THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY (level 04)
ECD 2201 / ECE 4201
MICROPROCESSORS & COMPUTERS
FINAL EXAMINATION 2005

049

DATE :29th APRIL 2006 **TIME : 9.30 – 12.30 hours**

INSTRUCTIONS TO CANDIDATES

- **This question paper consists of three sections, SECTION A, SECTION B and SECTION C.**
- **Select either SECTION A OR SECTION B and answer ALL questions in the selected section.**
- **From SECTION C, answer TWO questions**

NOTE: When you have to write any assembly language program for your answer, you must include appropriate comments where necessary. **Full marks will be given to correct programs, with comments**

Refer attached data sheets of the 8051 microcontroller, when answering questions in this paper

SECTION A:
(if you select this section, don't answer any questions in SECTION B)

Answer all questions.

1. (a) Using the data pointer (DPTR) and R0 (or R1) as pointers to the source and destination bytes, write an assembly language program to transfer 1000 bytes from location 0280 h to location FF00 h in the external RAM.

   (b) In a data block transfer routine, determine whether to start from the first byte or the last byte of the data block; in the situation when source and destination blocks
   - (i) overlap
   - (ii) does not overlap

2. (a) To illustrate the Boolean (bit-addressable) capabilities of the microcontroller a student wrote the following program:

```
org 8000h
setb p1.4
loop:  mov c, p1.4
       mov p1.0, c
       sjmp loop
```

[note: c is the carry bit]

Prior to running the program s/he connected an LED to p1.0 and a push-button to p1.4. Her/his intention was to light the LED when the push-button is pressed. Comment about the correctness of the program and in case if it does not work, explain how it should be modified.

(b) Modify the program discussed in (a) so that the LED will light when the push-button is released and will off when the push-button is pressed.

3. The following program was written by a student to flash an LED connected to bit 0 of port 1.

```
LED_flag equ 0f h
org 7000h
start:
        jb LED_flag, LED_off
        setb LED_flag
        clr p1.0
        mov r1, #0h
        mov r2, #0h

wait_1:
        djnz r1, wait_1
        djnz r2, wait_1
        sjmp start

LED_off:
        clr LED_flag
        setb p1.0
        mov r1, #0h
        mov r2, #0h

wait_2:
        djnz r1, wait_2
        djnz r2, wait_2
        ljmp start
```

(a) Modify and rewrite the program in an efficient manner, so that several lines of code is not repeated.

(b) If the clock frequency is 12 MHz calculate the time in which the LED is either on or off.

(c) What are the advantages/disadvantages of using software timing routines instead of microcontroller timers to obtain the required delay?

SECTION B:
(if you select this section, don't answer any questions in SECTION A)

Answer all questions.

Description
The following description is about a coin operated fruit juice vending machine (FJVM) and you are supposed to analyze the system according to 8051 specifications.

The fruit juice vending machine (FJVM)
A coin operated fruit juice vending machine (FJVM) could produce three different kinds of fruit juice; (for example papaya, mango and pineapple). Two different switches are needed to operate the machine. The customer has to input the correct amount of coins and then press the SWITCH 1. If s/he made a mistake in inserting the correct number of coins, by pressing the SWITCH 1 again, it is possible to retrieve the inserted coins. The FJVM only accepts 5 rupee coins. Assume that the three different types of juice papaya, mango and pineapple costs 15, 20 and 25 rupees per cup respectively. After inserting the correct number of coins, the customer has to place a disposable plastic cup (cups are provided on a separate tray) at the outlet and press the SWITCH 2, then the appropriate valve opens and the requested type of juice flows in to the cup through the outlet. This FJVM is controlled by a microcontroller. The three different types of fruit juice are held in three different containers. When the SWITCH 2 is pressed, first to mix the juice evenly in the containers, they are rotated at a speed of 20 rpm (revolutions per minute) first clockwise and then anticlockwise, by a stepper motor (the details of the stepper motor are given on page 5). Next, the stepper motor rotate the requested type of juice container by the appropriate angle so that it is correctly positioned in such a manner, when the valve of the particular container opens the juice will flow through the outlet into the cup.

Answer all questions.

1. Define the control system of the FJVM in the form of a simple functional block diagram. You should clearly indicate the input signals, the output signals, the micro-controller and other appropriate systems, if any. Briefly explain the

function/s of your control system as well as any assumptions you make. What happens if your FJVM malfunctions?

2. (i) Clearly present your control algorithm in plain English
   (ii) Convert the algorithm in to a software diagram/flowchart

3. Clearly draw a schematic diagram to indicate the relevant input and output signals connected to the microcontroller and the external transducers, activators etc. of the system proposed by you in the question 1 above. You should clearly indicate whether the signals are digital or analogue and also clearly label all the signals. (Do not attempt to design any electronic circuit required for interfacing)

SECTION C:

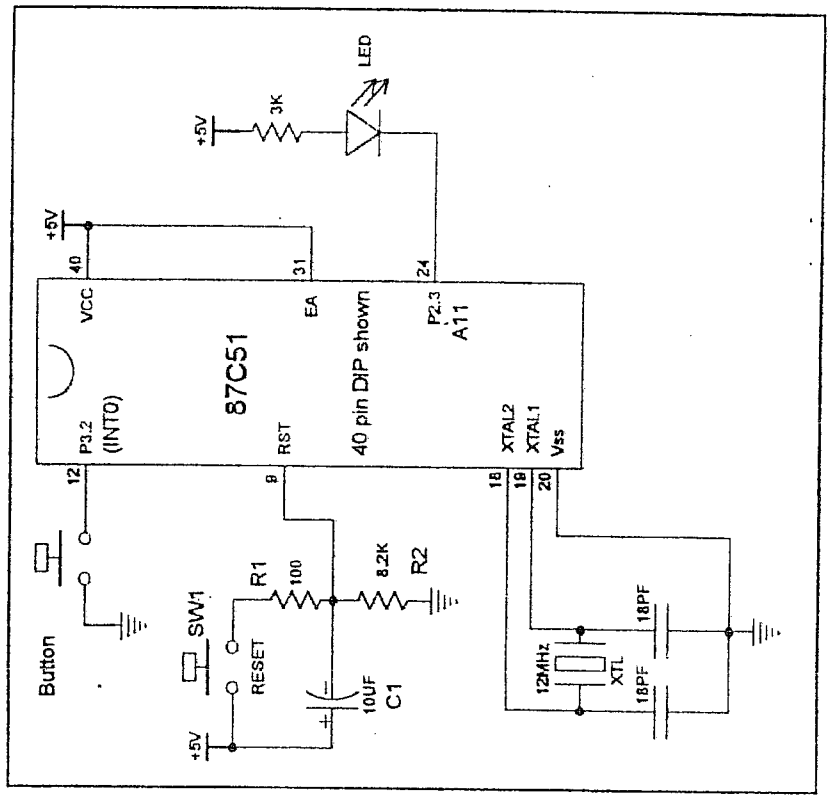
Answer **TWO** questions.

1. During an experiment, it is required to count the number of pulses generated during a period of 100 ms. Using the two timers of the microcontroller one as a timer to generate the required time period and the other as the counter, write an assembly language program to perform this operation. Using a diagram, show how the input signal is connected to the microcontroller. If this experiment is to be performed correctly, what can you say about the frequencies of the incoming pulses and that of the microcontroller? [Assume a digital input]

2. Instead of the timer, using software delay loops write an assembly language program to implement the situation considered in question 1 (SECTION C).

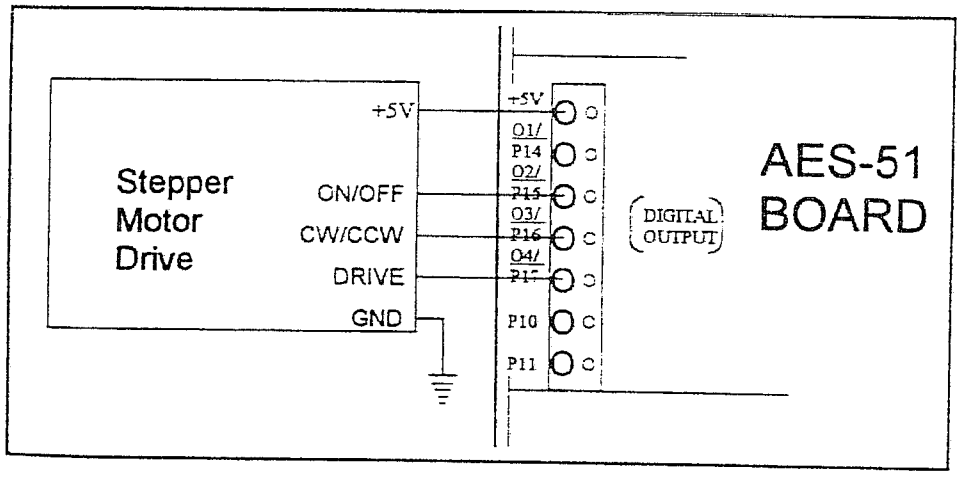
3. In a certain experiment a student has to find out the time a particular LED is on, using one of the timers of the microcontroller. In this situation, the particular LED is on when a push-button is continuously pressed (i.e. s/he has to continuously press the push-button to keep the LED on) and when the push-button is released the LED is off. Using a diagram illustrate how the LED and the push-button is connected to the microcontroller in this experiment and write an assembly language program to perform the operation. [Hint: use either GATE0 or GATE1 of the TMOD SFR]

4. Write the flash LED program considered in SECTION A, question (3) as an interrupt service routine. Think of a mechanism to generate the interrupt, when necessary. Draw a diagram to illustrate how the LED and the interrupting mechanism is connected to the microcontroller.



Drive a Stepper Motor

A stepper motor usually requires three drive signals - on/off, cw/ccw and a drive(step) pulse. We will arbitrarily designate the following signal states:



n/off - high is on and low is off
w/ccw - high is clockwise rotation and
low is counter-clockwise rotation
rive - a positive pulse of 20μs minimum width
and 1.8 degree rotation per pulse

Only the logic circuit on the Stepper-Motor-Drive is nnected to the AES-51. The Stepper-Motor-Drive must have a separate wer supply and drive transistors to drive the motor.