ISTM 214 Homework 3   (Due day: 10/11)

Name:_____   ID:_____

1. (60%) Given that a (5-volt) CMOS gate's P-channel pull-up has an "on" resistance of 80 Ω and that its N-channel pull-down has an "on" resistance of 40 Ω:

   (a) If the desired V_{OHmin} is 4.2 volts and the desired V_{OLmax} is 0.8 volts, what are the gate's I_{OHmax} and I_{OLmax} ratings?

   I_{OHmax} = _____ mA I_{OLmax} = _____ mA

   (b) If a DCNM of 1.2 volts is desired for this CMOS gate family, what do its V_{IHmin} and V_{ILmax} specifications need to be, based on the values given in part (a)?

   V_{IHmin} = _____ V V_{ILmax} = _____ V

   (c) If the I_{IH} and I_{IL} specifications for gates in this family are +0.1 mA and -0.1 mA, respectively, what is the practical fan-out for circuits constructed using these gates, based on values calculated in part (a)?

   (d) Show how an LED (with forward voltage V_{LED} = 1.5 V) should be interfaced to gates in this family to obtain maximum brightness, and calculate the value of the current limiting resistor required along with its power dissipation.

   Current limiting resistor = _____ Ω Resistor power dissipation = _____ mW

2.   (40%) Assume two logic families have the following D.C. characteristics:

Logic Family "A"

$V_{CC} = 5$ V	$V_{OH} = 4.1$ V	$V_{OL} = 0.4$ V	$V_{IH} = 3.3$ V	$V_{IL} = 1.3$ V
$V_{TH} = (V_{OH} - V_{OL})/2$	$I_{OH} = -7.5$ mA	$I_{OL} = 7.5$ mA	$I_{IH} = 0.25$ μA	$I_{IL} = -0.25$ μA

Logic Family "B"

$V_{CC} = 5$ V	$V_{OH} = 3.4$ V	$V_{OL} = 0.33$ V	$V_{IH} = 2.7$ V	$V_{IL} = 1.2$ V
$V_{TH} = (V_{OH} - V_{OL})/2$	$I_{OH} = -900$ μA	$I_{OL} = 8.8$ mA	$I_{IH} = 13$ μA	$I_{IL} = -0.13$ mA

(a) Calculate the following: DCNM $_{A \to B}$,   DCNM $_{B \to A}$,   Practical Fanout $_{A \to B}$,   Practical Fanout $_{B \to A}$

(b) Draw the circuit and calculate the value of the current limiting resistor for a Type "A" gate driving an LED to the maximum brightness possible in a current sourcing configuration. Assume V_{LED} is 1.5V.

(c) Draw the circuit and calculate the value of the current limiting resistor for a Type "B" gate driving an LED to the maximum brightness possible in a current sinking configuration. Assume V_{LED} is 1.5V