CS 3410, Fall 2008
Homework 2

Due: October 13, 2008, noon

1 Numbers

Fill in the blanks:

	Decimal	Octal	Hex	Binary
a)				1010111001_2
b)			$0xcf75$	
c)		561_8		
d)	423412_{10}			

2 Addition

For the following arithmetic operations, assume that the number is represented by 7 bits (if this causes problems, explain what bit size is needed for the operation). In each computation $A+B$, first show what A and B are in two's complement binary, perform the operation (and show your working), and then convert from binary back to decimal.

a) $10 - 10$
b) $64 + 56$
c) $-63 + 10$
d) $-43 - 21$
e) $24 + 18$

3 Logic

Lets design a 3-input majority gate. The majority gate has three 1-bit inputs – X, Y, and Z – and a 1-bit output (R). If two or more inputs are equal to 1, R will also be 1. Otherwise, R will equal 0. For example, if X=1, Y=0, Z=1 then R=1. However, if X=0, Y=0, Z=0 then R=0.

1. Derive the truth table for this gate.

2. Find the equation for R from the truth table in the sum-of-products form.

3. Draw a circuit for R using AND, OR and NOT gates.

4 Finite State Machines: robot

We want to design a Landminer robot that can find and retrieve land mines from a maze. Assume a simply connected maze, i.e., one with no closed circuits (or disconnected components). Design a finite state machine to implement such a robot.

Goal: The Landminer must find each mine, pick it up (assume it has the motors and arms to pick one mine at a time), and bring back the mine to the start location by retracing its path. It must retrace its path so that in case there are land mines later in the path, it does not accidentally trip them as it is trying to return to the start position.

Expected Behavior: The robot will follow the `keep wall to right` rule while looking for mines. This protocol is guaranteed to explore the maze fully. Once it finds a mine, it should retrace its path.

If the robot returns to the start position without finding any mines, it should stop.

Robot capabilities and start state:

The robot has one sensor in the front, and one each to its right and left, to detect if it is going to walk into something. Initially all sensors are off, and the robot starts at the start location, in the stopped state. The robot has an infrared detector to detect when it has returned to the start location. When the *on* button is pressed, the robot should start moving forward.

The robot actions at each timestep include, moving forward, or turning left by 90 degrees, or turning right by 90 degrees.

If you need to assume anything else, explain your assumptions clearly.

1. Design a finite state machine that implements the robot's motion. Clearly explain the states, the inputs, the outputs, the actions, etc.

2. Design a circuit to implement this FSM.