EASTERN UNIVERSITY, SRI LANKA

DEPARTMENT OF MATHEMATICS

FIRST YEAR EXAMINATION IN SCIENCE - 2015/2016

SECOND SEMESTER (MAY/JUNE., 2018)

CS 106 - COMPUTER ORGANIZATION AND ARCHITECTURE

Answer all questions **Time allowed: Two hours**

Q1) Computer Architecture is the design of the systems visible to the assembly level programmer or those attributes that have a direct impact on the logical execution of a program

a) Briefly describe the concepts behind *Instruction Set Architecture* (ISA).

b) All computers more or less based on the same basic design of Von Neumann Architecture.

i. Sketch a basic Von Neumann computer architecture, identifying all the key components, and describe the basic function of each component.

ii. Briefly explain the bottleneck problem in Von Neumann Architecture.

iii. State some approaches to overcome the above problem.

c) Describe the functions of the following registers in a typical Central Processing Unit (CPU).

i. Program Counter (PC);

ii. Memory Address Register (MAR);

iii. Instruction Register (IR);

iv. Accumulator.

d) A computer has a system clock frequency of 5 GHz. Assume that a 0.4 kHz periodic pulse train is sent to a Light-Emitting Diode (LED). What should the pulse width be to make the light emitted from the LED three-fourth of its full capability?

Q2) Digital electronics only understand two states, ON and OFF. This is why digital electronics use the binary number system.

a) Convert the following hexadecimal numbers to binary numbers:

i. $FD73_{16}$;

ii. 75.53_{16} .

b) Multiplexing is the generic term used to describe the operation of sending one or more analogue or digital signals over a common transmission line at different times.

i. Draw any simple line multiplexer circuit constructed from standard NAND gates acts to control which input gets passed to the output.

ii. Briefly explain the advantages of using multiplexers in digital circuits.

c) What are the three common ways of representing signed numbers? Explain any two of them with suitable examples.

d) Write down the description for the following typical machine language instructions.

i. COMPARE R1,R2;

ii. MULT R1, R2;

iii. JUMPGT R1.

Q3) A Boolean expression is one that conforms to one of two given Boolean results commonly characterized as true or false. These expressions and operators are a core part of computer science and programming languages.

a) Convert the following Boolean expression into standard *Sum of Product* (SOP) form by stating step by step rules involved in the procedure.

$$A\bar{B}D + A\bar{D} + \bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D}$$

b) Consider the following Rocket Launcher scenario.

A famous company has gained a missile defense capability governed by the security council. The council consist of four members: The President and the Counselors (the chief of staff of the Army and two Air Forces). The missile system is to be activated by a device obeying these rules: each member of the security council has a button to push; the missiles fire only of the President and at least one Counselor push their buttons.

i. Specify the input and output variables and two states of each.

ii. Construct the truth table for the above design and write down the sum of min terms.

iii. Simplify the above formula and draw the relevant circuital diagram.

c) i. Distinguish between Sequential circuits and Combinational circuits.

ii. Write down one example for sequential type of circuits. Briefly explain how does the above given example circuit works (use any diagram to support your answer).

d) Reduce the following term as a minimized SOP form using a **Karnaugh Map**.

$$\mathbf{F(a,b,c,d)= \Sigma m\ (1,2,3,5,7,11,13)}$$

Q4) a) "Pipelining technique is the best method than sequentially processing each instruction in microprocessor". Briefly explain the validity of the above statement with suitable diagram.

b) i. State three different types of pipeline hazards.

ii. Briefly explain any two of which you have mentioned in part **b)i.** with suitable examples.

c) Describe the key concepts behind the superscalar architecture. If a microprocessor needs to execute two instructions simultaneously, calculate the number of required cycles. (Assume that, there are six instruction execution stages)

d) Briefly explain how the standard instruction cycle can be affected by an interrupt signal in a typical instruction execution.

e) Discuss the role of *Direct Memory Access* (DMA) controller with a suitable example.