EE230: Solution to Homework Assignment 1

Problem 1

a. Marvell Technology Group
b. 2.3B Marvell Vs 15 Billion Iowa corn and soybean
c. Market Capitalization: 12.72B (January 2010)

Problem 2

a. Paul Gray
b. **Abstract**
A pipelined, 13-bit, 250-ksample/s (ks/s), 5-V, analog-to-digital (A/D) converter has been designed and fabricated in a 3-µm, CMOS technology. Monotonicity is achieved using a reference-feedforward correction technique instead of (self-) calibration of trimming to minimize the overall cost. The prototype converter requires 3400 mil^2, and consumes 15 mW
c. Design of a small, low power and cost effective analog to digital converter
d. CMOS technology
e. Abstract : A mobile device includes a system-on-chip (SOC) that includes a mobile device control module, a solid state disk (SSD) control module, and a random access memory (RAM) control module. The mobile device control module executes application programs for the mobile device. The solid-state disk (SSD) control module controls SSD operations. The RAM control module communicates with the mobile device control module and the SSD control module and stores both SSD-related data and mobile device-related data in a single RAM.

Problem 3

a. Average area: 1.5cm^2

$$\text{4GB} \longrightarrow \frac{1.5cm^2}{4\times 8\times 10^9 bits} = 4.69\times 10^{-11} cm^2 / bit$$

Problem 4

3.5" diameter can hold 750 GB

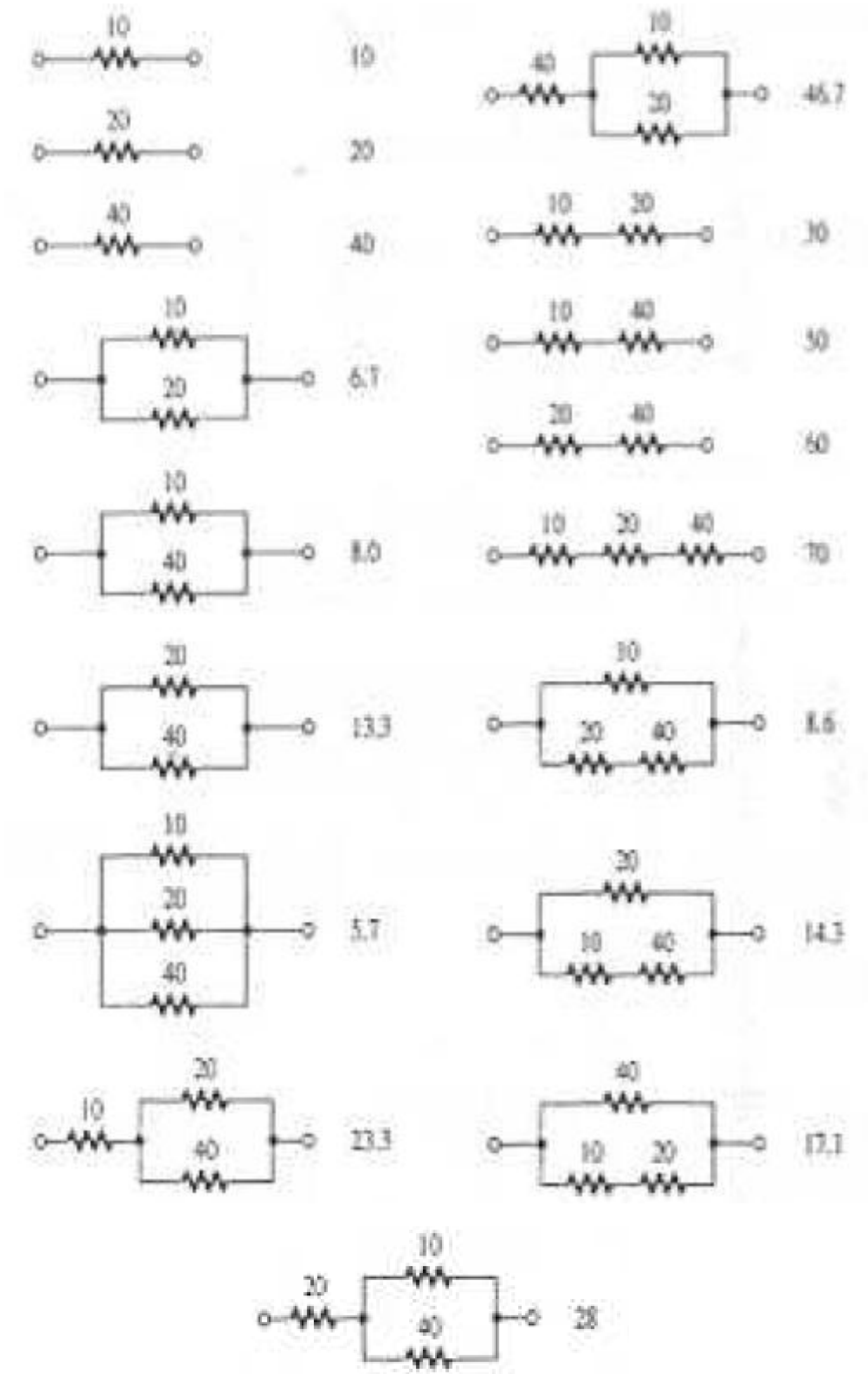
$$Area = \pi \times r^2 = 3.14\times\left(\frac{3.5inch}{2}\times\frac{2.54cm}{1inch}\right)^2 = 62cm^2$$

$$\frac{62cm^2}{8\times 750\times 10^9} = 10.33\times 10^{-12}\, cm^2/bit$$

Problem 5

a. 16 bit is common
b. Analog levels: 2^{16}=65536

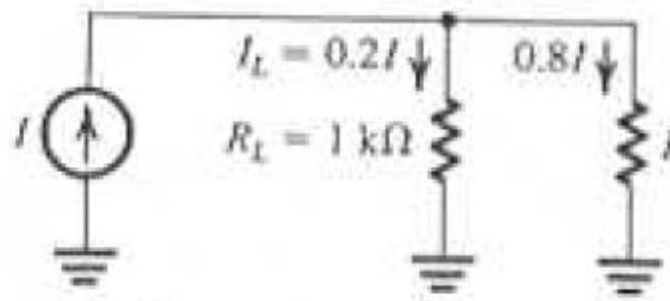
Problem 6 (Sedra/Smith Problem 1.4)



Problem 7 (Sedra/Smith Problem 1.11)

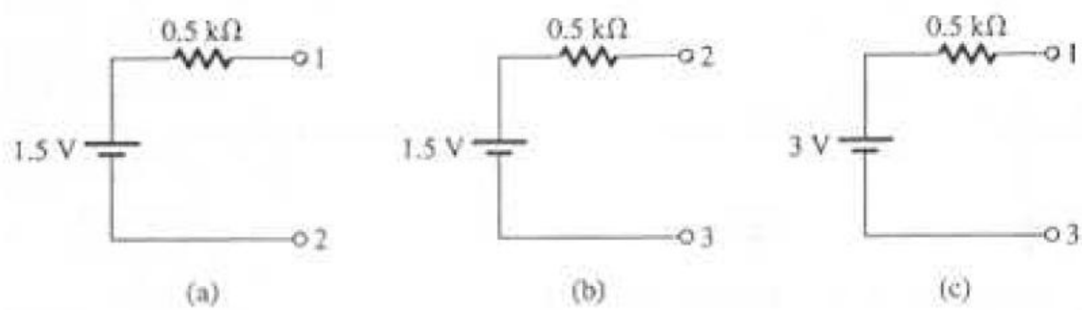
1.11 Connect a resistor R in parallel with R_L. To make $I_L = 0.2I$ (and thus the current through R, $0.8I$), R should be such

$$0.2I \times 1\ \text{k}\Omega = 0.8IR$$
$$\Rightarrow R = 250\ \Omega$$

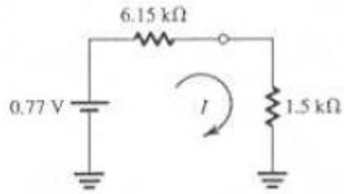


Problem 8 (Sedra/Smith Problem 1.14)

1.14



Problem 9 (Sedra/Smith Problem 1.16)



Now, when a resistance of 1.5 kΩ is connected between 4 and ground,

$$I = \frac{0.77}{6.15 + 1.5}$$

$$= 0.1 \text{ mA}$$

1.16 (a) Node equation at the common node yields

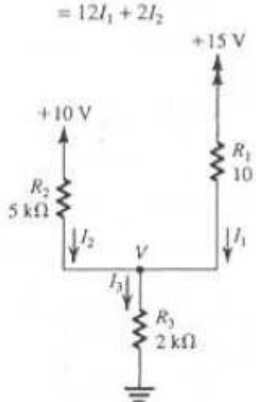
$$I_3 = I_1 + I_2$$

Using the fact that the sum of the voltage drops across R_1 and R_3 equals 15 V, we write

$$15 = I_1 R_1 + I_3 R_3$$

$$= 10 I_1 + (I_1 + I_2) \times 2$$

$$= 12 I_1 + 2 I_2$$



That is,

$$12 I_1 + 2 I_2 = 15 \qquad (1)$$

Similarly, the voltage drops across R_2 and R_3 add up to 10 V, thus

$$10 = I_2 R_2 + I_3 R_3$$

$$= 5 I_2 + (I_1 + I_2) \times 2$$

which yields

$$2 I_1 + 7 I_2 = 10 \qquad (2)$$

Equations (1) and (2) can be solved together by multiplying (2) by 6,

$$12 I_1 + 42 I_2 = 60 \qquad (3)$$

Now, subtracting (1) from (3) yields

$$40 I_2 = 45$$

$$\Rightarrow I_2 = 1.125 \text{ mA}$$

Substituting in (2) gives

$$2 I_1 = 10 - 7 \times 1.125 \text{ mA}$$

$$\Rightarrow I_1 = 1.0625 \text{ mA}$$

$$I_3 = I_1 + I_2$$

$$= 1.0625 + 1.1250$$

$$= 1.1875 \text{ mA}$$

$$V = I_3 R_3$$

$$= 1.1875 \times 2 = 2.3750 \text{ V}$$

To summarize:

$$I_1 \simeq 1.06 \text{ mA} \qquad I_2 \simeq 1.13 \text{ mA}$$

$$I_3 \simeq 1.19 \text{ mA} \qquad V \simeq 2.38 \text{ V}$$

(b) A node equation at the common node can be written in terms of V as

$$\frac{15 - V}{R_1} + \frac{10 - V}{R_2} = \frac{V}{R_3}$$

Thus,

$$\frac{15 - V}{10} + \frac{10 - V}{5} = \frac{V}{2}$$

$$\Rightarrow 0.8V = 3.5$$

$$\Rightarrow V = 2.375 \text{ V}$$

Now, I_1, I_2, and I_3 can be easily found as

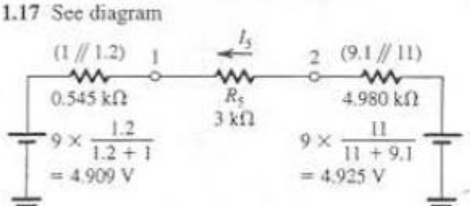
$$I_1 = \frac{15 - V}{10} = \frac{15 - 2.375}{10} = 1.0625 \text{ mA} \simeq 1.06 \text{ mA}$$

$$I_2 = \frac{10 - V}{5} = \frac{10 - 2.375}{5} = 1.125 \text{ mA} \simeq 1.13 \text{ mA}$$

$$I_3 = \frac{V}{R_3} = \frac{2.375}{2} = 1.1875 \text{ mA} \simeq 1.19 \text{ mA}$$

Method (b) is much preferred; faster, more insightful and less prone to errors. In general, one attempts to identify the least possible number of variables and write the corresponding minimum number of equations.

1.17 See diagram



$$I_5 = \frac{4.925 - 4.909}{4.98 + 3 + 0.545} = 1.88\ \mu\text{A}$$

$$V_5 = 1.88\ \mu\text{A} \times 3 \text{ k}\Omega = 5.64 \text{ mV}$$