ECE 300
Spring Semester, 2003
HW Set #6

Due: March 3, 2003 **Name________________________**
wlg **Print (last, first)**
Revision 1

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations**. **Be sure to show how you got your answers.** Text book problems counts 10 points each. Extra problems count 30 points each.

5.11 $i(t) = 6$ mA $0 <= t < = 2$; $i(t) = -6$ mA $2 < t < = 4$

5.15 Assume $v(0) = 0$ V: $v(t) = 3125t^2$ $0 < t < 4$ ms; $v(t) = 50$ mV $t > 4$ ms

5.24 $v(t) = 0$ $t < 0$; $v(t) = 250e^{-t}$ μV $t > 0$

$w(t) = 1.25[1 - 2e^{-t} + e^{-2t}]$ μJ

5.32 $i(t) = 500t^2$ A $0 < t$ 1 ms: $i(t) = 2t - 500t^2 - 10^{-3}$ A 1 ms <= t <= 2ms : $i(t) = 1$ mA $t > 2$ms

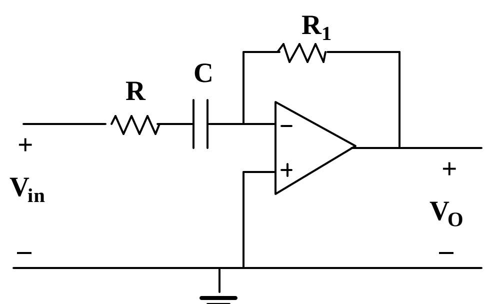
5.44 $v_0 = 12$ V

5.48 $C_{AB} = 1.32$ μF

5.53 $C_{eq} = 3.18$ μF

5.58 L = 4 mH

Extra 1 You are given the operational amplifier circuit shown below.

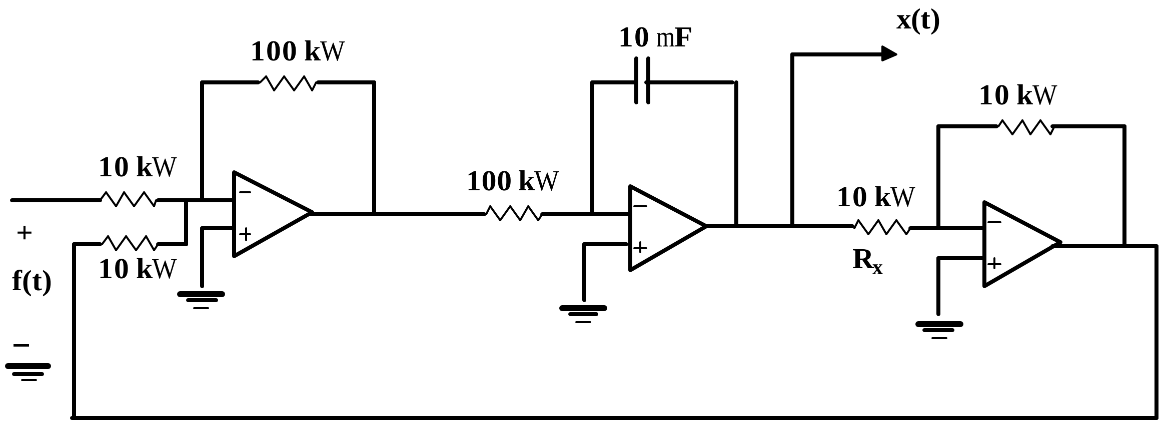


(a) Show that the circuit solves the differential equation $\frac{dv_O(t)}{dt} + Av_O(t) = -B\frac{dv_{in}(t)}{dt}$.

(b) Give the values of A and B in terms of R, R_1 and C.

(c) If R = 1 meg Ω, R_1 = 1 meg Ω and C = 1 μF, solve for $V_0(t)$ and sketch the waveform of $V_0(t)$. What is the value of $V_O(t)$ at t = 1.0, 2.0, 3.0, 4.0? Assume that $v_{in}(t) = u(t)$ where u(t) is defined in Extra 2. You may want to use Laplace transforms to solve the differential equation.

Extra 2. You are given the operational amplifier circuit shown in the following diagram.



f(t) is the forcing funtion of a differential equation. x(t) is the dependent variable of this differential equation. The circuit above solves this differential equation.

(a) Show that the circuit above solves

$$\frac{dx(t)}{dt} + 10x(t) = 10f(t)$$

(b) If R_X is changed from 10 kΩ to 5 kΩ what will be the new differential equation?

(c) What is the time constant of the differential equation of part (a)?

(d) What is the steady state value of the differential equation of part (a) if f(t) = u(t) where u(t) is defined as below.

$$u(t) = 1 \quad \text{for} \quad t > 0$$

$$u(t) = 0 \quad \text{for} \quad t < 0$$

(e) Sketch the waveform of x(t) for part (a) if f(t) = u(t). What is the value of x(t) at t = 0.1 sec, t = 0.2 sec, t = 0.3 sec and t = 0.4 sec?

** Extra 1 and Extra 2 are meant to be challenging problems. They are designed to test both your circuit skills and your math skills.