111C101

國立臺北科技大學 111 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

注意事項：

1.本試題共十題，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. (20 pts) Answer the following questions regarding computer networks concisely:
   (1) What is the length of the IPv4 internet address (in bits) ? (1 pt)
   (2) Is Internet routing protocol capable of providing delay guaranteed service? Explain the reason. (2 pts)
   (3) Is Internet routing protocol capable of providing bandwidth guaranteed service? Explain the reason. (2 pts)
   (4) What is the meaning of offered load? What is the meaning of throughput? (4 pts)
   (5) What is the main service can the DHCP (dynamic host configuration protocol) server provide? (2 pts)
   (6) Identify the main function provided by DNS (Domain Name System) protocol. (2 pts)
   (7) Two hosts, Hosts A and B, are connected by a single link of rate R bps. Suppose that the two hosts are separated by d meters, and suppose the propagation speed along the link is p meters/sec. Host A is to send a packet of size L bits to Host B. Then, (a) express the propagation delay of the link. (2pts) (b) determine the transmission time of the packet. (2pts)
   (8) Assume that a company has a IP network with network ID prefix: 140.124.3.0/24. The network administrator of this company wants to further divide such a network into 4 subnets with 60 hosts for each subnet. Then, (a) what are the subnet addresses for those 4 subnets? (2pts) (b) what is the subnet mask for those 4 subnets? (1pt)

2. (10 pts) For each one of the following questions, please select the right answer (a), (b), (c), or (d).
   (1) For the following statements about red-black trees, please justify the **CORRECT** statements. (2 pts)
      i. A subtree of a red-black tree is itself a red-black tree.
      ii. The sibling of an external node is either external or it is red.
      iii. There is a unique (2, 4) tree associated with a given red-black tree.
      iv. There is a unique red-black tree associated with a given (2, 4) tree.
   (a) i, ii　(b) ii, iii　(c) i, iv　(d) iii, iv

   (2) Let A and B be two problems. Suppose that we were able to establish the following fact:
   "If we could solve A in time $O(T(n))$, we could solve B in time $O(n \log n + T(n))$."
   Which one of the following statements is **TRUE**? (2 pts)
   (a) If A has an $\Omega(n \log n)$ time lower bound then B does too.
   (b) If B has an $\Omega(n \log n)$ time lower bound then A does too.
   (c) If A has an $\Omega(n^2)$ time lower bound then B does too.
   (d) If B has an $\Omega(n^2)$ time lower bound then A does too.

   (3) Given a set S of characters {A, B, C, D, E, F, G} with relative frequencies (13, 7, 27, 18, 8, 22, 5). Let T be an optimal Huffman code tree for S. What is the depth of tree T? (Note that the root is at depth 0) (2 pts)
   (a) 4　(b) 5　(c) 6　(d) 7

   (4) As the above problem (3), what is the length of the Huffman code for character E? (2 pts)
   (a) 5　(b) 4　(c) 3　(d) 2

   (5) A bipartite graph $G = (V, E)$ is an undirected graph whose vertices can be partitioned into two disjoint sets V_1 and $V_2 = V - V_1$ with the property that no two vertices in V_1 are adjacent in G and no two vertices in V_2 are adjacent in G. Which one of the following statements is **FALSE**? (2 pts)
   (a) A tree is a bipartite graph.
   (b) All bipartite graphs are 2-colorable.
   (c) A bipartite graph can contain an odd-length cycle.
   (d) Given a graph Q of size n, one can determine whether Q is bipartite by using BFS in $O(n)$ time.

注意：背面尚有試題

3. (10 pts) Mark by T(=true) or F(=False) each of the following statements. You don't need to prove it.
   (1) $3n^3 + 7n^2 = \Omega(n^2)$ (2 pts)
   (2) $n^3 / \log^2 n = \Theta(n^3)$ (2 pts)
   (3) $f(n) = O((f(n))^2)$ (2 pts)
   (4) When deleting a key from an AVL tree, at most one restructuring operation can restore the height balance property of the binary tree. (2 pts)
   (5) The operation insert() on a priority queue realized by a sorted list takes linear time. (2 pts)

4. (15 pts) Please answer the following questions concisely. You do not need to provide the details.
   (1) Find the asymptotic upper bound (using Big-O notation) for $T(n) = 3T(n - 1) + 2$ with $T(0) = 1$. (3 pts)
   (2) Let B be a binomial tree of size 29. Please draw the shape of this binomial tree.(3 pts)
   (3) Please write the following infix expression in postfix form: (3 pts)
   $((2 \times (4 - 1)) - (3 + 1)) + ((6/3) \times (2 + 4))$.
   (4) Suppose that we have a complete binary tree represented by the following array, where each cell of the array contains a key value. Please draw this complete binary tree. (3 pts)

Index	1	2	3	4	5	6	7	8	9	10
Key	3	12	44	30	20	25	55	87	16	27

   (5) A k-ary tree is a tree of which each node has at most k children. What is the maximum number of nodes in a k-ary tree of height h? (3 pts)

5. (6 pts) 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)
   (1) Shortest job first (SJF) scheduling algorithm will not result in starvation. (2 pts)
   (2) The major performance gain from adding additional CPU cores to an application is mostly determined by the number of cores. (2 pts)
   (3) A multithreaded program using multiple *user-level* threads can achieve better performance on a multiprocessor system than on a single-processor system. (2 pts)

6. (4 pts) What are the ideas of *linked* and *indexed* file allocation methods? Please compare their differences, and give at least one example in real file systems.

7. (4 pts) Among the following statements about *memory management*, please indicate whether each statement is true or false. If a statement is incorrect, please explain the reasons. (not just correcting the errors)
   (1) Pure paging has the problem of external fragmentation, while pure segmentation has the problem of internal fragmentation. (2 pts)
   (2) With demand paging, it's possible to run more programs that are larger than the physical memory. (2 pts)

8. (6 pts) 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)
   (1) To make cryptosystems safe, the implementation details of encryption and decryption algorithms should not be made public. (2 pts)
   (2) As a digital signature, the message signed by the sender's private key can be authenticated both in terms of source and data integrity. (2 pts)
   (3) Using public-key cryptography, it's easy to encrypt a message, and computationally infeasible to decrypt a message. (2 pts)

9. (5 pts) Given the three major goals of computer security: *Confidentiality*, *Integrity*, and *Availability*, please explain their meanings in detail, respectively.

10. (20 pts) The following problems are intended to investigate your understanding of the relationship between data hazards, control hazards, branch execution in a pipelined processor with a five-stage pipeline (**Figure 1**):
   [1] **IF**-Instruction fetch
   [2] **ID**-Instruction decode and register fetch
   [3] **EX**-Execution or calculate effective address
   [4] **MEM**-Access data memory
   [5] **WB**-Write back to registers

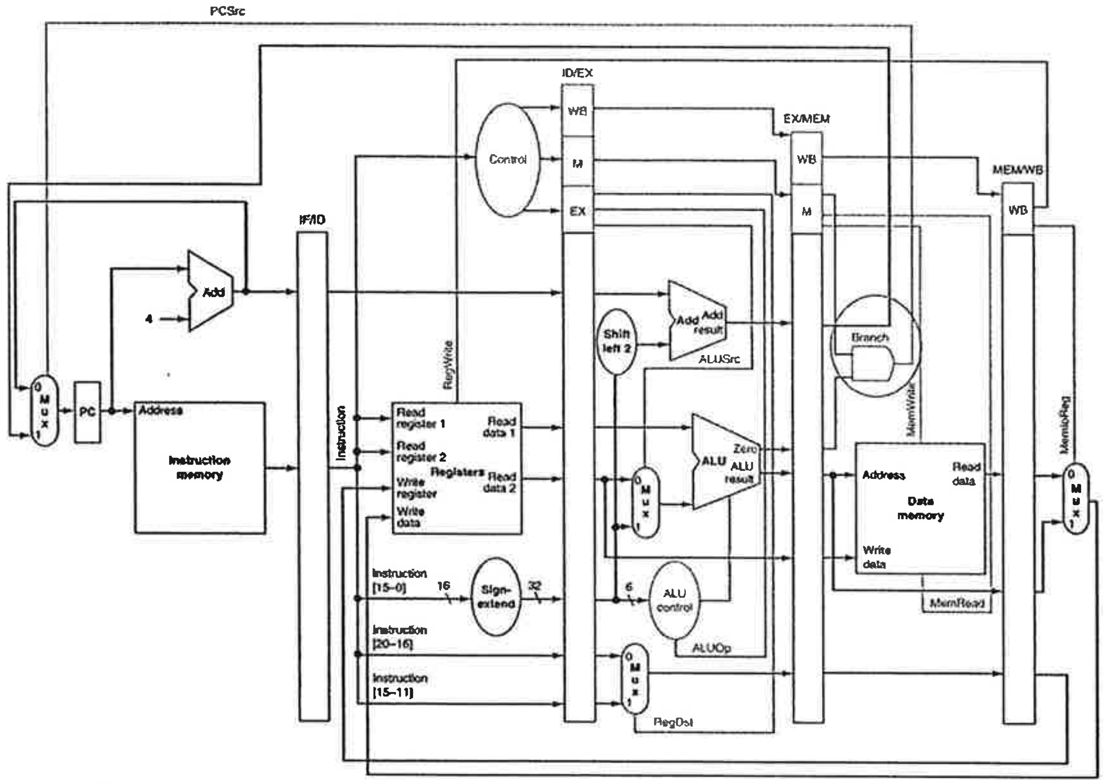

Figure 1. Typical pipelined datapath and control signals of a MIPS processor

In the following problems, we assume that the following MIPS code segment (a loop) is executed on a pipelined processor with a **5-stage pipeline, an always-predict-taken branch predictor with a branch target buffer, and there are no delay slots**:

MIPS code segment		
i1	**LOOP:**	**slt $t0, $zero, $s0**
i2		**beq $t0, $zero, EXIT**
i3		**sub $s0, $s0, $s1**
i4		**beq $zero, $zero, LOOP**
i5	**EXIT:**	

Assume that the register **$s0** is initialized to the value **10** and utilized as the loop index, and **$s1** is set as a constant value **1** for decreasing the loop index **$s0**; and *i4:* ***beq $zero, $zero, LOOP*** instruction behaves equal to an **always-taken jump instruction**.

(1) How is the total number of executed instructions for completing the above MIPS code segment? (2 pts)

(2) For the loop given above, please write the **equivalent C code**. Assume that the registers **$s0** and **$s1** are integer valuables *i*, *j*, respectively. (3 pts)

(3) Assuming that we have **full data hazard detection and forwarding units** (as shown in **Figure 2**) to perform full forwarding (i.e. forward all results that can be forwarded), and **assuming that branches are decided in MEM stage (as Figure 1 depicts). How many stalling (nops) cycles are we need due to data hazards and control hazards, and how is the total cycles will it take to complete the above MIPS code segment**? (5 pts)

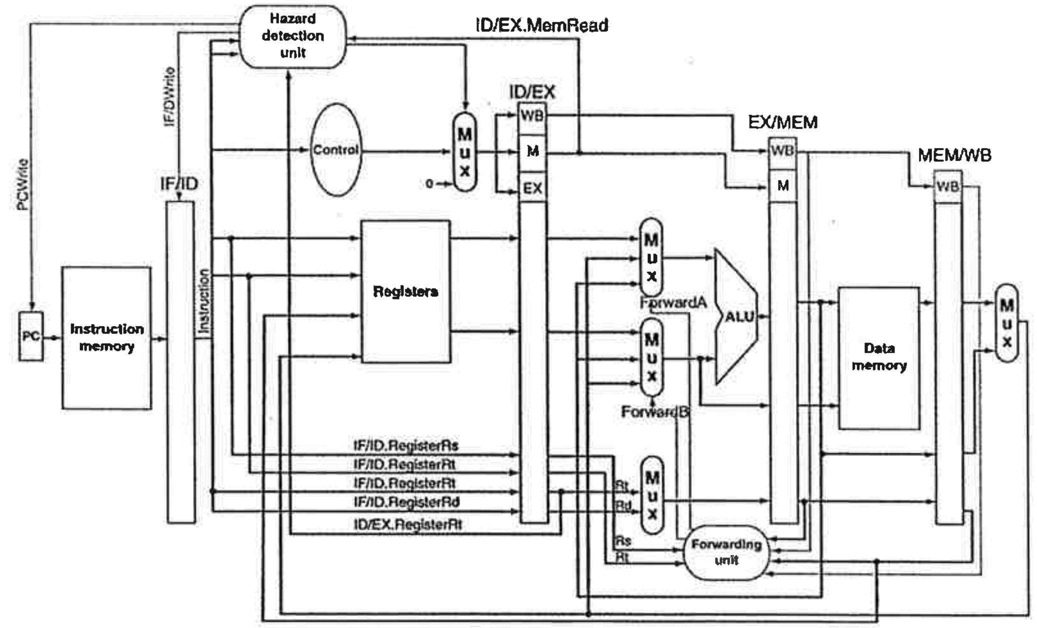

Figure 2. The data hazard detection and forwarding unit

(4) **Now assume that we optimize the datapath for branch by moving branch execution into the ID stage as depicted in Figure 3, 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 (i.e. possible data hazards in ID stage). **How many stalling (nops) cycles are we still need due to data hazards and control hazards, and how is the total cycles will it take to complete the above MIPS code segment**? (5 pts)

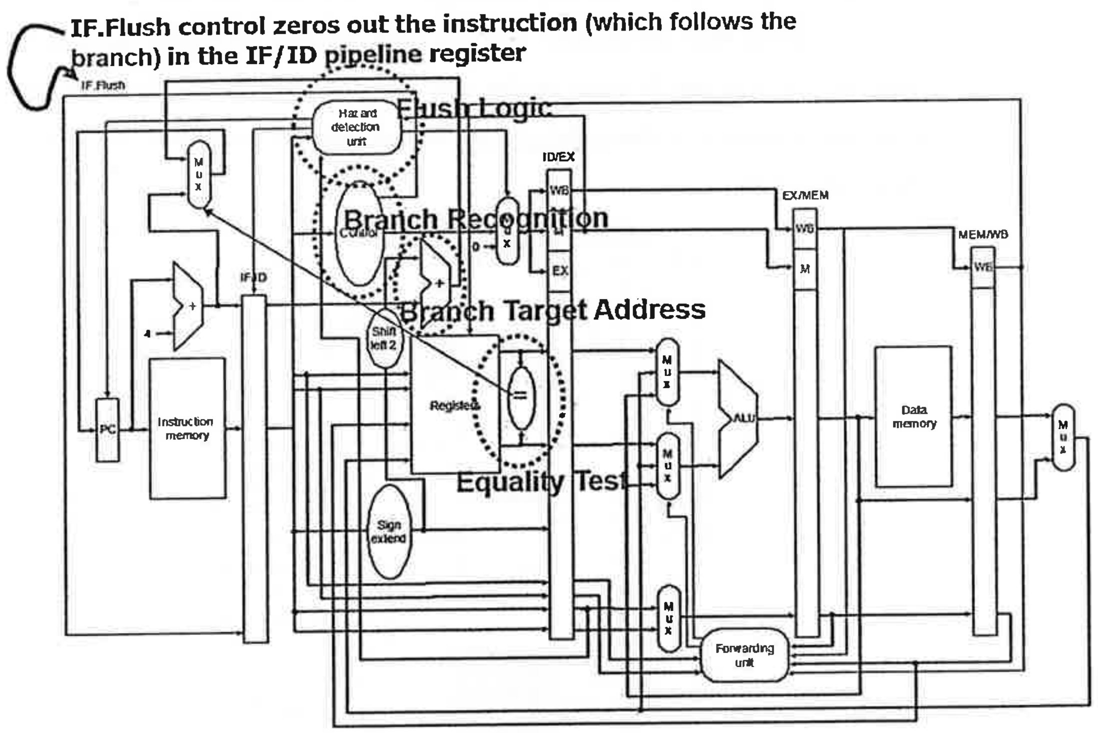

Figure 3. The optimized branch and data hazard detection and forwarding unit for determining the branch at ID stage.

(5) Following the previous problem that the branch is determined in **ID stage** with a full hazard detection and forwarding units, now a **two-bit predictor** is adopted for this MIPS code sequence of branch outcomes, and assuming that the predictor starts off in the **top-right state** from **Figure 4** (being started at **weak predict-taken**). **How many stalling (nops) cycles are we still need due to data hazards and control hazards, and how is the total cycles will it take to complete the above MIPS code segment**? (5 pts)

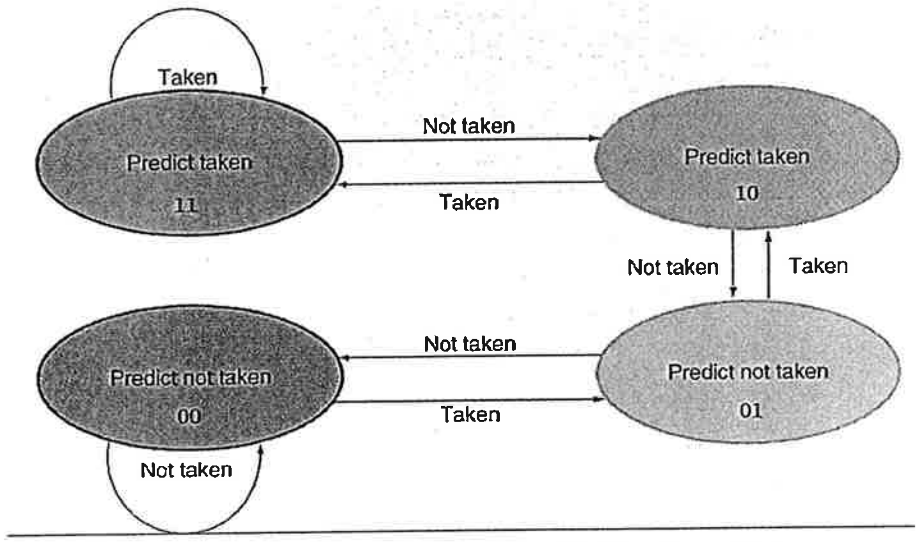

Figure 4. The state diagram of the two-bit branch predictor