

**ICOM 4036: Programming Languages**  
**Final Exam (Take Home)**  
**Deadline: December 14, 2013 – 11:45 am**

Source codes, header files, and a report discussing your implementations and the outcomes must be submitted via email to [wilson.riveragallego@upr.edu](mailto:wilson.riveragallego@upr.edu)

1. Write a regular expression for the following languages:
  - (a) Even binary numbers (read from left to right)
  - (b) All strings consisting of '0' and '1' that do not contain the substring '11'
2. Construct finite automata (DFA or NFA) for the following languages:
  - (a) Even decimal numbers
  - (b) Decimal numbers that are multiples of 3
3. Write the corresponding regular expressions for the automata in problem 2. Discuss when using an RE or FA is appropriate.
4. **(Python)** Consider the following function in Python

```
def art_pic(pict):  
    w = getWidth(pict)  
    h = getHeight(pict)  
    newPict = makeEmptyPicture(w * 2, h * 2)  
    copyInto (pict, newPict, 1, 1)  
    copyInto (clearRed(pict), newPict, w + 1, 1)  
    copyInto (clearGreen(pict), newPict, 1, h + 1)  
    copyInto (clearBlue(pict), newPict, w + 1, h + 1)  
    return newPict
```

Develop the code needed to complete the `art_pic` implementation. Turn in your code in one Python file. The `clearRed` function removes all the red in a picture. As a result, `myNewPict` is a copy of `myPict` with no red. Similarly, `clearGreen` and `clearBlue` removes green and blue, respectively.

5. **(openMP)** Consider a simple loop that calls a function dummy containing a programmable delay. All invocations of the functions are independent of the others. Partition this loop across four threads using static, dynamic and guided scheduling. Use different parameters for static and guided scheduling. Discuss the results of this experiment as the delay within the dummy function becomes large.