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OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER I EXAMINATIONS, 2000/2001

FOURTH YEAR ELECTRONIC AND COMPUTER ENGINEERING

EMBEDDED SYSTEMS

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Duration of examination: *Two* hours

Instructions: Answer *four* questions

1. (a) Explain with the aid of diagrams the following two methods of data transfer to registers in a datapath:
Multiplexer based transfer
Bus-based transfer

[6 marks]

- (b) As part of a design for a CPU you are required to design part of the ALU of the system. The 4 bit arithmetic circuit of the ALU has two input selection variables S_1 and S_2 , a C_{in} and A and B data inputs. The circuit is capable of generating the arithmetic operations as listed in Table 1 below. Draw the logic diagram for the circuit. [10 marks]

$S_1 S_0$	$C_{in} = 0$	$C_{in} = 1$
0 0	$F = A + B$ (add)	$F = A + B + 1$
0 1	$F = A$ (transfer)	$F = A + 1$ (increment)
1 0	$F = \bar{B}$ (complement)	$F = \bar{B} + 1$ (negate)
1 1	$F = A + \bar{B}$	$F = A + \bar{B} + 1$ (subtract)

Table 1

- (c) Explain in detail with the aid of diagrams what you understand by the term: *pipelined datapath*.

Your explanation should detail how pipelining of a datapath alters the rate at which a given datapath can execute microoperations. [9 marks]

2. (a) A block diagram for a n -bit binary multiplier is shown in figure 2 below. Explain in detail the operation of the system. Your explanation should include a description of the function of each register in the diagram. [10 marks]
- (b) Draw a ASM chart that describes the binary multiplier and list the two main aspects of implementing the control unit for multiplier. [5 marks]
- (c) Design a circuit that will implement the control unit for the circuit. [10 marks]

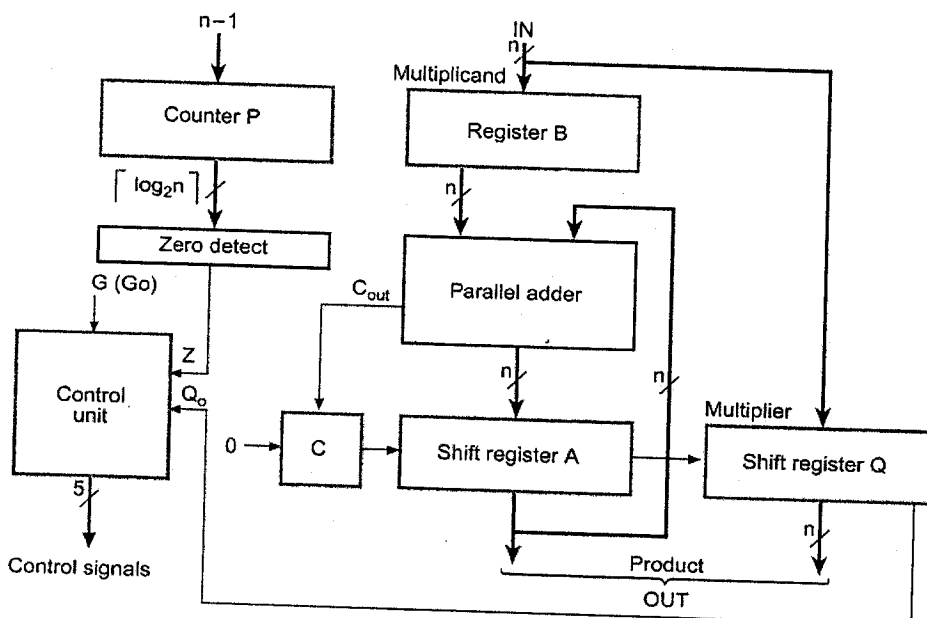


Figure 2

3. (a) Explain what you understand by the term *microprogrammed control* as applied to the design of control units. Give a block diagram showing the structure of a microprogrammed control unit. Explain the function of the various components of the diagram. [12 marks]
- (b) Design a microprogrammed control unit for the binary multiplier shown in figure 2. Your design should include an ASM chart for the microprogrammed control unit and details on the microinstruction Control word format along with a complete block diagram for the control unit. [13 marks]
4. (a) Explain what you understand by the terms *RISC* and *CISC* as applied to CPU architectures. Give a detailed comparison between both schemes. [15 marks]
- (b) A digital computer has a memory unit with 24 bits per word. The instruction set consists of 150 different operations. There is only one type of instruction format with an opcode part and an immediate operand part. Each instruction is stored in one word of memory.
- (i) How many bits are needed for the opcode part of the instruction.
 - (ii) How many bits are left for the immediate part of the instruction.
 - (iii) If the immediate operand is used as an unsigned address to memory, what is the maximum number of words that can be addressed in memory.
 - (iv) What are the largest and the smallest algebraic values of signed 2's complement binary numbers that can be accommodated as an immediate operand.
- [10 marks]

5. (a) Show how the following two unsigned numbers 100110 (multiplicand) and 110101 (multiplier) by using both the hand method and the hardware method.

[7 marks]

- (b) The diagram of figure 5 below shows an ASM chart. Assuming the initial state to be ST1 find the response of the system to the following sequence of inputs:

A: 0 1 1 0 1 1
B: 1 1 1 1 0 0

[7 marks]

- (c) Determine the state table for the chart and give a circuit implementation based on D type flip-flops using one flip-flop per state.

[11 marks]

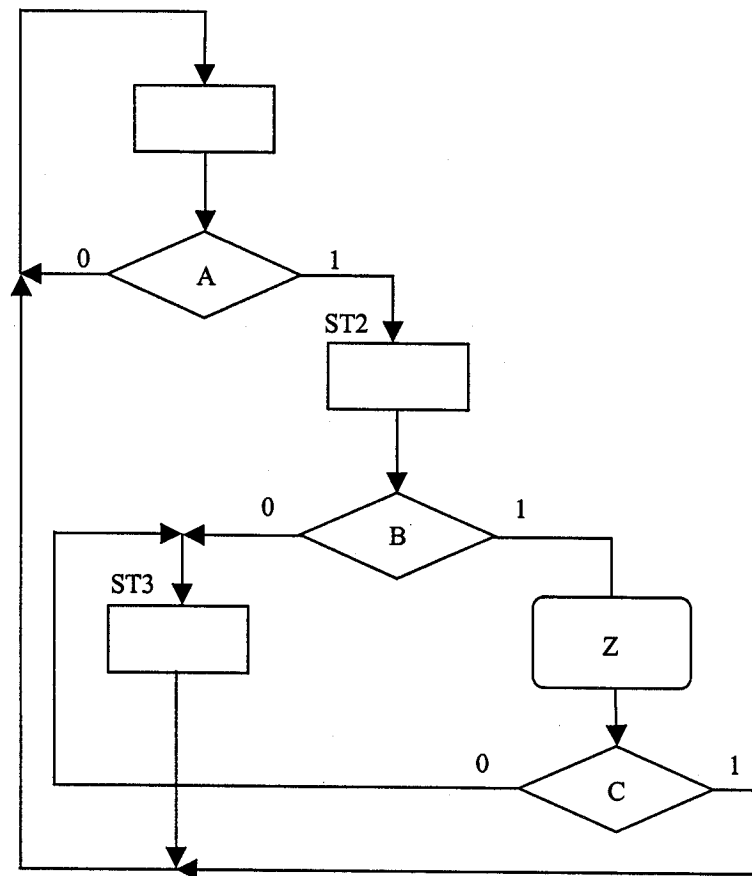


Figure 5