

[**Closed book/notes/calculator**] Show all of your work clearly in the space provided. Be sure to **read each problem carefully**. Note that the exam is double sided.

1. (5 points) Suppose a microprocessor is configured with a program counter that is 12 bits wide. How many program memory locations are available? Show your work.

2. (5 points) Suppose a microprocessor is configured with data memory that is 10 bits wide. What is the largest unsigned integer that can be stored in a data location? Show your work.

3. (5 points) Both R JMP and JMP are unconditional branch instructions. Explain how they differ.

4. (10 points) What is the purpose of the DDRB? Suppose 0xf3 is sent to it. What will this do?

5. (15 points) Suppose the values 0x32 and 0x4f are stored general purpose registers r16 and r17, respectively. Show the contents of the r16 and r17 registers and the H, N, Z, V, and C status flags after the following operation:

```
add r16, r17
```

6. (25 points) Write a subroutine that copies 25 bytes from **source** to **destination**.

The data segment looks like this:

```
.dseg
source:
    .byte 0x30
destination:
    .byte 0x30
```

7. Consider the following set of instructions (assume the stack pointer contains 0x800):

```
ldi    r16, 0x60
push   r16
ldi    r16, 0x70
push   r16
ldi    r16, 0x80
push   r16
pop    r17
add    r16, r17
pop    r17
add    r16, r17
```

(a) (12 points) How many cycles are required to execute this code?

(b) (10 points) Give the values contained by the following registers:

- Stack Pointer
- r16
- r17

(c) (13 points) What is stored in the following memory locations (if the value is unknown, indicate that with —):

- 0x7fb
- 0x7fc
- 0x7fd
- 0x7fe
- 0x7ff
- 0x800
- 0x801
- 0x802
- 0x803
- 0x804