

## Chapter 3 Exercises

**3.3** [10] ⟨3.2⟩ Convert 5ED4 into a binary number. What makes base 16 (hexadecimal) an attractive numbering system for representing values in computers?

|     |      |      |      |      |
|-----|------|------|------|------|
| hex | 5    | E    | D    | 4    |
| ten | 5    | 14   | 13   | 4    |
| two | 0100 | 1110 | 1101 | 0100 |

5ED4<sub>hex</sub> is 0100 1110 1101 0100<sub>two</sub>. Hexadecimal is the base-16 number system, a numeric representation format in which each digit can take on 16 values, ranging from 0 to F. Each hexadecimal digit therefore corresponds directly to 4 bits, making it convenient for representing binary values, as the translation between the two systems is straightforward. Hexadecimal is particularly useful in computing applications. It offers a more concise format than binary while maintaining easy conversion between the two number systems.

**3.20** [5] ⟨3.5⟩ What decimal number does the bit pattern 0x0C000000 represent if it is a two's complement integer? An unsigned integer?

|     |                 |                 |                 |                 |                 |                 |                 |                 |
|-----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|     | 16 <sup>7</sup> | 16 <sup>6</sup> | 16 <sup>5</sup> | 16 <sup>4</sup> | 16 <sup>3</sup> | 16 <sup>2</sup> | 16 <sup>1</sup> | 16 <sup>0</sup> |
| hex | 0               | C               | 0               | 0               | 0               | 0               | 0               | 0               |
| two | 0000            | 1100            | 0000            | 0000            | 0000            | 0000            | 0000            | 0000            |

$$12 \times 16^6 = 201,326,592$$

Two's complement integer: 201,326,592<sub>ten</sub>

Unsigned integer: 201,326,592<sub>ten</sub>

**3.21** [10] ⟨3.5⟩ If the bit pattern 0x0000006F is placed into the Instruction Register, what RISC-V instruction will be executed?

|     |                 |                 |                 |                 |                 |                 |                 |                 |
|-----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|     | 16 <sup>7</sup> | 16 <sup>6</sup> | 16 <sup>5</sup> | 16 <sup>4</sup> | 16 <sup>3</sup> | 16 <sup>2</sup> | 16 <sup>1</sup> | 16 <sup>0</sup> |
| hex | 0               | 0               | 0               | 0               | 0               | 0               | 6               | F               |
| two | 0000            | 0000            | 0000            | 0000            | 0000            | 0000            | 0110            | 1111            |

The last 7 bits corresponds to the opcode of the instruction. The opcode denotes the the operation and format of the instruction. It can be determined the instruction is jal x0,0(0), as jal is the only RISC-V instruction matching the opcode 1101111<sub>two</sub>.

**3.22** [10] ⟨3.5⟩ What decimal number does the bit pattern 0x0C000000 represent if it is a floating point number? Use the IEEE 754 standard.

| s  | exponent |    |    |    |    |    |    |    | fraction |    |    |    |    |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
|----|----------|----|----|----|----|----|----|----|----------|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| 31 | 30       | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22       | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0  | 0        | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0        | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

$$(-1)^s \times (1 + \text{Fraction}) \times 2^{\text{Exponent} - \text{Bias}} = (-1)^0 \times (1 + 0) \times 2^{(24-127)} = 2^{-103} = 9.86076132 \times 10_{\text{ten}}^{-32}$$

**3.23** [10] ⟨3.5⟩ Write down the binary representation of the decimal number 63.25 assuming the IEEE 754 single precision format.

$$63.25_{\text{ten}} = \frac{253}{4}_{\text{ten}} = \frac{253}{2^2}_{\text{ten}} \Rightarrow 11111.01_{\text{two}} \times 2^0 \Rightarrow 1.111101_{\text{two}} \times 2^5$$

| s  | exponent |    |    |    |    |    |    |    |    | fraction |    |    |    |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
|----|----------|----|----|----|----|----|----|----|----|----------|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| 31 | 30       | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21       | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0  | 1        | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 1  | 1        | 1  | 1  | 1  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

$$63.25_{\text{ten}} = 0100\ 0010\ 0111\ 1101\ 0000\ 0000\ 0000\ 0000_{\text{two}}$$