COE838: Systems-on-Chip Design Sample Final Examination

General Instructions

Maximum Marks: 60

- a) Total time allowed is **120 minutes**.
- b) The examination has 6 pages and 6 questions. Answer all the questions.
- c) To earn maximum credit, your answer must be concise, to the point and in the given space.
- d) Some questions contain special instructions. Please ensure that you read them carefully.
- e) Estimated time for each question is equivalent to the marks assigned to it.
- 1. Consider a SoC consisting of various function modules. It is organized as a pipeline of six functional units whose details and execution times are given below. These times do not include the clocking overhead of 0.5nsec. The functional units are listed in the suitable order (i.e. from F1 -to- F6) to perform the overall SoC function.

Functional Unit	Functions	Execution time (nsec)		
F1	Pre-processing	4.3		
F2	Filtering	4.2		
F3	Conversion	3.5		
F4	Computing	4.1		
F5	Decision Making	5.5		
F6	Control	4.5		

- (a) Determine the optimum number of pipeline stages.
- (b) Calculate the clock cycle of the amended SoC for all the pipeline stages identified in part (a).

(c) How long will it take to computer the SoC function for 1000 time for the pipelined SoC configures in parts (a) and (b)?

[[]Marks: 2+4+6]

List the differences between sc_thread and sc_method module implementations in SystemC. Explain how sc_thread may be implemented to run with the same characteristics as sc_method.

3. Consider the SoC given below consisting of a CPU, memory and accelerator core. 60% of the bus transactions move data from the memory to the CPU, occupying the bus for 32 clock cycles (c.c). Rest of the 40% bus transactions move data back and forth among the CPU and accelerator core, taking approximately 52 c.c on the bus. Memory transfers occur every 300 c.c, whereas accelerator to CPU transfers occur every 150 c.c. Determine the bus occupancy of the system. Show your complete work.

MARKS: 8



4. Consider a 4x4, 2D-mesh topology Network-on-Chip (NoC) as shown in Figure Q2. The NoC cores are labelled from 1 to 16. The NoC routers (cores) are connected via 32-bit wide channels and NoC communication is based on wormhole routing. The NoC is being operated at 1.0 GHz. 1Kbits of data is being sent from core (8) to core (13) in the NoC. The data is transferred as a packet consisting of 32-bit size flits.

MARKS: 10



(a) Determine the number of flits of the packet being sent from core (8) to (13).

[Marks: 4]

(b) Calculate the time required to transfer the 1Kbit data packet from core (8) to core (13) by using XY routing.

[Marks: 6]

5.	Indicate (in the space provided) whether the following are TRUE or FALSE. To obtain full marks for each
	question, include SHORT comments in support of your answer.

[Marks: 12 (2 each)]

(a) APB bus operates at a lower clock rate than the AHB bus. TRUE or FALSE?						
(b) Core-Connect bus supports concurrent read and write bus transactions. TRUE or FALSE?						
(c) Cortex A9 processor is mainly employed for real-time applications. TRUE or FALSE?						
(d) Apple A5 SoC consists of ARM Cortex A9 processor and few GPUs. TRUE or FALSE?						

(e) AMBA AHB lite bus has a higher bandwidth than AXI bus. TRUE ____ or FALSE ____?

(f) ARM	Cortex A9 pr	ocessors	are commonly	v used in d	esktop work	stations.
TRUE	_ or FALSE	?				

- 6. Consider a SoC with a master processor that must perform 4-beat burst (INCR4) read followed by (INCR4) burst write operations to/from a memory (slave) device from addresses (48) and (64) respectively. AMBA 2.0
 AHB (32-bit) bus is employed to connect the master with the memory device.
 - (a) Draw the timing diagram for the above transfers with respect to a clock if the memory device does not require any additional time (clocks) to complete the read or write operations. Your timing diagram may include HCLK, HADDR[31:0], HWRITE, HTRANS[1:0], HRDATA[31:0], HWDATA[31:0] and any other signals.
 - (b) Determine the number of clock cycles required to initiate and perform the above read and write burst transfer operations.

[Marks: 10+3]