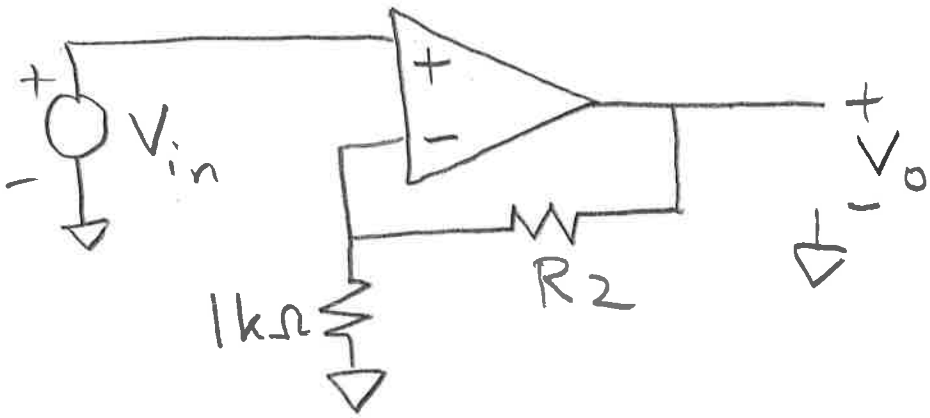
E100 MT2 Soln Spring 2016

1. a) Select R2 in the circuit below to give a voltage gain Vo/Vin = 40.

R2 = ______________________________




$$\frac{V_o}{V_{in}} = 1 + \frac{R2}{1k\Omega} = 40$$

$$\frac{R2}{1k\Omega} = 39 \Rightarrow R_2 = 39k\Omega$$

b) For the feedback circuit shown above, assume you are using a 741 opamp as in the lab. The 741 opamp has a finite gain-bandwidth product. Assume that the bandwidth (or cutoff frequency) of the circuit in part (a) is 25 kHz when the voltage gain = 40. If you change R2 to DOUBLE the voltage gain to 80, the bandwidth (or cutoff frequency) of the circuit will

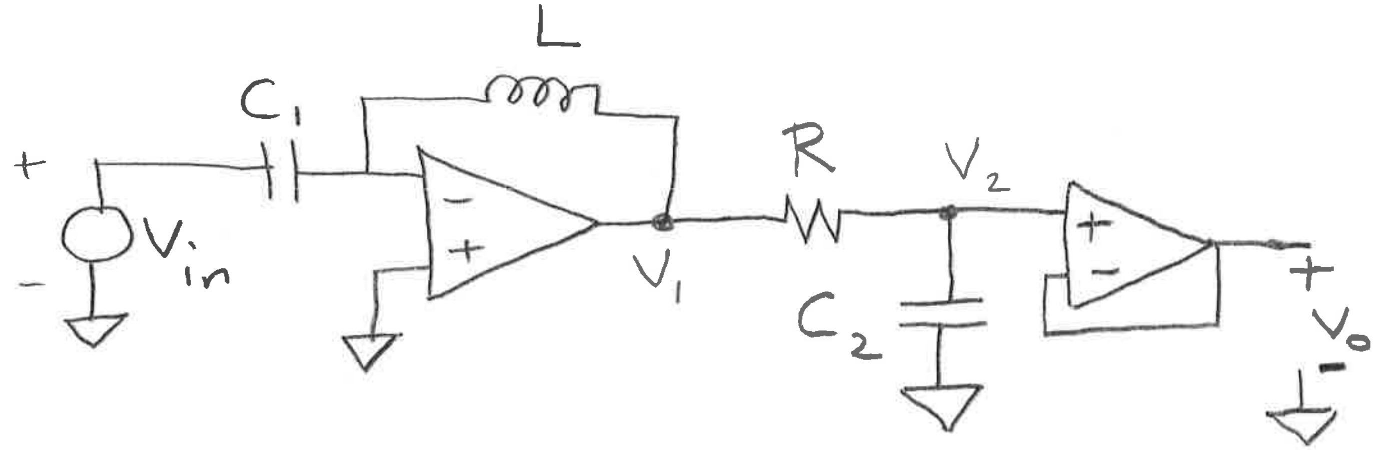
- ☐ increase.
- ☒ decrease.
- ☐ not change.

gain × bw = constant

gain ↑ ⇒ bw ↓

**2.** Find the s-domain transfer function $H(s) = V_o/V_{in}$ for the circuit below. ( Your answer should be in the form $H(s) = N(s)/D(s)$, where $N(s)$ and $D(s)$ are polynomials in 's'. )

$H(s)$ = ______________________________




$$\frac{V_1}{V_{in}} = -\frac{sL}{\frac{1}{sC_1}} = -s^2LC_1$$

$$\frac{V_2}{V_1} = \frac{\frac{1}{sC_2}}{R + \frac{1}{sC_2}} = \frac{1}{sRC_2 + 1}$$

$$\frac{V_o}{V_2} = 1$$

$$\Rightarrow \frac{V_o}{V_{in}} = \frac{V_o}{V_2} \cdot \frac{V_2}{V_1} \cdot \frac{V_1}{V_{in}} = 1 \cdot \frac{1}{sRC_2 + 1} \cdot (-s^2LC_1)$$

$$= -\frac{s^2LC_1}{sRC_2 + 1}$$

3. a) Convert the decimal number 22 ( or $22_{10}$) to a 6-bit binary number.

Binary number = 010110

| # | ÷ 2 = | remainder | |
|---|---|---|---|
| 22 | 11 | 0 | ← LSB |
| 11 | 5 | 1 | |
| 5 | 2 | 1 | |
| 2 | 1 | 0 | |
| 1 | 0 | 1 | |

unsigned = 10110

add sign:

010110

$2^3$ $2^1$ $2^{-2}$

b) Convert the binary number 01010.01 to a base 10 number.

Base 10 number = 10.25

$1 \cdot 2^3 + 1 \cdot 2^1 + 1 \cdot 2^{-2} = 8 + 2 + 0.25$

$= \boxed{10.25}$

4. a) What is the sum of the [redacted] binary numbers 001101 and 001001. Give the sum in binary form (base 2).

Sum (in base 2) = 0010110

sign extend

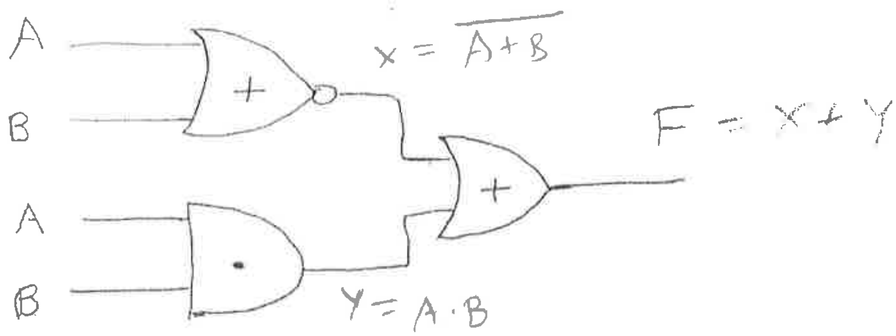
```
  0001101
+ 0001001
---------
  0010110  ← sum
```

b) What is the 2's-complement of the binary number 00101?

2's-complement = 11011

```
00101
11010  ← 1's compl.
   +1
-----
11011  ← 2's compl
```

5. For the logic circuit below, fill in the values for the output F in the truth table.




X+Y
=

| A | B | F | X | Y |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 1 |

↑ answer

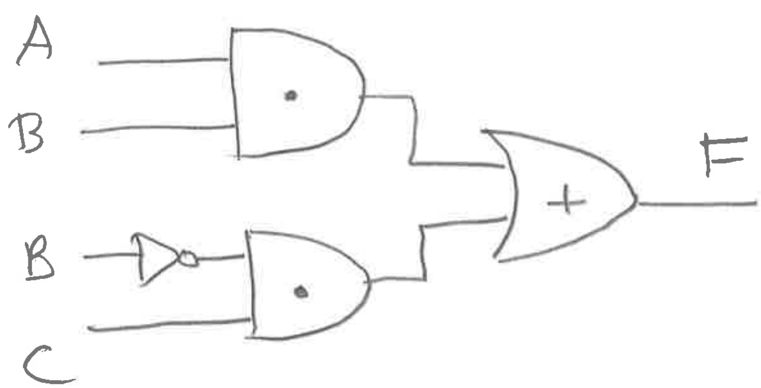
6. [redacted] Write a Sum of Products (a sum of minterms) expression for the logic function described by the truth table below.

F = $\bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C$

| A | B | C | F | minterm |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | |
| 0 | 0 | 1 | 1 | $\bar{A}\bar{B}C$ |
| 0 | 1 | 0 | 0 | |
| 0 | 1 | 1 | 1 | $\bar{A}BC$ |
| 1 | 0 | 0 | 0 | |
| 1 | 0 | 1 | 1 | $A\bar{B}C$ |
| 1 | 1 | 0 | 0 | |
| 1 | 1 | 1 | 0 | |

7. a) For the logic function below, draw a logic circuit that implements that logic function, using AND, OR and INVERT gates.

$$F = A \cdot B + \overline{B} \cdot C$$



8. Compute the difference n – m of the binary numbers n = 1011 and m = 0011. Give the answer in binary form (in 2's complement form).

n – m = 11000

add −m to n. −m = 2's compl. of m

m = 0011 ⇒ 1100 = 1's comp.

+ 1

1101 = −m

sign extend

11011 n

\+ 11101 −m

* 11000

ignore carry on left