Homework Set #3 – Chem 524, 2013 – due –April 16, 2013

Homework— From-- Notes 8 - detectors

Read Chap. 4, transducers, Sect. 4-4, and links below for: PMT and IR detectors

Discuss: Chap 4- #5, 6, 10, 17

a. I have several PMTs. Two nice ones are both cylindrical end-on designs, one has a transparent multi-alkalai photocathode (S-20) which covers most of the diameter of the tube (~50 mm) and the other has an InGaAs solid photocathode with an opening of ~10 x 15 mm. Why would I have two of them? What are the design advantages of each?
b. I have several MCT detectors, one is wide band and detects out to about 16 μ, two are narrow band and cut off at ~ 8 μ. Most are medium band cutting off at ~12 μ. They all vary in D*, but the narrow band ones are >4 x 10^{10} while the wide band is ~5 x 10^{9}, why is this? All are mounted in liquid N_2 dewars, why? These are photoconductors, why do they need a bias voltage?
c. I have an InSb detector, P-V design. Where would I use this (i.e. what kind of spectroscopy)? What kind of preamp would this need?
d. We have a photodiode array (PDA) and a CCD both based on Si chips and for use in a Raman Spectrometer. The CD can make an image of the spectrum at the exit plane, but the PDA cannot, why is this?

Problems to hand in: Chapter 4: #3, 15, 16

Homework— From Notes 9 – electronics – beyond the book

Discussion: chap 4-# 4,5

To hand in: chap. 4-17, plus below

3.1 It is desired to minimize a 60-Hz line voltage hum in an electronic circuit that will ordinarily carry 1–3 kHz signals. (a) Draw a simple *RC* filter that can be used. Choose a value for its cutoff frequency f_o and support your choice. Assume a roll-off of 20 dB per decade of frequency below f_o. (b) Select or calculate values for the filter components. Is there any advantage in picking $R = 1\ k\Omega$ instead of 10 kΩ? Explain. (c) For strong rejection of a 60-Hz hum what attenuation in decibels would be desirable?

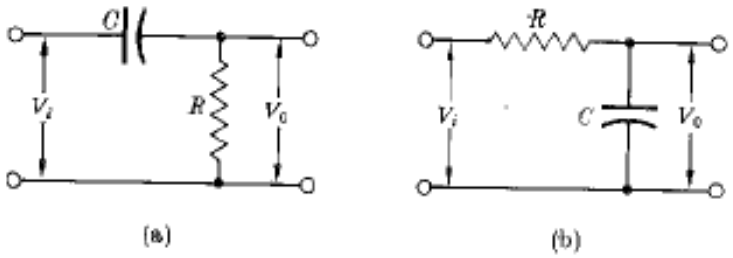
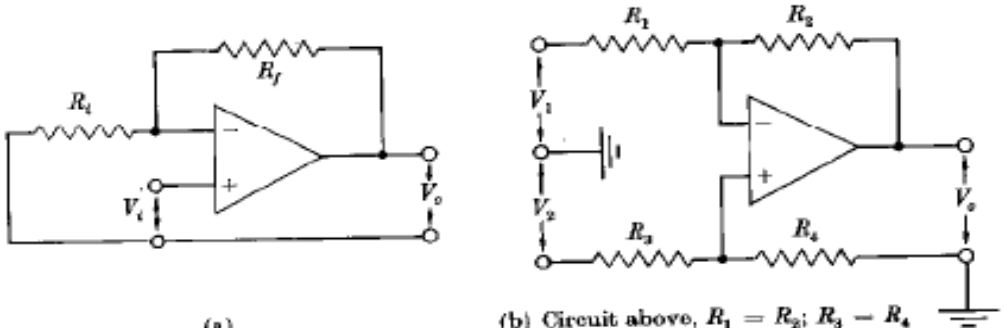


Fig. 3.2 Cutoff filters. (a) High-pass *RC* filter. (b) Low-pass *RC* filter. In each circuit the capacitor impedes low frequencies and blocks dc. Thus, low frequencies are attenuated in circuit (a) and passed in circuit (b).

3.3 What is the cut-on frequency f_c for the circuit of Fig. 3.2 if values of components are $C = 0.10\ \mu F$ and $R = 1\ k\Omega$?

4.1 Develop an expression for the output voltage in each of the op-amp circuits of Fig. 4.26 in terms of the input voltage(s).

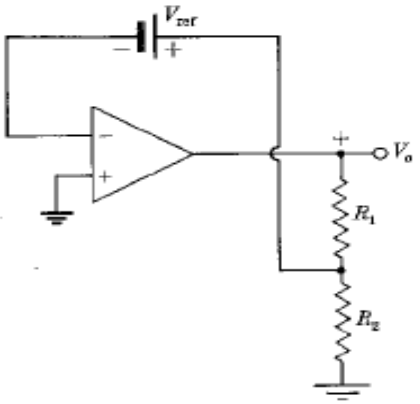


(a)

(b) Circuit above, $R_1 = R_2$; $R_3 = R_4$

(c) Circuit above, $R_1 \neq R_2$; $R_3 \neq R_4$

4.3 Show that the output voltage of the circuit in Fig. 4.27 is given by the expression $V_o = (1 + R_1/R_2)V_{ref}$.



Homework Notes#10 – Signal to Noise

Discussion questions: Chap 5 - #5, 6, 7, 8, 9, 11, 13, 14, 15, 16, 19

To hand in: Chap 5 - #2, 4, 10, 17

Homework – Notes #11 -- Statistical sampling (read Chap 6 and Append. A)

Discussion: Chap 6: #4, 5, 7, 8, 11, 12

To hand in: Problems Chap 6: #3, 6

Homework – Notes #12 – Atomic Absorption

Read chap 7. Skim *Chaps: 8,9,10,11* to see the various instruments and applications

Discuss: Ch 7 – 3, 4, 13, 14

Hand in : Ch7 - #5, 7, 10, 11 .

Homework -- From Notes 13 – Molecular Spectroscopy

Discussion: Chap 12: #6, 11, 13

To hand in: Chap 12: # 1, 4, 9,