國立臺灣師範大學 115 學年度碩士班招生考試試題

科目：計算機系統　　適用系所：資訊工程學系

注意：1.本試題共 4 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

1. (10 points) OS fundamental: Use at most two sentences to highlight what the computer hardware must do in protecting operating system kernel.

2. (10 points) File system: Use one sentence to summarize what "inode" is in file systems design.

3. (15 points) Process scheduling: For the following three computing jobs, using the round-robin scheduling policy, what would the overall average turnaround time among these three be? Assume scheduling quantum (aka time slice) = 3.
   - Job A: arrival time = 0; job length = 4.
   - Job B: arrival time = 1; job length = 3.
   - Job C; arrival time = 2; job length = 5.

4. (15 points) Virtual memory: Consider the following two-level page table and do address translation.
   - The page size is 32 bytes.
   - Physical memory consists of 128 pages. A physical address requires 12 bits.
   - The address space for a process has 1024 virtual pages.
   - 8-bit page directory entry (PDE): the format is VALID PT6 ... PT0, starting from the MSB.
   - 8-bit page table entry (PTE): the format is VALID PFN6 ... PFN0, starting from the MSB.

   Figure 1 shows a hexadecimal dump of some pages of memory. In the page dump, the first byte is shown on the left. Suppose that the page table directory (aka the page directory) is held in page 57 (decimal). Your job here is to translate the virtual address 0x5aa8 into the corresponding physical address. Write your answer in hexadecimal.

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page  19: 19 07 05 16 1d 06 1d 1b 12 0d 03 01 1d 07 15 07 19 12 09 05 16 02 07 11 1a 13 08 1c 06 00 08 0d
page  20: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  21: 06 1d 00 10 19 18 16 0c 18 19 17 1e 03 1d 0c 15 07 1c 00 11 07 0c 0b 14 19 0b 13 0a 08 1c 09 02
page  22: 11 04 0b 1b 1e 14 15 12 04 01 00 1c 15 1d 00 13 0e 16 09 1e 02 10 16 1b 16 15 18 1c 0a 15 1b 1b
page  23: 05 17 09 10 19 0e 08 1b 1c 0a 10 1d 0e 06 01 1d 18 0b 10 0f 08 1e 14 07 00 0e 0b 18 16 12 04 04
page  24: 04 13 03 0d 06 08 1e 18 09 1b 06 0c 1a 13 03 1e 06 08 17 0a 09 02 02 12 07 12 0b 0e 1d 0e 11 1a
page  25: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  26: 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 9b
page  27: 0b 04 0c 16 02 05 14 13 17 07 19 16 18 03 0e 00 1a 1d 1b 00 0a 10 10 03 18 09 0f 03 11 04 02 0f
page  28: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  29: 18 0f 1e 02 1a 16 07 19 0e 10 1a 06 08 13 02 11 18 0f 07 18 1a 17 11 1c 18 04 0b 03 01 0a 1a 19
page  30: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  31: 08 10 05 1b 1e 01 0e 17 0b 1c 0f 05 11 13 0b 14 18 10 0f 1a 15 10 1d 05 18 05 12 07 0d 17 18 18
page  32: 04 15 19 18 01 0c 0b 06 1e 01 0f 17 1e 04 0e 17 01 07 1b 04 0c 09 0d 02 01 1e 17 16 07 07 11 07
page  33: 0f 13 1e 08 10 04 17 00 19 1a 19 02 08 16 03 0e 0e 1d 12 1a 09 18 0c 1c 02 19 06 10 10 04 19 09
page  34: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  35: 7f 7f 7f 7f 7f 97 7f 7f 7f 7f 7f df 7f 7f 7f fc 7f be 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f
page  36: 12 16 0e 19 00 0f 0b 02 1c 04 06 1b 1d 1c 0a 1c 04 16 1d 05 04 15 1b 16 1d 0e 0b 03 08 1d 02 05
page  37: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  38: 0a 15 1d 1e 1d 1c 1a 1c 00 0f 12 15 12 13 1c 02 10 1d 00 03 1a 1d 00 00 19 15 10 11 17 19 00 02
page  39: b5 7f 7f 82 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f a6 7f d5 7f c9 7f 7f 7f 7f 91 7f 7f 7f 7f 7f
page  40: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  41: 13 08 07 0e 0b 08 01 01 1b 09 02 05 0e 1e 06 1a 0f 0c 19 0c 01 11 14 13 08 1d 1a 1e 0d 19 16 05
page  42: 0a 00 17 08 12 10 0a 14 0e 07 1b 05 04 07 0e 18 0a 07 14 08 10 07 1b 05 07 09 0a 16 14 18 10 02
page  43: 1e 12 01 0c 14 01 0a 15 1a 12 1b 0e 0c 1a 0b 18 06 0a 05 11 05 06 06 0e 09 0d 1e 15 1a 06 0b 02
page  44: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 80 00 00 00 00 00 00
page  45: 03 15 11 1c 1d 1c 0d 18 09 09 0c 1c 1b 07 0b 0b 0b 0c 0c 06 11 18 10 19 11 05 17 1b 08 00 0f 10
page  46: 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f ad 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f
page  47: 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 96 7f 7f
page  48: 7f 7f 7f 86 7f 7f 7f 7f 7f 7f 7f 7f 7f fe 7f 7f b4 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f c0 7f 7f 7f 7f
page  49: 1a 13 1b 02 1e 06 13 1b 16 06 14 0d 00 0a 09 13 08 12 15 05 03 15 0e 04 03 1d 12 0b 06 1e 15 16
page  50: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  51: 0a 0e 00 0b 13 13 07 1d 14 0a 14 11 10 0c 1e 13 15 17 1e 00 13 16 07 0c 01 06 0b 03 07 1c 11 0f
page  52: 04 13 0d 19 0c 0e 0f 1d 0a 15 07 11 08 1b 08 1a 14 0e 1c 0c 17 12 0d 01 0c 08 0d 1d 09 15 14 07
page  53: 13 0c 1c 1e 01 16 03 01 08 16 1e 03 0a 00 10 0e 0b 09 18 19 08 0c 13 17 1e 0c 15 10 18 04 05 03
page  54: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  55: 12 00 15 1a 05 0e 16 0c 06 05 0f 00 1b 18 15 1a 13 0c 12 0f 1e 18 08 1c 17 18 19 0c 1b 1b 15 17
page  56: 0a 14 06 0d 18 1c 1b 0b 12 09 04 0f 19 1a 16 1d 08 05 0d 08 06 0c 13 0f 09 1a 1e 0e 02 00 1b 01
page  57: 81 af dc c1 ae f4 7f a3 7f d7 ef b0 ea ee dd 7f 83 bb d3 cb 9a f2 a7 7f 89 e6 fa 7f c7 92 d1 eb
page  58: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  59: 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f cf 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f f6 7f 7f
page  60: 13 1d 0b 11 1d 17 13 13 0c 0c 08 19 1b 0b 1c 01 04 0f 09 0b 1e 04 05 07 15 07 00 10 0c 07 0f 14
page  61: 05 1a 1a 01 07 0f 18 0c 16 07 16 0a 0a 17 1a 19 11 0d 15 13 19 18 03 0b 14 07 05 00 12 1d 1e 04
page  62: 06 11 0f 01 12 16 11 1b 05 04 00 0f 0d 0d 08 18 02 1c 11 10 18 07 04 09 01 09 13 10 08 12 02 19
page  63: 08 04 0c 0e 05 14 07 02 0a 0d 04 12 15 11 15 00 0c 0b 01 0c 01 0f 12 0e 0a 07 00 0a 1b 11 08 14
page  64: 11 0a 07 1d 03 1d 14 02 1b 03 11 03 1e 09 1b 01 14 02 00 11 1e 15 1a 18 10 02 10 05 10 0a 0f 06
page  65: 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 8f 7f 7f 7f 7f 7f 7f 7f c4 e4 7f 7f 7f b1 7f e7 7f 7f 7f 7f 7f
page  66: 08 11 0a 13 01 14 04 1d 12 0e 0c 13 15 17 17 0f 1e 19 1a 0c 0d 11 1c 10 10 0d 1c 09 01 16 1b 16
page  67: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  68: 1a 03 1b 0e 00 0d 0b 14 1c 0f 15 0c 18 03 17 05 12 06 0a 05 0a 12 10 0c 11 1a 0b 12 0e 1e 0a 15
page  69: 11 08 1c 1e 19 12 03 19 08 1b 07 11 19 05 10 02 00 05 1e 1d 14 09 14 16 0b 12 18 00 06 0e 04 0b
page  70: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  71: 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f c5 7f 7f
page  72: 19 02 12 17 01 1c 04 0e 05 0f 12 01 1d 0d 10 12 0b 08 14 11 08 16 09 00 07 01 04 17 0c 1b 17 01
page  73: 18 00 04 0e 00 19 07 04 01 13 0d 13 14 19 1d 15 06 0e 05 00 0e 16 05 08 0a 15 10 13 17 0c 18 1c
page  74: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
page  75: 7f 7f 7f e0 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f 7f
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Figure 1

5. (10 points) Consider two different processors P1 and P2 executing the same instruction set. Processor P1 has a 2 GHz clock rate and a CPI of 1.5. Processor P2 has a 1.5 GHz clock rate and a CPI of 1.0. On both processors, we are trying to reduce the execution time of a program by 20% but this leads to an increase of 20% in the CPI. What clock rate of each processor should we have to get this time reduction? Show your calculation process.

6. (10 points) Assume the contents of two register $t0 and $t1 are 0xAAAAAAAA and 0x12345678, respectively. Show the resultant contents of register $t2 for the following sequence of MIPS instructions.

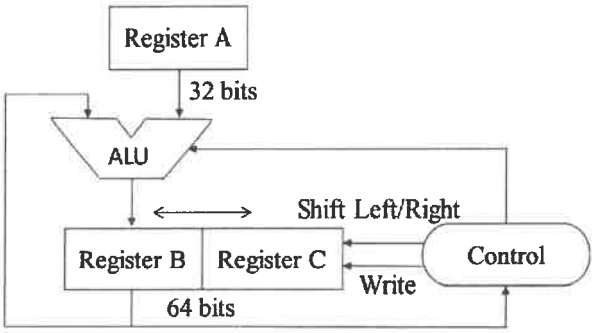
(a) (5 points)

```
sll  7.  $t2,  8.  $t0,  9.  4
or   10. $t2,  11. $t2,  12. $t1
```

(b) (5 points)

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srl   13. $t2,  14. $t0,  15. 3
andi  16. $t2,  17. $t2,  18. 0xFFEF
```

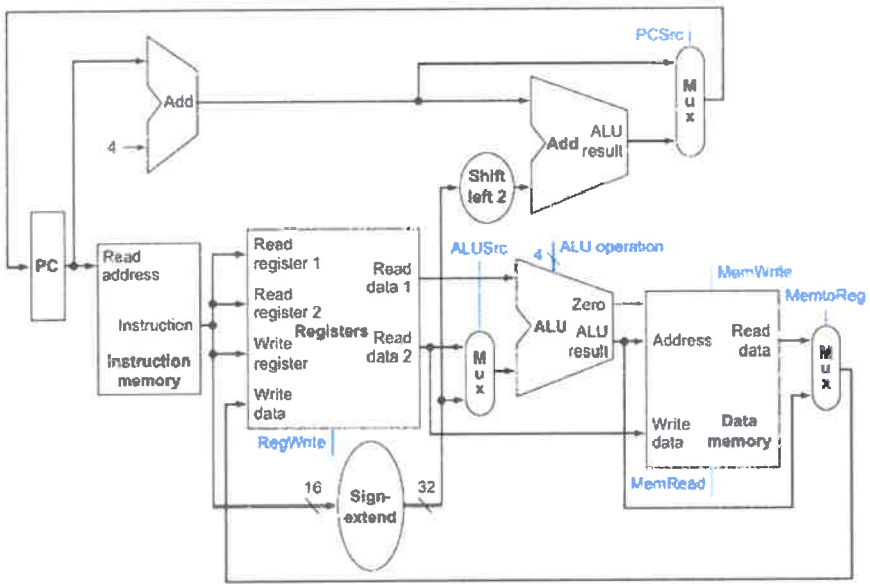
7. (10 points) A hardware for combined multiplication and division is shown below. Please specify the corresponding operand register (in Register A, B, or C) and shift direction (Left, Right, or None) for the following operand. For example, operand Multiplicand is stored in Register A and its shift direction is None.



(a) (5 points) Multiplier

(b) (5 points) Quotient

8. (10 points) A datapath of a processor is shown below. The latency of the logic blocks used to implement the datapath is listed in the following table. If the processor is used to support ONLY conditional PC-relative branch instructions, what would the minimum cycle time be for the datapath? Show your calculation process.



Block	I-Mem	Add	ALU	Mux
Latency (ps)	180	70	100	20
Block	Regs	D-Mem	Sign-Ext	Shift-left-2
Latency (ps)	90	220	10	5

9. (10 points) A cache contains 4096 double-word, and the block size is 2 double-words.

(a) (5 points) How many tag bits are provided in a direct mapped 64-bit cache address?

(b) (5 points) What is the total number of bits in such a cache?