Op Amps with Capacitors

You might want to look through section 6.6 to see op amp circuits with capacitors being used to differentiate and integrate the input. Op Amps can do more than add and amplify.

Problem 1:

For an op amp differentiator, assume $R = 250 \, \text{kΩ}$ and $C = 10 \, \mu\text{F}$. If the input voltage is a ramp function where $r(t) = 12t$ mV

- Draw and label the circuit diagram.
- Write the expression for the voltage output, $v_o(t)$
- Draw and label a single graph with the input and output voltages, $v(t)$ v. $t$.

Problem 2:

For an op amp integrator, design the circuit (select the $C$ value and the $R$ value(s) with $R \leq 100\, \text{kΩ}$) so that

$$v_o = -2 \int_0^t v_i(t) \, dt$$

- Draw and label the circuit diagram, specifying your $R$ and $C$ values.
- Draw and label a single graph with the input (of your choosing – but something that can be integrated) and output voltages, $v(t)$ v. $t$. 
Chapter 8 Problems

Note that for HW 7 you will find the complete solutions for these problems.

For this homework set, for problems 3, 4, and 5, set up the problem to be solved (without finding constants $A_1$ and $A_2$ until HW 7).

a) Find the relevant initial and final conditions, $I_0$ and $I_\infty$, or $V_0$ and $V_\infty$. (Do not, for this homework, find $(di/dt)|_{t=0}$ or $(dv/dt)|_{t=0}$ That is coming next.)

b) Identify the circuit as series RLC, parallel RLC or general RLC (which means the 3 elements, R, L and C are not all in series or all in parallel).

c) Calculate $\alpha$ and $\omega_0$, and $s_1$ and $s_2$. (for a general circuit, $\alpha$ and $\omega_0$ are not defined, but you could find $s_1$ and $s_2$)

d) Identify if the circuit behavior is overdamped, underdamped or critically damped.

e) Construct the complete mathematical expression for the final response (using either the text book or class notes/slides), putting in the numerical values you do have and identifying the constants still needing to be found.
   o This means constructing the natural response, and adding on the forced response term if there is one, which is determined by the independent sources connected to the circuit for $t > 0$.

f) Sketch an approximate graph showing the expected, or anticipated, circuit behavior
   o Either a graph of $v(t)$ vs. $t$ or $i(t)$ vs. $t$
   o The graph should show the voltage or current starting at its initial condition, ending at its final condition, and show the form of the “damping” as it moves from one to the other – under-, over- or critically damped.

Problem 3:
In the circuit below, the switch moves from $A$ to $B$ at time $t = 0$. Set up the solution, as outlined above, to find $v(t)$ (All constants to be found for HW 7)

![Circuit Diagram]
**Problem 4:**
In the circuit below, the switch moves from $A$ to $B$ at time $t = 0$.
- As outlined above, set up the problem to find $i(t)$ for all $t \geq 0$.

![Circuit Diagram](image1.png)

**Problem 5:**
- As outlined above, set up the problem to find $i(t)$ for all $t \geq 0$.
- (Note that this is the only circuit in this homework with non-zero forcing function at $t = \infty$)

![Circuit Diagram](image2.png)