

Mid-semester exam  
AT81.15 Embedded Systems Architecture  
(3 hours, 5 questions)

For all questions, please show your step-by-step solution to get full-credits

Questions 1: Assume a 5 stage in-order microprocessor system (Fetch, Decode, Execute, Memory, and Writeback), calculate the total number of cycles of below instructions. Note that for in-order execution, Instruction Fetch, Decode, Execute, Memory, and Writeback have to be maintained from original program order.

- 1) No pipeline system ( 5points)
- 2) A pipeline system ( 15points)

In this question, all instructions take 1 cycle in EX stage. Data bypass/forwarding is allowed.

1. LDR R2, [R0]            (load word)
2. LDR R4, [R2]
3. LDR R3, [R2]
4. ADD R5, R3, R1
5. LDR R7, [R5]
6. LDR R9, [R5]
7. LDR R9, [R7]
8. LDR R10, [R9]
9. ADD R11, R10, R1

Questions 2: Given below instruction:

- 1 MUL R1, R2, R8
- 2 ADD R2, R3, R10
- 3 ADD R3, R4, R12
- 4 MUL R4, R5, R11
- 5 ADD R5, R8, R12
- 6 MUL R1, R5, R8
- 7 ADD R2, R1, R9
- 8 MUL R3, R1, R10
- 9 ADD R4, R1, R11
- 10 ADD R5, R1, R12

a) Identify all type of data dependency (RAW, WAR, WAW) between all pairs of instructions in this program. Note that you must identify data dependency among all 10 instructions (10 points)

b) Calculate the ILP for the above code. All instructions take 1 cycle for execution? ( 10 points)?

3) Given the two-integer variable a and b, write a C program to find the greatest common divider (GCD) e.g, GCD of a=8 and b=12 is 4. (20 points)

4)

- a) You are driving the car over the bridge on a one lane road and there is another car coming at the same time. You are trying to make the reverse driving but there is another car behind you. The same thing is happening with the car in front of you. What is this scenario and how could we avoid it? (10 points)
- b) By having the time slice/time quantum mechanism such as round robin schedule, it could help address the starvation and long waiting time. Why don't we make the time slice/time quantum very often to help increase the fairness as well as reduce the process waiting. (10 points)

5) Assuming all task comes in the ascending order (T1 comes first and T8 comes last) before time 0. Please calculate the waiting time for FIFO scheduling, SJF scheduling, and round robin using time slice of 5 seconds (only for round robin). Note that for FIFO and SJF scheduling, once the task is scheduled, it has to be executed until completion. Please provide details calculation and justify which is the best methods (20 points)

Task	T1	T2	T3	T4	T5	T6	T7	T8
Run time	50	32	5	1	2	3	2	4