注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 108 學年度碩士班考試入學試題

系所班組別：**資訊系統與應用研究所**

考試科目(代碼)：**計算機概論(2401)**

－作答注意事項－

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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1. (10%) Suppose a machine stores numbers in two's complement notation.
   (a) (5%) What are the largest and the smallest numbers that can be stored if the machine uses bit patterns of length seven?
   (b) (5%) In the following problem, each bit pattern represents a value stored in two's complement notation. Find the answer and convert it back to base ten notation.

$$\begin{array}{r} 1110010 \\ +\ 0010000 \\ \hline \end{array}$$

2. (10%) When given the error-correcting code with bit patterns of length five as shown below:

Symbol	Code
A	00000
B	00111
C	11110
D	11001

   (a) (5%) Up to how many errors per pattern can we detect? Up to how many errors per pattern can we correct?
   (b) (5%) Use the code to decode the following message:
   10000 01110 00110 11011

3. (10%)
   (a) (5%) A right circular shift of 2 bits on a string of 8 bits is equivalent to a left circular shift of how many bits?
   (b) (5%) What is the result of performing a 2-bit right circular shift on the bit pattern CF (represented in hexadecimal notation)? Give your answer in hexadecimal form.

4. (10%) Kernel is the most important component in an operating system.
   (a) (6%) Name four major software components in an OS kernel, and briefly explain their functions.
   (b) (4%) Give two examples that kernel needs to take control from user programs. In modern computer systems, what kind of mechanism is used to force user programs returning the control to the kernel?

5. (10%) Layer approach is commonly used in computer network software
   (a) (6%) Name four layers of Internet software, and briefly explain their functions.
   (b) (4%) Protocols in different layers may perform similar tasks. For example, both CSMA/CD and TCP have the resend function. Explain their differences in terms of (1) why do they need to resend messages? And (2) how do they detect the situations to resend messages?

6. (10%) For a binary tree,
   (a) (6%) Describe the methods to store and traverse a binary tree using (1) array, and (2) structure with pointers.
   (b) (4%) If a binary tree has L levels (the root is at level 1 and so on) and N nodes, the data in each tree node takes A bytes to store, and a pointer takes B bytes to store. Provide an analysis on under which circumstances that storing a binary tree in an array uses less memory than storing it in a structure with pointers.

7. (10%) $f(n) = \Theta(g(n))$ if and only if there exist positive constants c_1, c_2, and n_0 such that $c_1 g(n) \leq f(n) \leq c_2 g(n)$ for all $n \geq n_0$. Prove or disprove the following statements are correct. (To get the score, you need to prove your answer. No score if you only answer true or false).
   (a) (5%) $5n^2 - 6n = \Theta(n^2)$.
   (b) (5%) $n^2 \log n = \Theta(n^2)$.

8. (10%) Please modify the following program segment to calculate the factorial of a positive number N without using recursion.

```
int fact (int N){
  if (N==1)
  return 1;
  return N*fact(N-1);
}
```

9. (10%) Please rewrite the following program segment using a while loop instead of a for loop.

```
for (i = 0; i<100; i++) {
  if (i % 2 == 0){
    print (i)
  }
}
```

10. (10%) Please design a Turing machine for decrementing a value (integer) greater than zero.