

考試科目	微積分	系所別	資訊科學系 二年級	考試時間	7月8日(三)第二節
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無演算過程者不予計分

1. (20%) Please evaluate each of the following limits if it exists:

(a) (5%) $\lim_{n \rightarrow \infty} \frac{\tan x - \sin x}{x \cos x}$

(b) (5%) $\lim_{n \rightarrow \infty} \frac{x - x^2 \sin \frac{1}{x} - \cos x}{x}$

(c) (5%) $\lim_{n \rightarrow 0^+} x^x$

(d) (5%) $\lim_{(x,y) \rightarrow (0,0)} \frac{\sin(x^2+y^2)}{2(x^2+y^2)}$

2. (20%) Please evaluate each of the following integrals:

(a) (5%) $\int_0^{\infty} \int_x^{\infty} e^{-y} dy dx$

(b) (5%) $\int_0^{\infty} x e^{-x} dx$

(c) (5%) $\int \sec^2 x (1 + e^{\tan x}) dx$

(d) (5%) $\iint_D \tan^{-1}\left(\frac{y}{x}\right) dx dy$, where D is the region bounded by $0 \leq x^2 + y^2 \leq 2$ and $0 \leq y \leq x$.

3. (10%) If we would like to construct a metal box with a square base, which holds 125 cubic inches. Please find the dimension of the box that minimizes the amount of metal used to construct the box.

4. (10%) Please find all critical points of $f(x) = \sin x + \cos x$ on $[0, 2\pi]$.

5. (10%) At what point on the $xy = 12$ is the tangent line parallel to the line of $3x + y = 3$?

6. (15%) Please evaluate $\int_{-\infty}^{\infty} e^{-x^2} dx$. (Hint: consider evaluating $(\int_{-\infty}^{\infty} e^{-x^2} dx)^2$)

7. (15%) Please find the area under one arc of the cycloid having parametric equations: $\begin{cases} x = t - \sin t \\ y = 1 - \cos t \end{cases}$

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一、作答於試題上者，不予計分。
二、試題請隨卷繳交。

考試科目	計算機概論	系所別	資訊科學系 二年級	考試時間	2月8日(三)第4節
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1. (10%) Convert the decimal number -344 into signed 10-bit binary number in the 2's complement representation.
2. (10%) Describe the three characteristics of object oriented programming language.
3. Please describe the following terms.
 - (1) (5%) SATA
 - (2) (5%) Difference between RISC and CISC
 - (3) (5%) Control Unit
 - (4) (5%) ARP spoofing
4. (10%) Suppose we have a magnetic disk with the following parameters.
 - Controller overhead: 1 ms
 - Average seek time: 12 ms
 - #sectors per track: 32 sectors/track
 - Sector size: 512 bytes
 If we would like an average access time of 21.33 ms to read or write 8 consecutive sectors, what disk rotation is needed?
5. (1) (5%) Describe Amdahl's Law and explain the meaning of Amdahl's Law.
 (2) (10%) Suppose a program 80 seconds on a machine, which multiplication responsible for 64 seconds of the time. According to Amdahl's Law, is it possible for simply improving the speed of multiplication to have the program run at 5 times faster? Please justify your answer.
6. (15%) Please show and explain the time complexities of quick sort for the best case and the worst case.
7. Suppose we have an IP address 100.2.34.10/28.
 Answer the following questions.
 - (1) (5%) What is the network address of this IP.
 - (2) (5%) What is the broadcast address of this IP.
 - (3) (5%) What is the maximum number of hosts per subnet.
 - (4) (5%) What is the range of hosts per subnet.

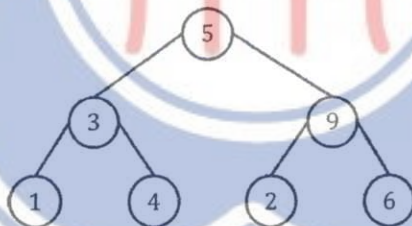
備註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。
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考試科目	資料結構	系所別	資訊科學系 三年級	考試時間	7月8日(三)第二節
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- (20%) 用 C 語言實作以下 function: `int IsMultiple2020(int n)`。
輸入為一個整數 n 。
若 n 為 2020 的倍數，則輸出 1；否則輸出 0。
- (20%) 用 C 語言實作以下 function: `int FindSecondSmallest(int arr[], int n)`。
輸入為一個整數陣列 `arr`，與陣列長度 n 。
輸出為該陣列所存資料的第二小的數。可以假設陣列中沒有重複出現的數字，且 $n > 1$ 。
範例：若輸入陣列內容為 $\{1, 2, 3, 4\}$ ，則輸出為 2。
- (20%) 用 C 語言實作以下 function: `int SUMList(struct node* head)`。
輸入為一個 linked list 的 head pointer。struct node 定義如下：

```
struct node{
    int data; //紀錄該 node 所存資料
    struct node* pNext; //紀錄下個 node 的位置
};
```

 輸出為 head 所指到的 linked list 中的資料總和。
舉例來說，假設 head 所指到的 linked list 包含三個 node，且這三個 node 的 data 欄位分別記錄 1, 2 與 3，則 SUMList 回傳 6。
- (10%) 是非題：所有排序演算法的最差狀況 (worst-case) 時間複雜度均為 $O(n^2)$ ，其中 n 為欲排序的陣列大小。請解釋你的答案。
- (10%) 考慮下圖的 binary tree。



- (5%) 請問該 tree 是否為一個 binary search tree？請解釋你的答案。
 - (5%) 請問該 tree 是否為一個 min heap？請解釋你的答案。
- (10%) 請解釋在 hash table 中，何謂 collision。collision 如何影響搜尋資料所需時間？
 - (10%) 假設 n 為 binary tree 的節點個數，請問是否存在高度為 $\Theta(\log_2 \log_2 n)$ 的 binary tree？請解釋你的答案。

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- 作答於試題上者，不予計分。
- 試題請隨卷繳交。

考試科目	離散數學	系所別	資訊科學系 三年級	考試時間	7 月 8 日(三) 第 4 節
<p>1. (10%) Please find all the solutions to the system of congruences.</p> $x \equiv 2 \pmod{5}$ $x \equiv 3 \pmod{7}$ $x \equiv 4 \pmod{11}$ <p>2. (10%) Let n be the product of two unknown primes p and q. Please show that we can find p and q if we know the value of $(p-1)(q-1)$.</p> <p>3. (10%) For $A = \{1,2,3,4\}$, and $B = \{u, v, w, x, y, z\}$, please determine the number of one-to-one function $f: A \rightarrow B$ when $f(1) \neq u$; $f(2) \neq v$; $f(3) \neq w$; and $f(4) \neq x$.</p> <p>4. (10%) Given $(x+y)^n = \sum_{k=0}^n \binom{n}{k} x^k y^{n-k}$, where $x, y \in \mathbb{Z}$ and n is a prime, please prove that $(x+y)^n \equiv x^n + y^n \pmod{n}$.</p> <p>5. (10%) Please use mathematics induction to prove that $1^3 + 2^3 + \dots + n^3 = (1+2+\dots+n)^2$.</p> <p>6. (10%) Alice, a coffee lover, visits a coffee shop each day and orders on a cup of either Espresso, Cappuccino, Latte. In how many ways can she order one cup of coffee each day so that she enjoys each of the 3 types of coffee at least once during a (7-day) week.</p> <p>7. Please solve the following recurrence relations :</p> <p>(a) (10%) $a_n - 10a_{n-1} + 25a_{n-2} = 0, n \geq 2, a_0 = 1, a_1 = 0$</p> <p>(b) (10%) $3a_n + 5a_{n-1} + 2a_{n-2} = 10n + 11, n \geq 2, a_0 = 10, a_1 = \frac{-10}{3}$</p> <p>8. Please determine the following statements are true or not.</p> <p>(a) (5%) $\forall x [P(x) \wedge Q(x)] \leftrightarrow \forall x P(x) \wedge \forall x Q(x)$</p> <p>(b) (5%) $\forall x [P(x) \vee Q(x)] \leftrightarrow \forall x P(x) \vee \forall x Q(x)$</p> <p>(c) (5%) $\exists x [P(x) \wedge Q(x)] \leftrightarrow \exists x P(x) \wedge \exists x Q(x)$</p> <p>(d) (5%) $\exists x [P(x) \vee Q(x)] \leftrightarrow \exists x P(x) \vee \exists x Q(x)$</p>					
備註	<p>一、作答於試題上者，不予計分。</p> <p>二、試題請隨卷繳交。</p>				