113 CIO

國立臺北科技大學 113 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. 本試題共八題，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. Mark by T(=true) or F(=false) each of following statements. You don't need to prove it. (10 pts)
   (1) The worst-case running time of quicksort algorithm is O(n). (2 pts)
   (2) If a problem that is in the class NP has a polynomial time solution, then P is equal to NP. (2 pts)
   (3) $n^3 + 4n^2 = \Omega(n^2)$. (2 pts)
   (4) The shortest path tree from a root u for a positively weighted undirected graph G does not change if the weight of every edge in G is doubled (i.e., the new weight is twice the old weight). (2 pts)
   (5) 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. (2 pts)

2. 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). Let T be an optimal Huffman code tree for S. Mark by T(=true) or F(=false) each of the following: (10 pts)
   (1) T is unique. (2 pts)
   (2) Characters B and H have the same path length from the root in T. (2 pts)
   (3) Recall that the *weighted path length* (WPL) is defined as $\sum(f_i \times p_i)$ 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, the weighted path length of T is 249. (2 pts)
   (4) The path length of character C is 2. (2 pts)
   (5) Consider another set S' of characters (A, B, C, D, E, F, G, H) with relative frequencies (10, 5, 23, 18, 13, 12, 15, 4). Let T' be an optimal Huffman code tree for S'. Then, WPL(T) and WPL(T') differ by 13. (2 pts)

3. Let A_1, …, A_6 be matrices with dimension 5×10, 10×3, 3×12, 12×5, 5×50, 50×6, respectively. Let $C_{i,j}$ be the smallest number of scalar multiplications needed for computing the matrix product $A_iA_{i+1}\ldots A_j$, assuming that multiplying an $r\times s$ matrix with an $s\times t$ matrix takes rst scalar multiplications. With the dynamic algorithm for Matrix-chain Multiplication problem, mark by T(=true) or F(=false) each of the following statements: (8 pts)
   (1) $C_{1,5} = 1655$. (2 pts)
   (2) $C_{2,6}$ is computed before $C_{1,3}$. (2 pts)
   (3) $C_{2,5}$ is derived from $C_{2,3}$ and $C_{4,5}$. (2 pts)
   (4) The optimal order to multiply A_1, …, A_6 with fewest number of scalar multiplications is $((A_1A_2)((A_3(A_4A_5))A_6))$ (2 pts)
4. Please answer the following questions: (12 pts)
   (1) Let G be an undirected, connected graph with at least one vertex of odd degree. Show that G contains no *Eulerian walk*. An Eulerian walk is a cycle in which each edge in G is passed exactly once. (4 pts)
   (2) Consider the following recurrence and derive the asymptotic upper bound using the "big oh" notation with T(1) = d for some constant d. (4 pts)

$$T(n) = 35T\left(\frac{n}{3}\right) + 7n^3.$$

   (3) Given two sets A and B represented as sorted sequences, describe an efficient algorithm for computing $A \oplus B$, which is the set of elements that are in A or B, but not in both. Please write the pseudo-code and give the time complexity of your algorithm. (4 pts)
5. Multiple choice questions (One or more options will be the answer) (10 pts)
   (1) Different layers in the TCP/IP protocol have different address names. Which of the following statements are correct? (5 pts)
      (a) Port number is used for Transport Layer
      (b) IP address is used in Network Layer
      (c) MAC address is used in the physical layer (Physical Layer)
      (d) Email address is used in Application Layer
   (2) Which of the following network devices are not responsible for decrementing the packet time to live (TTL) value? (5 pts)
      (a) Router; (b) Switch; (c) Server; (d) Bridge
6. Fill-in questions: (10 pts)
   (1) OSI seven-layer network communication model, what is the encapsulation sequence for data transmission from the upper layer to the lower layer _____? (5 pts)
      (a) data (b) bit (c) segment (d) packet (e) frame
   (2) Among common encryption technologies, which of the following two combinations _____ are asymmetric encryption technologies? (5 pts)
      (a) DES (b) RSA (c) AES (d) 3DES (e) ECC

注意：背面尚有試題

7. For each one of the following questions, please select the correct answer. (20 pts)

(1) In a computer system equipped with a Translation Lookaside Buffer (TLB), the efficiency of memory access is critical. Assume that the probability of finding the desired page number in the TLB is 95 percent. The time taken to search the TLB is 20 nanoseconds. However, if the page number is not found in the TLB, the system must access the memory, which takes an additional 100 nanoseconds. Calculate the Effective Memory Access Time (EAT) for this system. (3 pts)

(a) 24 nanoseconds
(b) 25 nanoseconds
(c) 120 nanoseconds
(d) 125 nanoseconds

(2) In a paging system with a page table, which of the following statements is true? (2 pts)

(a) The page table is stored in the CPU
(b) A page table maps virtual addresses to physical addresses
(c) Each process has the same page table to ensure consistency
(d) Paging eliminates the need for fragmentation handling

(3) The memory allocation strategies are used to determine where incoming programs or data should be placed in memory. Which of the following descriptions is corrent? (2 pts)

(a) Worst Fit prioritizes using the largest partition, resulting in larger remaining blocks, which are more likely to accommodate other space requirements.
(b) Best Fit uses the block closest in size to the requirement, minimizing the size of the remaining allocatable memory blocks and improving space utilization in memory.
(c) First Fit allocates the first block that is sufficiently large, with the advantage of being simple and fast in allocation.
(d) Next Fit starts searching from the point of the last allocation, looking for a block closest in size to the requirement.
(e) All of the above

(4) In the file systems, which of the following statements is true? (2 pts)

(a) Directories can only contain files, not other directories
(b) File allocation table (FAT) does not support hierarchical file structure.
(c) Inodes in UNIX contain the actual data of the files.
(d) A symbolic link can point to a file on a different file system.

(5) Regarding the deadlocks, which of the following statements is correct? (3pts)

(a) Deadlock prevention is achieved by designing a system that cannot enter a deadlock state.
(b) Deadlock avoidance involves dynamically checking resource allocation at runtime to ensure the system does not enter an unsafe state.
(c) An operating system can effectively avoid deadlocks without knowing the future resource needs of processes.
(d) A deadlock situation can arise when the following four conditions occur simultaneously in a system: Mutual Exclusion, Hold and Use, No Preemption, and Circular Wait.

(6) Which technology is designed to optimize the performance of processors by allowing them to access local memory faster than non-local memory (1 pts)

(a) Storage Area Network (SAN)
(b) Symmetric Multiprocessing (SMP)
(c) Direct Memory Access (DMA)
(d) Non-uniform Memory Access (NUMA)

(7) Which of the following storage components is of a volatile type (1 pts)

(a) Read-Only Memory (ROM)
(b) Cache
(c) Hard Disk
(d) Optical Disk
(e) None of the above

(8) Consider the following snapshot of a system, calculate the Need matrix for each process and verify the accuracy of the given resource request claims (a) to (e) for processes P_0 to P_4. Identify the correct one. (2 pts)

	Allocation					Max					Available			
	A	B	C	D		A	B	C	D		A	B	C	D
P_0	3	0	1	4		5	1	1	7		0	3	0	1
P_1	2	2	1	0		3	2	1	1					
P_2	3	1	2	1		3	3	2	1					
P_3	0	5	1	0		4	6	1	2					
P_4	4	2	1	2		6	3	2	5					

(a) Need matrix for P_0 is (1,1,0,1)
(b) Need matrix for P_1 is (1,0,0,1)
(c) Need matrix for P_2 is (0,1,0,0)
(d) Need matrix for P_3 is (1,1,1,1)
(e) Need matrix for P_4 is (0,1,1,0)

(9) Regarding to the above question 7(8), is the system in a safe state? Please explain your answer in detail. (4 pts)

8. (1) Translate the following C code to MIPS assembly code. Please fill the blanks **(8-a)~(8-d)** with correct statements. (8 pts, each 2 pts)

C code	
01	int f(int n) {
02	int x = 0, y=0;
03	if (n<=0) return 0;
04	x = n/10;
05	y = n%10;
06	return y + f(x);
07	}

MIPS code		
01	## Function int f(int n)	
02	fun:	
03	addi $sp, $sp, -12	
04	sw $ra, 8($sp)	
05	sw $s0, 4($sp)	
06	sw $s1, 0($sp)	
07	move $s0, $a0	# store args to $s0
08	li $v0, 0	# return value for terminal condition
09	ble $s0, 0, funExit	# check terminal condition
10	li _____, 10	**# (8-a)** #divisor =10
11	div $s0, $t0	# n/10
12	mflo $t1	# copy quotient to $t1, $t1 = n/10 = x
13	mfhi _____	**# (8-b)** # copy remainder to …, n%10 = y
14	add $a0, $t1, $zero	# set args for recursive call to f(x)
15	jal _____	**# (8-c)** # call f(x)
16	add $v0, _____, $s1	**# (8-d)** # add result of f(x)+y to return value
17	funExit:	
18	lw $ra, 8($sp)	
19	lw $s0, 4($sp)	
20	lw $s1, 0($sp)	
21	addi $sp, $sp, 12	
22	jr $ra	

(2) Translate the following MIPS code to C code **(8-e)**. Assume that the variables f, g, h, i, and j are assigned to registers $s0, $s1, $s2, $s3, and $s4, respectively. Assume that the base address of the arrays A and B are in registers $s6 and $s7, respectively. (2 pts)

MIPS code	C code
addi$t0, $s6, 40 lw$t0, 0($t0) sll$t0, $t0, 3 sll$t1, $s4, 2 add$t1, $t1, $s7 lw$t1,0($t1) add$t0, $t0, $t1 add$s3, $t0, $s2	i = A[10] * **(8-e)** + B[j] + h

(3) For the 5 stages pipeline processor as the below figure, assume the following sequence of instructions: (10 pts, each 2 pts)

Instructions			Notes
3C	sub	$11, $2, $4	(f) is the pc values. (g), (h), and (i) are the register numbers. (k) is the control signal.
40	and	$12, $2, $5	
44	or	$13, $2, $6	
48	add	$11, $11, $3	
4C	slt	$15, $3, $6	
50	lw	$16, 50($6)	

The "48 add" overflow is detected in EX. at the cycle 6. Please complete the following (f), (g), (h), (i), and (k) in the pipelined datapaths and control.