**T62 Tutorial 4**

Enter the following program. **X** is 3 if the last digit of your student ID number is 1, 3, 5, 7, or 9. **X is 4** if the last digit of your student ID number is 0, 2, 4, 6, or 8. **Y(1)** is the last digit of your student ID number plus one. **Z(8)** is the second last digit of your student ID number.

LIST P=18F4520

#include <P18F4520.INC>

cblock 0x**4**0

mem1

mem2:d'8'

mem3:0e

mem4

endc

ORG 0x0000

goto Main

ORG 0x00**1**0

Main: movlw a'a'

movwf mem1

movlw d'**8**0'

movwf mem2

movlw b'01101100'

addwf mem2,w

movwf mem3

movlw 0f

andwf mem3,w

movwf mem4

Here: goto Here

nop

END

* 1. Copy the program from the list file.

(2 marks)

LOC OBJECT CODE LINE SOURCE TEXT

VALUE

Warning[205]: Found directive in column 1. (LIST)

00001 LIST P=18F4520

00002 #include <P18F4520.INC>

00001 LIST

00002

00003 ;

00004 ; MPASM PIC18F4520 processor include

00005 ;

00006 ; (c) Copyright 1999-2013 Microchip Technology, All rights reserved

00007 ;

00008

01488 LIST

00003

00004 cblock 0x40

00000040 00005 mem1

00000041 00006 mem2:d'8'

00000049 00007 mem3:0e

00000057 00008 mem4

00009 endc

000000 00010 ORG 0x0000

000000 EF08 F000 00011 goto Main

000010 00012 ORG 0x0010

000010 0E61 00013 Main: movlw a'a'

000012 6E40 00014 movwf mem1

000014 0E50 00015 movlw d'80'

000016 6E41 00016 movwf mem2

000018 0E6C 00017 movlw b'01101100'

00001A 2441 00018 addwf mem2,w

00001C 6E49 00019 movwf mem3

00001E 0E0F 00020 movlw 0f

000020 1449 00021 andwf mem3,w

000022 6E57 00022 movwf mem4

000024 EF12 F000 00023 Here: goto Here

000028 0000 00024 nop

00025 END

* 1. Show the opcodes of movlw, movwf, addwf, andwf, and goto.

(2 marks)

movlw: 0EXX

movwf: 6EXX

addwf: 24XX

andwf: 14XX

goto: EFXX FXXX

* 1. Show the operand of goto Here instruction in binary representation.

(2 marks)

00010010 000000000000

* 1. Show the calculation of PC for goto Here instruction in binary representation. Then, show PC in hexadecimal representation.

(4 marks)

00010010 add 0 to the last bit, and become 00100100

PC become 24 in hexadecimal

* 1. What are the memory addresses of mem1, mem2, mem3, and mem4?

(2 marks)

mem1: 0x40

mem2: 0x41

mem3: 0x49

mem4: 0x57

* 1. After the program is executed, what are the contents of mem1, mem2, mem3, and mem4?

(2 marks)

mem1: 0x61

mem2: 0x50

mem3: 0xBC

mem4: 0x0C

Enter the following program. **X(0)** is the last digit of your student ID number. **Y(8)** is the second last digit of your student ID number. **Z(6)** is the third last digit of your student ID number.

LIST P=18F4520

#include <P18F4520.INC>

ORG 0x0000

goto Main

ORG 0x0060

Main: movlw 0x57

addlw 0x**0**F

movlw 0xAB

andlw 0x5**8**

movlw 0x32

xorlw 0x**6**D

Here: goto Here

nop

END

* 1. Copy the program from the list file.

(2 marks)

LOC OBJECT CODE LINE SOURCE TEXT

VALUE

Warning[205]: Found directive in column 1. (LIST)

00001 LIST P=18F4520

00002 #include <P18F4520.INC>

00001 LIST

00002

00003 ;

00004 ; MPASM PIC18F4520 processor include

00005 ;

00006 ; (c) Copyright 1999-2013 Microchip Technology, All rights reserved

00007 ;

00008

01488 LIST

00003

000000 00004 ORG 0x0000

000000 EF30 F000 00005 goto Main

000060 00006 ORG 0x0060

000060 0E57 00007 Main: movlw 0x57

000062 0F0F 00008 addlw 0x0F

000064 0EAB 00009 movlw 0xAB

000066 0B58 00010 andlw 0x58

000068 0E32 00011 movlw 0x32

00006A 0A6D 00012 xorlw 0x6D

00006C EF36 F000 00013 Here: goto Here

000070 0000 00014 nop

00015 END

* 1. Show the contents of WREG and STATUS register after addlw 0x**X**F is executed. Explain why you observe the status of the flag bits.

(2 marks)

WREG: 0x66

STATUS: 0x02

02H = 102, which means DC = 1,

there is a carry from the first to second nibble as 7 + F = 16.

* 1. Show the contents of WREG and STATUS register after andlw 0x5**Y** is executed. Explain why you observe the status of the flag bits.

(2 marks)

WREG: 0x08

STATUS: 0x02

02H = 102, as andlw only affect flag bits “Z” and “N”, but “Z” and “N” did not change, so STATUS is still 0x02.

* 1. Show the contents of WREG and STATUS register after xorlw 0x**Z**D is executed. Explain why you observe the status of the flag bits.

(2 marks)

WREG: 0x5F

STATUS: 0x02

02H = 102, as xorlw only affect flag bits “Z” and “N”, but “Z” and “N” did not change, so STATUS is still 0x02.

Enter the following program. **X(9)** is the second last digit of your student ID number plus one. **Y(1)** is the last digit of your student ID number plus one. Set the frequency to 4 MHz.

LIST P=18F4520

#include <P18F4520.INC>

MyReg EQU 0x0F

ORG 0x0000

goto Main

ORG 0x0060

Main: nop

call Delay

nop

Here: goto Here

Delay: movlw 0x**91**

movwf MyReg

Again: nop

nop

nop

nop

decf MyReg,F

bnz Again

return

END

* 1. Copy the program from the list file.

(2 marks)

LOC OBJECT CODE LINE SOURCE TEXT

VALUE

Warning[205]: Found directive in column 1. (LIST)

00001 LIST P=18F4520

00002 #include <P18F4520.INC>

00001 LIST

00002

00003 ;

00004 ; MPASM PIC18F4520 processor include

00005 ;

00006 ; (c) Copyright 1999-2013 Microchip Technology, All rights reserved

00007 ;

00008

01488 LIST

00003

0000000F 00004 MyReg EQU 0x0F

00005

000000 00006 ORG 0x0000

000000 EF30 F000 00007 goto Main

00008

000060 00009 ORG 0x0060

000060 0000 00010 Main: nop

000062 EC36 F000 00011 call Delay

000066 0000 00012 nop

000068 EF34 F000 00013 Here: goto Here

00006C 0E91 00014 Delay: movlw 0x91

00006E 6E0F 00015 movwf MyReg

000070 0000 00016 Again: nop

000072 0000 00017 nop

000074 0000 00018 nop

000076 0000 00019 nop

000078 060F 00020 decf MyReg,F

00007A E1FA 00021 bnz Again

00007C 0012 00022 return

00023 END

1. Execute the program with “Step Into” button. Examine the Stopwatch window. Show the calculation to find the number of instruction cycles required by the Delay function.

(4 marks)

number of instruction cycles required = 1 + 1 + 7 x 145 – 1 + 1 = 1017

1. Execute the program with “Step Over” button. Examine the Stopwatch window. What is the time delay generated by the Delay function?

(2 marks)

time delay generated = 1.017ms

**Submission**

Enter your name, student ID number, and the answers in the MS Word document file. Re-name the file with your student ID number, e.g. 12345678.docx. **Deduct 4 marks for wrong file name.**

Submit the file by e-mail ([itklchan@cityu.edu.hk](mailto:itklchan@cityu.edu.hk)) before 3:00 pm. **Late submission will not be accepted.**