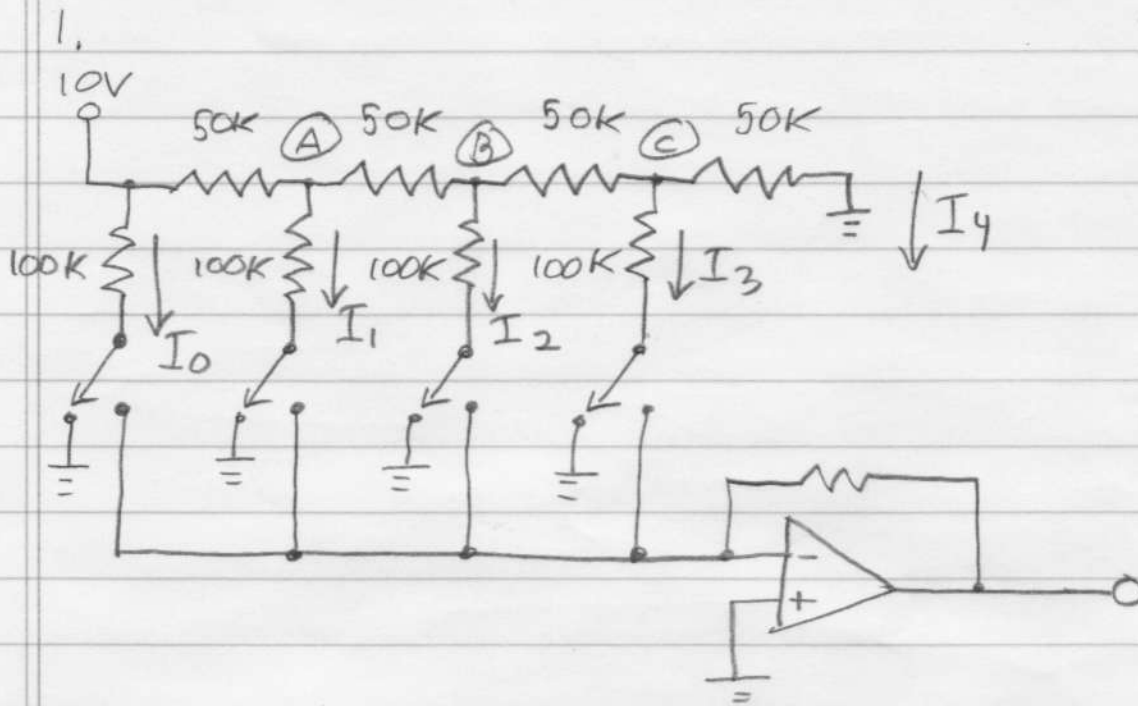


PHYS 335-SPRING QUARTER 2012  
HOMEWORK 4 SOLUTIONS

①

V1.0



EACH SWITCH POSITION IS TO A GROUND:  
EITHER A REAL GROUND (AS SHOWN) OR  
TO A "VIRTUAL" GROUND. THEREFORE,  
CURRENTS  $I_0$  THROUGH  $I_4$  DON'T DEPEND  
ON SWITCH POSITIONS. NOTICE CURRENT  
ENTERING NODE (C) FROM THE LEFT; IT  
SPLITS EVENLY THROUGH TWO 100K RESISTORS.  
AS FOR NODE (B), THE RESISTANCE "LOOKING"  
RIGHT IS 100K ( $50K + 100K \parallel 100K = 100K$ ).  
HENCE, CURRENT ENTERING (B) SPLITS  
EVENLY. THE SAME ARGUMENT HOLDS  
FOR NODE (A). HENCE, AT EACH NODE,  
CURRENT SPLITS EVENLY.

THE CURRENT  $I_0$  IS  $10\text{V}/100\text{k}\Omega = 100\mu\text{A}$ .  
 HENCE  $I_1 = 50\mu\text{A}$ ,  $I_2 = 25\mu\text{A}$ , AND  
 $I_3 = I_4 = 12.5\mu\text{A}$ .

2. FOR  $V_{\text{REF}} = 10\text{V}$  WITH 16 "STEPS", EACH  
 STEP IS  $10\text{V}/16 = 0.625\text{V/COUNT}$ .

$7.21\text{V}/0.625\text{V/COUNT} \approx 11.5$  COUNTS,  
 HENCE, THE 4 MSBs ARE 1011.

THE SECOND ADC SEES INPUT  
 $7.21\text{V} - 11\text{COUNTS} \times 0.625\text{V/COUNT} = 0.335\text{V}$ .

NOTICE THE "STEP" SIZE (LEAST COUNT) IS  
 $\times 16$  SMALLER THAN THAT OF THE FIRST ADC:

$$(10\text{V}/16)/16\text{V/COUNT} = 0.039\text{V/COUNT}.$$

SO, AGAIN,

$$0.335\text{V}/0.039\text{V/COUNT} \approx 8.6\text{COUNTS},$$

HENCE, THE 4 LSBs ARE 1000  
 AND THE 8-BIT OUTPUT IS 10111000.

(YOU CAN QUIBBLE ABOUT WHETHER TO  
 ASSIGN COUNT THRESHOLDS AT THE  
 BOTTOM, MIDDLE, OR TOP OF A  
 STEP.)