

國立臺灣科技大學 111 學年度碩士班招生試題

系所組別：資訊工程系碩士班

科目：資訊工程概論

(總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分)

1. An engineering task force claims that they can reduce the time required for the current processor to calculate trigonometric functions by 40% in two months; they also claim that they can improve the clock rate of the current processor by 5% given two months of working period, but these two approaches are mutually exclusive. Assume that trigonometric function calculation is responsible for 13% of total execution time of one computer's daily tasks. Which improvement would you suggest and why? (10%)

2. The following formula is for the average memory access time of a memory system with two-layered caches. Assume that subscription L1 denotes first-level cache, L2 denotes second-level cache, and Mem denotes main memory. (10%)

$$\text{Hit_timeL1} + \text{Miss_rateL1} \times (\text{Hit_timeL2} + \text{Miss_rateL2} \times \text{Miss_penaltyL2}) + \text{Hit_timeMem}$$

(1) Correct the formula. (3%)

(2) To reduce miss rate of one specific layer, does it make sense to increase or to decrease the following attributes like block size, cache size, associativity, and the number of levels of caches? (7%)

3. Assume a five-stage single-pipeline microarchitecture (fetch, decode, execute, memory, write-back) and the code below. All ops are one cycle except memory read/write which takes three cycles. And there is no forwarding. (15%)

(1) Assume the loop iterates for its first run and the LW R3, 0(R0) instruction was fetched at the first cycle. At which cycle would this instruction be fetched the second time? (10%)

(2) How many clock cycles per loop iteration are lost to branch overhead? (5%)

Loop:	LW	R3, 0(R0)
	LW	R1, 0(R3)
	ADDI	R1, R1, #1
	SUB	R4, R3, R2
	SW	R1, 0(R3)
	BNZ	R4, Loop



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4. Recall that protected instructions can only be executed in the kernel mode (i.e., can only be executed by the OS but not by user-level processes). For each instruction below, is it a protected instruction? (5%)

A. load instruction (read a value from memory into a register) (1%)

B. modify the PC register (program counter) (1%)

C. modify the SP register (stack pointer) (1%)

D. modify the register that controls kernel/user mode (1%)

E. direct access I/O device (1%)

5. Five processes A, B, C, D and E arrived in this order at the same time with the following CPU burst and priority values. A smaller value means a higher priority.

	CPU Burst	Priority
A	4	4
B	6	2
C	2	3
D	5	1
E	3	5

Fill the entries of the following table with waiting time and average waiting time for each indicated. (14%)

Scheduling Policy	Waiting Time					Average Waiting Time
	A	B	C	D	E	
First-Come-First-Served						
Non-Preemptive Shortest-Job First						
Priority						
Round-Robin (time quantum=2)						



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6. A paging system uses 16-bit address and 4K pages. The following shows the page tables of two running processes, Process 1 and Process 2. (16%)

Process 1		Process 2	
Logical Page #	Physical Page #	Logical Page #	Physical Page #
0	3	0	2
1	7	1	0
2	1	2	6
3	5	3	4

- (1) Translate the logical addresses in the table below to their corresponding physical addresses and fill the table entries with your answers. (8%)

Process	Logical Address	Page #	Offset	Physical Address
Process 1	11,034			
Process 2	12,345			

- (2) Construct an inverted page table from the system snapshot of the page tables by filling the following table. (8%)

Physical Page #	Process ID (Process 1 or 2)	Logical Page #
0		
1		
2		
3		
4		
5		
6		
7		



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7. For the tree structure, we define the height of the root node as 1. (20%)

(1) The minimum number of nodes in a minimum binary heap of height n is $2^i + j$. What is the value of $i + j = ?$ (5%)

(2) What is the maximum number of keys in a B-tree of order 6 and height 4? (5%)

(3) Suppose we want to search for the element 2022 in a binary search tree, and $\{5566, 3344, 1314, k, 1500, 1800, 2022\}$ is the sequence of nodes we examined. Which of the following are the possible values of k ? (5%)

A. 2505

B. 3388

C. 1450

D. 2987

E. 6891

F. 2468

(4) Suppose we construct a Splay tree from scratch by using the following eight steps. What is the inorder traversal of the Splay tree? (5%)

Step1: insert 40

Step2: insert 80

Step3: insert 70

Step4: insert 50

Step5: insert 90

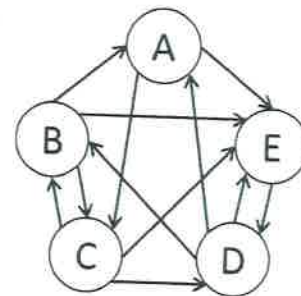
Step6: delete 70

Step7: insert 70

Step8: delete 80

8. About the graph: (10%)

(1) Given an unweighted digraph, how many paths of length 4 are there from node C to node E ? (5%)



(2) Given an undirected connected graph, which nodes are the articulation points? (5%)

