Department of Communications and Computer Engineering
Faculty of ICT
Computer Logic and Organisation CCE 1012
January 2009

Answer ANY FOUR questions

1. Write short notes on the following topics
   (i) Primary and secondary cache
   (ii) Out of range detection in a 2's complement integer arithmetic
   (iii) special processor registers for instruction fetch and execute
   (iv) chip select pin on memory IC
   (v) asynchronous and synchronous timing waveforms for a data write.
   (25 marks)

2. A computer system uses cache memory together with main memory. The cache address space is 1 Kbyte, while the main memory space is 1 Mbyte.
   The block transfer between main memory and cache is of 128 bytes, and the cache is organized using 2 blocks per set.
   Calculate:
   (i) the number of bits necessary to represent a main memory address (2 marks)
   (ii) the TAG, SET and WORD values for the address (5 marks)
   A program resides in main memory is 2Kbyte long and is in main memory between address 1024 and address and 3071. It has a loop between address 2048 and address 2559 of main memory. The loop is executed five times. The operating system uses the LRU algorithm for block replacement in the cache. Memory access time is 50ns and the cache is ten times faster than main memory.

   (iii)Calculate the time the program takes to execute using main memory and cache. State any assumptions made.
   (13 marks)
   (iv) Show clearly which blocks of main memory reside in the cache at the end of program execution.
   (5 marks)

3. (a) Distinguish between optical disk storage and magnetic disk storage.

   (b) A hard disk drive uses 4000 tracks and eight surfaces. The system uses two values for angular velocity. For the inner 2000 tracks the number of sectors is 200 per track. For the outer 2000 tracks the number of sectors is 250. Each sector has 512 bytes.
   (i) Why do systems use different numbers of sectors per track?
   (3 marks)

(ii) Calculate the total data, in Megabytes, that can be stored on the disk volume. (8 marks)

(c) A sector on disk is made up of bits some of which are control and others are data. Describe the organization, (different fields) of a sector on a hard disk drive (8 marks)

(d) Describe the difference between RAID1 and RAID2 disk storage organisation stating clearly the advantages and disadvantages in each case. (6 marks)

4 (a) Distinguish between dynamic and static memory with respect to size, speed and use. (5 marks)

(b) Sketch the organization of 1 bit of dynamic memory, and give reasons why a refresh circuit is necessary in a dynamic RAM. (5 marks)

(c) A RAM chip has 256 bits. The RAM uses RAS and CAS organization for bit storage.

(i) Using a sketch, show how the memory is organized, including the row bits and the RAS decoder, the column bits and the CAS decoder. (5 marks)

(ii) For your design show how the bit 10100110 is accessed. (3 marks)

(d) Modern RAMS use extra check bits. What is the reason for doing so?

A RAM has eight data bits denoted b_7 to b_0 and three check bits denoted b_8, b_9, and b_{10}. The check bits are parity checks on the data bits given by

$$b_8 = b_0 \oplus b_5 \oplus b_7$$
$$b_9 = b_1 \oplus b_4 \oplus b_5$$
$$b_{10} = b_2 \oplus b_3 \oplus b_6 \oplus b_7$$

(i) Given the data bit pattern 11001010, work out the three check bits. (4 marks)

(ii) Given the 11 bit pattern, b_{10} down to b_0, 101 1111 1001 , check whether this is a valid (correct) data pattern. (3 marks)

5 (a) Minimise the four variable binary logic function, f(A,B,C,D) given in minterms as

$$F = \Sigma (0, 1, 6, 8, 11, 12, 14, 15)$$

using Karnaugh Map techniques.
Give the minimized output binary logic function. (6 marks)

(b) Multiply, using Booth's algorithm the following two numbers

Multiplicand 7 Multiplier -3

The numbers use 5 bit 2's complement representation.

Show clearly your working and give your result as a 10-bit two's complement number.

(9 marks)

(c) A computer uses a floating point number representation consisting of 1 bit for the sign, 6 bits for the mantissa, and 5 bits for the exponent. The mantissa is normalized and the exponent uses two's complement excess code.

Give the binary representation of the following decimal numbers

(i) 3.2 (ii) - 0.8

(10 marks)