1091CI01

國立臺北科技大學 109 學年度碩士班招生考試

系所組別：2300 資訊工程系碩士班

第一節　計算機概論　試題

第 1 頁　共 3 頁

注意事項：
1. 本試題共十二大題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Please answer the following questions shortly and concisely. It is assumed that $T(1) = d$ for some constant d. (15 pts)
   (1) The symbols ~ and → denote the negation and implication respectively. Please indicate whether the following statement formula is **tautology** or not. (3 pts)
   $$\sim p \rightarrow (p \rightarrow q)$$
   (2) A bakery provides 10 types of donuts. Ms. Chiu wants to buy 4 donuts. In how many different ways can she do this? (3 pts)
   (3) Please write the following prefix expression in infix form: (3 pts)
   $$+ / + \times a\ b \times c\ c + d\ e\ f$$
   (4) State, using the "big oh" notation, the solution to $T(n) = 8T\left(\frac{n}{2}\right) + n^3$. (3 pts)
   (5) State, using the "big oh" notation, the solution to
   $$T(n) = 14T(\tfrac{n}{2}) + 18n^3\sqrt{n}.\ (3\ \text{pts})$$

2. **True or False**. Just state the answer - you do **NOT** need to justify them. (9 pts)
   (1) Let T be a **minimum spanning tree** (MST) of graph G. Given a connected subgraph H of G, $T \cap H$ is contained in some MST of H. (3 pts)
   (2) Are there graphs for which Prim's algorithm is faster than Kruskal's algorithm? (3 pts)
   (3) Dijkstra's algorithm for shortest path problem allows the edges having negative weight in the input graph? (3 pts)

3. Please consider the following questions and answer them concisely. (6 pts)
   (1) Solve the *continuous-knapsack problem* for the following weights (w), profits (p), and knapsack capacity (M). Please show your work step by step. (3 pts)
   $$w_1 = 25, w_2 = 15, w_3 = 20, w_4 = 10, w_5 = 24;$$
   $$p_1 = 10, p_2 = 3, p_3 = 5, p_4 = 8, p_5 = 8;$$
   $$M = 75.$$
   (2) Consider two tennis players, A and B, playing a series of games until one of them win n games. Assume that the probability of player A winning a game is the same for each game and equals to p, and let the probability of player A losing a game is $q = 1-p$. (Hence, there are no ties.) Let $P(i, j)$ be the probability of player A winning the series if player A needs i more games to win the series and player B needs j more games to win the series. Set up a recurrence relation for $P(i, j)$ that can be used by a dynamic programming algorithm to find the probability of player A winning a seven-game series. (3 pts)

4. Given a set S of characters (A, B, C, D, E, F, G, H, I) with relative frequencies (10, 5, 23, 18, 7, 12, 15, 4, 6). The **weighted path length** (WPL) is defined as $\Sigma\ (f_i \times p_i)$ where f_i is the frequency of character i and p_i is the length of the path in a code tree from the root to character i. Let T be an optimal Huffman code tree for S. Please answer the following questions shortly. (5 pts)
   (1) Is T unique? (2 pts)
   (2) Do both characters B and H have the same path length from the root in T? (3 pts)

5. For the following questions regarding *process management*, please indicate whether each statement is true or false. If a statement is incorrect, please explain the reasons. (not just correcting the errors) (4 pts)
   (1) Shortest-job-first scheduling algorithm is optimal, which can be exactly implemented in real operating systems. (2 pts)
   (2) To solve the problem of starvation, the idea of aging can be implemented by moving processes between queues with different priorities, according to how much CPU time each process used. (2 pts)

6. Answer the following questions regarding *memory and file management*: (8 pts)
   (1) Please explain the ideas of two memory allocation schemes: *segmentation* and *paging*. What are their major differences? (3 pts)
   (2) What is the idea of *demand paging*? How can we implement demand paging? (2 pts)
   (3) For the three major file allocation methods: *contiguous allocation*, *linked allocation* and *indexed allocation*, compare their differences. (3 pts)

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7. Among the following statements about *processes* and *threads*, please indicate whether each statement is true or false. If a statement is incorrect, please explain the reasons. (not just correcting the errors) (4 pts)
   (1) To ensure proper execution of the OS, we usually distinguish between *user mode* and *kernel mode*. When a user process requests a srevice from the OS via system calls, the system must transition from user to kernel mode to complete the request. (2 pts)
   (2) A Multithreaded program using multiple *user-level* threads can achieve better performance on a multiprocessor system than on a single-processor system. (2 pts)

8. Regarding the following questions about *information security*, please indicate whether each statement is true or false. In the case of false statement, you must explain the reason why it's not correct. (not just correcting the errors) (6 pts)
   (1) To ensure the security of cryptosystems, it should be computationally easy to encrypt a message, and computationally infeasible to decrypt a message. (2 pts)
   (2) Symmetric encryption is no longer used, because public-key encryption is more secure. (2 pts)
   (3) Since SHA-512 has the same structure as SHA-1, which has been proven insecure, we should also stop using SHA-512. (2 pts)

9. What is the idea of *integrity* in information security? Please describe an example algorithm that can be used to provide this security service. (3 pts)

10. Answer the following questions: (20 pts)
    (1) What is the length of the IPv4 internet address (in bits)? (1 pt)
    (2) Compare the capability/service provided by **UDP** and **TCP** transport protocols in the following aspects (Your answer should be V (Yes) or X (No)): (a) reliable data transfer; (b) flow and congestion control; (c) bandwidth guarantee; (d) delay guarantee. (4 pts)
    (3) Compare the main features between **circuit switching** (CS) and **packet switching** (PS) strategies in the following aspects (Your answer should be V (Yes) or X (No)): (a) connection setup/tear down; (b) bandwidth reservation; (c) dynamic routing path selection; (d) possible queueing delay inside the switching node. (4 pts)
    (4) Describe and compare the following three channel partitioning mechanisms of the MAC protocol in computer networks: FDMA, TDMA, and CDMA. (3 pts)
    (5) **Explain why** the CSMA scheme, a MAC mechanism in the LAN, becomes less effective if the network range of a broadcast LAN becomes larger. (2 pts)
    (6) Describe briefly the main function of DHCP (Dynamic Host Configuration Protocol). (2 pts)
    (7) Identify **two** major different features between the following two error control strategies used in computer networks: go-back-N (GBN) and selective-repeat (SR). (4 pts)

11. Given the following MIPS assembly code segment of a *while loop* in **Figure 1**. Assume that there are two C integer arrays **A** and **B** are stored in the saved registers **$s4** and **$s5**, respectively, and the C integer variables **g, h, i, j** are assigned to the saved registers **$s0, $s1, $s2, $s3**, respectively. Assume that the elements of the arrays A and B are 4-byte words (int array). What is the **equivalent C code** of the above MIPS assembly code? (8 pts)

MIPS Code	**Loop:** **sll $t0, $s2, 2** **add $t0, $s4, $t0** **lw $t0, 0($t0)** **slt $t0, $t0, $s0** **beq $t0, $zero, LEAVE** **add $t0, $s0, $s1** **addi $t1, $s3, 1** **sll $t1, $t1, 2** **sw $t0, 0($t1)** **j LOOP:** **Leave:**

Figure 1. MIPS assembly code segment

12. In the following problems, we assume that the following MIPS code is executed on a pipelined processor with a <u>5-stage pipeline (IF, ID, EX, MEM, WB), a predict-not-taken branch predictor with a branch target buffer, and there are no delay slots</u>: (12 pts)

i1		**lw $2,12($1)**
i2		**add $2, $2, $1**
i3	**label1:**	**beq $1, $2, label2** ***# not-taken once, then taken***
i4		**sw $2,0($1)**
i5		**sub $2, $3, $1**
i6		**beq $2, $3, label1** ***# taken***
i7	**label2:**	**lw $2, 0($3)**

   (1) Assume that we currently have **no forwarding units**, and **branches are computed in EX stage and decided in the <u>MEM stage</u> (as Figure 2 depicts)**, please <u>identify all possible data hazards</u> in the above code segment in terms of the <u>instruction *in* and registers *rm*</u>. **In this problem, you need not to consider the branch results of the codes**. (4 pts)

(2) Assuming that we have **data hazard detection and forwarding units** (as shown in **Figure 3**) to perform full forwarding (i.e. forward all results that can be forwarded), and **assuming that branches are still computed in EX stage and decided in <u>MEM stage</u> (as Figure 2 depicts). <u>How many cycles will it take to complete the above MIPS codes</u>**, and **<u>how many cycles are we still need stalling (nops) due to data hazards and control hazards</u>**? (4 pts)

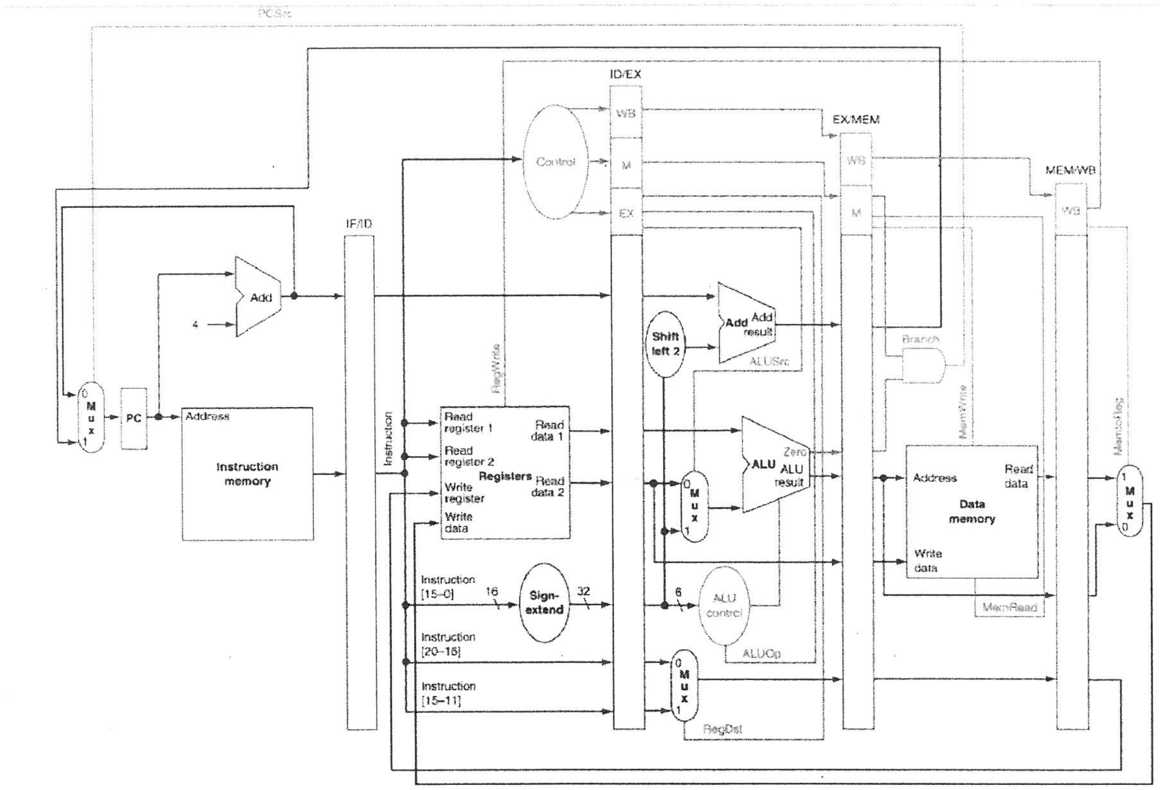

Figure 2. MIPS Pipelined datapath and control signals

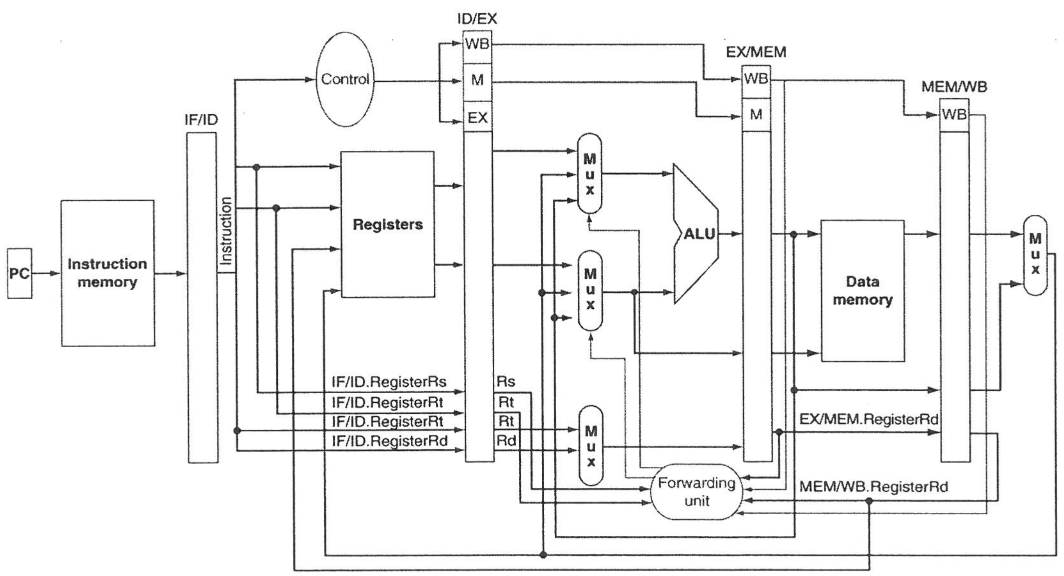

Figure 3. The data hazard detection and forwarding unit

(3) **Now assume that we optimize the datapath for branch by moving branch execution into the ID stage (as depicted in Figure 4), and** we also make additions to the **forwarding and hazard detection units** to **forward** to or **stall** the branch at the **ID stage** in case the branch decision depends on an earlier result. **<u>How many cycles will it take to complete the MIPS codes</u>**, and **<u>how many cycles are we still need stalling (nops) due to data hazards and control hazards</u>**? (4 pts)

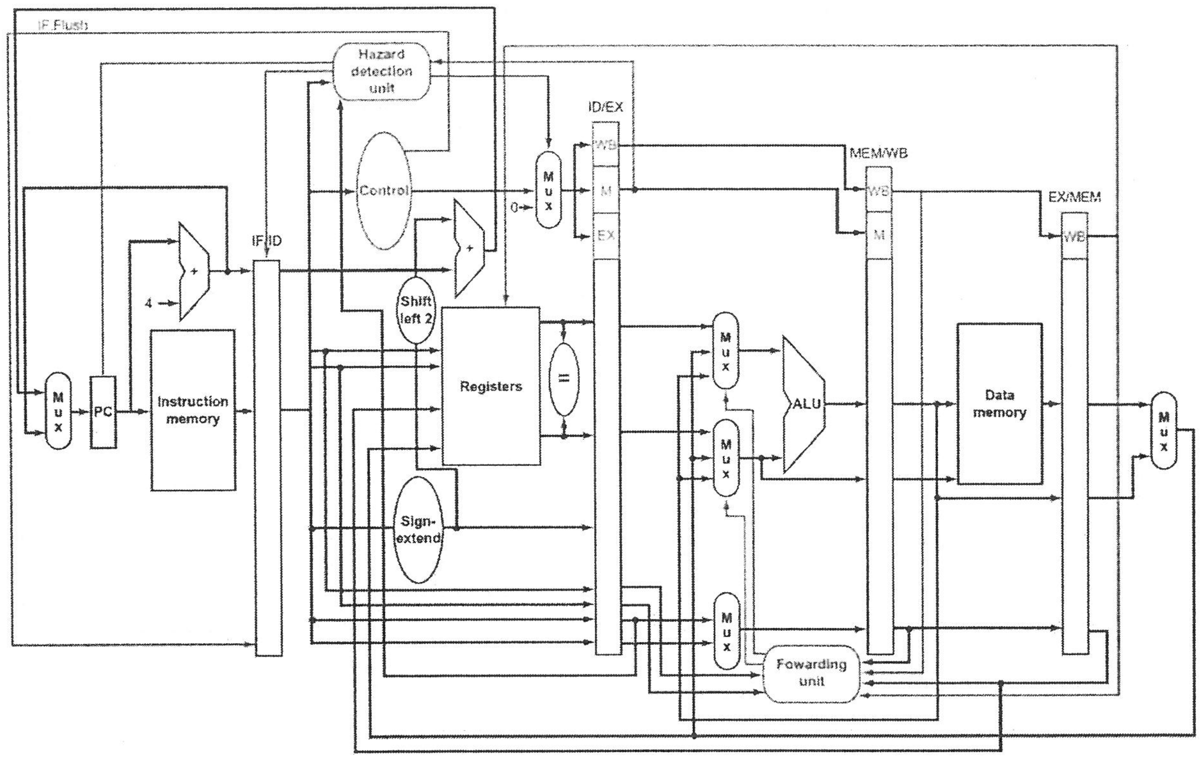

Figure 4. The optimized branch and data hazard detection and forwarding unit for determining the branch at ID stage.