ECE 476/676 - Homework #2

Loops, Subroutines, Loops, Binary Outputs

Loops in Python

1) A and B are playing a dice game.
   - Player A rolls three 12-sided dice and takes the sum (3d12)
   - Player B rolls four 8-sided dice and takes the sum (4d8)

Whoever has the higher total wins. Player A wins on ties.

Determine the odds that player A will win a given game using a Monte-Carlo simulation of 10,000 games.

Some sample Python code for rolling dice:

```
from random import randint
d8  = randint(1,8)
d12 = randint(1,12)
```

Python Code

```
from random import randint
from time import ticks_ms

W=0
T0 = ticks_ms()

for n in range(0,10_000):
    A = B = 0
    for i in range(0,3):
        A += randint(1,12)
    for i in range(0,4):
        B += randint(1,8)
    if(A >= B):
        W += 1

T1 = ticks_ms()

print('Problem #1')
print('A wins ', W, ' games')
print('Elapsed Time = ', T1-T0, 'ms')
```

shell window

```
Problem #1
A wins  6027  games
Elapsed Time =  1191 ms
```

2) Instead of playing a single game, player A and B play a 5-game match.

- Five games are played as per problem #1
- Whoever wins the most number of games wins the match.

Determine the odds that player A will win the match given this format using a Monte-Carlo simulation of 10,000 games.

```
from random import randint
from time import ticks_ms

T0 = ticks_ms()
M = 0

for n in range(0,10_000):
    W = 0
    for games in range(0,5):
        A = B = 0
        for i in range(0,3):
            A += randint(1,12)
        for i in range(0,4):
            B += randint(1,8)
        if(A >= B):
            W += 1
    if(W >= 3):
        M += 1

T1 = ticks_ms()

print('Problem #2')
print('A wins ', M, ' matches')
print('Elapsed Time = ', T1-T0, 'ms')
```

shell window

```
Problem #2
A wins  6865  matches
Elapsed Time =  6091 ms
```

3) Instead of playing a best-of-5 match, player A and B play a first-to-5 games, win-by-2 match

- The match keeps going until one player has won five games.
- If neither player is up by two games at that point, the match keeps going until someone is up by two games.

Determine the odds that player A will win the match given this format using a Monte-Carlo simulation of 10,000 games.

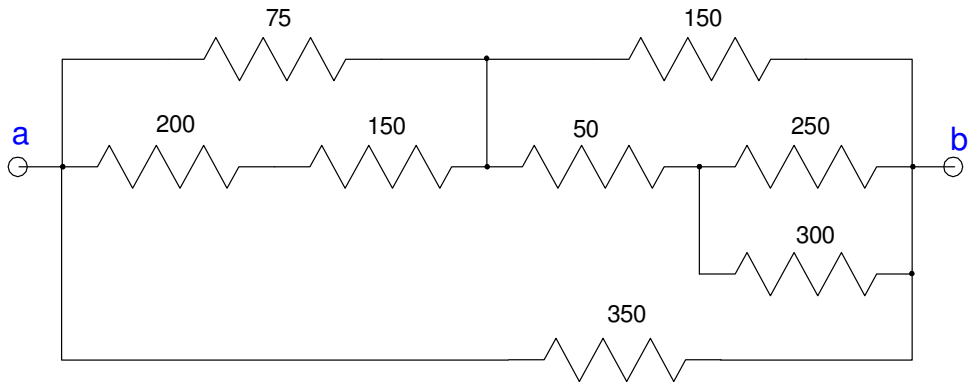
```
from random import randint
from time import ticks_ms

T0 = ticks_ms()
M = 0

for n in range(0,10_000):
    Wa = Wb = 0
    while(max(Wa, Wb) < 5):
        A = B = 0
        for i in range(0,3):
            A += randint(1,12)
        for i in range(0,4):
            B += randint(1,8)
        if(A >= B):
            Wa += 1
        else:
            Wb += 1
    while(abs(Wa-Wb) < 2):
        A = B = 0
        for i in range(0,3):
            A += randint(1,12)
        for i in range(0,4):
            B += randint(1,8)
        if(A >= B):
            Wa += 1
        else:
            Wb += 1

    if(Wa > Wb):
        M += 1
    # print(Wa, Wb, M)

T1 = ticks_ms()

print('Problem #3')
print('A wins ', M, ' matches')
print('Elapsed Time = ', T1-T0, 'ms')
```

shell window

```
>>> %Run -c $EDITOR_CONTENT

MPY: soft reboot
Problem #3
A wins  7585  matches
Elapsed Time =  11203 ms
```

Python Subroutines

4) Using Python subroutines, determine the resistance Rab

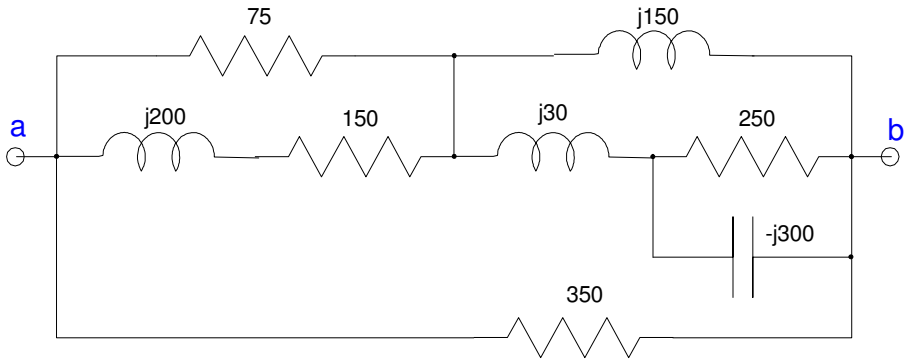



```
from time import ticks_us

T0 = ticks_us()

def Series(R1, R2):
    Rnet = R1 + R2
    return(Rnet)

def Parallel(R1, R2):
    Rnet = 1 / (1/R1 + 1/R2)
    return(Rnet)

R1 = Parallel(250, 300)
R2 = Series(R1, 50)
R3 = Parallel(R2, 150)

R4 = Series(200, 150)
R5 = Parallel(R4, 75)

R6 = Series(R3, R5)

Rab = Parallel(R6, 350)

T1 = ticks_us()

print('Problem #4')
print('Rab = ', Rab)
print('Elapsed Time = ', T1 - T0, 'us')
```

shell window

```
MPY: soft reboot
Problem #4
Rab =  102.46165
Elapsed Time =  777 us
```

5) Using Python subroutines, determine the resistance Zab




```
from time import ticks_us

T0 = ticks_us()

def Series(R1, R2):
    Rnet = R1 + R2
    return(Rnet)

def Parallel(R1, R2):
    Rnet = 1 / (1/R1 + 1/R2)
    return(Rnet)

R1 = Parallel(250, -300j)
R2 = Series(R1, 30j)
R3 = Parallel(R2, 150j)

R4 = Series(150 + 200j, 75)

R5 = Series(R3, R4)

Rab = Parallel(R5, 350)

T1 = ticks_us()

print('Problem #5')
print('Rab = ', Rab)
print('Elapsed Time = ', T1 - T0, 'us')
```

shell window

```
MPY: soft reboot
Problem #5
Rab =  (133.72505+44.200412j)
Elapsed Time =  885 us
```

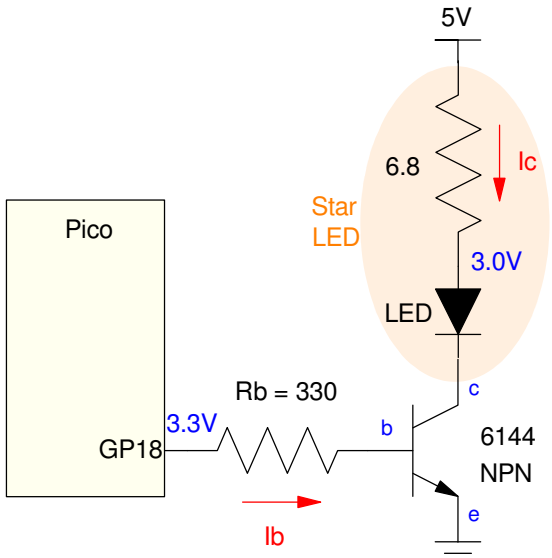
Binary Outputs

6) Write a Python program which turns on three LEDs sequentially:

- GP16 (on-board LED) for one second, then
- GP17 (on-board LED) for one second, then
- GP18 (external 1W LED) for one second, then
- repeat

Measure the following for the 1W LED when turned on:

- The voltage out of the Pico microcontroller
- The voltage across the 1W LED and
- The volage Vce across the 6144 NPN transistor



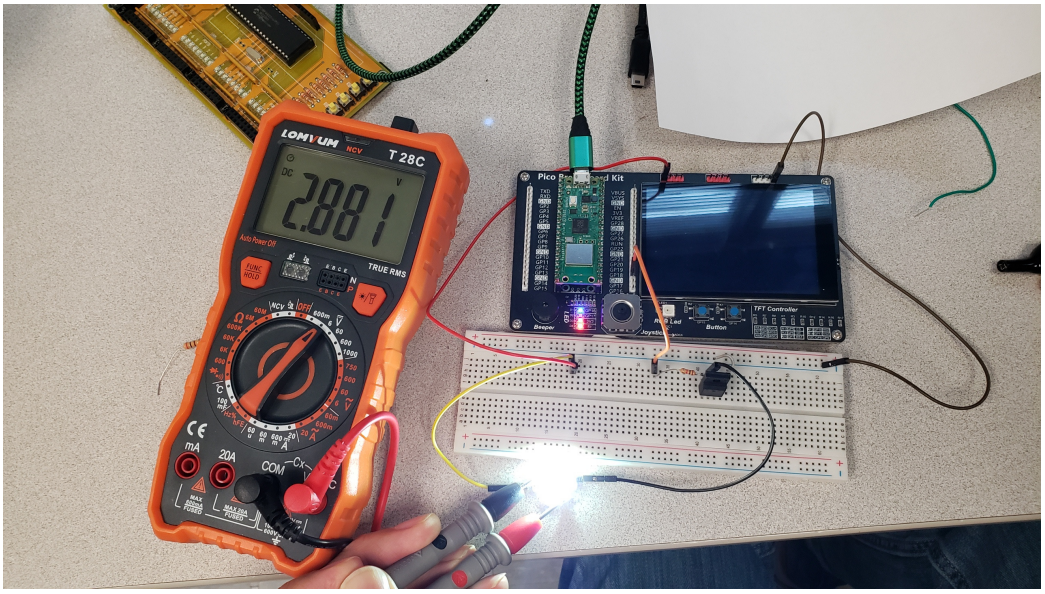
Problem #6

```
from machine import Pin
from time import sleep

LED16 = Pin(16, Pin.OUT)
LED17 = Pin(17, Pin.OUT)
LED18 = Pin(18, Pin.OUT)

while(1):
    LED16.value(0)
    LED17.value(0)
    LED18.value(0)
    sleep(1)
    LED16.value(1)
    sleep(1)
    LED17.value(1)
    sleep(1)
    LED18.value(1)
    sleep(1)
```

shell window

Lab Data

	Calculated	Measured
Vbe	700mV	726mV
Vce	200mV	20mV
Vd (LED voltage)	3.0V @ 330mA	2.881V
Id (LED current)	264.7mA	195.4mA



7) Write a python program to drive an H-bridge tied to your DC motor. The motor should

- Spin clockwise for one second, then
- Stop for one second, then
- Spin in counter clockwise for one second, then
- Stops for one second,
- Then repeats

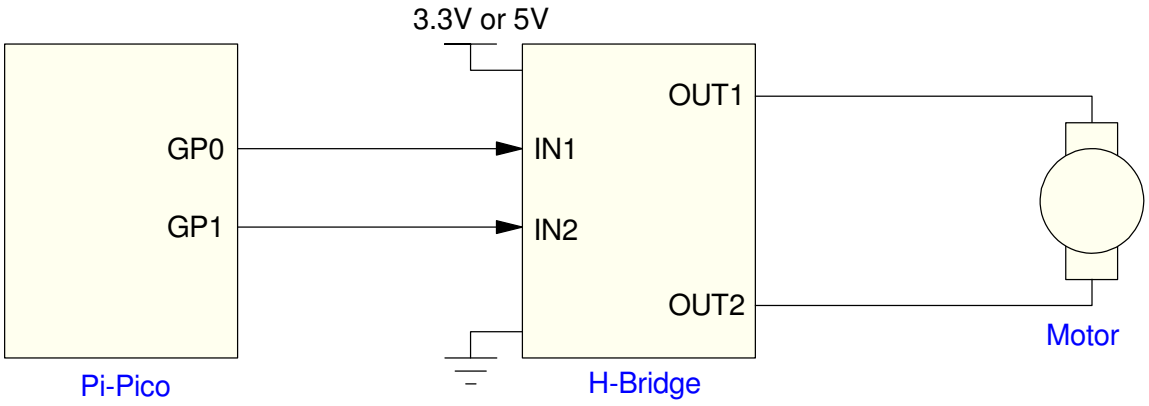
```
from machine import Pin
from time import sleep

LED16 = Pin(16, Pin.OUT)
LED17 = Pin(17, Pin.OUT)
GP0   = Pin(0, Pin.OUT)
GP1   = Pin(1, Pin.OUT)

def Fwd():
    LED16.value(1)
    LED17.value(0)
    GP0.value(1)
    GP1.value(0)

def Rev():
    LED16.value(0)
    LED17.value(1)
    GP0.value(0)
    GP1.value(1)

def Stop():
    LED16.value(0)
    LED17.value(0)
    GP0.value(0)
    GP1.value(0)

while(1):
    Stop()
    sleep(1)
    Fwd()
    sleep(1)
    Stop()
    sleep(1)
    Rev()
    sleep(1)
```

shell window

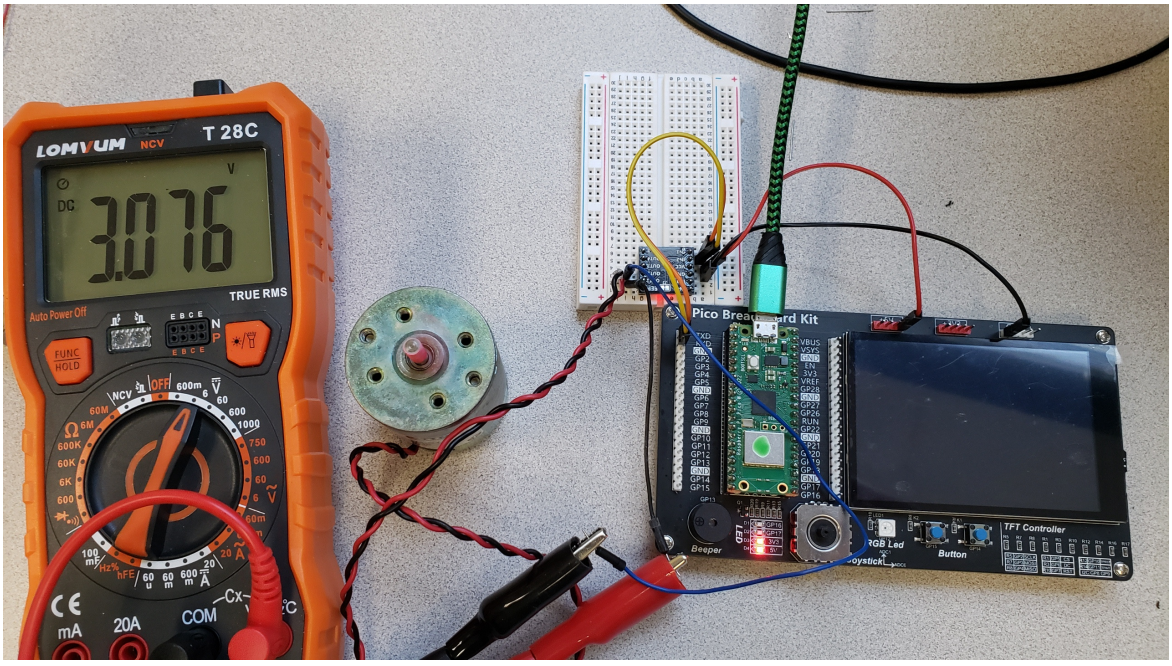
8) Measure the votlages when the motor is spinning clockwise, stopped, and counter-clockwise

- The voltage out of the Pico microcontroller
- The votlage across the motor

State	GP0	GP1	V(motor)	Motor
fwd	3.076V	0.00V	+4.467V	CW
stop	0.00V	0.00V	0V	stop
ref	0.00V	3.021V	-4.447V	CCW



Problem 7 & 8



9) Demonstrate either the LED or the motor problem
   - in-person or attach a short video showing the lights or motor