The first half of the final exam will be much like the midterm in that it will deal with things like for loops, while loops, lists, strings and function definitions, though it will also expect you to be more comfortable working with these programming structures and data types. You should be able to write and understand simple nested for loops, use list and string methods, use list and string slicing, and you should be able to use loops to manipulate strings and lists. There are four additional files available in the Final Exam folder on Sakai. If you are comfortable with the problems on the midterm as well as the Final Exam study materials, it will go a long way towards helping you be well prepared for the final exam. Looking at past i>clicker questions and knowing how to solve the lab and program assignments will also help ensure you are well prepared.

Below is a set of sample final exam questions. Unless otherwise marked, these problems would typically be worth 3 points each.

1. What does the following Python code print?:

```
def f(n, m):
    if n >= m:
        return n + m
    else:
        return 1 + f(n + 1, m – 2)

print(f(3, 7))
```

---

2. What does the following Python code print?

```
L = [3, 2, 4, 1]
for i in range(1, len(L)):
    total = L[i] – L[i – 1]
    print(total)
```

---

3. What does the following Python code print?

```
def mixed(b, c, d, e):
    print(e, d, c, b)
    return

y = mixed(5, 4, e = 3, d = 6)
```

---

4. What does the following Python code print?

```
list1 = [4, 6, 8]
list2 = [3, 7, 9, 12]
for m in list2:
    list1 = [m] + list1
print(list1)
```

Problems 5, 6, and 7 use the following 2D Python list:

```
x = [[0, 5, 2, 1], [4, 2, 4, 7], [8, 9, 1, 2], [-2, -3, 6, 7]]
```

5. What does the following Python code print?

```
print(x[3][1])
print(x[1][0])
```

6. What does the following Python code print?

```
for j in [3, 1]:
    print(x[j])
```

7. What does the following Python code print?

```
for j in range(2, 3):
    for k in range(2):
        print(x[j][k])
```

8. What does the following Python code print?

```
fruit = 'orange'
print(fruit[3])
print(fruit[2:5])
print(fruit[1:6:2])
```

Questions 9 and 10 refer to the following Python code:

```
def f(x):
    string = '0123456789ABCDEF'
    if 0 <= x and x <= 15:
        return string[x]
    else:
        return

print(f(11))
```

9. What does the above Python code print?

10. What would be a more meaningful name for the above function? (Hint: think about your lab assignments.)

11. When a programmer wants to open a file for input or output, the Python statement used is:

```
file_reference = open(                          )
```

Describe all the arguments that you need to specify in the above call to the `open()` function.

12. Describe direct recursion:

Describe indirect recursion:

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13. Write Python code that uses indirect recursion. The code doesn't need to do anything meaningful other than use indirect recursion.

14. (6 pts) Answer parts a, b and c based on the following Python code:

```
def f(k):
    if type(k) != int or k < 1:
        print('k must be a positive integer')
        return None

    if k == 1:
        return 1
    else:
        return k ** 2 + f(k – 1)
```

a. (1 pt) What do we call this type of function?

b. (2 pts) Evaluate f(3):

c. (3 pts) Describe what this function does:

15. (7 pts) A mathematical function g(x) is defined as follows:

$$g(x) = \begin{cases} 5 & \text{when } x = 0 \\ 3 & \text{when } x = 1 \\ g(x-2) - g(x-1) & \text{when } x \geq 2 \end{cases}$$

Write a recursive Ptyhon function named g(), that takes a single parameter, x, and that returns a value according to the above definition of g(x). (No documentation is required, though it might help earn partial credit.)

16. (2 pts) Name two algorithms used for searching:

(4 pts) Suppose you are running a test in which you are collecting lots of data, and the data is written to a file as it is collected. The data is numeric and the values continually fluctuate up and down. Which of the two search algorithms we've studied would you use to search this file for a specific value? Why?

17. (4 pts.) Using a **linear** search of an unordered list containing **n** elements, what is the average number of comparison needed to find the index of a target value, **k**, assuming that **k** is in the list? _____

What is the worst case number of comparisons, assuming **k** is in the list? _____

18. (4 pts.) Using a **binary** search of a sorted list containing **n** elements, what is the average number of comparison needed to find the index of a target value, **k**, assuming that **k** is in the list? _____

Using a **binary** search on a dictionary containing **W** words, it takes **d** comparisons on average to find the index of a random word. How many comparisons does it take on average to find a random word in a dictionary containing **8W** words (i.e., 8 times as many words)? _____

Questions 19 – 30 refer to MATLAB

19. (4 pts.) In MATLAB, what is the purpose of each of the following commands:

```
diary



hold
```

20. (4 pts.) Consider the following MATLAB code. Circle all the elements of x that will be summed up.

```
x = [3 4 5 6 7; 1 2 4 6 8; 5 7 9 1 3; 8 7 6 5 4; 9 8 7 6 5]

total = 0
for n = 2:2:4
    for k = 1:1:3
        total = total + x(k, n)
    end
end
```

21. What is the value of x after executing the following MATLAB command?

```
x = 0:0.1:0.5
```

---

22. What is the value of x after executing the following MATLAB command?

```
x = linspace(0, 0.5, 6)
```

---

23. What is the advantage of using the linspace() function instead of the colon operator, to generate an array of numbers from a to b inclusive?

24. Write a single MATLAB expression that will assign to M, a 2D array composed of the bold underlined values in the 2D array A, shown below. The expression must work even if you can't see the numbers stored in A.

$$E = \begin{bmatrix} 1 & \mathbf{9} & \mathbf{11} & \mathbf{0} & \mathbf{51} & 3 \\ 17 & \mathbf{13} & \mathbf{1} & \mathbf{7} & \mathbf{43} & -4 \\ -1 & 0 & 6 & 27 & -2 & 5 \\ 2 & 8 & -18 & 2 & -6 & 0 \\ 11 & 71 & 3 & 0 & 8 & 11 \\ 20 & \mathbf{49} & \mathbf{16} & \mathbf{-18} & \mathbf{2} & 21 \end{bmatrix}$$

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25. (4 pts.) In MATLAB, suppose you have the following 2D array representing a set of four simultaneous equations involving 4 unknowns. Assuming you want to solve these equations by manipulating the rows using Gauss-Jordan elimination, as presented in class, write a MATLAB command that you might start with.

$$A = \begin{bmatrix} 6 & 6 & 2 & 4 & 7.4 \\ 1 & 5 & 6 & 8 & 8.9 \\ 4 & 7 & 3 & 2 & 3.4 \\ 2 & 3 & 4 & 3 & 1.1 \end{bmatrix}$$

---

26. Create a MATLAB array named numbers with the values 1.5, 1.7, 1.9, 2.1, ..., 3000.5

(Problems 27 and 28)
In the class example for using the Monte Carlo Method and MATLAB to estimate the value of π (Pi), an if statement similar to the following was used. The variable name used in class has been replaced with x in this code.

```
if mod(x, 200) == 0
    drawnow
end
```

27. What does the variable x represent?

---

28. What was the purpose of this of code?

---

29. Describe what the following MATLAB command does

    print –dpng 'filtered_data.png'

30. Is the following statement true or false (circle one)?

    When performing a Monte Carlo simulation, if you throw 11 “darts”, instead of 10 “darts”, your result is guaranteed to be more accurate.

    True False

DATABASE PROGRAMMING

31. Suppose you are asked to write a program for manipulating a database, and the program must include the following menu options:

    i – insert a new record
    d – delete a record
    m – modify an existing record
    e – exit the database

a. (4 pts) Discuss how the choice to make the database a global variable or a local variable affects how the various database functions can modify the database.

b. (6 pts) Write a Python function called get_valid_input() that asks the user to choose a menu option, and performs input validation to ensure that the user enters one of the valid choices from the above menu. The function should return the user's valid choice. Your function does not need to print the menu of choices, and your function does not need to be documented.

c. (15 pts) Write a Python function called main() that could serve as the primary function to drive the database program. Your program should assume that the following functions are already written (Do NOT write these functions!), and that they don't take any arguments or return any values:

menu() – Display the menu of choices
insert() – Allow the user to insert a new record
delete() – Allow the user to delete a record
modify() – Allow the user the modify an existing record

Your program does not need to display a welcome message. Your program does not need to be documented. Your program MUST use the four functions listed above, and it MUST use your function from part b. Your function Must output a simple goodbye message when the user chooses 'e' to exit. **Your solution must NOT be recursive**.