1.1. Represent the following numbers as directed:

a. 12 as a 4-bit unsigned number **1100**

b. 12 as a 5-bit unsigned number **01100**

c. +1 as a 4-bit 2’s complement number **0001**

d. –1 as a 4-bit 2’s complement number **1111**

e. –1 as a 5-bit 2’s complement number **11111**

f. +1 as a 4-bit signed-magnitude number **0001**

g. –1 as a 4-bit signed-magnitude number **1001**

1.3. What is the 16-bit FP number representation of –5.375 in hex with 1-bit sign, 4-bit biased exponent, and 11-bit fraction, where bias = 7?

0101.0110 🡪 1.0110110 \* 29 🡪 1, 1001, 010110…

**(1, 1001, 01011000000) = 1100 1010 1100 0000 = 0xCAC0**

1.5. What is the real number equivalent to FP number 0x3400 with 1-bit sign, 4-bit biased exponent, 11-bit fraction, and bias = 8?

0x3400 🡪 0,0110,10000000000 🡪 bias\_exp = 6 so bias = -2 🡪 1.100 \* 2-2 🡪 .0110 = **0.375**

1.7. What is the biggest positive FP number that can be represented in 16-bit format using 1-bit sign, 4-bit biased exponent, and 11-bit fraction, where bias is 8? **127.0**

1.8. Do the following assuming 16-bit FP numbers with 4-bit bias exponent, bias = 7, and 11-bit fraction:

a. What real number does an FP number with sign = 0, bias exponent = 1, and fraction = 0 represent?

0,0001,00000000000 🡪 0000.00000100 🡪 1/64 🡪 **0.015625**

b. What real number does an FP number with sign = 1, bias exponent = 14, and fraction = (11111111111)2 represent?

1, 1110, 11111111111 🡪 11101111.11111110 🡪 **-255.9875**

1.9. Represent the following real numbers as 16-bit FP numbers with 4-bit biased exponent, bias = 7, and 11-bit fraction:

a. 1.0 **(0, 0111, 00000000000) = 0x3800**

b. 0.5 **(0, 0110, 00000000000) = 0x3000**

c. 0.25 **(0, 0101, 00000000000) = 0x2800**

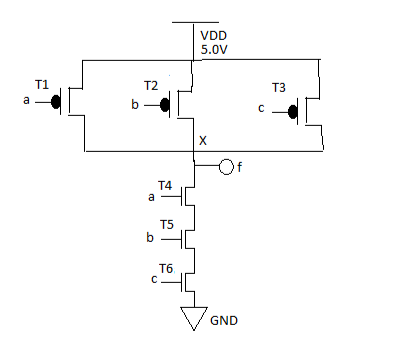
1.10. Do the following assuming 16-bit FP numbers with 4-bit bias exponent, bias = 8, and 11-bit fraction:

a. What real number does an FP number with sign bit = 0, bias exponent = 1, and fraction = 0 represent?

(0,0001,00000000000) 🡪 0000.0000001 🡪 1/128 🡪 **0.0078125**

b. What real number does an FP number with sign bit = 1, bias exponent = 14, and fraction = (11111111111)2 represent? (1, 1110, 11111111111) 🡪 11110111.1111 🡪 **-127.096875**

1.15. Draw a transistor-level schematic of a three-input CMOS NAND gate and determine its truth table in terms of transistor ON and OFF positions.

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1.18. What is the difference between pipelining and parallelism architectures? Identify their application areas.

**Pipelining is the concept of organizing a CPU's data path into stages to execute programs faster (like an assembly line). Pipelining is most useful when tasks are dependent upon a prior task's completion.**

**Parallelism is the concept of executing tasks in parallel, but only truly works when tasks are not reliant on the output/result of other tasks.**

1.21. Explain why a further increase in performance comes from parallel processing.

**You can combine parallelism architecture and pipelining to execute nondependent tasks at the same time in different registries/on different processors, then stagger the execution of dependent tasks (still in parallel) to maximize efficiency. It's like having four sets of assembly lines instead of just one assembly line set.**