Final Exam, Version 2
CSCI 127: Introduction to Computer Science
Hunter College, City University of New York

December 18, 2023

Exam Rules

- Show all your work. Your grade will be based on the work shown.
- The exam is closed book and closed notes.
- When taking the exam, you may have with you pens, pencils, and an 8 1/2" x 11" piece of paper filled with notes, programs, etc.
- You may not use a computer, calculator, tablet, smart watch, or other electronic device.
- Do not open this exam until instructed to do so.

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I understand that all cases of academic dishonesty will be reported to the Dean of Students and will result in sanctions.
Name: Melissa Lynch
EmpID:
Signature:

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	*[NULL]*	32	20	*[SPACE]*	64	40	@	96	60	`
1	1	*[START OF HEADING]*	33	21	!	65	41	A	97	61	a
2	2	*[START OF TEXT]*	34	22	"	66	42	B	98	62	b
3	3	*[END OF TEXT]*	35	23	#	67	43	C	99	63	c
4	4	*[END OF TRANSMISSION]*	36	24	$	68	44	D	100	64	d
5	5	*[ENQUIRY]*	37	25	%	69	45	E	101	65	e
6	6	*[ACKNOWLEDGE]*	38	26	&	70	46	F	102	66	f
7	7	*[BELL]*	39	27	'	71	47	G	103	67	g
8	8	*[BACKSPACE]*	40	28	(	72	48	H	104	68	h
9	9	*[HORIZONTAL TAB]*	41	29	)	73	49	I	105	69	i
10	A	*[LINE FEED]*	42	2A	*	74	4A	J	106	6A	j
11	B	*[VERTICAL TAB]*	43	2B	+	75	4B	K	107	6B	k
12	C	*[FORM FEED]*	44	2C	,	76	4C	L	108	6C	l
13	D	*[CARRIAGE RETURN]*	45	2D	-	77	4D	M	109	6D	m
14	E	*[SHIFT OUT]*	46	2E	.	78	4E	N	110	6E	n
15	F	*[SHIFT IN]*	47	2F	/	79	4F	O	111	6F	o
16	10	*[DATA LINK ESCAPE]*	48	30	0	80	50	P	112	70	p
17	11	*[DEVICE CONTROL 1]*	49	31	1	81	51	Q	113	71	q
18	12	*[DEVICE CONTROL 2]*	50	32	2	82	52	R	114	72	r
19	13	*[DEVICE CONTROL 3]*	51	33	3	83	53	S	115	73	s
20	14	*[DEVICE CONTROL 4]*	52	34	4	84	54	T	116	74	t
21	15	*[NEGATIVE ACKNOWLEDGE]*	53	35	5	85	55	U	117	75	u
22	16	*[SYNCHRONOUS IDLE]*	54	36	6	86	56	V	118	76	v
23	17	*[ENG OF TRANS. BLOCK]*	55	37	7	87	57	W	119	77	w
24	18	*[CANCEL]*	56	38	8	88	58	X	120	78	x
25	19	*[END OF MEDIUM]*	57	39	9	89	59	Y	121	79	y
26	1A	*[SUBSTITUTE]*	58	3A	:	90	5A	Z	122	7A	z
27	1B	*[ESCAPE]*	59	3B	;	91	5B	[	123	7B	{
28	1C	*[FILE SEPARATOR]*	60	3C	<	92	5C	\	124	7C	|
29	1D	*[GROUP SEPARATOR]*	61	3D	=	93	5D	]	125	7D	}
30	1E	*[RECORD SEPARATOR]*	62	3E	>	94	5E	^	126	7E	~
31	1F	*[UNIT SEPARATOR]*	63	3F	?	95	5F	_	127	7F	*[DEL]*

(Image from wikipedia commons)

1. (a) What will the following Python code print:

i.
```
banana = "xxyyzzZcaabbZbcyc"
print(banana.count("c"))
```

Output: 3

ii.
```
B = banana.split("Z")
print(B[0])
```

Output: xx yy zz

iii.
```
up = B[-1].upper()
print(up)
```

Output: BCYC

iv.
```
for c in up:
    print(c.lower())
```

Output:
b
c
y
c

(b) Consider the contents of the current directory:

```
banana.txt  banana.py   carrot.csv  clementine.py   dragonfruit
```

i. What is the output for:

```
$ ls *r*
```

Output:
carrot.csv
dragonfruit

ii. What is the output for:

```
$ mv *.py ./dragonfruit
$ ls
```

Output:
banana.txt
carrot.csv
dragonfruit

iii. What is the output for:

```
$ ls -l | grep "banana" | wc -l
```

Output: 1

2. (a) Select the correct option.

   i. What color is tina after this command? `tina.color("#880000")`
   ☐ black ■ red ☐ white ☐ gray ☐ green

   ii. Select the SMALLEST binary number:
   ☐ 1011 ☐ 1101 ■ 0111 ☐ 1010 ☐ 1110

   iii. Select the LARGEST hexadecimal number:
   ■ FD ☐ EA ☐ EF ☐ FC ☐ CD

   iv. What is the binary number equivalent to decimal 7?
   ☐ 1011 ☐ 0001 ☐ 1100 ■ 0111 ☐ 1110

   v. What is the hexadecimal number equivalent to decimal 34?
   ☐ 34 ■ 22 ☐ 24 ☐ 2B ☐ CD

   (b) Fill in the code below to make an image in which a pixel is green if it has an entry of 50 or greater in the array `elevations`. Otherwise, the pixel should be colored red.

```
# Takes elevation data of NYC and displays storm surge map
import numpy as np
import matplotlib.pyplot as plt
elevations = np.loadtxt("elevationsNYC.txt")
#Base image size on shape (dimensions) of the elevations:
mapShape = elevations.shape + (3,)
floodMap = np.zeros(mapShape)

for row in range(mapShape[0]):
    for col in range(mapShape[1]):
```

```
if elevations[row,col] >= 50:
    floodMap[row,col,1] = 1.0
else:
    floodMap[row,col,0] = 1.0
```

```
#Save the image:
plt.imsave("floodMap.png", floodMap)
```

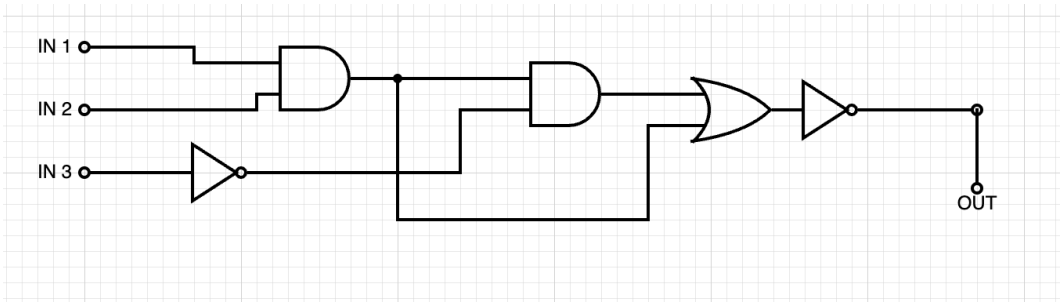
3. (a) What is the value (True/False):

i.
```
in1 = False
in2 = False
out = in1 or in2
```
out = False

ii.
```
in1 = False
in2 = True
out = not in1 or (in2 and not in1)
```
out = True

iii.
```
in1 = True
in2 = False or not in1
in3 = in1 and in2
out = in1 or not in3
```
out = True

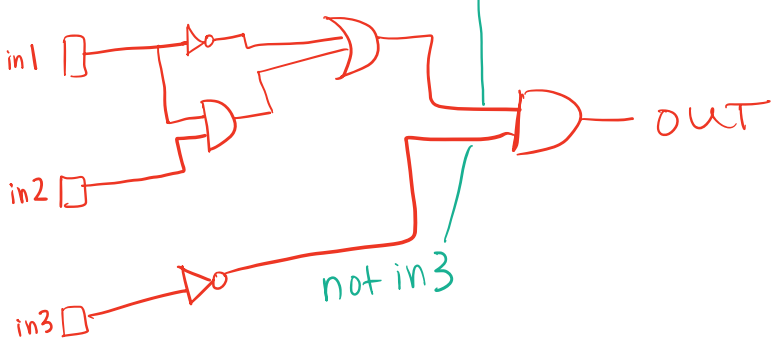
iv.




```
in1 = True
in2 = True
in3 = False
```
out = False

(b) Design a circuit that implements the logical expression:

```
((not in1) or (in1 and in2)) and (not in3)
```

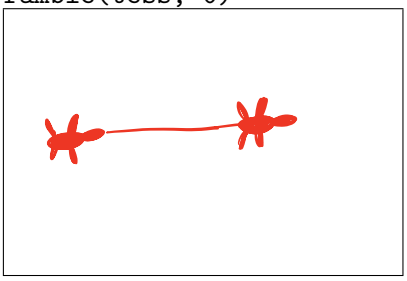


4. (a) Draw the output for the function calls:

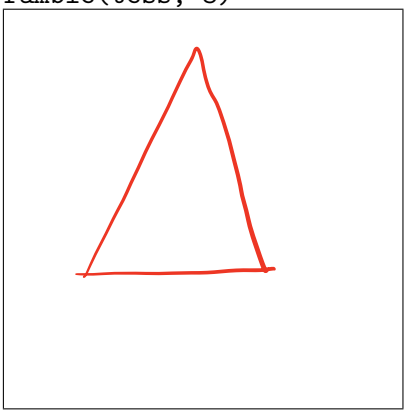
```
import turtle
tess = turtle.Turtle()
tess.shape("turtle")

def ramble(t, side):
    if side == 0:
        t.stamp()
        t.forward(50)
        t.stamp()
    else:
        for i in range(side):
            t.forward(50)
            t.left(360/side)
```

i. `ramble(tess, 0)`



ii. `ramble(tess, 3)`



(b) What is the output:

```
#Another mystery program...
def mystery(num):
     send = chr(num)
     if num < ord("d"):
          send = send + "X"
     return send

def enigma(letters):
    data = ""
    for x in letters:
        n = ord(x)
        c = "C"
        if n > 100:
            c = mystery(n)
        data = data + c
    return data

word = input("Enter a word: ")
s = enigma(word)
print(s)
```

i. When the user enters: `aa`?

Output:

CC

ii. When the user enters: `cab`?

Output:

CCC

iii. When the user enters: `alice`?

Output:

ClCe

5. Fill in the Python program below. Consider the following pseudocode:

   - Generate a random integer from 0 to 7 (inclusive), call it `x`
   - Print the number in one's complement representation; that is, given a binary string, all 0's become 1's and all 1's become 0's
   - **Example:** 0110 in one's complement representation is 1001

```
#imports the library for generating random numbers
import random

#generates a random integer from 0-7 inclusive
x = random.randrange(8)

#converts the random integer to a binary string
binary = bin(x)[2:]  # sample use:  bin(6)[2:]  == "0110"

#stores the one's complement representation of x
result = ""

#loops through the binary string
for c in binary:
    #if the char is "0", add "1" to result
    if c == "0":
        result += "1"
    #otherwise, add "0" to result
    else:
        result += "0"

#prints x and its one's complement representation
print(x, result)
```

6. Consider the following main function that analyzes star data:

```
import pandas as pd
    def main():
        stars = pd.read_csv("stars.csv")
        top3 = topK(stars, "Star color", 3)
        maxTemp = hottestStar(stars)
```

Define the functions below:

```
def topK(df, colName, k):
    """
    Returns the top k values in the given column and DataFrame
    Assume the following:
    - k is a valid integer (will not cause errors)
    - colName is a string that is the name of a column in the DataFrame df
    """
```

```
top_k = df[colName].value_counts()[:k]
return(top_k)
```

```
def hottestStar(df):
    """
    Takes a DataFrame as input
    Returns the maximum value in the column, "Temperature"
    """
```

```
hottest_star = df["Temperature"].max()
return(hottest_star)
```

7. Fill in the Python program below that asks the user for the name of a .png (image) file and **turns the left half of the image red.** The new image should then be displayed to the user.

```
#import the libraries for images
import numpy as np
import matplotlib.pyplot as plt

#get user input
infile = input("Enter file name: ")

#read the image file
img = plt.imread(infile)

#get the width of the image
width = img.shape[1]

#make a copy of the original image
img2 = img.copy()

#set the green and blue channels to 0.0
img2[:, :width//2, 1:] = 0.0

#set the red channel to 1.0
img2[:, :width//2, 0] = 1.0

#load the image into pyplot
plt.imshow(img2)

#display the image
plt.show()
```

8. (a) Consider the following MIPS program:

```
ADDI $s0, $zero, 3
ADD $s1, $s0, $s0
ADD $s2, $s1, $s1
ADDI $s3, $s2, 5
```

After the program runs, what is the value stored in:

i. register `$s1`

6

ii. register `$s2`

12

iii. register `$s3`

17

(b) What is the output for a run of this MIPS program:

Output:

LMNO

```
#Loop through four letters:
ADDI $sp, $sp, -5           # Set up stack
ADDI $t0, $zero, 76         # Start $t0 at 76 (L)
ADDI $s2, $zero, 80         # Use to test when you reach 80 (P)
SETUP: SB $t0, 0($sp)       # Next letter in $t0
ADDI $sp, $sp, 1            # Increment the stack
ADDI $t0, $t0, 1            # Increment the letter
BEQ $t0, $s2, DONE          # Jump to done if $t0 == 80
J SETUP                     # If not, jump back to SETUP for loop
DONE: ADDI $t0, $zero, 0    # Null (0) to terminate string
SB $t0, 0($sp)              # Add null to stack
ADDI $sp, $sp, -4           # Set up stack to print
ADDI $v0, $zero, 4          # 4 is for print string
ADDI $a0, $sp, 0            # Set $a0 to stack pointer for printing
syscall                     # print to the log
```

9. What is the output of the following C++ programs?

(a)

```
//Heraclitus
#include <iostream>
using namespace std;
int main() {
   cout << "No man steps foot\n";
   cout << "in the same river\ntwice, ";
   cout << "for it is not the" << endl;
   cout << "same river, and he is";
   cout << "\nnot the same man;";
}
```

Output:

No man steps foot
in the same river
twice, for it is not the
same river, and he is
not the same man;

(b)

```
//Mystery C++, #2
#include <iostream>
using namespace std;
int main() {
  int sum = 4;
  while (sum < 10) {
    cout << sum;
    sum = sum + sum;
  }
}
```

Output:

48

(c)

```
//Mystery C++, #3
#include <iostream>
using namespace std;
int main() {
  for (int i = 0; i < 4; i++) {
    for (int j = 0; j <  4; j++) {
      if (j % 2 == 0) {
        cout << "+";
      } else {
        cout << "-";
      }
    }
    cout << endl;
  }
}
```

Output:

+ - + -
+ - + -
+ - + -
+ - + -

10. (a) Write a **complete C++ program** that prompts the user for a string until a non-empty string is entered. The program then prints the non-empty string that was entered.

```
//include library for input/output and declare namespace
#include <iostream>
using namespace std;

//main function signature
int main()
{
  //prompt user for string until non-empty string is entered
  string s = ""; // empty string
  while (s == "") {
    cout << "Enter a nonempty string: ";
    cin >> s;
  }

  //print non-empty string that was entered
  cout << s;

  return 0;
}
```

(b) Write a **complete C++ program** that prints the change in population of predator and prey following the Lotka-Volterra model:

$$r = 2 * r - (0.25 * r) * f$$
$$f = 0.95 * f + (0.1 * r) * f$$

Assume that the starting population of prey (rabbits) is 1000 and the starting population of predators (foxes) is 100. Your program should print for the first 10 years: the year, the number of prey, and the number of predators.

```
//include library for input/output and declare namespace
```

```
#include <iostream>
using namespace std;
```

```
//main function signature
```

```
int main ()
```

```
{
  //calculate and print the predicted population
```

```
double r = 1000.0;
double f = 100.0;

for (int year = 0; year < 10; year++) {
    cout << year << endl;
    cout << r << "\t" << f << endl;
    //calculate next year's population
    r = r*2.0 - (r*0.25)*f;
    f = f*0.95 + (r*0.1)*f;
}
```

```
  return 0;
}
```