GX553

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

SUMMER EXAMINATIONS, 1999

SECOND YEAR ELECTRONIC ENGINEERING
SECOND YEAR ELECTRONIC & COMPUTER ENGINEERING
THIRD YEAR INDUSTRIAL ENGINEERING

MICROPROCESSOR SYSTEMS ENGINEERING

Professor L.E. Davis
Professor D.J. Wilcox
Dr. P. Corcoran

Duration of Examination: *Two* Hours

Instructions: Answer *all* questions in Section A
and *three* questions in Section B

Section A

(Attempt **all questions** in this section - 25 marks)

A1. How many address lines has the PC-AT system bus?

a) 8 b) 12
c) 16 d) 20
e) 32 f) 64

A2. In an 8086 based computer system the bottom of the stack is at memory address (in hex):

a) 0100 b) 1000
c) 0F00 d) 7FFF
e) FFFF f) none of the above

A3. Which of the following communications methods does NOT transmit data serially?

a) RS232 b) I2C
c) RS485 d) SCSI
e) USB f) none of the above

A4. Which of the following computer languages is an interpreted language?

a) C b) C++
c) FORTRAN d) Pascal
e) BASIC f) none of the above

A5. The MS-Windows 95 operating system performs:

a) hardware optimized task switching b) co-operative multitasking
c) synchronous task multiplexing d) synchronous task de-multiplexing
e) pre-emptive multitasking f) none of the above

A6. The CPU clock speed of the standard PC-AT system bus is:

a) 1.0 MHz b) 2.56 MHz
c) 3.37 MHz d) 4.77 MHz
e) 8.0 MHz f) none of the above

A7. The Centronics parallel printer port transfers data as:

a) 32-bit blocks b) 16-bit blocks
c) 8-bit blocks d) 4-bit blocks
e) It depends on the CPU f) none of the above

A8. The GNU Public Licence is:

a) a professional qualification
b) a software tax payable in USA
c) export permission for encryption software
d) a seal of approval for software
e) all of the above
f) none of the above

A9. The PIC 16F84 microcontroller is different from the 8086 microprocessor because it has no:

a) central processing unit
b) external system bus
c) hardware interrupts
d) arithmetic logic unit
e) general purpose registers
f) none of the above

A10. Character information in most computer systems is stored in:

a) floating-point format
b) BCD format
c) alphabetic format
d) decimal format
e) ASCII format
f) none of the above

A11. Which of the following peripherals is NOT available in the PIC family of microcontrollers :

a) interrupt-driven I2C interface
b) RS-232 UART
c) parallel/printer port
d) LCD display driver
e) analog-to-digital converter
f) none of the above

A12. Which of the following data/stop/parity settings is most commonly used with the RS-232 protocol :

a) 7 data, 1 stop, even parity
b) 8 data, 1 stop, odd parity
c) 7 data, 1 stop no parity
d) 8 data, 1 stop, even parity
e) 8 data, 1 stop, no parity
f) none of the above

Section B

(Attempt **3 questions**in this section - 75 marks)

1. **(a)** Demonstrate the binary operations of subtraction and multiplication by converting the decimal numbers on the LHS of each equation below to binary numbers and performing the indicated operation. Check your results by converting your binary answer into decimal form.

i)	7 x 3 = 21	ii)	3 - 8 = -5
iii)	17 - 3.25 = 13.75	iv)	3.375 - 2.5 = 0.875
v)	6 x 7 = 42	vi)	3 x 2.625 = 7.875

[10 marks]

(b) Write an x86 assembly language program to multiply two 4-bit numbers together. The numbers are located at memory locations FF00 and FF02 and the result should be written to memory location FF10.

The program should implement all of the following:

(i) load the numbers from memory into the CPU
(ii) test all the higher bits to ensure numbers are genuine 4-bit
(ii) perform the necessary basic arithmetic manipulations to multiply the two numbers
(iv) output the result of the multiplication to the final memory location

(Note that you may feel it helpful to consider the manipulations required to solve No. (v) in the previous part of this question.)

[14 marks]

2. **(a)** Draw a block diagram of the layout of the different system components and peripherals in a modern digital computer. Include a detailed diagram of the internal structure of the CPU, or central processing unit.

Describe the function of each of the internal components of the CPU. Explain in detail the operation of the CPU as it:

(i) loads a program instruction from memory
(ii) makes a jump to a subroutine
(iii) responds to an interrupt request

If you wish you may illustrate these explanations with short code samples.

[8 marks]

(b) Explain, sketching diagrams and including small pieces of example code, the functionality of

(i) interrupts and
(ii) DMA or direct memory access.

Why does a computer system use interrupts? Why does it use DMA?

[8 marks]

(c) **Fig. 2** shows the main signals on the IBM PC-AT system bus. Give a brief description of each signal, or group of signals on the bus.

[8 marks]

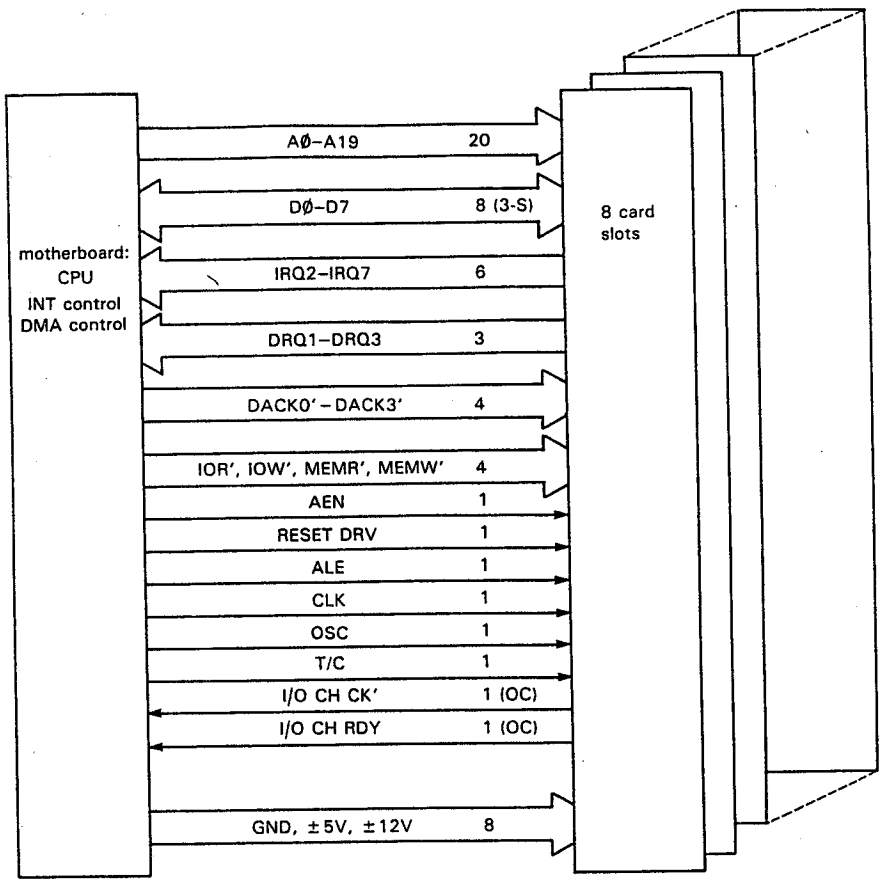

Fig 2: *PC-AT System Bus Signals*

3. (a) Draw a diagram showing the arrangement of the general-purpose CPU registers in an x86 microprocessor. Note the special function, if any, of each register.

Write a short assembly language program which accesses two 100-word arrays in memory, VECTOR1[0 .. 99] and VECTOR2[0 .. 99]. The program should cycle through these arrays, adding each element and storing the value in a third array, TOTAL[0 .. 99], as follows:

$$TOTAL[x] = VECTOR1[x] + VECTOR2[x]$$

State which general purpose registers you use to perform this vector addition and explain why you chose those particular registers.

[8 marks]

(b) Explain in detail the function of **program-I** given below. You should first separate it into 2-5 functional blocks and then explain how each of these implements its fuctionality.

[6 marks]

(c) Explain in detail the function of **program-II**. Separate it into 2-5 main functional blocks. Then explain the operation of each of these in more detail.

[10 marks]

(Note that programs I & II are appended to this exam paper along with a listing of common x86 assembly language instructions.)

4. (a) Explain, using sketches of typical waveforms, how the (i) RS-232 and (ii) I2C protocols are used to transmit and receive data.

What are the main application areas for each of these protocols? What are the main limitations of RS-232 and how can these be overcome?

[8 marks]

(b) **Fig 4** shows the main signal timings for a standard Centronics PC printer port. Sketch a diagram of the printer port hardware and explain its operation.

[8 marks]

(c) Describe how a CSMA/CD communications protocol such as Ethernet works. Describe, and sketch the structure of a standard Ethernet packet and explain how it differs from serial protocols like RS-232 and I2C.

[8 marks]

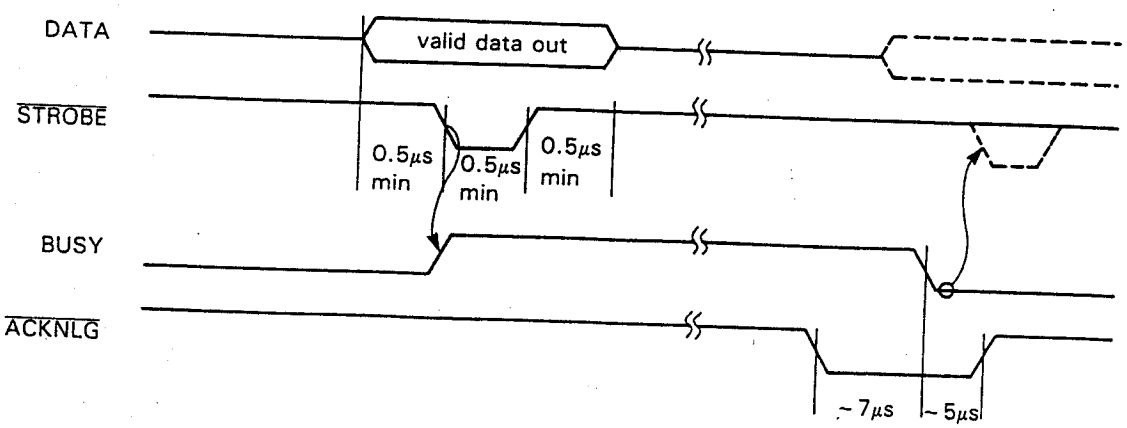

Fig 4: *Centronics/printer interface timings.*

5. Fig 8(a) shows a PIC microcontroller configured to use the 4 port_A pins as inputs and the 8 port_B pins as outputs. The microcontroller is required to read a 4-bit binary input and to generate a pair of BCD (binary coded decimal) output nybbles corresponding to the binary input value. The table of Fig 8(b) illustrates the values of the output nybbles corresponding to the input states.

(a) Draw the full binary truth table for inputs and outputs from the PIC.

[6 marks]

(b) Write an assembly language program to read the state of the inputs from port_A and, using a look-up table, to generate and write appropriate values to the output pins of port_B.

[14 marks]

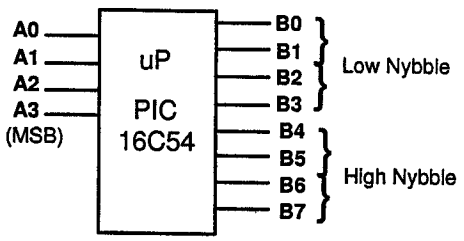

Fig 5(a): *A PIC configuration to use port_A as input and port_B to generate BCD (binary coded decimal) output on the two nybbles: B7-B4 and B3-B0.*

A3	A2	A1	A0	High	Low
0	0	0	0	0	0
0	0	0	1	0	1
0	0	1	0	0	2
0	0	1	1	0	3
0	1	0	0	0	4
0	1	0	1	0	5
0	1	1	0	0	6
0	1	1	1	0	7
1	0	0	0	0	8
1	0	0	1	0	9
1	0	1	0	1	0
1	0	1	1	1	1
1	1	0	0	1	2
1	1	0	1	1	3
1	1	1	0	1	4
1	1	1	1	1	5

Fig 5(b): *Input pin states and Output Nybble values.*