Tutorial 9: Solution

NB It is possible to solve these problems in more than one way. These are typical solutions.

Problem 1: INC(Increment) Result = Number + 1

State 1: Load the instruction register
State 2: Clear Register A by setting zero on the ALU
State 3: Load the number into B
State 4: Load the Instruction register
State 5: Add A and B with the carry in set to 1, shifter unchanged, load the result into RES

		Instruction register (IR)							
State	Data In	IR7	IR6	IR5	IR4	IR3	IR2	IR1	IR0
1	0000000X	X	X	X	X	X	X	X	X
2	XXXXXXXX	0	0	0	0	0	0	0	X
3	Number	0	0	0	0	0	0	0	X
4	X0110000	0	0	0	0	0	0	0	X
5	XXXXXXXX	X	0	1	1	0	0	0	0

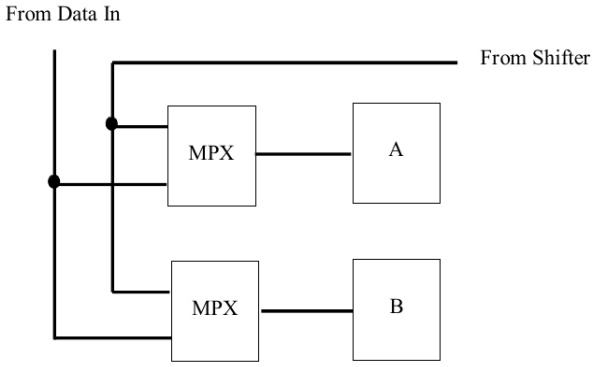
Problem 2. FN1(A+B-C)/2 Result = (Number1+Number2-Number3)/2

State 1: Load the instruction register
State 2: Load Number 1 into A
State 3: Load Number 2 into B
State 4: Load the instruction register
State 5: Clear C by setting the ALU to zero
State 1: Load the instruction register
State 2: Add A and B with zero carry in, Load the result into A
State 3: Load Number 3 into B (assume that there is no carry from the previous stage)
State 4: Load the instruction register
State 5: Subtract B from A, set the shifter to shift right, load result into RES

		Instruction register (IR)							
State	Data In	IR7	IR6	IR5	IR4	IR3	IR2	IR1	IR0
1	1XXXXXXX	X	X	X	X	X	X	X	X
2	Number 1	1	X	X	X	X	X	X	X
3	Number 2	1	X	X	X	X	X	X	X
4	X000XXXX	1	X	X	X	X	X	X	X
5	XXXXXXXX	X	0	0	0	X	X	X	X
1	00110001	X	0	0	0	X	X	X	X
2	XXXXXXXX	0	0	1	1	0	0	0	1
3	Number 3	0	0	1	1	0	0	0	1
4	X0101101	0	0	1	1	0	0	0	1
5	XXXXXXXX	X	0	1	0	1	1	0	1

Problem 3

Both multiplexers could be set from IR7.



Alternatively we could use the basic shifter which has just four functions and therefore two function select bits, and use the spare bit to set the multiplexer on the input to B.

Another possibility is to decode the IR. Using the bits directly is very inefficient. We will explore this idea in more detail in the last lectures of the course.