• **INTEGRITY:** By taking this exam, you pledge that this is your work and you have neither given nor received inappropriate help during the taking of this exam in compliance with the Honor Code of Emory University. Do NOT sign nor take this exam if you do not agree with the honor code.

• **INSTRUCTIONS:**
  - Keep your eyes on your own paper.
  - Do your best to prevent anyone else from seeing your work.
  - Do NOT communicate with anyone other than the professor/proctor for ANY reason in ANY language in ANY manner.
  - Do not use notes, books, calculators, etc during the exam.
  - Turn all mobile devices off and put them away now. You cannot have them on your desk.
  - Write neatly and clearly. What I cannot read, I will assume to be incorrect.
  - Academic misconduct will not be tolerated. You are to uphold the honor and integrity bestowed upon you by Emory University. Penalties for misconduct will be a zero on this exam, an F grade in the course, and/or other disciplinary action.

• **TIME:** This exam has 9 questions on 9 pages including the title page. Please check to make sure all pages are included. You will have 50 minutes to complete this exam.

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*I commit to uphold the ideals of honor and integrity by not betraying the trust bestowed upon me as a member of the Emory community. I have read and understand the requirements outlined above.*

Signature: __________________________

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1. **Multiple Choice.** Choose the best answer and circle your answer.

(a) (2 points) A cyborg is ____________.
   - A. a robot.
   - B. a mechanical/artificial humanoid.
   - **C. a robot which has biological components.**
   - D. a mobile robot.

(b) (2 points) Modern computers are “digital”. This means that:
   - A. their data must be human readable.
   - B. they store all data in binary format.
   - C. they must contain memory.
   - D. they have no moving parts.
   - E. they must be programmed in natural languages.

(c) (2 points) A language which must be compiled or interpreted into a form the computer can run is called:
   - A. a high-level language.
   - B. a machine language.
   - C. a natural language.
   - D. an assembly language.

(d) (2 points) The word “robot” was originally coined by:
   - **A. the Czech playwright, Karel Capek.**
   - B. the ancient Greek inventor, Archtas of Tarentum.
   - C. the French automaton maker, Jacques de Vaucanson.
   - D. Hisashige Tanaka, who was known as “Japan’s Edison.”

(e) (2 points) The first autonomous electronic robot which could sense and respond to its environment was:
   - A. Televox.
   - B. the “tortoises,” Elmer and Elsie.
   - C. Unimate.
   - D. Elektro

(f) (2 points) The 2005 DARPA Grand Challenge was won by ____________ which successfully completed the 7.36 mile course without human intervention.
   - A. Sandstorm
   - B. Highlander
   - **C. Stanley**
   - D. TerraMax

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2. **Find the Errors.** All of the example programs below have errors. Identify the error and explain why it is an error or how you would fix it.

(a) (3 points)
```python
def area:
    a = 3.14 * radius ** 2
    return a
print "Area of a three foot circle " + area(3)
```

**Solution:** incorrect function definition. should be `def area(radius):`

(b) (3 points)
```python
def area(radius):
    a = 3.14 * radius ** 2
    return a
print "Area of a three foot circle " + area(3)
```

**Solution:** no indentation for statements in function.

(c) (3 points)
```python
def area(radius):
    a = 3.14 * radius ** 2
    return a
print "Area of a three foot circle " + area()
```

**Solution:** no argument given when call to `area()` is made in print statement. Needs to have a value for the argument such as `area(3), area(6.2), etc.`

(d) (3 points)
```python
def area(radius):
    a = 3.14 * radius ** 2
    return a
area(3)
print "Area of a three foot circle " + a
```

**Solution:** `a` is a local variable and is only defined inside the function. Need to assign `a` a value in the main body of the program. Ex: `a = area(3)`

(e) (3 points)
def area(radius):
    a = 3.14 * radius ** 2

print "Area of a three foot circle " + area(3)

Solution: no return statement from function. Will cause program to only print
Area of a three foot circle with no result.
3. (6 points) What are “comments” in the context of programming in Python? Why would you include comments in your code?

**Solution:** Comments are lines in the program which begin with a #. They are not executed like normal program statements. You use them to make your code more readable and to explain your intentions when writing the code.

4. (6 points) Why do the Mars rovers, Spirit and Opportunity, have the ability to operate autonomously? Why don’t we remotely control/drive them from Earth?

**Solution:** Takes a long time for commands/programs/data to travel back and forth between Earth and Mars. On order of 15-30 minutes. Human perception of state of robot is particularly bad with a time delay.

5. (8 points) Explain the difference between *syntax errors* and *semantic errors* in programming. Give an example of each.

**Solution:**

- **Syntax errors:** rules that must be followed in programming: mistakes in spelling, indentation, etc.
  - Ex: `print bob` only works if there is a variable named `bob`. It will not print the string "bob".

- **Semantic errors:** mistakes in logic. Program will run, but doesn’t do what you wanted it to.
  - Ex: expecting the mod operator to give a percentage instead of the remainder.
  - Ex: expecting `2^3` to be 8 (correct power operator is `**`).
6. (9 points) List three tasks that a robot might be particularly suited to do in space and what makes them suited better suited for it than a human.

**Solution:** Answer varies. Must make connection to space. For example “collecting data” is something that robots do equally well on Earth or in space. Good answers would be things like mining other planets for minerals, performing pre-arrival tasks for space colonization, exploring other planets/moons, etc. Reasons include that robots are rugged, expendable, have no biological processes, cheaper, etc.
7. **Definitions.** Define the following terms and give an example of each from the robots you have seen, read about, or encountered during this course.

(a) (3 points) Robot

**Solution:** any (partly) autonomous mechanical machine which takes over human tasks in place of (or in conjunction with) a human. Examples: Stanley, Spirit, Opportunity, Topio, etc.

(b) (3 points) Sensor

**Solution:** sensors: any device which allows the robot to gather data about the state of the robot or the environment around the robot. Examples: cameras, IR sensors, light sensors, pressure sensors, etc.

(c) (3 points) Effector

**Solution:** effectors: what the robot uses to effect or manipulate the world around it. Examples would be pincers, wheels, arms, etc.

(d) (3 points) Actuator

**Solution:** actuators: mechanism which enables effector to execute actions. Examples would be gears, hydraulic or pneumatic cylinders, motors, etc.
8. **INTERPRETER.** Pretend you are the Python interpreter and evaluate the following mathematical expressions. Pay attention to the data types.

(a) (2 points) >>> 7.0 / 14

(b) (2 points) >>> 7 / 14

(c) (2 points) >>> 7 % 14

(d) (2 points) >>> 21 / 6

(e) (2 points) >>> 21 % 6

(f) (2 points) "a"*5

(g) (2 points) "b" + "a" + "d"
9. Code Writing. For each problem, write the correct Python code.

(a) (7 points) Write a function called \texttt{sticksToTbsp} which takes a parameter representing the number of sticks of butter and \texttt{returns} the number of tablespoons of butter. One stick of butter is equivalent to 8 Tbsp, so \texttt{sticksToTbsp(1)} should return 8 and \texttt{sticksToTbsp(1.5)} should return 12.

Solution:
\begin{verbatim}
def sticksToTbsp(sticks):
    tbsp = sticks * 8.0
    return tbsp
\end{verbatim}

(b) (11 points) Write a composite function called \texttt{gramsToTbsp} which takes a parameter representing the number of grams of butter and \texttt{returns} the number of tablespoons. There are 113.4 grams in one stick of butter. This function should call the function you wrote in part (a). You may assume the function from part (a) works correctly and as described.

Solution:
\begin{verbatim}
def gramsToTbsp(grams):
    sticks = grams/113.4
    tbsp = sticksToTbsp(sticks)
    return tbsp
\end{verbatim}