Carleton University **ELEC 2607 MIDTERM** March 6, 2009

Open book.

In the spirit of the code of honor of Carleton University I solemnly declare this examination is completely my own work, and I did not aid my answer to any question by dishonorable means.

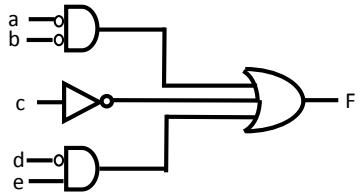
NAME_____STUDENT No_____

Write answers on the question sheet. Use additional paper if necessary. Attempt all questions.

1 General

a) Find the $\sum$ of $\prod$ for the following expression: $F = (A + B)\left(B + \overline{C}\right)(\overline{A} + D)$. (10%)

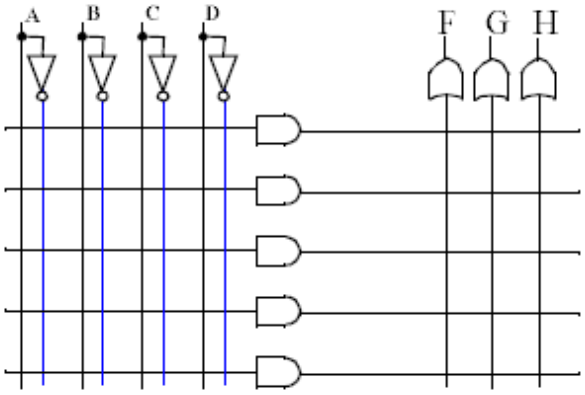
b) Redraw the following circuit using only NAND, and NOR gates and inverters. (10%)



c) Simplify the following expression: $G = \overline{E}A\overline{B}C\overline{D} + \overline{A}B\overline{D}CF + \overline{A}B\overline{D}C\overline{F} + \overline{A}BCD + ABCD + ABC\overline{D} + A\overline{B}CD + A\overline{B}C\overline{D}E$. Hint: There may be a couple of variables that are "easier" then the rest. (10%)

d) How many flip flops are required to make a finite state machine with 5 states? Is this the maximum number of states that can be made with this number of flip flops? Explain. (5%)

e) Implement the following three functions on the PLA given below: (10%)



$F = AB + ACD + \overline{B}D$

$G = CD + AB + AC\overline{B}D$

$H = ACD + \overline{B}D + A$

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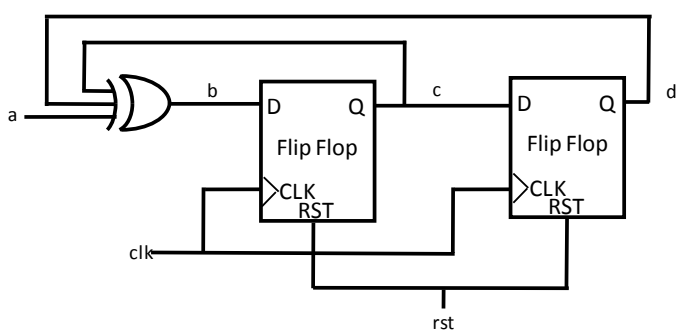
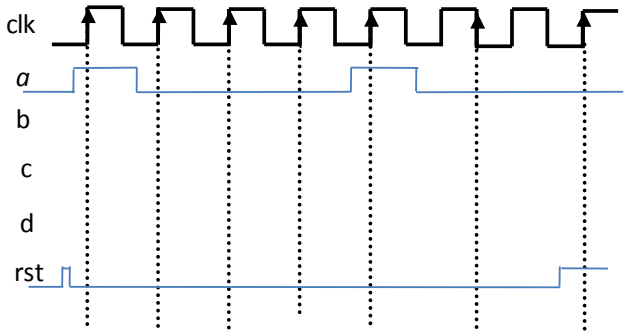
2 Draw the Waveforms (15%)

Plot all of the waveforms for the circuit below. The input rst is an asynchronous reset signal.

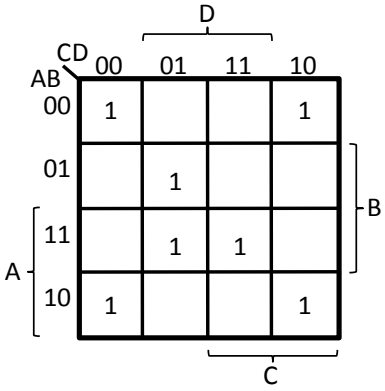




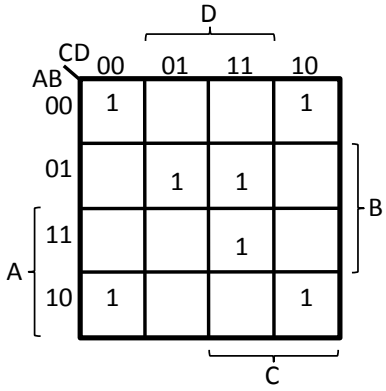
3 Five Variable Maps (20%)

Circle the maps below to determine an optimal expression for F.

Map of E



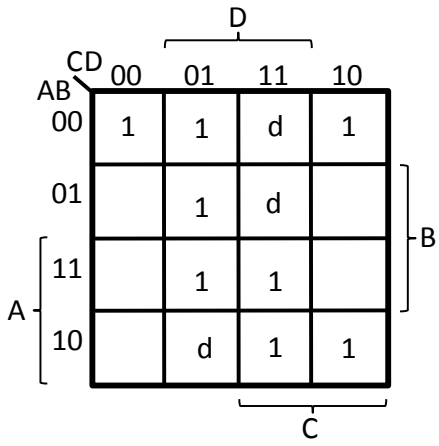
Map of $\bar{E}$



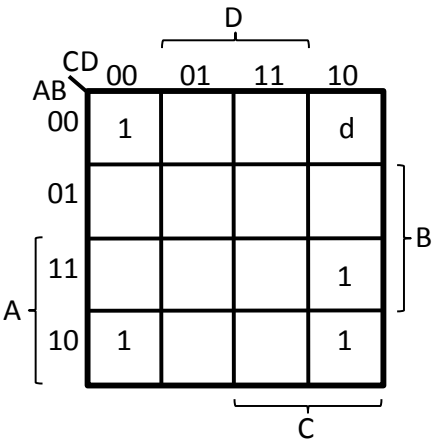
4 Multi Variable Maps (20%)

Circle the following three maps to provide the lowest gate count possible.

Map of F



Map of G



Map of H