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 10, 1999

This exam has three (3) questions on two (2) pages. The marks for each question are as indicated. There are a total of 50 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. You may keep this exam paper.

Question 1 (8 marks)

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

```
#include <stdio.h>
#define N 8

main()
{
   int i, c ;
   char x[N] = { 5, 2, 7, 0, 3, 6, 9, 4 } ;
   for ( i=1 ; i & 0x7 ; i++ ) {
      if ( x[i] & 4 ) {
         printf ( "%d\n", x[i] ^ 7 ) ;
      }
   }
}
```

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

Question 2 (14 marks)

Write a C function, `minchar()`, that takes one character (`char`) array called `s` and one integer (`int`) called `n` as arguments and returns a character. `s` has `n` characters. Your function should return the smallest character (the one with the smallest ASCII value) in the array.

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

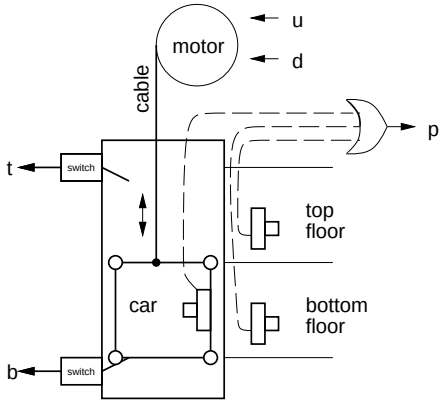
For example, if a variable `x` was declared as:

```
char x[5] = "3x10" ;
```

then `minchar(x,3)` would return `'1'` (letters appear after digits in the ASCII table). You may assume all the characters in `s` have values between 0 and 127.

Question 3 (28 marks)

This question asks you to design a controller for an elevator for a two-floor building. The controller has 3 inputs: one sensor, `t`, indicates that the elevator car is at the top floor, a second sensor, `b`, indicates that the elevator car is at the bottom floor, and the third signal `p`, indicates that one of three pushbuttons (one in the car and one on each floor) is being pushed. The controller has two outputs, `u` and `d` that cause a motor to move the car up and down respectively:



The elevator operates as follows: If the car is on the top floor then pushing a button causes the car to go to the bottom floor. If the car is on the bottom floor then pushing a button causes the car to go to the top floor. If the car is moving between floors then the controller ignores the buttons and the car continues to move in the same direction it was moving previously. If the car is stopped between floors or is stopped simultaneously at both the top and bottom floors it should not move the car.

Design a state machine controller for the elevator controller. List the inputs and outputs. Choose a sufficient number of states and give a name to each state. Write a table showing the outputs 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 binary encodings for the states. Write out 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.