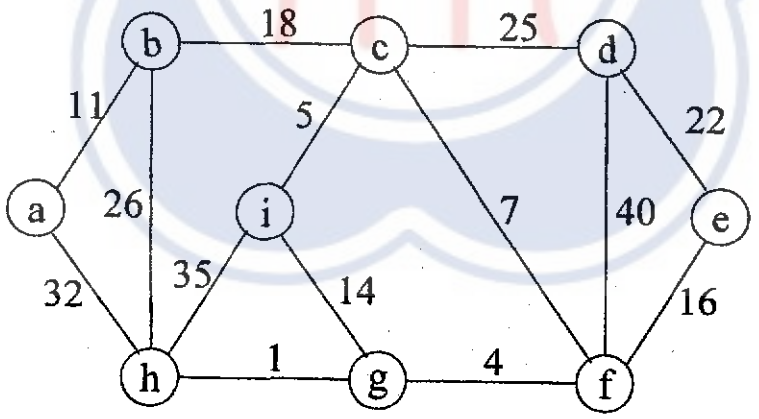
11. (16%)

There are two algorithms, the Kruskal's algorithm and the Prim's algorithm, for finding the Minimum Spanning Tree(MST) of a graph G=(V,E), where V denotes the set of vertices and E denotes the set of edges. These algorithms are given below:

Algorithm Kruskal(G)
//Kruskal's algorithm for constructing a MST
//Input: A weighted connected graph G=(V,E)
//Output: E_T, the set of edges composing a MST of G
Sort E in non-decreasing order of the edge weights
so that $w(e_{i_1}) \le w(e_{i_2}) \le \cdots \le w(e_{i_{|E|}})$
$E_T \leftarrow \varnothing$; *ecounter* $\leftarrow 0$ //Initialize the set of tree edges and its size
$k \leftarrow 0$ //Initialize the number of processed edges
while *ecounter* $< |V|-1$
  $k \leftarrow k+1$
  if $E_T \cup \{e_{i_k}\}$ is acyclic
    $E_T \leftarrow E_T \cup \{e_{i_k}\}$; *ecounter* $\leftarrow$ *ecounter* $+1$
return E_T

Algorithm Prim(G)
//Prim's algorithm for constructing a MST
//Input: A weighted connected graph G=(V,E)
//Output: E_T, the set of edges composing a MST of G
$V_T \leftarrow \{v_0\}$ //Initialize the set of tree vertices to v_0
$E_T \leftarrow \varnothing$
for $i \leftarrow 1$ **to** $|V|-1$ **do**
  find a minimum - weight edge $e^* = (v^*, u^*)$
    among all the edges (v, u)
    such that v^* is in V_T and u^* is in $V - V_T$
  $V_T \leftarrow V_T \cup \{u^*\}$
  $E_T \leftarrow E_T \cup \{e^*\}$
return E_T

Given this graph and answer the following questions:



(a) (4%) Name the third edge added to the MST using the Kruskal's algorithm.
(b) (4%) Name the third edge added to the MST using the Prim's algorithm starting at node i.
(c) (4%) What is the time complexity of Kruskal's algorithm in terms of |V| and |E|?
(d) (4%) What is the time complexity of Prim's algorithm in terms of |V| and |E|?

備考	試題隨卷繳交
命題委員：	（簽章） 97 年 3 月 6 日

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考試科目	計算机系统	所別	資訊科学	考試時間	3月15日 星期六 第二節

814

Operating Systems 2008 Master Entrance Examination

There are 10 problems for this examination and the weights for each (sub)problem is indicated. Please do all of them.

1. Please answer the following questions:

   (a) (4%)What is the purpose of system calls?

   (b) (6%)What are three general methods used to pass parameters to the operating system in the system calls during different circumstances?

2. Please answer the following questions:

   (a) (5%) Why we have to guard against **race condition** and synchronize the **critical section**?

   (b) (5%)A solution to the critical-section problem must satisfy the following three requirements: mutual exclusion, progress, and bounded waiting. Assume the elements of the array boolean flag[2] are initialized false. Please justify whether the following algorithm for the structure of process P_i where $i = 0, 1$ satisfies these three requirements for two-process synchronization. Your answer must explicitly prove each condition's satisfaction:

```
do {
     flag[i] = true;
     while (flag[j]);

     critical section

     flag[i]=false;

     remainder section
   } while (1);
```

3. (8%) A file is to be shared among different processes, each of which has a unique number. The file can be accessed simultaneously by several processes, subject to the following constraint: The sum of all unique numbers associated with all the processes currently accessing the file must be less than n. Write a monitor to coordinate access to the file.

備考	試題隨卷繳交

命題委員： （簽章） 2008年 3月 5日

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考試科目	計算机系統	所別	資訊科学 (814)	考試時間	3月15日 星期六 第二節

4. (12%) Consider a file currently consisting of 40 blocks. Assume that the file control block (and the index block, in case of indexed allocation) is already in memory. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies, if, for one block, the following conditions hold. In the contiguous allocation case, assume that there is no room to grow in the beginning, but there is room to grow in the end. Assume that the block information to be added is stored in memory:

   (a) The block is added at the beginning.

   (b) The block is added in the middle.

   (c) The block is removed from the middle.

   (d) The block is removed from the end.

5. Please answer the following questions:

   (a) (5%)Assume we have a demand-paged memory. The page table is held in registers. It takes 15 ms to service a page fault if an empty page is available or the replaced page is not modified, and 25 ms if the replaced page is modified. Memory access time is 100 ns. Assume that the page to be replaced is modified 80 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 100 ns?

   (b) (5%)Consider a demand-paging system with a paging disk that has an average access and transfer time of 10 ms. Addresses are translated through a page table in main memory, with an access time of 2 μs per memory access. Thus, each memory reference through the page table takes two accesses. To improve this time, we have added an associated memory that reduces access time to one memory reference, if the page-table entry is in the associative memory.Assume that 80 percent of the accesses are in the associative memory, and that, of the remaining, 20 percent (or 4 percent of the total) cause page faults. What is the effective memory access time?

備考	試題隨卷繳交

命題委員： (簽章) 2018年 3月 5日

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考試科目	計算機系統	所別	資訊科學	考試時間	3月15日 星期六 第二節

8|4|

6. **[Multilevel Cache]** Consider 3 processors with different cache configurations:
   - Cache 1: Direct-mapped with one-word blocks
   - Cache 2: Direct-mapped with four-word blocks
   - Cache 3: Two-way set associative with four-word blocks

   The following miss rate measurements have been made:
   - Cache 1: instruction miss rate is 4%; data miss rate is 6%
   - Cache 2: instruction miss rate is 3%; data miss rate is 4.5%
   - Cache 3: instruction miss rate is 2%; data miss rate is 3%

   For these processors, one-third of the instructions contain a data reference. Assume that the cache miss penalty is 8 + Block size in words. The CPI for this workload was measured on a processor with cache 1 and was found to be 2.0. (a) Determine which processors spend the most cycles on cache misses. (6%) (b) Assume that the cycle time is 400ps for processors 1 and 2, and 300ps for processor 3. Determine which processor is the fastest and which is the slowest. (4%)

7. **[I/O Communication]** Suppose we want to use a laptop to send 100 files of approximately 50 MB each to another computer over a 5 Mbit/sec wireless connection. The laptop battery currently holds 100,000 joules of energy. The wireless network card alone consumes 5 watts while transmitting, while the rest of the laptop consumes 40 watts. Before each file transfer we need 10 seconds to choose which file to send. How many complete files can we transfer before the laptop's battery runs down to zero? (10%)

8. **[Performance]** Consider a non-pipelined processor whose instruction set contains floating point (FP) instructions. Suppose we have measured the CPI of the FP instructions to be 12, while the average CPI for all other instructions is 5. A proposed enhancement is to reduce the CPI of FP instructions to 6. Another proposed enhancement is to decrease the clock cycle time by 30%. Let f be the fraction of instructions that are FP instructions. For what value of f would the two above enhancements be equivalent? (10%)

9. **[IEEE 754 Representation]** The IEEE 754 floating-point standard specifies 64 bit double precision with a 53-bit significand (including the implied 1) and an 11-bit exponent. IA-32 offers an extended precision option with a 64-bit significand and a 16-bit exponent. (a) Assume extended precision is similar to single and double precision, what is the bias of the exponent? (4%) (b) What is the range of numbers that can be represented by the extended precision option? (6%)

考試科目	計算機系統	所別	資訊科學	考試時間	3 月 15 日 星期 六 第二節

8141

10. **[Branch Prediction]** We have a program core consisting of four conditional branches. The program core will be executed thousands of times. Below are the outcomes of each branch for one execution of the program core (T for taken, N for not taken.)

- Branch 1: T-T-T
- Branch 2: N-N-N-N
- Branch 3: T-N-T-N-T-N
- Branch 4: T-T-T-N-N

Assume the behavior of each branch remains the same for each program core execution. For dynamic schemes, assume each branch has its own prediction buffer and each buffer is initialized to the same state before each execution. List the predictions for the following branch prediction schemes and compute the prediction accuracies. (10%)

a. Always taken
b. Always not taken
c. 1-bit predictor, initialized to prediction taken.

國立政治大學 九十七學年度 碩士班暨碩士在職專班招生考試 命題紙

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考試科目	計算機數學	所別	資訊科學系	考試時間	3月 15 日 星期六 第 三 節

I 是非題: (10 %,不倒扣,正確答 O 錯誤答 X)

1. True or false questions:
   (a) 3 + 2 = 6 if and only if 1 + 1 = 3.
   (b) $\forall x \exists y P(x,y)$ implies $\exists x \forall y P(x,y)$.
   (c) Let A and B be propositional formulas. Then B is a logical consequence of A if and only if $(A \wedge \sim B)$ is satisfiable.
   (d) If A is a language, then $(A^*)^+ = A^+$.
   (e) A connected multigraph has a Eular circuit if and only if the degrees of all its vertices are even.
   (f) There exists a graph in which there are an odd number of vertices of odd degree.
   (g) There is exactly one simple path from any vertex of a tree to any other vertex.
   (h) Any subset of a countable set is countable.
   (i) There are finite languages which are not regular.
   (j) Let $x > y \geq 0$ be arbitrary non-negative integers. Then the greatest common divider (gcd) of x and y must equal the gcd of x+y and x-y.

II 單選題 (12 %;每題三分不倒扣)

2. Which one of the following propositional formulas logically implies all the others?
   (a) $(\sim p) \wedge q$ (b) $p \rightarrow q$ (c) $p \vee q$ (d) q
3. Let G = (N, T, S, P) be a context free grammar, where N= {S,A} is the set of nonterminal symbols, T = {0,1} is the set of terminal symbols, S is the start symbol and the set of productions P is given as follows: { S → 1S, S → 00A, A→ 0A, A→0 }. Then which of the following bit strings belongs to the language L(G) generated by G.
   (a) 11001 (b) 111000 (c) 11100 (d) 001110
4. Which kind of the following machine models can recognize a language which all other kinds of machines cannot recognize?
   (a) finite automata (b) pushdown automata (c) Turing machine (e) Linear bounded automata
5. Let f be an increasing function satisfies the divide-and-conquer relation $f(n) = 3\, f(n/2) + 2n^2$ and the initial condition f(1) = 1. What is the asymptotic order of f(n) ?
   (a) $\Theta(n^3 \log n)$ (b) $\Theta(n^2 \log n)$ (c) $\Theta(n^{\log_2 3})$ (d) $\Theta(n^2)$

備考	試題隨卷繳交
命題委員：	（簽章） 97 年 3 月 1 日

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考試科目	計算機數學	所別	資訊科學系	考試時間	3 月 15 日 星期六 第 三 節

III 填空題 [18%; 每格三分]

6. Let G be a planar graph with 30 vertices and 50 edges. Then
   (a) there are _____ regions if G is connected and
   (b) there are _____ regions if G has 5 connected components.
7. Let A be the set of all bit strings of length 11. Define an equivalence relation R on A with the condition that xRy iff bits x and y have the same number of 1's. Then
   (a) the equivalence class [11010101010] has _____ members and
   (b) The quotient set A/R has _____ equivalence classes.
8. There are _____zeros at the end of the decimal representation of $1 \times 2 \times 3 \times \ldots \times 400$.
9. Let A = {1, 2, …, 9}. Then there are _____ subsets of A which do not contain consecutive numbers.(i.e., if $x \in A$ is in the subset then x-1 and x+1 must not be selected.)

IV 計算與證明 (20 %; 每題十分)

10. [10%]Let Σ = {a,b,c,d}. A palindrome over Σ is a (possibly empty) sequence of symbols from Σ such that the sequence is the same as its reverse listing. So, for example, aba is a palindrome (of length 3) while aacb is not. Now let S_n ($n \geq 0$) denote the number of palindromes over Σ of length n.
    (a) What are S_0 and S_1. (2%)
    (b) Derive a recurrence relation for S_n for $n \geq 2$. [4%]
    (c) Solve the recurrence relation you got at (b) with the initial conditions you got at (a) to derive a general solution for S_n. [4%]

11. [10%]Let G= (V, E) be an undirected graph with k connected components and has no simple circuits. Show that |V| = |E| + k. Hint: Prove by induction on the number of edges |E| in G.

備考	試題隨卷繳交
命題委員：	（簽章） 97 年 3 月 1 日

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考試科目	計算機數學-線性代數	所別	8141 資訊科學系	考試時間	3月15日 星期六 第三節

(10%)V. Please find a least squares solution of the following inconsistent system.

$$\begin{aligned} x &= 1 \\ y &= 2 \\ x+y &= 3.001 \end{aligned}$$

(10%)VI. Determine which of the following matrices are non-singular and find the inverse, where possible.

$$\text{(a)}\begin{bmatrix} 1 & 1 & 1 \\ -1 & 1 & 0 \\ 2 & 0 & 0 \end{bmatrix} \quad \text{(b)}\begin{bmatrix} 2 & 2 & 4 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \quad \text{(c)}\begin{bmatrix} 4 & 6 & -3 \\ 0 & 0 & 7 \\ 0 & 0 & 5 \end{bmatrix}$$

$$\text{(d)}\begin{bmatrix} 2 & 0 & 0 \\ 0 & -5 & 0 \\ 0 & 0 & 7 \end{bmatrix} \quad \text{(e)}\begin{bmatrix} 1 & 2 & 4 & 6 \\ 0 & 1 & 2 & 0 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 2 \end{bmatrix} \quad \text{(f)}\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 5 & 7 & 9 \end{bmatrix}.$$

(10%)VII. Determine which of the following matrices are unitary:

$$A=\begin{bmatrix} i/2 & -\sqrt{3}/2 \\ \sqrt{3}/2 & -i/2 \end{bmatrix}, \quad B=\frac{1}{2}\begin{bmatrix} 1+i & 1-i \\ 1-i & 1+i \end{bmatrix}, \quad C=\frac{1}{2}\begin{bmatrix} 1 & -i & -1+i \\ i & 1 & 1+i \\ 1+i & -1+i & 0 \end{bmatrix}$$

(10%)VIII. Which of the following symmetric matrices are positive definite?

$$(a)\quad A=\begin{bmatrix} 3 & 4 \\ 4 & 5 \end{bmatrix}, (b)\quad B=\begin{bmatrix} 8 & -3 \\ -3 & 2 \end{bmatrix}, (c)\quad C=\begin{bmatrix} 2 & 1 \\ 1 & -3 \end{bmatrix}, (d)\quad D=\begin{bmatrix} 3 & 5 \\ 5 & 9 \end{bmatrix}$$

備考	試題隨卷繳交

命題委員： （簽章） 97 年 3 月 3 日

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國立政治大學 九十七學年度 碩士班暨碩士在職專班招生考試 命題紙

8141

考試科目	計算機數學與網路	所別	資訊科學系	考試時間	3月 15 日 星期六 第 三 節

I 是非題: (10 %,不倒扣,正確答 O 錯誤答 X)

1. True or false questions:
   (a) 3 + 2 = 6 if and only if 1 + 1 = 3.
   (b) $\forall x \exists y P(x,y)$ implies $\exists x \forall y P(x,y)$.
   (c) Let A and B be propositional formulas. Then B is a logical consequence of A if and only if $(A \wedge \sim B)$ is satisfiable.
   (d) If A is a language, then $(A^*)^+ = A^+$.
   (e) A connected multigraph has a Eular circuit if and only if the degrees of all its vertices are even.
   (f) There exists a graph in which there are an odd number of vertices of odd degree.
   (g) There is exactly one simple path from any vertex of a tree to any other vertex.
   (h) Any subset of a countable set is countable.
   (i) There are finite languages which are not regular.
   (j) Let $x > y \geq 0$ be arbitrary non-negative integers. Then the greatest common divider (gcd) of x and y must equal the gcd of x+y and x-y.

II 單選題 (12 %;每題三分不倒扣)

2. Which one of the following propositional formulas logically implies all the others?
   (a) $(\sim p) \wedge q$ (b) $p \rightarrow q$ (c) $p \vee q$ (d) q
3. Let G = (N, T, S, P) be a context free grammar, where N= {S,A} is the set of nonterminal symbols, T = {0,1} is the set of terminal symbols, S is the start symbol and the set of productions P is given as follows: { S → 1S, S → 00A, A→ 0A, A→0 }. Then which of the following bit strings belongs to the language L(G) generated by G.
   (a) 11001 (b) 111000 (c) 11100 (d) 001110
4. Which kind of the following machine models can recognize a language which all other kinds of machines cannot recognize?
   (a) finite automata (b) pushdown automata (c) Turing machine (e) Linear bounded automata
5. Let f be an increasing function satisfies the divide-and-conquer relation $f(n) = 3\, f(n/2) + 2n^2$ and the initial condition f(1) = 1. What is the asymptotic order of f(n) ?
   (a) $\Theta(n^3 \log n)$ (b) $\Theta(n^2 \log n)$ (c) $\Theta(n^{\log_2 3})$ (d) $\Theta(n^2)$

備考	試題隨卷繳交
命題委員：	（簽章） 97 年 3 月 1 日

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III 填空題 [18%; 每格三分]

6. Let G be a planar graph with 30 vertices and 50 edges. Then
   (a) there are _____ regions if G is connected and
   (b) there are _____ regions if G has 5 connected components.
7. Let A be the set of all bit strings of length 11. Define an equivalence relation R on A with the condition that xRy iff bits x and y have the same number of 1's. Then
   (a) the equivalence class [11010101010] has _____ members and
   (b) The quotient set A/R has _____ equivalence classes.
8. There are _____zeros at the end of the decimal representation of 1 x 2 x 3 x … x 400 .
9. Let A = {1, 2, … ,9}. Then there are _____ subsets of A which do not contain consecutive numbers.(i.e., if $x \in A$ is in the subset then x-1 and x+1 must not be selected.)

IV 計算與證明 (20 %; 每題十分)

10. [10%]Let Σ = {a,b,c,d}. A palindrome over Σ is a (possibly empty) sequence of symbols from Σ such that the sequence is the same as its reverse listing. So, for example, aba is a palindrome (of length 3) while aacb is not. Now let S_n ($n \geq 0$) denote the number of palindromes over Σ of length n.
    (a) What are S_0 and S_1. (2%)
    (b) Derive a recurrence relation for S_n for $n \geq 2$. [4%]
    (c) Solve the recurrence relation you got at (b) with the initial conditions you got at (a) to derive a general solution for S_n. [4%]

11. [10%]Let G= (V, E) be an undirected graph with k connected components and has no simple circuits. Show that |V| = |E| + k. Hint: Prove by induction on the number of edges |E| in G.

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考試科目	計算機網路概論 8141	考試時間	3月15日 星期六 第三節

(10%) V. Calculate the latency (from first bit sent to last bit received) for the following:

(a) A 10-Mbps Ethernet with a single store-and-forward switch in the path, and a packet size of 5,000 bits. Assume that each link introduces a propagation delay of 10 μs, and that the switch begins retransmitting immediately after it has finished receiving the packet.
(b) Same as (a) but with three switches.
(c) Same as (a) but assume the switch implements "cut-through" switching: it is able to begin retransmitting the packet after the first 200 bits have been received.

(10%) VI. Let A and B be two stations attempting to transmit on an Ethernet. Each has a steady queue of frames ready to send; A's frames will be numbered A_1, A_2, and so on, and B's similarly. Let T = 51.2 μs be the exponential backoff base unit.

Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of 0 × T and 1 × T, respectively, meaning A wins the race and retransmits A_1 while B waits. At the end of this transmission, B will attempt to retransmit B_1 while A will attempt to transmit A_2. These first attempts will collide, but now A backs off for either 0 × T or 1 × T, while B backs off for time equal to one of 0 × T, …, 3 × T.

(a) Give the probability that A wins this second backoff race immediately after this first collision, that is, A's first choice of backoff time k × 51.2 is less than B's.
(b) Suppose A wins this second backoff race. A transmits A_3, and when it is finished, A and B collide again as A tries to transmit A_4 and B tries once more to transmit B_1. Give the probability that A wins this third backoff race immediately after the first collision.
(c) Give a reasonable lower bound for the probability that A wins all the remaining backoff races.
(d) What then happens to the frame B_1?

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命題委員： （簽章） 97 年 3 月 3 日

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(10%)Ⅶ. The following table is a routing table using CIDR. Address bytes are in hexadecimal. The notation "/12" in C4.50.0.0/12 denotes a netmask with 12 leading 1 bits, that is, FF.F0.0.0. Note that the last three entries cover every address and thus serve in lieu of a default route. State to what next hop the following will be delivered.

Net/MaskLength	NextHop
C4.50.0.0/12	A
C4.5E.10.0/20	B
C4.60.0.0/12	C
C4.68.0.0/14	D
80.0.0.0/1	E
40.0.0.0/2	F
00.0.0.0/2	G

(a) C4.5E.13.87.
(b) C4.5E.22.09.
(c) C3.41.80.02.

(10%)Ⅷ. Assume that TCP implements an extension that allows window sizes much larger than 64 KB. Suppose that you are using this extended TCP over a 1-Gbps link with a latency of 100 ms to transfer a 10-MB file, and the TCP receive window is 1 MB. If TCP sends 1-KB packets (assuming no congestion and no lost packets):

(a) How many RTTs does it take until slow start opens the send window to 1 MB?
(b) How many RTTs does it take to send the file?
(c) If the time to send the file is given by the number of required RTTs multiplied by the link latency, what is the effective throughput for the transfer? What percentage of the link bandwidth is utilized?

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