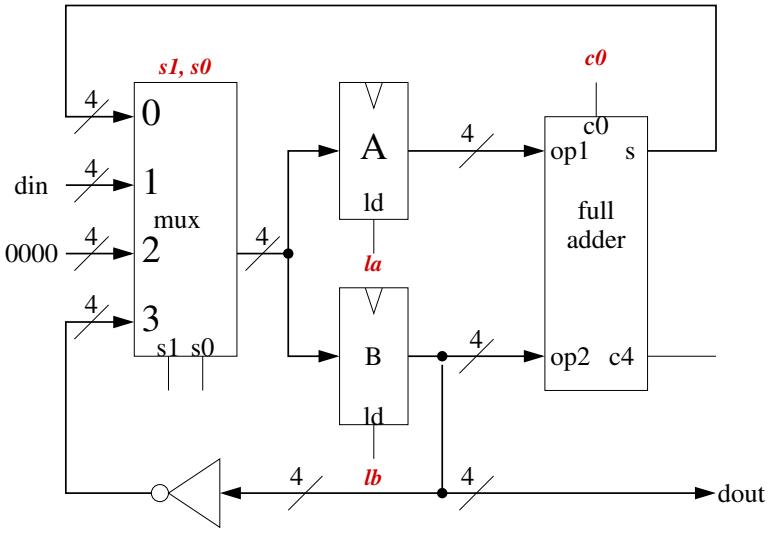
Sample Sequential Circuit Questions SOLUTIONS

1. Consider the following logic diagram of a sequential system:



(a) On the diagram, label all the control inputs only.

(b) Propose a control word format for this system, indicating which control inputs are defined by which bit positions.

ANSWER:

s1	s0	la	lb	c0
4	3	2	1	0

(c) For each of the following tasks determine if it can be performed by a single μ-instruction; that is, by a single control word assignment. If it can, then give the control word that will cause the task to be executed, using your control word format from question (b).

i. **B** $\leftarrow$ **A plus B**

ANSWER: Yes: 00010

ii. **A** $\leftarrow$ **0**

ANSWER: Yes: 1010X

iii. **A** $\leftarrow$ **B**$'$

ANSWER: Yes: 1110X

iv. **B** $\leftarrow -$**B**

ANSWER: No, it will take 2 μ-instructions

(d) Without using data input port 1 of the MUX, Find a sequence of μ-instructions, expressed as register transfer statements, that enable the sequential system to perform the following tasks:
HINT: How is the functional specification of an n-bit Full Adder expressed?

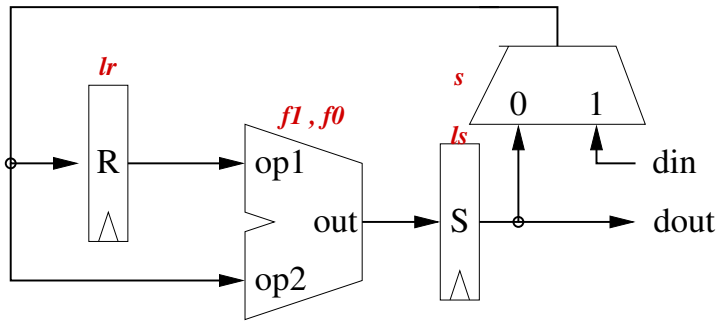
i. **A** $\leftarrow$ **1**

ANSWER;
A $\leftarrow$ 0
B $\leftarrow$ 0
A $\leftarrow$ A plus B plus 1

ii. **A** $\leftarrow -1$

ANSWER:
A $\leftarrow$ 0
B $\leftarrow$ 0
B $\leftarrow$ A plus B plus 1
B $\leftarrow$ B'
A $\leftarrow$ A plus B plus 1

2. A digital system is implemented by the following logic diagram:



f1	f0	ALU FUNCTION
0	0	out = 0
0	1	out = op1 plus op2
1	0	out = op1 nand op2
1	1	out = 1

R and S are storage registers.

(a) On the logic diagram assign and label the control inputs to all devices as required.

(b) Which of the following register transfer statements are μ-instructions? For those that are, indicate what values the control inputs must have to achieve the desired effect. For those that are not, give a sequence of μ-instructions that will result in the desired effect.

i. S $\leftarrow$ 1

ANSWER: Control word format:

lr	f1	f0	ls	s
4	3	2	1	0

Control word: 0111X

ii. S $\leftarrow$ R plus 1

ANSWER: Control word: 00111 (with din = 1)

iii. S $\leftarrow$ R nand S

ANSWER: Control word: 01010

iv. S $\leftarrow -1$

ANSWER: μ-program:

μ-instruction
S $\leftarrow$ 0
R $\leftarrow$ S
S $\leftarrow$ R nand S

OR

μ-instruction
S $\leftarrow$ 1
R $\leftarrow$ S
S $\leftarrow$ R nand S
R $\leftarrow$ S
S $\leftarrow$ 1
S $\leftarrow$ R plus S