TRINITY COLLEGE DUBLIN

THE UNIVERSITY OF DUBLIN

Faculty of Engineering, Mathematics and Science
School of Computer Science and Statistics

Year 2 Integrated Computer Science Programme
Year 3 Integrated Engineering

Trinity Term 2015

CS2022 – Computer Architecture I

Friday 1st May 2015 | Luce Upper | 09:30 – 11:30

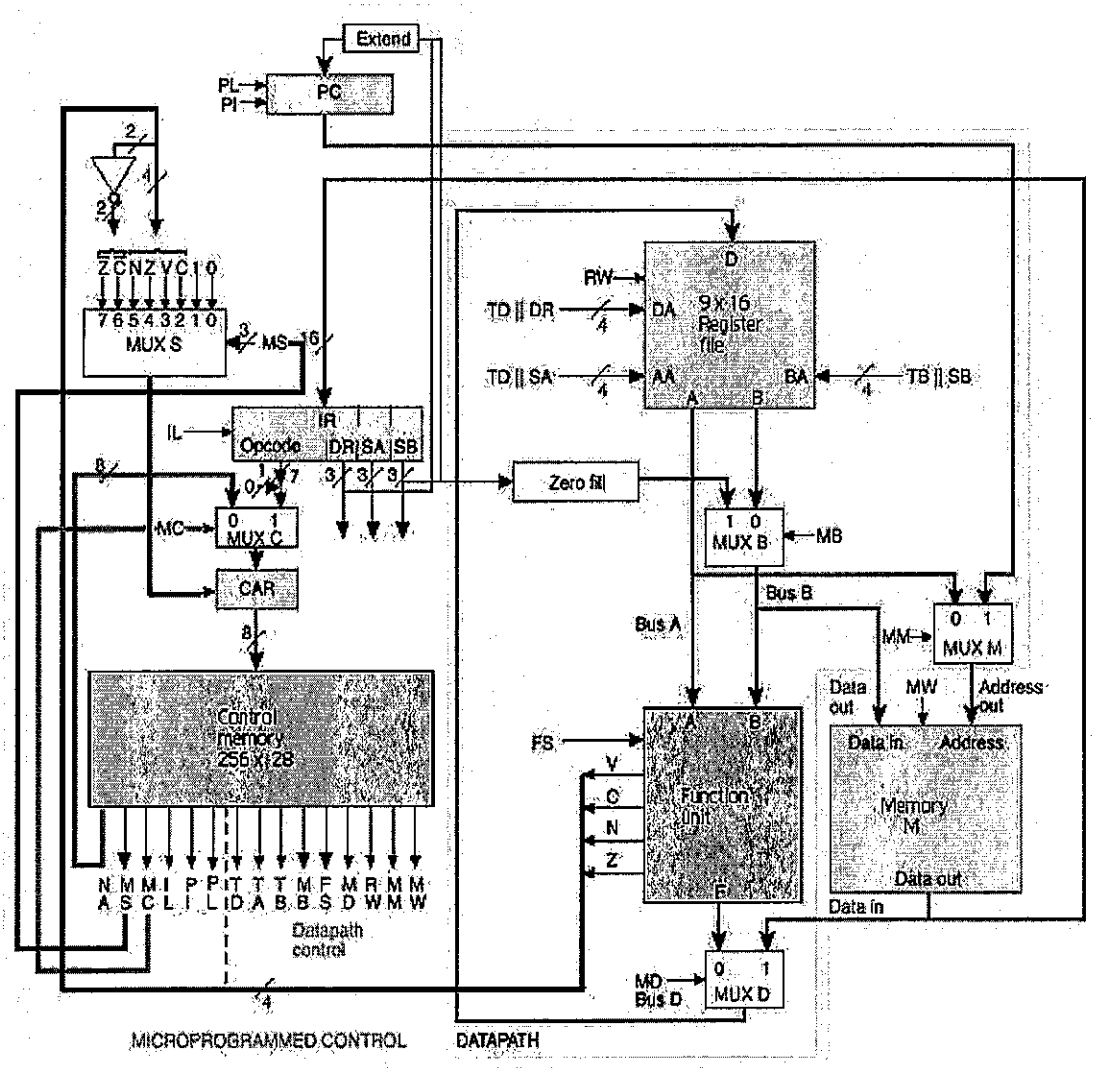
Dr. Michael Manzke

Answer **three** questions.

The use of non-programmable calculators is permitted.

1. a) Explain in detail the operations that take place when the following multiple cycle microprogrammed instruction set processor executes a single machine instructions. Your explanation must include operations in the processor's control e.g. how does one instruction in the IR register execute several control words in the Control Memory.

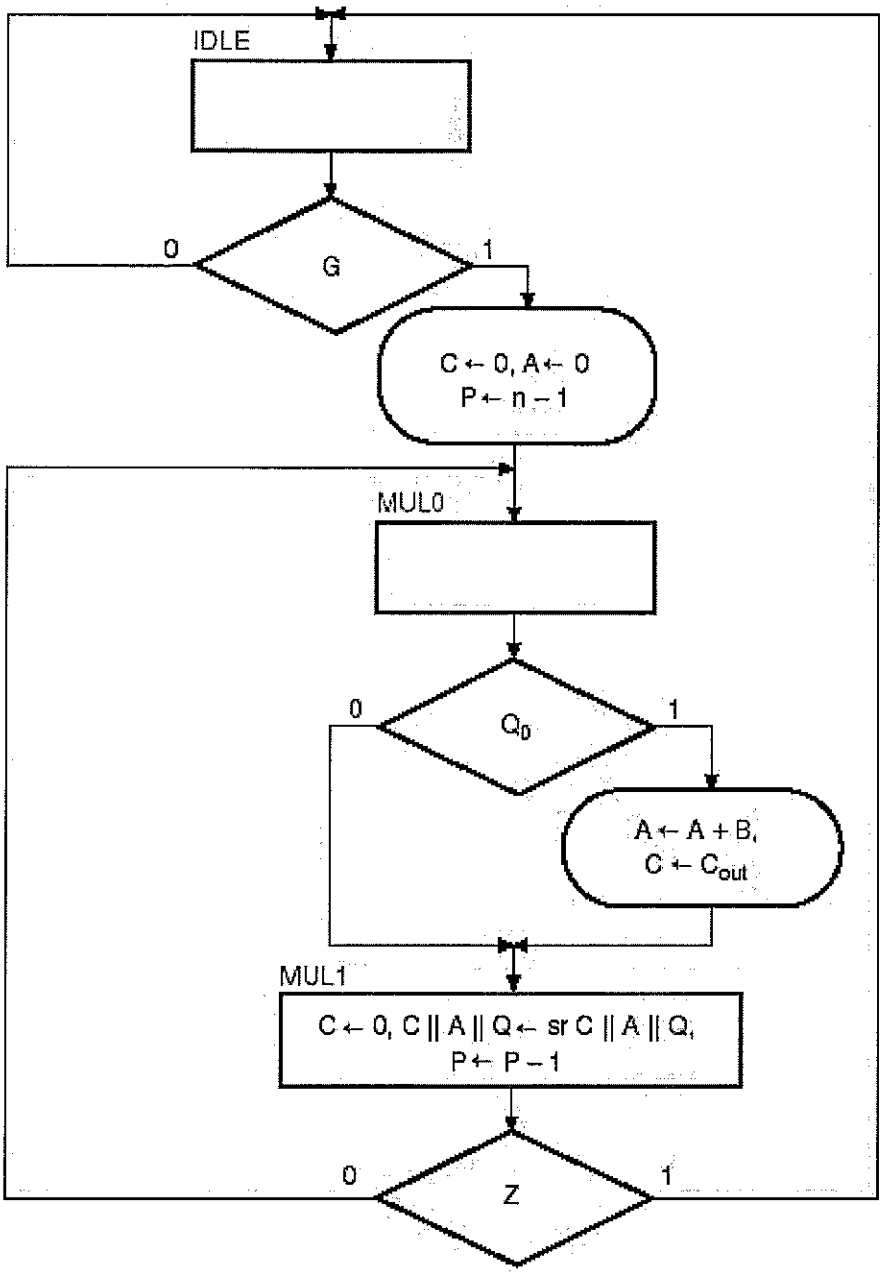
[15 marks]



b) How would you implement the PC and CAR?

[5 marks]

2. The following Algorithmic *State Machine* (ASM) chart shows the operations of a *Binary Multiplier*.



a) Provide an example (multiply two binary numbers) that explains the operations of the *Binary Multiplier.*
Please multiply 10111 x 10011.

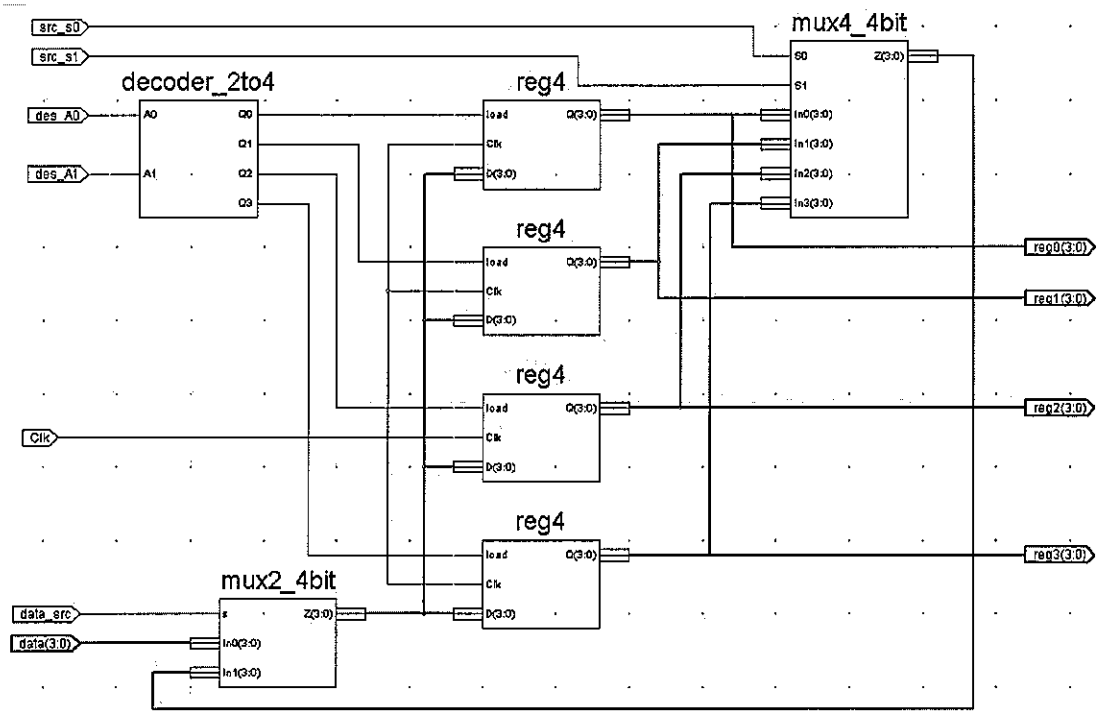
[8 marks]

b) Write VHDL code that implements the *Binary Multiplier.*

[12 marks]

3. a) Write VHDL code that implements the following *Register-file*:

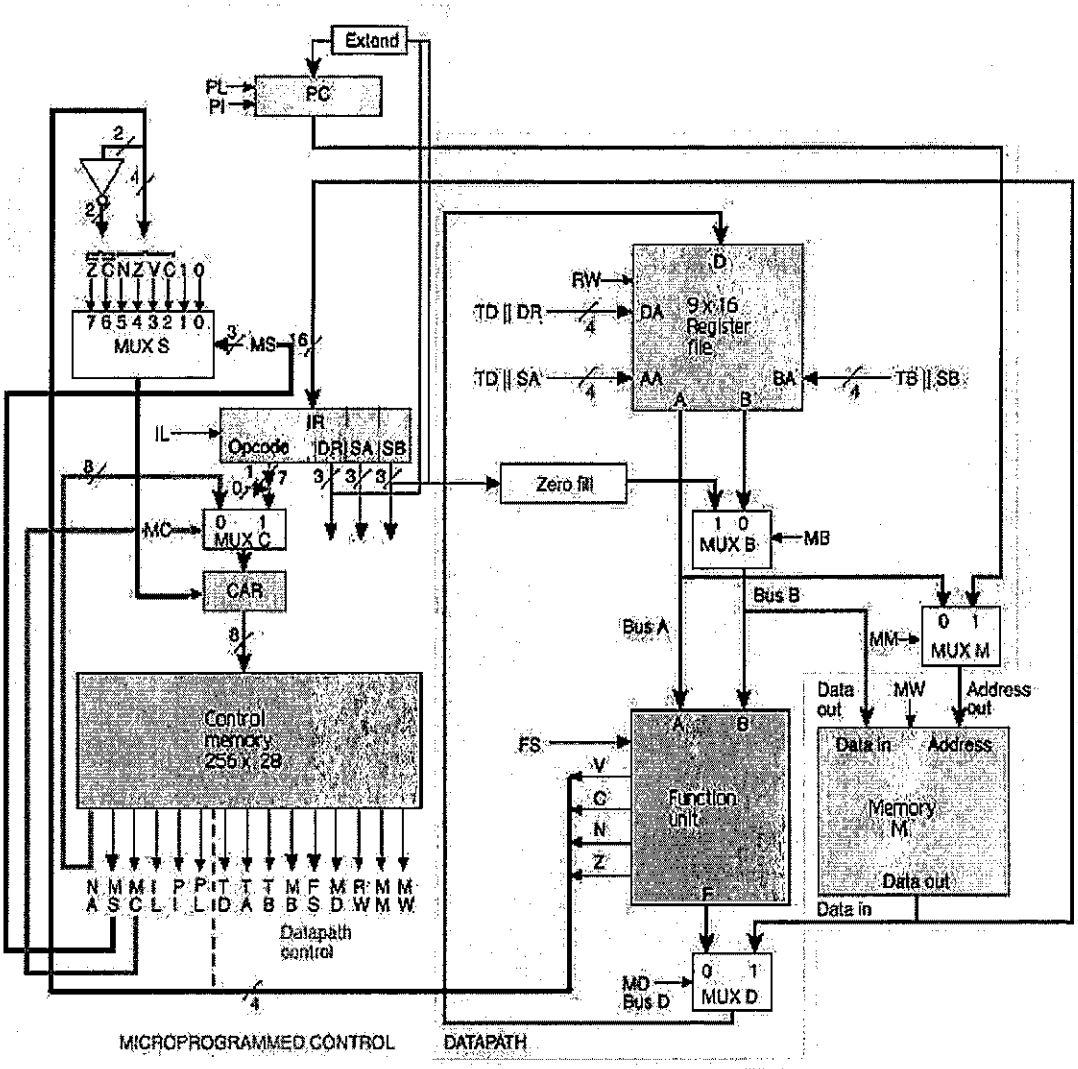
[15 marks]



(Question 3 continues on next page)...

...(Question 3 continued from previous page)

b) Discuss necessary modification to the above Register-file that would make the implementation suitable for the following processor :



[5 marks]

4. a) Provide a detailed schematic for a *Function Unit* that implements the following *micro-operations*:

[15 marks]

Table 1: FS code definition

FS	Micro-operation
00000	$F = A$
00001	$F = A + 1$
00010	$F = A + B$
00011	$F = A + B + 1$
00100	$F = A + \bar{B}$
00101	$F = A + \bar{B} + 1$
00110	$F = A - 1$
00111	$F = A$
01000	$F = A \wedge B$
01010	$F = A \vee B$
01100	$F = A \oplus B$
01110	$F = \bar{A}$
10000	$F = B$
10100	$F = sr B$
11000	$F = sl B$

b) What do the following Boolean Expressions implement? Please provide a detailed discussion. How would you implement C_8?

$C_{i+1} = g_i + p_i C_i$

$C_1 = x_0 y_0 + C_0(x_0 + y_0)$

$= g_0 + C_0 p_0$

$C_2 = x_1 y_1 + C_1(x_1 + y_1)$

$= x_1 y_1 + [x_0 y_0 + C_0(x_0 + y_0)](x_1 + y_1)$

$= g_1 + p_1 g_0 + p_0 p_1 C_0$

$C_3 = g_2 + p_2 g_1 + p_1 p_2 g_0 + p_0 p_1 p_2 C_0$

$C_4 = g_3 + p_3 g_2 + p_2 p_3 g_1 + p_1 p_2 p_3 g_0 + p_0 p_1 p_2 p_3 C_0$

[5 marks]