A5 (50 marks)

Focus: MIPS Procedures, MIPS Instruction Format

Q1. Write a MIPS program that prompts the user for an integer N, and then displays all prime numbers up to (N – 1). Use a procedure `isPrime` that accepts an integer argument and returns 1 if the argument is prime and 0 otherwise. **Comment your code.**

It would help if you start by implementing your program in a high-level language (C or Java), test it to make sure your algorithm works, and then translate it to MIPS. **Include your high-level code (or a pseudo-code version of it)** as comments at the beginning of your MIPS program. **(***18 marks***)**

HINTS:

- A number is prime if and only if it is divisible only by 1 and itself. You can use a **for-loop** to check this.
- To check if a number is divisible by another number, use the division instruction `div` and check the remainder stored in the register `HI`.

Sample run

```
Enter an integer N from 2 to 100: 100
2 3 5 7 11 13 17 19 23 29 31 37 41 43 47 53 59 61 67 71 73 79 83 89 97
```

Q2. Write a MIPS program named **hanoi.asm** to solve the *Towers of Hanoi* puzzle. Your program should first prompt the user to input the number of disks, and then solve the puzzle **recursively** as illustrated in the attached C program **hanoi.c**. **Comment your code.** **(***22 marks***)**

Sample run

```
Enter the number of disks: : 3
Move disk 1 from peg 1 to peg 2.
Move disk 2 from peg 1 to peg 3.
Move disk 1 from peg 2 to peg 3.
Move disk 3 from peg 1 to peg 2.
Move disk 1 from peg 3 to peg 1.
Move disk 2 from peg 3 to peg 2.
Move disk 1 from peg 1 to peg 2.
```

Q3. Download the program **arrays.asm**, and then load it, assemble it, and run it in MARS: **(***10 marks***)**

a. What is the hex encoding of the instruction `sw $s0, ($t0)`? Explain this encoding.
b. The branch instruction `beq` is encoded as 0x12120007. Explain how the digit 7 in the encoding is determined? Add details to explain how this value (7) is used to execute the instruction located at the label "exit" if the condition of `beq` is true.
c. Explain why the jump instruction `j` is encoded as 0x08100007?

Note: if any of your solutions is unreasonably long (e.g. twice as many instructions as another solution would need), then you might lose some marks for the extra instructions.

Submission Instructions: Compress all your files (including the assembly files) into one zip file and submit it to Canvas. You can resubmit an assignment, but the new submission overwrites the old one and receives a new timestamp.