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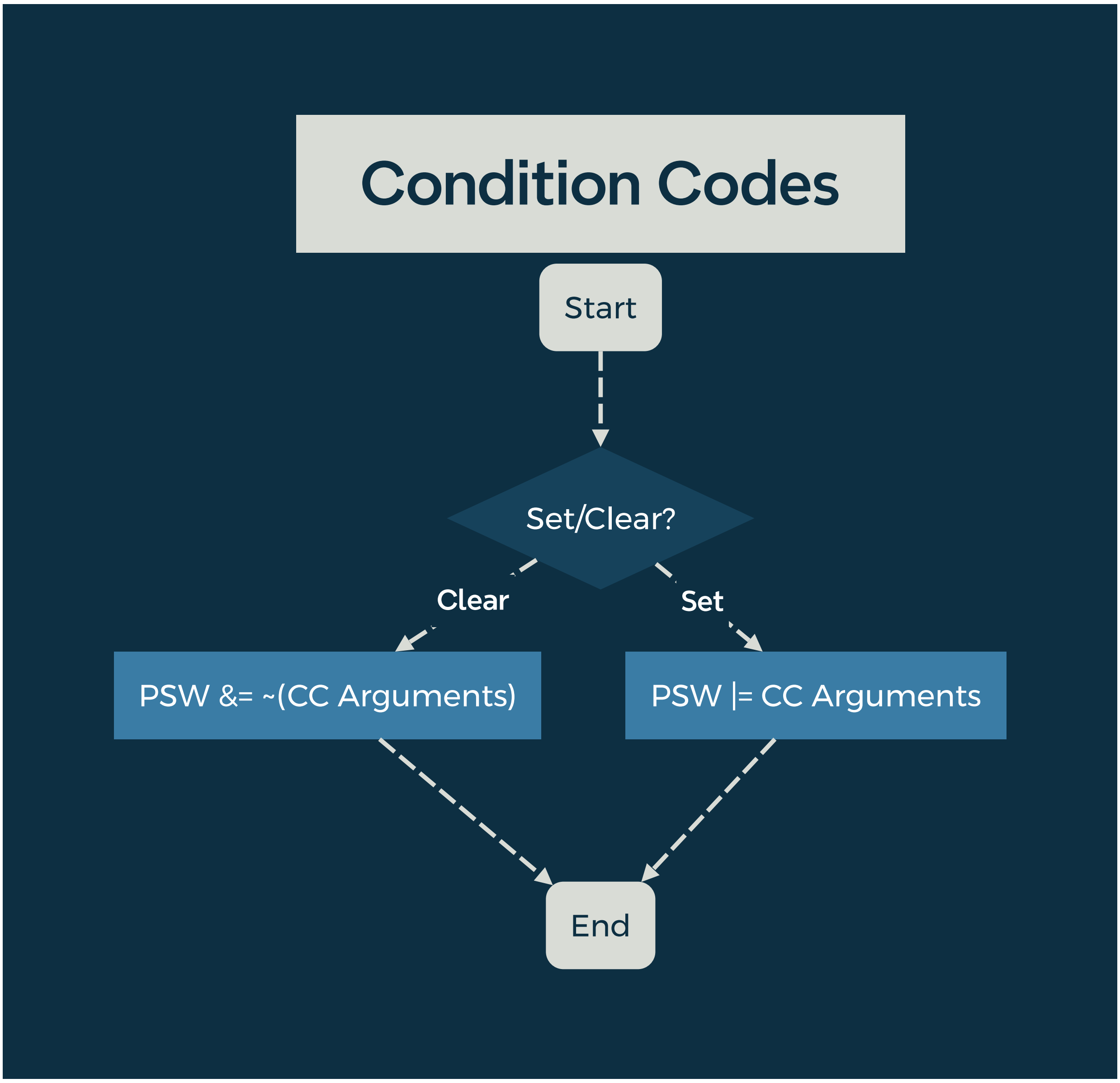
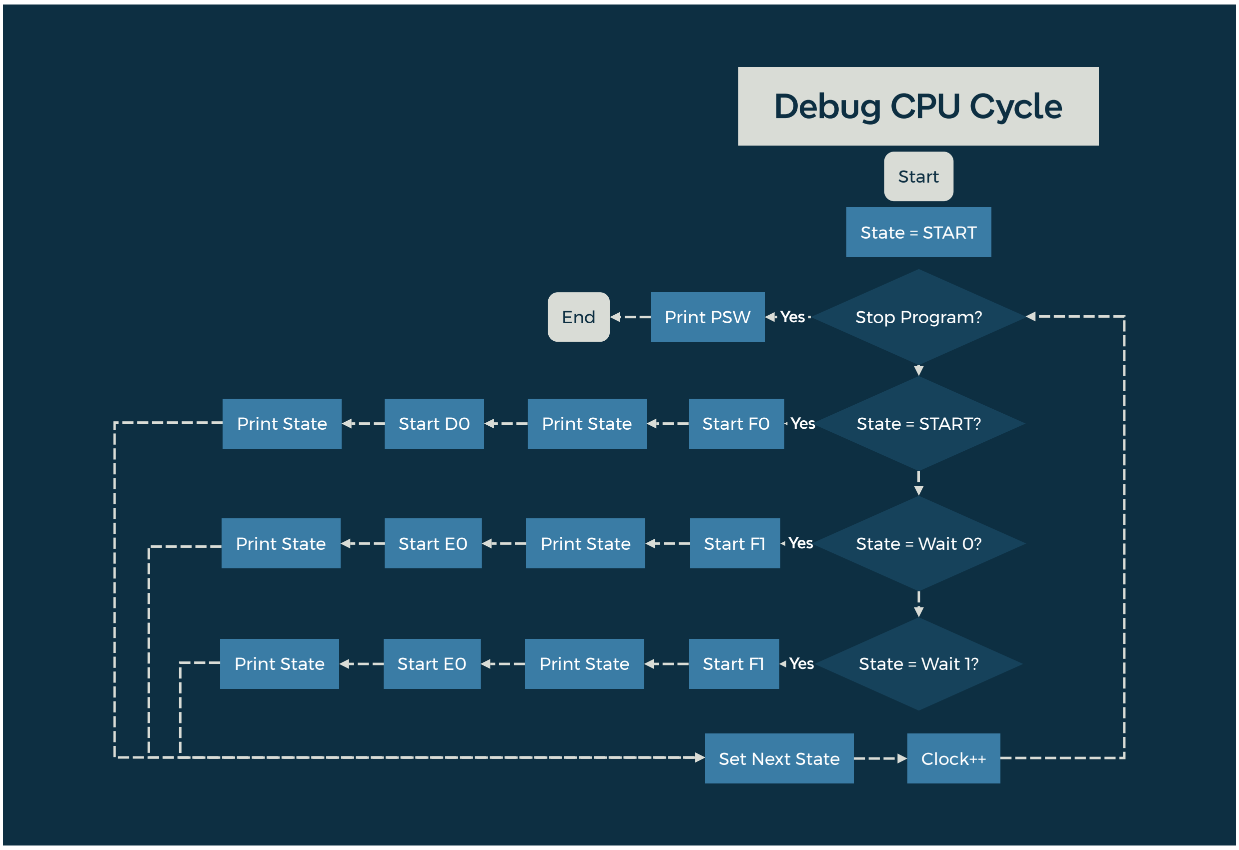
Lab 4 - Condition Codes and Debug Mode

This lab implements condition code manipulation and debug printing to the XM23P Emulator.

Design

The design contains logic flowcharts detailing the implementation of the condition code and debug features.
A Data Dictionary for the current state of the emulator is included.




Debug CPU Cycle
Start
State = START
Stop Program?
Yes
Print PSW
End
State = START?
Yes
Start F0
Print State
Start D0
Print State
State = Wait 0?
Yes
Start F1
Print State
Start E0
Print State
State = Wait 1?
Yes
Start F1
Print State
Start E0
Print State
Set Next State
Clock++

Data Dictionary

```
PROGRAM         =   IMEM + DMEM + REGFILE + BREAKPOINT + START_ADDRESS + IR

IMEM            =   64*2^10{BYTE}64*2^10
DMEM            =   64*2^10{BYTE}64*2^10

REGFILE         =   3{GPR}3 + BP + LR + SP + PC
GPR             =   WORD *General Purpose Register*
BP              =   WORD *Base Pointer*
LR              =   WORD *Link Register*
SP              =   WORD *Stack Pointer*
PC              =   WORD *Program Counter*

PSW             =   PRV_PRI + 4{DC}4 + FLT + CUR_PRI + V + SLP + N + Z + C
PRV_PRI         =   3{BIT}3 *Previous Priority*
DC              =   BIT     *Don't Care*
FLT             =   BIT     *Fault*
CUR_PRI         =   3{BIT}3 *Current Priority*
V               =   BIT     *Arithmetic overflow*
SLP             =   BIT     *Sleep State*
N               =   BIT     *Negative Result*
Z               =   BIT     *Zero Result*
C               =   BIT     *Carry*

BREAKPOINT      =   ADDRESS
START_ADDRESS   =   ADDRESS
IR              =   WORD

INSTRUCTION     =   CODE + 1{PARAMETER}4
CODE            =   [0-20] *Contiguous encoding of instructions*
PARAMETER       =   [RC|WB|SOURCE|DESTINATION|BYTE]

RC              =   BIT
WB              =   BIT
SOURCE          =   3{BIT}3
DESTINATION     =   3{BIT}3

ADDRESS         =   WORD
WORD            =   2{BYTE}2
BYTE            =   8{BIT}8
BIT             =   [0|1]

S_REC           =   'S' + REC_TYPE + LENGTH + ADDRESS + DATA
REC_TYPE        =   ['0'|'1'|'2'|'9']
LENGTH          =   BYTE_PAIR
ADDRESS         =   2{BYTE_PAIR}2
DATA            =   1{BYTE_PAIR}30
BYTE_PAIR       =   2{CHAR}2
CHAR            =   ['0'-'F']
```

Testing

The following tests were implemented:

- Test_24: Debug Toggle
- Test_25: Pipeline Printing
- Test_26: Set Condition Codes
- Test_27: Clear Condition Codes

Each test may be run from a powershell terminal with the following command:

```
Get-Content '.\Path\To\Input\File' | '.\Path\To\Executable'
```

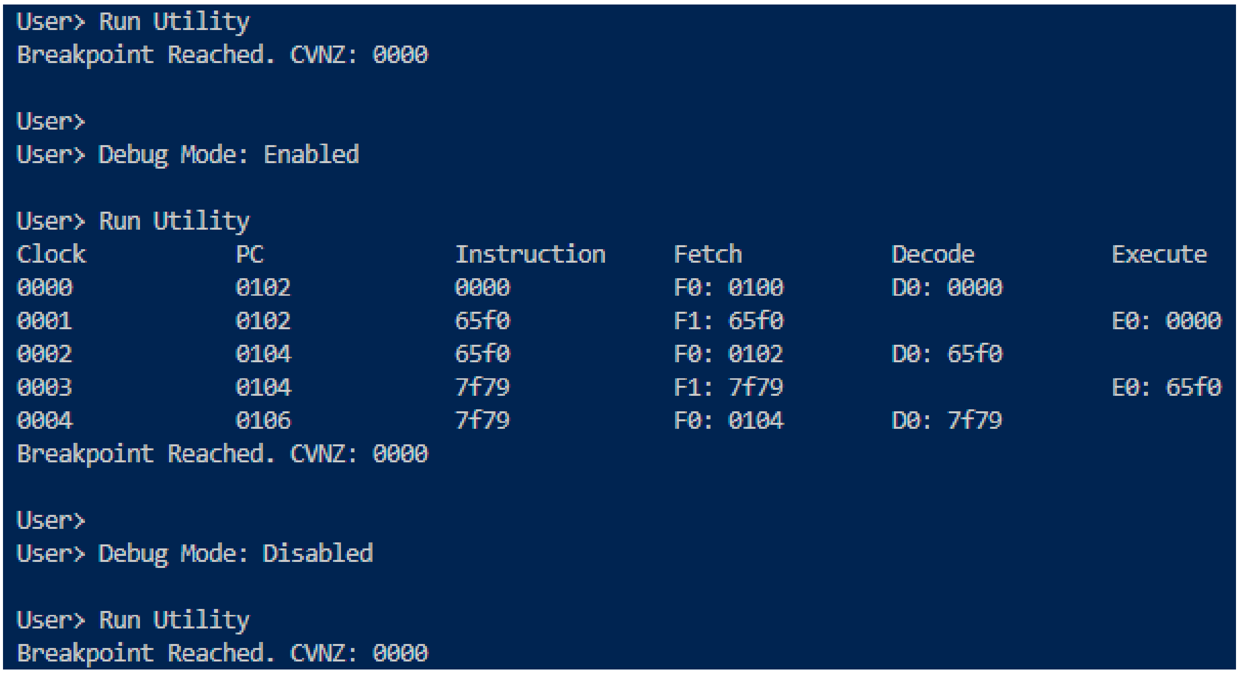
Test_24: Debug Toggle

Purpose
Test the functionality of the debug toggle feature in the XM23P Emulator.
Configuration

.\tests\Debug_Tests\Input_Files\test24.in

1. Test10_Program_Debugging.xme was loaded into the emulator.
2. The program was executed without enabling the debug mode.
3. The debug toggle was activated after program execution.
4. The program was executed with debug mode enabled.
5. The debug toggle was deactivated after program execution.
6. The program was executed with debug mode disabled.

Expected Results
The first and third executions of the program should not display debug information. The second execution should display debug information.
Results
The debug toggle successfully enabled and disabled the debug mode.\



```
User> Run Utility
Breakpoint Reached. CVNZ: 0000

User>
User> Debug Mode: Enabled

User> Run Utility
Clock           PC              Instruction     Fetch           Decode          Execute
0000            0102            0000            F0: 0100        D0: 0000
0001            0102            65f0            F1: 65f0                        E0: 0000
0002            0104            65f0            F0: 0102        D0: 65f0
0003            0104            7f79            F1: 7f79                        E0: 65f0
0004            0106            7f79            F0: 0104        D0: 7f79
Breakpoint Reached. CVNZ: 0000

User>
User> Debug Mode: Disabled

User> Run Utility
Breakpoint Reached. CVNZ: 0000
```

Pass/Fail

Pass.

Test_25: Pipeline Printing

Purpose

Test the pipeline printing functionality in the XM23P Emulator.

Configuration

.\tests\Debug_Tests\Input_Files\test25.in

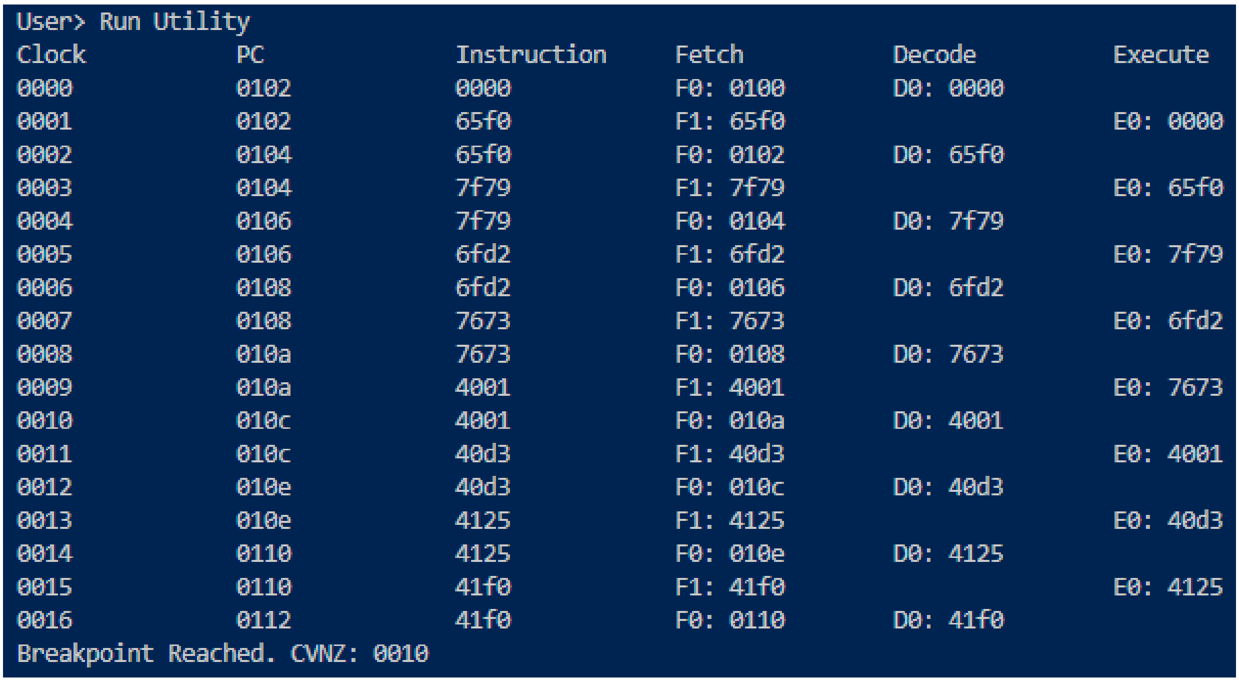
1. Test10_Program_Debugging.xme was loaded into the emulator.
2. The debug toggle was activated using `d`.
3. A breakpoint was set at address `0110` using `b 110`
4. The program was executed using `g`.

Expected Results

The pipeline printing should display the stages of the pipeline during program execution. During the first clock cycle, stages F0 and D0 should run, and during the second clock cycle F1 and E0 should run. The program counter should increment after every second clock tick.

Results

The pipeline printing successfully displayed the stages of the pipeline as expected.\



```
User> Run Utility
Clock          PC             Instruction    Fetch          Decode         Execute
0000           0102           0000           F0: 0100       D0: 0000
0001           0102           65f0           F1: 65f0                      E0: 0000
0002           0104           65f0           F0: 0102       D0: 65f0
0003           0104           7f79           F1: 7f79                      E0: 65f0
0004           0106           7f79           F0: 0104       D0: 7f79
0005           0106           6fd2           F1: 6fd2                      E0: 7f79
0006           0108           6fd2           F0: 0106       D0: 6fd2
0007           0108           7673           F1: 7673                      E0: 6fd2
0008           010a           7673           F0: 0108       D0: 7673
0009           010a           4001           F1: 4001                      E0: 7673
0010           010c           4001           F0: 010a       D0: 4001
0011           010c           40d3           F1: 40d3                      E0: 4001
0012           010e           40d3           F0: 010c       D0: 40d3
0013           010e           4125           F1: 4125                      E0: 40d3
0014           0110           4125           F0: 010e       D0: 4125
0015           0110           41f0           F1: 41f0                      E0: 4125
0016           0112           41f0           F0: 0110       D0: 41f0
Breakpoint Reached. CVNZ: 0010
```

Pass/Fail

Pass.

Test_26: Set Condition Codes

Purpose

Test the functionality of the setcc instruction in the XM23P Emulator.

Configuration

.\tests\Execute_Tests\Input_Files\test26.in

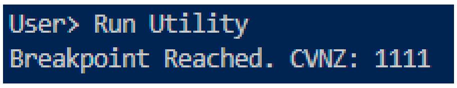
1. Test26_Condition_Codes.xme was loaded into the emulator.
2. A breakpoint was set at address `0102` using `b 102`
3. The program was executed using `g`.

Expected Results

The condition codes should be correctly set based on the executed instructions.

Results

The condition codes were correctly set based on the executed instructions as expected.\



```
User> Run Utility
Breakpoint Reached. CVNZ: 1111
```

Pass/Fail

Pass.

Test_27: Clear Condition Codes

Purpose

Test the functionality of the clrcc instruction in the XM23P Emulator.

Configuration

.\tests\Execute_Tests\Input_Files\test27.in

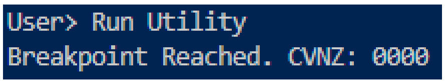
1. Test26_Condition_Codes.xme was loaded into the emulator.
2. A breakpoint was set at address `0104` using `b 104`
3. The program was executed using `g`.

Expected Results

The condition codes should be cleared based on the executed instructions.

Results

The condition codes were cleared based on the executed instructions as expected.\



```
User> Run Utility
Breakpoint Reached. CVNZ: 0000
```

Pass/Fail

Pass.