EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

REGULAR – NJORO CAMPUS

FIRST SEMESTER 2017/2018 ACADEMIC YEAR

SECOND YEAR RESIT/SPECIAL EXAMINATION FOR DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE

COMP 211: BASIC CIRCUIT DESIGN

STREAM: BSC (COMPUTER SCIENCE) **TIME:** 2 HOURS

SESSION: OCTOBER **YEAR:** 2018

INSTRUCTIONS

i) Answer question ONE and any other TWO questions
ii) Write on both sides of the answer sheet
iii) Begin each new answer on a separate page of the answer sheet

Question One: 30 Marks

(a) (i) What is a memory cell? **[1 marks]**

(ii) Explain what is meant by the term toggle state in J-K flip-flop and importance. **[3 marks]**

(iii) What is the difference between spatial locality and temporal locality? **[3 marks]**

(b) From first principles derive an expression for the speedup ratio of a memory system with cache (assume that the hit ratio is h, and the ratio of main store access time to cache access time is k, where $k < 1$). Assume that the system is an ideal system and that you don't have to worry about the effect of clock cycle times **[4 marks]**

b) Distinguish between cache miss and cache hit. **[2 marks]**

(c) What do you understand by the following memory terminology?

(i) Bandwidth:

(ii) Latency

(iii) Seek time:

(iv) Memory refreshing: **[4 marks]**

(d) What is memory hierarchy? What are the characteristics of memory hierarchy? Why does memory hierarchy provide economy? **[5 marks]**

(e) A certain hard disk data sheet has the following parameters. Rotational rate 10,000 rpm, average seek time 9ms and average number of sectors/track is 500. Calculate the

(i) rotational latency (T_{avg} rotation)

(ii) Transfer time (T_{avg} transfer) and

(iii) Total Average Access time (T_{access}) [2 marks each total 6 marks]

(f) A computer's memory is composed of 8K words of 32 bits each. How many bits are required for memory address if the smallest addressable memory unit is a word? (a word = 8 bit byte)

[2 MARKS]

Question Two: 20 Marks

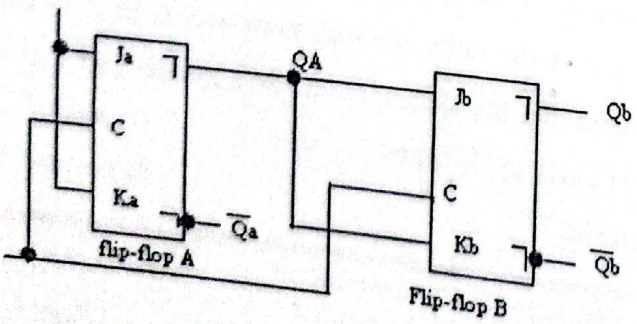
(a) What is the meaning of the following: -

i) ISR

ii) Vectored Interrupts **[2 marks]**

(b) Show the Q output of the flip-flop in the figure below in proper relation to the clock. The flip-flops are initially RESET. Describe what happens after each clock pulse. There are five clock pulses **[3 marks]**

[7 marks]



(c) "DRAMs are normally cheaper and larger in storage size than SRAMs. So SRAMs are not used in most computers." (i) Is this statement correct? (ii) Justify your answer. **[4 marks]**

(d) A certain memory has a capacity of 1024K X 32. How many data input and data output lines does it have? How many address lines does it have? What is the capacity in bytes? **[4 marks]**

Question Three: 20 Marks

(a) What is cache memory? Why do computers use cache memory? **[4 marks]**

(b) What is virtual memory? Consider a computer with 16-bit address bus and has 4096 words of memory- those that are physically available. Illustrate how this computer will use virtual memory technique to address its available address space? (Assume the physical memory is available at address 0 – 4095). What happens if a program tries to select an address above 4095 e.g. from 12287 - 16382? **[10 marks]**

(c) Explain the differences in physical address space and virtual address space? **[2 marks]**

(d) A certain hard disk has the following parameters : 512 bytes/sector, 400 sectors/track (on average), 25,000 tracks per/ surface, 2 surfaces (sides)/platter and 8 platters **[4 marks]**

Question Four: 20 Marks

a) Many software programs are larger than the RAM available to store them. How then does the main memory get round this capacity problem? What role does Cache memory play in solving this problem? **[4 marks]**

b) What is paging? Why is paging said to be transparent? **[2 marks]**

c) What is the difference between VRAM and FPM DRAM? **[4 marks]**

d) A computer has main memory with an access time of 60 ns and cache memory with an access time of 15 ns. The cache has a line size of 16 bytes and the computer's memory bus is 32 bits wide. The cache controller operates in a burst mode and can transfer 32-bits between cache and main memory in 80 ns. Whenever a miss occurs the cache must be reloaded with a line. If the average hit ratio is 92%, what is the speedup ratio? **[6 marks]**

e) What are the primary reasons of using RAID Technology? **[4 marks]**

Question Five: 20 Marks

(a) A hard disk has 10 disks and 18 surfaces available for recording. Each surface is composed of 200 concentric tracks and the disks rotate at 7200 r.p.m. Each track is divided into 8 blocks of 256 64-bit words. There is one R/W head per surface and it is possible to read the 18 tracks of a given cylinder simultaneously. The time to step up from track to track is ms (10^{-3}s). Between data transfers the head is parked at the outermost track of the disk. Calculate:

(i) The total capacity of the floppy disk in Kilo Bytes **[2 marks]**

(ii) The maximum data rate in bits/second **[2 marks]**

(iii) The average access time in milliseconds **[2 marks]**

(iv) The average transfer rate when reading 256 blocks located randomly on the disk **[2mark]**

(v) The recording density (bits/in) of the innermost and the outmost tracks if the disk has 6 in diameter and the outermost track comes to 1 in from the edge of the disk. The track density is 200 tracks/in. **[3 marks]**

(b) What factors determine the drive performance (usually hard disk) of a computer system? **[5 marks]**

(c) What is the difference between SIMM and DIMM? What is the major disadvantage of SIMM? **[4 marks]**

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EXAMINATION SESSION: OCTOBER **YEAR:** 2017

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Question One (30 marks)

a) Explain the difference between Combinational and Sequential Logic Circuits? **(2 marks)**

b) With the aid of a diagram, explain a set of S-R Flip Flop can be used to store a 4-bit number. **(5 marks)**

c) With an example in each case differentiate between weighed and unweighted codes. **(4 marks)**

d) Explain any two disadvantages of using a microprocessor for building automating controls instead of discrete components. **(4 marks)**

e) Design a combinational circuit that complements an entire 8-bit binary string whenever activated by a control signal. A HIGH on the control signal causes the circuit to complement the 8-bit string and a LOW does not. **(7 marks)**

f) Carry out the following arithmetic operations;

i. $32_{10} - 37_{10}$ using two's complement **(2 marks)**

ii. $67_8 + 77_8$ in binary **(2 marks)**

iii. $8_{10} + 9_{10}$ using BCD **(2 marks)**

iv. $16_{16} + 4F_{16}$ in binary **(2 marks)**

Question Two (20 marks)

a) List any two advantages of digital systems over the analog systems. **(2 marks)**

b) Convert 236_{10} to Gray code and state why the code is used for indicating shaft positions in rotating machines instead of pure binary. **(4 marks)**

c) With the aid of diagrams, explain how you can trouble shoot a digital logic circuit. List the tolls used and describe their operation. **(6 marks)**

d) With the aid of a truth table design a full adder circuit. **(8 marks)**

Question Three (20 marks)

a) Define a binary counter and state any two areas of application. **(3 marks)**

b) With the aid of a diagram and waveforms explain the operation of a mod-8 ripple counter. **(6 marks)**

c) Design and explain the operation of a combinational circuit that counts the number of people entering a shop. The design should include parts;

i. Sensing part **(4 marks)**

ii. Counting. **(5 marks)**

iii. State the assumptions made if any. **(2 marks)**

Question Four (20 marks)

a) What is a universal logic gate? **(2 mark)**

b) State the similarities and application of the following;

i. Truth table

ii. K-Map **(4 marks)**

c) Explain any three reasons for digital circuit minimization. **(6 marks)**

d) Implement a simplified expression for $X = \overline{A}\,\overline{B}C + \overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,B\,\overline{C}$ by using NAND gates only. Explain any two disadvantages of using NAND gates for implementing the expression. **(8 marks)**

Question Five (20 marks)

a) Describe any two applications of multiplexers. **(2 marks)**

b) Differentiate between the Ripple and Synchronous Counters, stating one disadvantage in each case. **(4 marks)**

c) Design a 4 to 1 multiplexer, and describe its operation **(4 marks)**

d) Explain any two applications of BCD in digital circuits. **(4 marks)**

e) With the aid of a diagram, describe the operation of a Binary Weighted Digital to Analog Converter. **(6 marks)**

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