Preliminary Report

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1. Generate the Object Code for **`beq`** and **`bne`** instructions in HEX.

opcode of beq is 4(hex) = 000100(binary)

Now we must compute the Branch Target Address (PC+ 4 + [16-bit immediate])

Steps for forming 16-bit immediate (branch offset)

- [(Current PC + 4) - Branch Destination Address]
- Divide Result by 4 to get Word Address
- Extend to 16 bits (if necessary)
- If branch offset is negative, form 2's complement version of the negative number

`beq $8, $9, continue -> 0x1109FFC`

`bne $8, $9, next -> 0x15090003`

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2. Generate the object code for the **`j`** (jump) instructions in HEX.

opcode for `j` is 2(hex)

At this point we know, we're working with `Jump and Link` instruction and all Jump instructions have `J-Type` format. `6-bit opcode` and `26 bit adress`. Jump Address computed by:

- Concatenating "00" at the end to make it a word address
- Concatenating the uppermost 4 bits of the current PC.

Address of `_Lab4main = 0x00400000`

Address of `next = 0x00400018`

`j _Lab4main -> 0x08100000`

`j next -> 0x08100006`

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3. Using 4 bits & 16 bits what is the minimum and maximum integers that we can represent using sign magnitude representation.

An N-bit sign/magnitude number uses the most significant bit as the sign and the remaining N-1 bits as the magnitude (absolute value). A sign bit of 0 indicates positive, negative otherwise.

N-bit sign/magnitude number spans the range `[-2^(N-1) + 1, 2^(N-1) -1]`. Both +0 and -0 exists.

- Numbers ranging from `−15 to +15` can be represented using <u>4-bits.</u>
- Number ranging from `-65535 to +65535` can be represented using <u>16-bits.</u>

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4. Using 4 bits what is the minimum and maximum integers that we can represent using 2's complement notation representation for negative numbers.

- <u>4-bit</u> two's complement number represents 16 values: `-8 to +7`. In general, the range of an N-bit two's complement number spans `[-2^(N-1), 2^(N-1) -1]`. It should make sense that there is one more negative number than positive number because there is no -0. The most negative number is -2^(N-1) is sometimes called the <u>weird number</u>.
- <u>16-bit</u> two's complement number represents 2^16 values. `-65536 to +65535`

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5. For a number with hexadecimal representation is **`4AB.5F`**. Show its IEEE 754 single precision an double precision representations.

sign = `0 (positive)`

0x4AB5F = `0(sign) 10010101(exponent) 01101011111(mantissa) [binary]`

Exponent = `10010101[base 2] = 149 [base 10]; 149 − 127 = 22`

Denormalize: `1.01101100001000000000000(base 2) × 2^22 =`
`10110110000100000000000 = 5965824.0`

6. For the following single precision number represented by using IEEE 754 format give the corresponding decimal number: 0x43824000

The value of a IEEE-754 number is computed as:

`sign * 2^exponent * mantissa`

In this example sign bit is 0, meaning it is positive, exponent is 8, mantissa (significand) is 1.017578125

Encoded as: `0(sign)   135(2^exponent)     147456 (mantissa)`

Decimal representation: `260.5`