國立臺北科技大學 110 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.本試題共十一題，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。

一、 Please answer the following questions concisely. (20 pts)

(1) What is the length of the Ethernet MAC address (in bits)? (1 pt)

(2) What protocol is used for the mapping between the user specified hostname (such as www.ntut.edu.tw) and IP address? (2 pts)

(3) List **three** main services/functions that TCP transport protocol can provide while UDP transport protocol is not able to provide. (3 pts)

(4) Assume the length of an application message is 160 bytes. Each message is encapsulated in a TCP segment and then in an IP datagram. What percentage of each IP datagram will be the application message? (2 pts)

(5) A coffee shop is equipped with a Wi-Fi wireless router that provides free internet service to all customers. Assume that this router connects to the ISP (Internet Service Provider) with a single assigned IPv4 address of 140.124.180.060. List the **two** major network protocols or functions that this router has to provide such that the mobile devices of customers in this shop can obtain their temporary IPv4 addresses and enjoy surfing the internet simultaneously. (4 pts)

(6) Two hosts, Hosts A and Host B, are connected by a single communication link of rate R bps. Assume that these two hosts are separated by d meters, and the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B. Then, what is the **end-to end delay of the packet** sent from Host A to Host B, starting from the time that Host A sends the first bit until Host B receives the last bit of the packet? (3 pts)

(7) Describe the main purpose of employing MAC mechanism in the local area network (LAN) environment. (3 pts)

(8) Explain why IEEE 802.11 CSMA/CA protocol instead of IEEE 802.3 CSMA/CD protocol is used in the wireless local area networks. (2 pts)

二、 Please answer the following questions. Just give the answers and you do not need to explain. (15 pts)

(1) Which one is false? (3 pts)

    a. Every infinite subset of a countably infinite set is countable infinite.

    b. The set $\{p \mid p$ is a prime number$\}$ is a countably infinite set.

    c. The set $\{i+i^2+i^3 \mid i \in N\}$ is a countably infinite set.

    d. No infinite set can be put into one-to-one correspondence with at least one of its proper subsets.

(2) Let x_n be a sequence satisfying $x_{n+1}=3x_n-2x_{n-1}$ with $x_0=2$, $x_1=3$, what is x_n? (3 pts)

    a. $n+2$

    b. n^2+2

    c. 2^n+1

    d. 2^n-1

(3) Let R and S be two relations. Please list the statements which are TRUE among the following statements. You must correctly list all the true statements to get the credits. There is no partial credit on this problem. (3 pts)

    a. If R and S are transitive, the $R \cup S$ is transitive.

    b. If R is transitive, the R^{-1} is transitive, where R^{-1} is the inverse of R.

    c. If R and S are symmetric, then $R \cap S$ is symmetric.

    d. If R and S are anti-symmetric, then $R \cup S$ is anti-symmetric.

    e. If R is anti-symmetric, then R^{-1} is anti-symmetric.

    f. S is anti-symmetric if S is asymmetric and irreflexive.

(4) Please give the asymptotic upper bound ("Big-Oh" notation) for each of the following two functions. (6 pts)

    a. $T(n) = 3n^5 + 6n^5\sqrt{n} + n^5 \log n$ (3 pts)

    b. $T(n) = 2T(\frac{n}{2}) + n^2$ (3 pts)

三、 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. Note that the length of a path is the number of edges on that path. Answer the following questions: (10 pts)

(1) What is the depth of tree T (The depth of the root is 0)? (2 pts)

(2) Characters C and F have the same path length from the root. True or False? (2 pts)

(3) Recall that the total *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 T from the root to the character i. Then, what is the weighted path length of character D? (2 pts)

(4) What is the length of the code for character E? (2 pts)

(5) Consider another set S' of characters (A, B, C, D, E, F, G) with relative frequencies (13, 7, 27, 18, 9, 22, 4). Let T' be an optimal Huffman code tree for S'. Then, what amount do WPL(T) and WPL(T') differ? (2 pts)

四. Suppose Alice and Bob work on a project at different places and Bob needs to send a binary tree T to Alice. The communication channel between Bob and Alice only allows to send/receive one node of the tree at a time. One way for them to communicate is to serialize the binary tree. A binary tree can be serialized by arranging the nodes linearly. Thus, a *serialization* of a given binary tree T is a sequence of nodes. Answer the following questions. (10 pts)

(1) How many serializations for a given binary tree T with n nodes? (2 pts)

(2) Please provide a way for Bob to send a binary tree T over the channel and Alice can restore T by receiving the nodes from the channel. Explain how Bob sends and Alice restores the tree with time and space analysis. (4 pts)

(3) Suppose that the tree to be sent is a *binary search tree* (BST). Again, please provide a more efficient way for them to communication and explain why the scheme works with time and space analysis. (4 pts)

五. 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) (6 pts)

(1) *Round-robin* scheduling algorithm is designed for time-sharing systems, where preemption is required to switch between processes when time quantum is expired. (2 pts)

(2) Context switch is the overhead that can be ignored when the operating system switches a CPU to another process. (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)

六. What is the idea of *system calls*? Please describe the detailed steps of how the operating system handles a user application invoking a system call. (5 pts)

七. Among the following statements about *memory and file 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) Pure paging has the problem of external fragmentation, since free memory space is broken into little pieces that are not contiguous. (2 pts)

(2) Both *linked* and *indexed* file allocation methods can efficiently support direct access of files. (2 pts)

八. What is the idea of *nonrepudiation* in information security? Please clearly describe the necessary steps to provide this security service in one example. (4 pts)

九. 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 make cryptosystems safe, we should hide the implementation details of encryption and decryption algorithms. (2 pts)

(2) Since public keys are public, we can safely send them to anyone or announce them to the public. (2 pts)

(3) Public-key encryption such as RSA is more secure than symmetric encryption (e.g. AES). (2 pts)

十. Given a MIPS processor implemented by a single-cycle control and datapath shown in **Figure 1**. Assume that the functional blocks adopted to implement the datapath have the following latencies in **Table 1**: (10 pts)
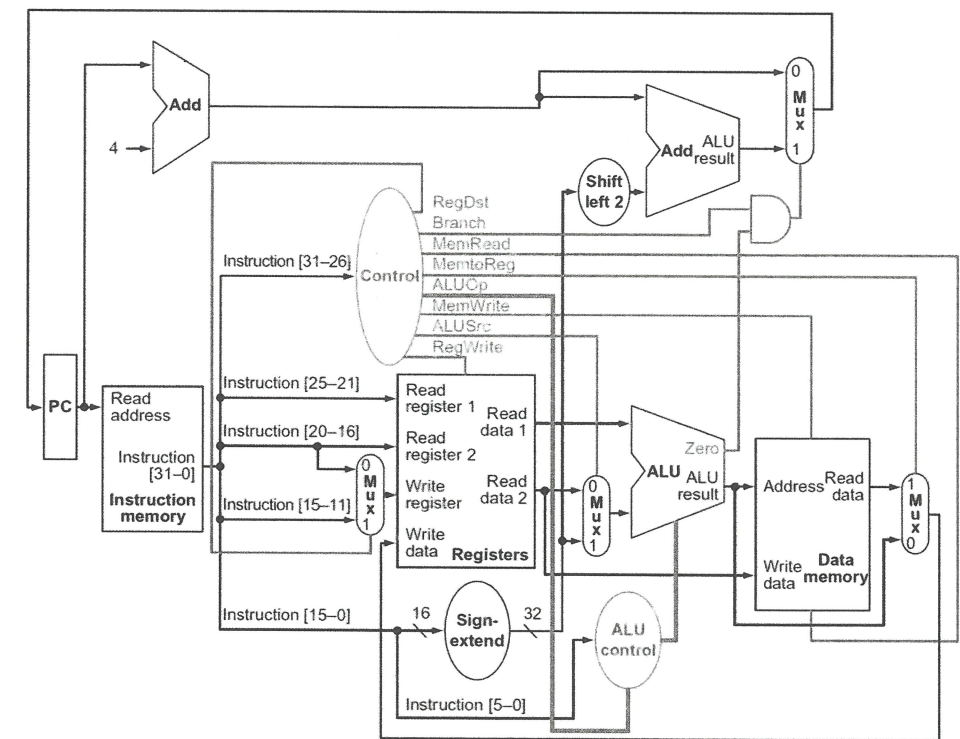

Figure 1. The single-cycle datapath with the control unit

Table 1. Latencies of the functional units on the datapath

PC's Clk.-to-Q	Inst.-Mem.	Add	Mux	ALU	ALU-Ctrl.	Regs. Access	Data-Mem.	Sign-extend	AND-Gate	Shift-left-2
30ps	500ps	60ps	30ps	100ps	60ps	250ps	500ps	30ps	20ps	10ps

(1) In the control and datapath diagram shown in **Figure 1, when we execute** *add* **instruction, which control signal is the most critical** that is needed to be quickly generated, and **how much time** can the control unit to generate this signal to avoid lengthening the critical path? (4 pts)

(2) From previous problem, you have the latency time for generating the most critical control signal, then **we now use this time as the latency time of the main Control Unit** (assume all the control signals will be simultaneously generated). If this processor only need to support **add, sw** and **beq** instructions, what is the **clock cycle time**? (3 pts)

(3) From previous problem, what is the **clock cycle time** of this processor that support **add, lw, sw, and beq** instructions? (3 pts)

十一.In the following problems, we examine in detail how a MIPS instruction is executed in a single-cycle datapath with control signals as in Figure 1, and the sample opcodes and funct fields of typical MIPS instructions are listed in Table 2. Assume the binary representation of a MIPS instruction is: (10 pts)

1000 1110 0100 1000 0000 0000 0001 0100

Table 2. MIPS Instruction Opcode & Funct fields

Instr.	Opcode	Funct
add	0_{10}	32_{10}
sub	0_{10}	34_{10}
beq	4_{10}	
bne	5_{10}	
lw	35_{10}	
sw	43_{10}	

Assume that **the processor's registers and some given data memory slots have the following values** (please refer to the values in **Table 3 and Table 4**) at the beginning of the cycle in which the above instruction word is fetched:

Table 3. Values in Registers

r0	r1	r2	r3	r6	r8	r9	r10	r11	r12	r14	r16	r18	r19	r31
0	40	268	120	500	80	736	64	672	8	1280	1000	980	2000	3000

Table 4. Values in Data Memory

Memory Address	8	40	64	80	120	268	500
values	352	678	10289	65535	888	72	168
Memory Address	672	736	980	1000	1280	2000	3000
values	777	15	0	200	128	250	400

※In the following blocks, each answer earns 1 point:

(1) What are the values of the following control signals (1 or 0 or X(don't care)): (5 pts)

RegDst	ALUOp[1..0]	ALUSrc	Branch	MemToReg

(2) What are the values (**in decimal**) of the following inputs and outputs for the "**Registers**" unit? (5 pts)

Read Reg.1	Read Reg.2	Write Reg.	Write Data	RegWrite