Computer science and Engineering Department, IIT Kharagpur

Subject: Computer Organization and Architecture, Subject No. CS31007
Mid Semester Examination, September, 2015, Time: 2 Hours, Full Marks: 60

Instruction: Answer all questions having equal marks

Q1. (a) Calculate the time required to add four 16-bit numbers using full carry lookahead adders versus carry save with carry lookadead adder forming the sum. [6]

(b) Draw the simple single cycle datapath for the MIPS architecture combining all the elements required to different instruction classes. Briefly mention the function of the datapath elements. [9]

Q2. (a) Distinguish between single cycle and multi-cycle execution of instructions and compare their CPI values and relative datapath requirements. [6]

(b) How the datapath gets modified as you go for multicycle execution. Give the modified multi-cycle datapath. [9]

Q3. (a) Distinguish between output depenedence and antidependence with examples. [4]

(b) Explain with an example how control dependence degrades the performance of a pipelined processor. [4]

(c) Consider a 7-stage pipelined processor with branch instruction latency of 5 cycles and 2 cycle latency for other instructions. Assuming that the branch represented by the bne instruction is not taken, draw the pipeline execution diagram to compute the execution time for the following code fragment.

```
bne   $4, $5, 25
or    $2, $1, $7
add   $8, $9, S10
sub   $5, $2, $9
and   $10, $5, $8
```

[7]

Q4. (a) What is forwarding? Explain how forwarding is used to avoid data hazards. [4]

(b) What is the execution time (in terms of clock cycles) of the following instruction sequence on a pipeline processor having five stages, namely Instruction Fetch, Instruction Decode, Register Read, Execute and Write Back. Assume that no forwarding exists.

```
add   $3, $4, $5
sub   $7, $3, $9
or    $8, $7, $10
and   $8, $9, $10
add   $2,$6,$8
```

[6]

(c) Can the execution time of the above code fragment be improved by reordering the instructions without changing the result of computation? If so, show the execution sequence with the shortest execution time and compute its execution time. [5]