# 元智大學 103 學年度研究所 **碩士班** 招生試題卷

系(所)別：生物與醫學資訊碩士學位學程　組別：不分組　科目：計算機概論　用紙第 1 頁共 2 頁

●不可使用電子計算機

一、單選題 (每題有五個選項，正確選項只有一個) (16%，每題 4 分)

1. Which of the following is true?
(a) For a combinational circuit, an input pattern could generate two different output values.
(b) For a sequential circuit, its output values depend only on the input values.
(c) A Boolean function could have more than one sum-of-minterm form.
(d) Two sequential circuits that have different numbers of storage elements could be functionally equivalent.
(e) None of above.

2. Which of the following is NOT the reason that slows down the frequency scaling of uniprocessor in the last decade?
(a) Decreases in voltage cannot reduce dynamic power consumption anymore.
(b) Gap between on-chip processing throughput and off-chip memory bandwidth grows.
(c) Increases in clock frequency require prohibitively expensive cooling requirements.
(d) Performance acceleration using instruction level parallelism has stalled.
(e) None of above.

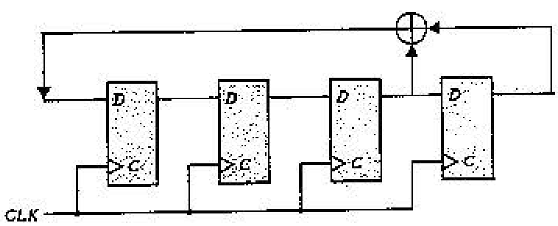
3. Consider two machines M1 and M2, and a benchmark program G. M1 has a clock rate of 5MHz and M2 has a clock rate of 25MHz. Assume that M2 is 12 times faster than M1 in terms of CPU time for executing G, and the performance of M1 and M2 in terms of MIPS are 1 and 18, respectively. Which of the following is true?
(a) The CPI of M1 is 1.4.
(b) The CPI of M2 is 1.5.
(c) Improving the clock rate of M1 to be 10MHz can reduce the half of the instruction count of M1.
(d) Improving the clock rate of M2 to be 50MHz does not affect the CPI of M1.
(e) The ratio of the instruction count of M1 with respect to M2 for G is 1.5.

4. Which of the following is NOT a form of parallel computing?
(a) Multiprocessor computing.
(b) Cloud computing.
(c) Instruction pipelining.
(d) Carry bit computing in carry look-ahead adders.
(e) None of above.

二、(4%) In the MIPS 5-stage pipeline, forwarding is an effective technique for solving data hazards. However, not all data hazards can be solved by forwarding. (2%) Show one example of data hazard that forwarding cannot solve, and (2%) show how to solve it.

三、(6%) Consider a computer with 32-bit addressing, a 256KB cache and the block size is 16-byte wide. How many bits are there in the tag entry? (3%) Assume that it is a fully associative cache. (3%) Assume that it is a 4-way set associative cache.

四、(5%) A linear-feedback shift register (LFSR) is a shift register that is usually used to generate random values in hardware design. A simple LFSR is composed of a shift-right register and some XOR gates (⊕). For example, the following LFSR is a 4-bit shift-right register whose input bit is driven by the XOR of the rightmost two bits of the shift register.




(a) (2%) If the initial value in the Flip-Flops of the LFSR is 1111 (from the left to right), what is the value of the LFSR after 5 cycles?
(b) (3%) How many cycles later the value of LFSR becomes 1111 again?

五、(4%) What is the effect of cache block size on system performance?

六、(4%) Compare the virtual machine mechanisms of Java virtual machine with that of .NET virtual machine.

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七、(6%) Explain the Shortest-Job-First CPU scheduling algorithm and discuss its advantages and disadvantages.

八、(6%) Explain the Optimal Page Replacement algorithm for memory management and discuss its advantages and disadvantages.

九、(5%) What is the output of the C++ program in Figure 1?

十、(5%) What is the output of the C++ program in Figure 2?

```
#include <iostream>
using namespace std;
int main()
{     int a[5][2]={1, 2, 2, 2, 1, 2, 2, 2, 1, 2};
      int b[2][3]={2, 1, 2, 1, 2, 1};
      int c[5][3]={0, 1, 2, 0, 1, 2, 1, 2, 1, 2, 1, 2, 1, 2, 0};
      for (int i=0; i < 5; i++) {
          for (int j=0; j < 3; j++) {
              for (int k=0; k < 2; k++)
                  c[i][j] += a[i][k]*b[k][j];
              cout << c[i][j]; }
          cout << endl; }
      return 0;
}
```

Figure 1

```
#include <iostream>
using namespace std;
int main()
{     int a[5]={ 1, 2, 3, 1, 2};
      int *b=&a[0];
      int *c=&a[4];
      for (int i=0; i < 5; i++, b++, c--)
      if (*c >= *b)
         *b=*b+*c;
      for (int j=0; j < 5; j++)
          cout << a[j];
      cout << endl;
      return 0;
}
```

Figure 2

十一、(4%) What is the output of the C++ program in Figure 3?

```
#include <iostream>
using namespace std;
int main()
{for (int i=0; i < 4; i++){
        for (int j=0; j < 5; j++){
            if (i%2 == j%2)
                cout << j; }
        cout << endl;}
        return 0;
}
```

Figure 3

十二、(10%) Prove the existence of a randomized polynomial-time algorithm that, given any simple undirected graph $G = (V, E)$, outputs a set $S \subseteq V$ satisfying

$$\mathbb{E}[|\{e \in E \mid e \text{ has exactly one endpoint in } S\}|] \geq \frac{|E|}{2}, \qquad (1)$$

where the expectation is taken over the random coin tosses of the algorithm. (Remark: Do not confuse the leftmost $\mathbb{E}$ in inequality (1) with the edge set $E$ of $G$. The left-hand side of inequality (1) is the expected number of edges in $E$ with exactly one endpoint in $S$.)

十三、(15%) Write down the depth-first search (DFS) in pseudo-code form, assuming for simplicity that its input is an adjacency list representation of a simple undirected connected graph $G = (V, E)$. Then prove that DFS runs in $O(|V| + |E|)$ time.

十四、(10%) Recall the following asymptotic notations for all functions $f: \mathbb{N} \to \mathbb{N}$ and $g: \mathbb{N} \to \mathbb{N}$, where $\mathbb{N}$ denotes the set of all natural numbers:

- The notation "$f(n) = O(g(n))$" stands for
  $$\exists C > 0\ \exists n_0 > 0\ \forall n \geq n_0\ (f(n) \leq C \cdot g(n));$$
- The notation "$f(n) = \omega(g(n))$" stands for
  $$\forall C > 0\ \exists n_0 > 0\ \forall n \geq n_0\ (f(n) \geq C \cdot g(n)).$$

Please do one of the following:

- Construct a function $h: \mathbb{N} \to \mathbb{N}$ such that both $h(n) = O(n^2)$ and $h(n) = \omega(n^2)$ are false;
- Prove that every function $h: \mathbb{N} \to \mathbb{N}$ must satisfy at least one of $h(n) = O(n^2)$ and $h(n) = \omega(n^2)$.