Problem Set 1
Resonant and Soft-Switching Techniques in Power Electronics
Spring, 2006
Review of material related to resonant converters

1 A circuit is described by the following differential equation:

\[ LC \frac{d^2v(t)}{dt^2} + v(t) = V_g \]
\[ v(0) = V_0 \]
\[ C \frac{dv(t)}{dt} \bigg|_{t=0} = I_0 \]

where \( L \), \( C \), \( V_g \), \( V_0 \), and \( I_0 \) are constants. Solve the differential equation to write an expression for \( v(t) \).

2 You are given the following parallel resonant circuit:

![Parallel Resonant Circuit Diagram]

with \( L = 1 \, \mu\text{H} \), \( C = 1 \, \mu\text{F} \), and \( R = 10 \, \Omega \). The input voltage \( v \) is a sinusoidal source having frequency \( f \).

(a) At what frequency or range of frequencies does/is the current \( i \)

(i) lead the voltage \( v \)

(ii) in phase with the voltage \( v \)

(iii) lag the voltage \( v \)

(b) Sketch the Bode plots of the magnitude and phase of the impedance \( Z(s) = \frac{v(s)}{i(s)} \). Label the values of all slopes and break frequencies. What is the maximum value of \( \| Z(j\omega) \| \)?

3 A PWM buck converter contains a silicon diode. Write a few sentences, in your own words, explaining what happens during the turn-off reverse recovery process of the diode. Your sentences should explain:

(1) why it takes time to switch off the diode, and
(2) how the diode induces switching loss in the transistor.

You may assume that the transistor switching times are much shorter than the diode reverse recovery time.