THE UNIVERSITY OF BRITISH COLUMBIA
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
APSC 380 : Introduction to Microcomputers
1998/99 Winter Session Term 2

MID-TERM EXAMINATION
9:30 am – 10:20 am
February 8, 1999

This exam has three (3) questions. The marks for each question are as indicated. There are a total of 28 marks. Answer all questions. Write your answers in the exam book provided. Show your work. You may answer the questions in any order. Books, notes and calculators are allowed.

Return this exam paper with your answers. The contents of this exam must be kept confidential. Revealing the contents of this exam will be considered academic dishonesty and will result in sanctions according to University policies.

Question 1 (8 marks)

What is printed by the following C program? Show your work.

```
#include <stdio.h>
#define N 7

main()
{
   int i, c ;
   char x[N] = { 9, 5, 2, 7, 6, 0, 3 } ;
   for ( i=0 ; x[i] ; i++ ) {
      if ( x[i] & 0x02 ) {
         printf ( "%d\n", x[i] ^ i ) ;
      }
   }
}
```

Hints: Use a table. Start by figuring out the values taken on by `i`.

Question 2 (14 marks)

Write a C function called `area()` that takes two one-dimensional integer (`int`) arrays called `w` and `d` as arguments and returns an integer. Both arrays have the same number of values. Each pair `w[i]`, `d[i]` gives the width and depth dimensions of a wooden board. The end of each array is indicated by placing a negative element at the end of both arrays.

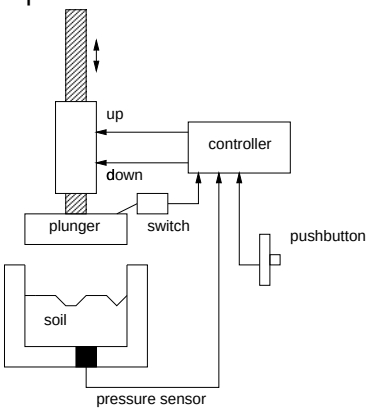
Your function should return the sum of the areas of all of the usable boards. A board is defined as usable if *both* the width and depth are greater than 12.

Write only the function `area()`, not a complete program.

For example, if `w` was set to { 1, 2 3, -1} and `d` was set to { 5, 2, 1, -1}, then `area(w,d)` would return 12.

Question 3 (28 marks)

This question asks you to design a controller for a device that manufactures adobe bricks by compressing soil. The controller is connected to a pressure sensor that indicates that the brick has been sufficiently compressed, a switch that indicates that the plunger has been completely retracted and a pushbutton. The controller can move the plunger up and down by asserting one of two signals, `up` and `down` that drive a motor:



The device operates as follows: The operator puts soil in the container and presses the push-button. The controller moves the plunger down until the pressure indicator indicates that the pressure has reached a sufficiently high level. At this point the motor is shut off. When the operator pushes on the button again, the plunger is raised until it reaches the fully-retracted position.

Design a state machine controller for the motor controller. List the inputs and outputs. Choose a sufficient number of states and give a name to each state. Write a table giving the output conditions for each state. Write out a tabular description of the state machine with the following columns: starting state, input, next state. Draw a state transition diagram showing the states and the logical conditions that cause transitions between them.

Use "X" to indicate that an *input* has no effect.

Choose encodings for the states. Write out the sum-of-products boolean expressions for each output signal and for each signal necessary to determine the next state. You need not simplify your expressions.

Draw a schematic diagram for the controller that uses only D flip-flops, NOT inverters and multiple-input AND and OR gates. Use standard symbols for the gates. Show where a clock would be connected.