Engineering FIRST YEAR

Part 1A Paper 3: Electrical and Information Engineering

DIGITAL CIRCUITS AND INFORMATION PROCESSING

EXAMPLES PAPER 4

* Harder questions § Straightforward questions

Throughout this examples paper, the prefix 0x is used to denote hexadecimal numbers. You will need to refer to the Electrical and Information Data Book for information on the PIC instruction set.

§ 1. (a) The PIC12F675 has multiple registers, but some of the most important are the Program Counter, the Working Register, the STATUS Register, and the GPIO and TRISIO registers. Describe their function and for the STATUS Register outline the usage of each bit.

(b) What is tri-state logic? Explain how it is used to enable a microprocessor's data bus to be bi-directional.

(c) What does EPROM stand for? How is it used?

(d) Explain what is meant by the Fetch-Decode-Execute cycle

§ 2. What will be the contents of the working register and the memory location 0x30 after the following programme segments have been executed?

(a)
```
movlw 0x30
movwf 0x30
movlw 30
addwf 0x30
```

(b)
```
     movlw 4
     movwf 0x20
     clrf 0x30
lab  incf 0x30
     decfsz 0x20
     goto lab
    sleep
```

3. (a) Figure 1(a) shows a microprocessor connected to a memory chip that is organised for 8-bit data. What is the capacity of the memory chip in bits, and what addresses will it occupy in the memory map of the microprocessor.

(b) Figure 1(b) shows a similar microprocessor connected to a different memory chip. Copy the diagram and add address decoding logic to locate the chip in the microprocessor memory map from 0x0300 to 0x037F.

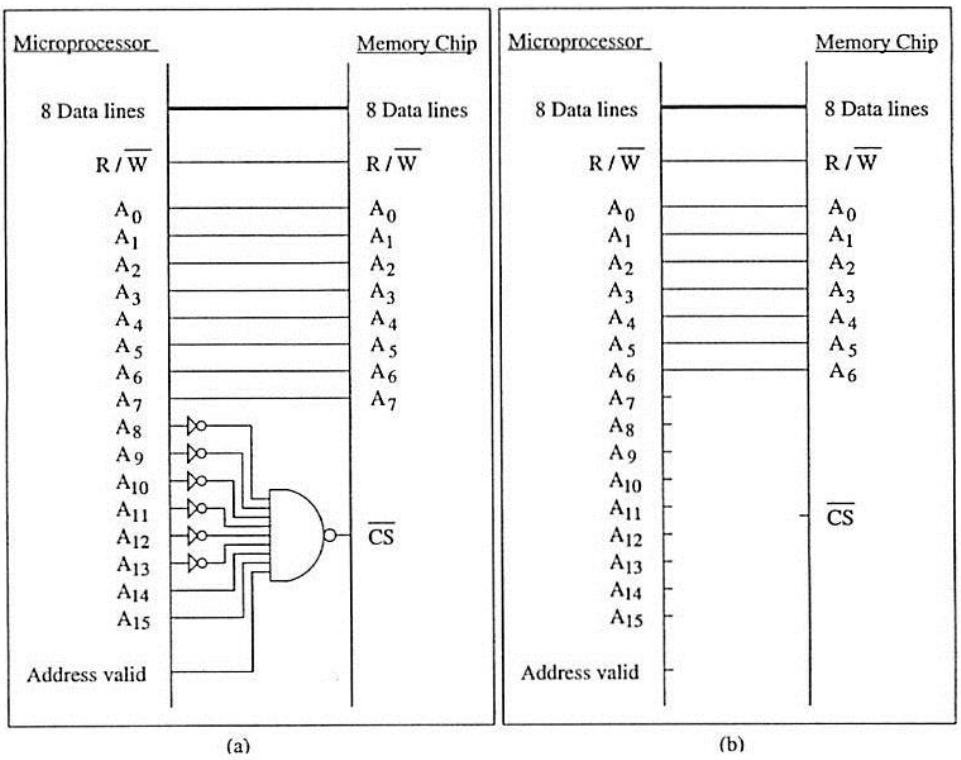

Figure 1

4 (a) A programmer wishes to use bits 3-5 and bits 0-2 of the GPIO register of a PIC microcomputer as input and output ports respectively. Draw a flow diagram to show how data at the input port can be transferred to the output port repeatedly. (Use operations such as "Load W from memory location ...", rather than the actual code.)

(b) If the input data is a sequence of numbers in 2's complement form (i.e. top bit of three bit word determines sign), draw a new flow diagram which sends only positive numbers to the output port.

5 Complete the table below showing which STATUS register condition codes are set by each addition.

A plus B		C	DC	Z
0x7F	0x01			
0xC0	0x0A			
0x27	0xD9			
0x08	0x0F			
0x80	0x80			

* 6 Write a programme in PIC assembler mnemonics that will take 3 bit data words from bits 3-5 of the GPIO register and pass it, after multiplying by two, to bits 0-2 of GPIO. The data at the input port is a sequence of unsigned numbers in the range 0 to 3 (decimal values). You should remember to set up the TRISIO register appropriately.

7 Assemble the programme in question 2(b) into a list of binary machine instructions for the PIC12F675 processor. You should assume that the programme starts at location 0x0005

8 (a) A sequence of instructions for a PIC12F675 processor, which is operated with an instruction clock frequency of 10 MHz, is shown below. What is the time taken to execute the sequence if: (i) the numbers originally in locations 0x080 and 0x081 are equal and (ii) the numbers originally in locations 0x080 and 0x081 are not equal?

```
        movlw 22
        movf 0x80, W
        subwf 0x81, W
        btfss 0x03, 2
        call sr
        sleep
        ....
sr      movwf 0x82
        return
```

(b) Write a fragment of PIC assembly code to introduce a time delay of exactly 82 clock periods by loading a number into a memory location and counting down until the number reaches zero. At the end of the fragment, put the processor into sleep mode (include this in the 82 clock cycles).

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Revision tripos questions

2017 Paper 3, Q8
2016 Paper 3, Q8
2015 Paper 3, Q8
2014 Paper 3, Q8
2013 Paper 3, Q6

ANSWERS

2 (a) 78
(b) 4

3 (a) 2048 bits, 0xC000 to 0xC0FF

5

A plus B		C	DC	Z
0x7F	0x01	0	1	0
0xC0	0x0A	0	0	0
0x27	0xD9	1	1	1
0x08	0x0F	0	1	0
0x80	0x80	1	0	1

8 (a) (i) 0.6 µs, (ii) 1.0 µs.