Week - 4

1) The tpdf and tpdr of an N input NAND gate is
   a) RC(N^2+5N)/2, RCN(N+2)
   b) RC(2N^2+5N)/2, RCN(N+2)
   c) RC(5N^2+5N)/2, RCN(N-4)
   d) RC(3N^2+5N)/2, RCN(N)
   e) RC(2N^2+2N)/2, RCN(N-3)
   f) RC(2N^2+4N)/2, RCN(N+7)
   g) RC(2N^2+N)/2, RCN(N-9)
   h) RC(2N^2+6N)/2, RCN(N-1)

2) The tpdr and tpdf of an N input NOR gate is
   a) RC(2N^2), RCN(2N+2)
   b) RC(3N^2+N), RCN(2N)
   c) RC(N^2+N), RCN(2N+3)
   d) RC(4N^2+5N), RCN(2N+4)
   e) RC(2N), RCN(N+3)
   f) RC(2N^2+3N), RCN(N+2)
   g) RC(2N^2+2N), RCN(N+1)
   h) RC(N^2+2N), RCN(2N+1)

3) What is the logical effort for the input in a tristate based 2:1 multiplexer, considering long channel current model? Note that select lines are not inputs
   a) 8
   b) 1
   c) 2
   d) 16
   e) 4/3
   f) 5/3
   g) 7/3
   h) 10

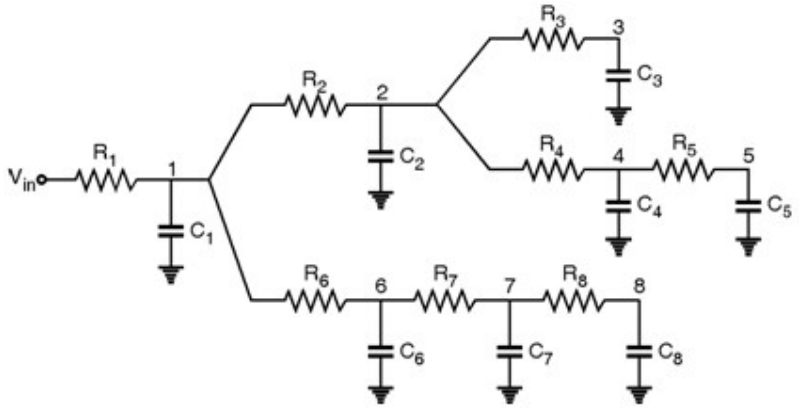
4) For a 4-NAND (4 input NAND gate), what is the propagation delay falling and rising delay as per the ELMORE Delay method?
   a) 16 RC & 16 RC
   b) 10 RC & 10 RC
   c) 24 RC & 24 RC
   d) 17 RC & 17 RC
   e) 18 RC & 24 RC
   f) 17 RC & 16 RC
   g) 16 RC & 16 RC
   h) 10 RC & 10 RC

5) For a 4-NOR (4 input NOR gate), what is the propagation delay falling and rising delay as per the ELMORE Delay method?
   a) 16 RC & 16 RC
   b) 10 RC & 10 RC
   c) 24 RC & 24 RC
   d) 17 RC & 17 RC
   e) 36 RC & 24 RC
   f) 17 RC & 16 RC
   g) 16 RC & 16 RC
   h) 13.4 RC & 17.6 RC

6) What is the logical effort of 4-NOR (4-input NOR) gate considering long channel current model?
   a) 2.51
   b) 6.55
   c) 3
   d) 6
   e) 2
   f) 4
   g) 8
   h) 1

7) What is the logical effort of 4-NAND (4-input NAND) gate considering long channel current model?
   a) 1.59
   b) 2.79
   c) 3
   d) 6
   e) 2
   f) 4
   g) 8
   h) 1

8) The elmore delay from node Vin to node 4 is _____ .



a) **R1C1 + R1C6 +R1C7 + R1C8 +(R1 + R2)(C2 + C3) + (R1 + R2 + R4)(C4 + C5)**
b) **R1C1 + R2C6 +R1C7 + R1C8 +(R3 + R2)(C2 + C3) + (R1 + R2 + R4)(C1 + C5)**
c) **R1C1 + R2C5 +R1C7 + R1C8 +(R6 + R2)(C2 + C3) + (R1 + R2 + R4)(C3 + C5)**
d) **R1C1 + R2C3 +R1C7 + R1C8 +(R8 + R2)(C2 + C3) + (R1 + R2 + R4)(C6 + C5)**
e) **R4C1 + R4C4 +R1C7 + R1C8 +(R3 + R2)(C2 + C3) + (R1 + R2 + R4)(C2 + C5)**
f) **R4C1 + R4C5 +R1C7 + R1C8 +(R1 + R2)(C2 + C3) + (R1 + R2 + R4)(C3 + C5)**
g) **R4C1 + R4C7 +R1C7 + R1C8 +(R6 + R2)(C2 + C3) + (R1 + R2 + R4)(C8 + C5)**
h) **R4C1 + R4C8 +R1C7 + R1C8 +(R1 + R7)(C2 + C3) + (R1 + R2 + R4)(C5 + C5)**

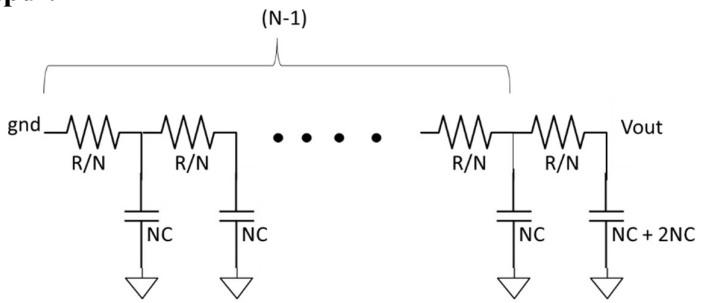
9) According to ELMORE delay method, determine the propagation falling delay for 2-NOR gate which is sized to P:N as 4:1 ?
   a) 8RC
   b) 16RC
   c) 24RC
   d) 10RC
   e) 72RC
   f) 12RC
   g) 3RC
   h) 9RC

10) According to ELMORE delay, determine the propagation rising delay for 2-NAND gate which is sized to P:N as 2:2 ?
   a) 8RC
   b) 16RC
   c) 24RC
   d) 36RC
   e) 72RC
   f) 12RC
   g) 3RC
   h) 9RC

Solution:

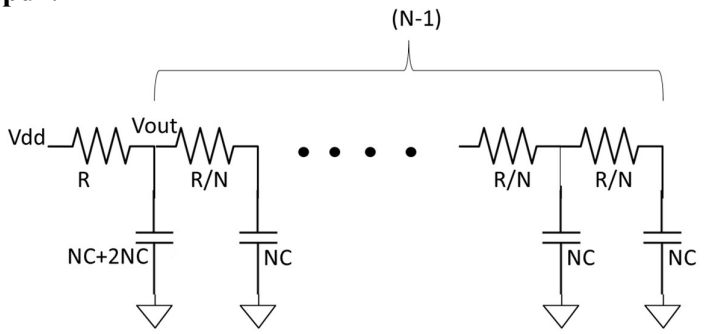
1) **a) RC(N²+5N)/2, RCN(N+2)**

tpdf:



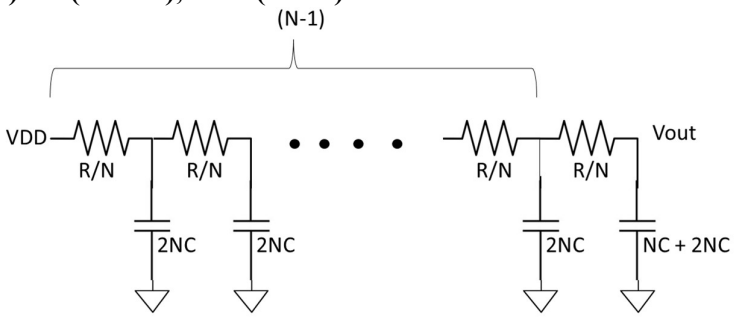
$$\text{tpdf} = \frac{R}{N} X\ NC + \frac{2R}{N} X\ NC + \cdots + \frac{(N-1)R}{N} X\ NC + R\ X\ 3NC = \text{RC}(N^2+5N)/2$$

tpdr:

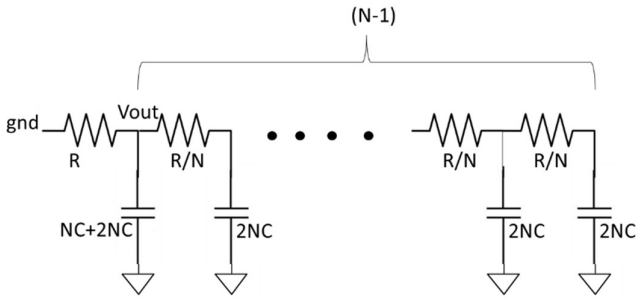


tpdf = $R\ X\ 3NC\ +\ R\ X\ NC\ X\ (N-1)$ = RCN(N+2)

2) **h) RC(N^2+2N), RCN(2N+1)**



tpdr = $\frac{R}{N}\ X\ 2NC\ +\ \frac{2R}{N}\ X\ 2NC\ +\cdots+\frac{(N-1)R}{N}\ X\ 2NC + R\ X\ 3NC$ = RC(N^2+2N)



tpdf = $R\ X\ 3NC\ +\ R\ X\ 2NC\ X\ (N-1)$ = RCN(2N+1)

3) **c) 2**

4) **e) 18RC and 24RC**
Formula based.

5) **e) 36RC and 24RC**
Formula based.

6) **c) 3**
   g = (1+8)/3 = 3

7) **e) 2**
   g = (2+4)/3 = 2

8) **a) R1C1 + R1C6 +R1C7 + R1C8 +(R1 + R2)(C2 + C3) + (R1 + R2 + R4)(C4 + C5)**
   Application of elmore delay model.

9) **d) 10RC**
   4:1 2-NOR gate is a symmetric gate, with 2:1 inverter as the benchmark. So, direct application of formula.

10) **a) 8RC**
   2:2 2NAND gate is a symmetric gate, with 2:1 inverter as the benchmark. So, direct application of formula.