# 6.01 Midterm 2 Spring 2011

| Name: | Section: |
|---|---|

**Enter all answers in the boxes provided.**
**Clearly written work will be graded for partial credit.**

During the exam you may:

- read any paper that you want to
- use a calculator

You may not

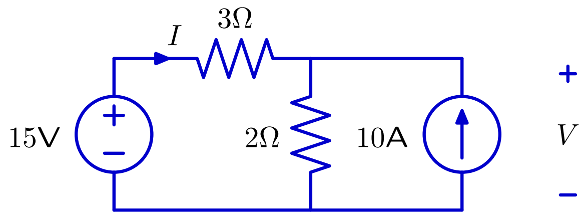
- use a computer, phone or music player

For staff use:

| | |
|---|---|
| 1. | /12 |
| 2. | /12 |
| 3. | /12 |
| 4. | /12 |
| 5. | /18 |
| 6. | /12 |
| 7. | /12 |
| 8. | /10 |
| total: | /100 |

## 1 Find the Voltage and Current (12 points).

Determine V and I in the following circuit.

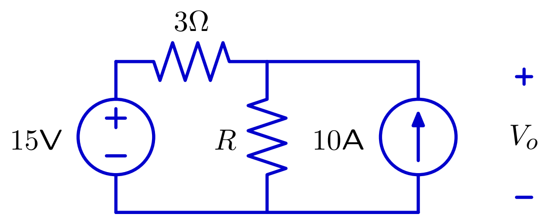



V =

I =

## 2 Find the Resistance (12 points).

Find the value of R so that $V_o = 30V$.




Enter your answer below, or enter **none** if no such value of R can be found.

R =

# 3 LTI SM (12 points).

Write a difference equation for each of these machines if it describes an LTI system or give a very brief reason why it does not. The input to the machine at step $n$ is $x[n]$ and the output of the machine at step $n$ is $y[n]$.

```
class MM1(sm.SM):
   startState = [0, 0]
   def getNextValues(self, state, inp):
       return ([state[1], inp], 2*state[0])
```

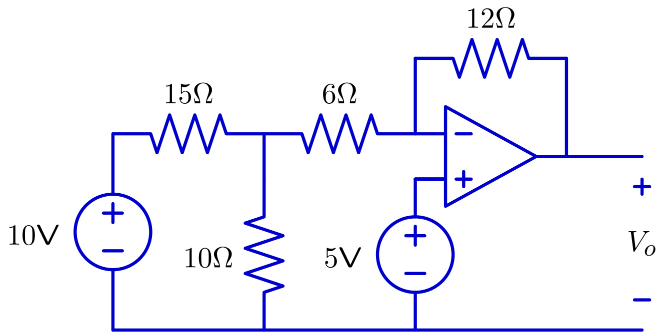
```
class MM2(sm.SM):
   startState = [0]
   def getNextValues(self, state, inp):
       return (state + [inp], sum(state))
```

```
class MM3(sm.SM):
   startState = 0
   def getNextValues(self, state, inp):
       return (max(state, inp), max(state, inp))
```

```
class MM4(sm.SM):
   startState = 0
   def getNextValues(self, state, inp):
       return (state + 1, state)
```

# 4 Op-Amp Circuit (12 points).

Determine $V_o$ in the following circuit. Assume that the op-amp is ideal.




$V_o$ =

# 5 Run Length (18 points).

One simple approach to sequence compression is called *run-length encoding* (RLE). A *run* is a subsequence of repeated entries. The idea is to represent the original sequence by a list of pairs of the form:

```
(runLength, entry)
```

For example, we could represent this list of digits:

```
[3, 3, 3, 3, 5, 5, 9, 9, 9, 3, 3]
```

by this:

```
[(4, 3), (2, 5), (3, 9), (2, 3)]
```

This representation is useful when there are likely to be long subsequences of repeated entries in the sequence.

In this problem, you will define a class to represent and manipulate RLE sequences.

```
class RLE:
    def __init__(self, seq):
        self.rleSeq = self.encode(seq)
    def encode(self, seq):
        # code 1
    def decode(self):
        # code 2
    def add(self, other):
        # code 3
```

## 5.1 Encoding

Write the definition of the `encode` method, which takes a list of digits and returns an RLE-encoded list.

```
def encode(self, seq):
```

## 5.2 Decoding

Write the definition of the `decode` method, which returns a list of digits corresponding to the RLE-encoded list for the class instance.

```
def decode(self):
```

## 5.3 Addition

Let's define addition on our sequences as component-wise addition. Assume that both sequences are the same number of characters when decoded.

```
>>> RLE([2,3,4,4,4]).add(RLE([2,3,3,3,4]))
```

should produce a new instance of the RLE class whose content is:

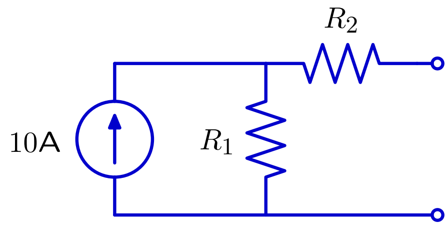
```
[(1, 4), (1, 6), (2, 7), (1, 8)]
```

Don't try to be efficient in your solution. It's fine to decode the sequences to add them.

```
def add(self, other):
```

# 6 Make it Equivalent (12 points).

Determine values of $R_1$ and $R_2$ in the following circuit




so that

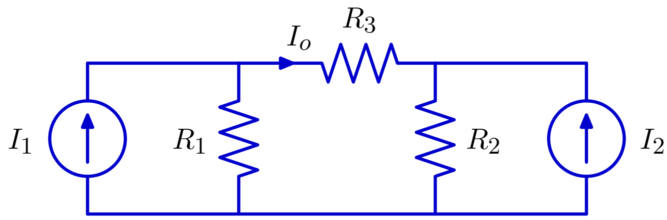
- the Thevenin equivalent voltage $V_T = 1V$, and
- the Thevenin equivalent resistance $R_T = 1\Omega$.

$R_1 =$

$R_2 =$

# 7 Current from Current Sources (12 points)

Determine an expression for $I_o$ in the following circuit.



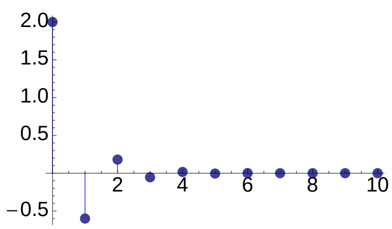

$I_0 =$ 

# 8 Poles (10 points)

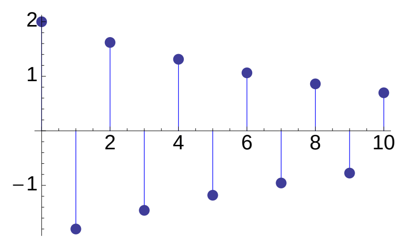
Each signal below has the form

$$s[n] = (a + bj)^n + (a - bj)^n$$

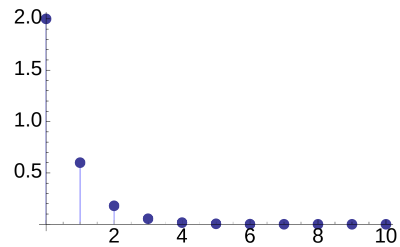
where $a$ and $b$ can have values $0, 0.3, 0.5, 0.9, 1.1, -0.3, -0.5, -0.9, -1.1$. The periodic signals have a period of either 2, 4, or 8. For each one, specify $a$ and $b$.



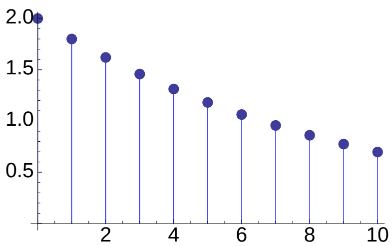

$a : -0.3 \;\; b : 0$



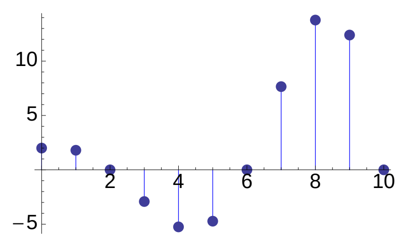

$a : -0.9 \;\; b : 0$



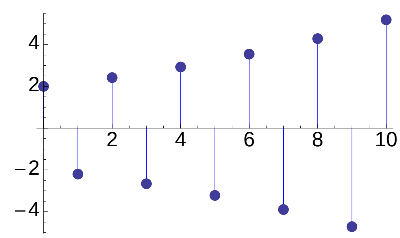

$a : 0.3 \;\; b : 0$



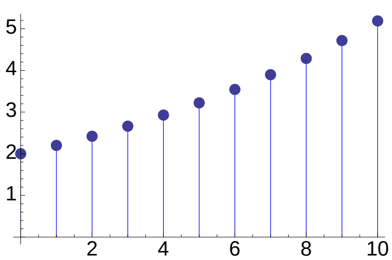

$a : 0.9 \;\; b : 0$



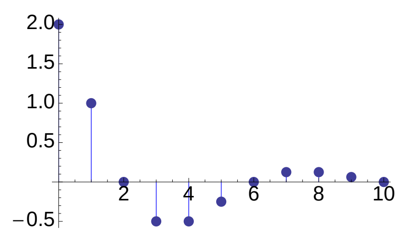

$a : 0.9 \;\; b : \pm 0.9;$



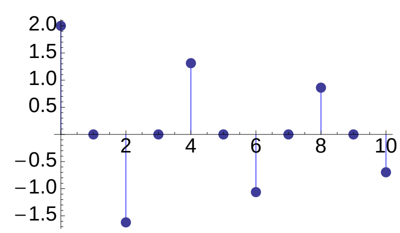

$a : -1.1 \;\; b : 0$



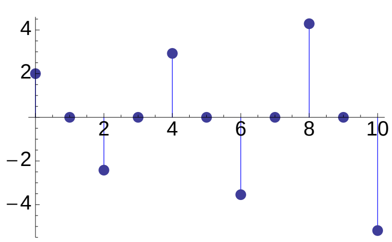

$a : 1.1 \;\; b : 0$




$a : 0.5 \;\; b : \pm 0.5$




$a : 0.0 \;\; b : \pm 0.9$




$a : 0.0 \;\; b : \pm 1.1$

*Worksheet (intentionally blank)*