# CS240 HW #4

Answers to the following exercises should be prepared in a text editor and submitted through Canvas as a .pdf file. Equations should be properly formatted using equation editing software. Don't forget to include your name and an honor code statement.

1. Write the value of the following recurrences for $n = 0$ to 4. (3pts)

   - $T(0) = 1$
     $T(n) = 5T(n-1)$

   - $T(0) = 2$
     $T(1) = 2$
     $T(n) = 4T(n-2) + 2$

   - $T(0) = 0$
     $T(n) = T(n-1) + n^2 + n$

2. Write the value of the following recurrences for $n = 1$, 2, 4 and 8. (3pts)

   - $T(1) = 3$
     $T(n) = 4T(n/2)$

   - $T(1) = 1$
     $T(n) = T(n/2) + 4$

   - $T(1) = 0$
     $T(n) = T(n/2) + n^2 + n$

3. Write recurrence relations that describe the number of times that `print` is called by each of the following recursive functions. (2pts)

```
def fun1(n):
    if n == 0:
        print(n)
    else:
        for i in range(3):
            print(i, n)
        fun1(n - 1)

def fun2(n):
    if n == 0:
        print(n)
    else:
        print(n)
        for i in range(4):
            fun2(n - 1)
```

4. Use the method of backward substitution to solve the recurrences from the previous exercise. Show your work. (2pts)

   Hints:

   - For the second recurrence, it may be useful to recall the general formula for a geometric sum:

     $$\sum_{j=0}^{n} r^j = \frac{1 - r^{n+1}}{1 - r}.$$

     It follows from this that:

     $$\sum_{j=0}^{n-1} r^j = \frac{1 - r^n}{1 - r}.$$

   - Since we are counting print statements, you should be able to double check your solution by executing the code and counting the number of lines printed.
   - Wolfram alpha (www.wolframalpha.com) is able to solve recurrences like these automatically. Feel free to use this tool to check your answers. Your score will be based on showing the steps required to solve the recurrences using backward substitution.