

# ELE1EDP 2007 Laboratory: PSpice: Frequency Response and Power Plot

## 1 AC Frequency Response

### 1.1 CAPACITOR Voltage in an RC circuit

Open a new schematic: **File -> New**.

Save the file as follows.

**File->Save As**.

Click on the Parent Directory button, until you reach “My Computer”.

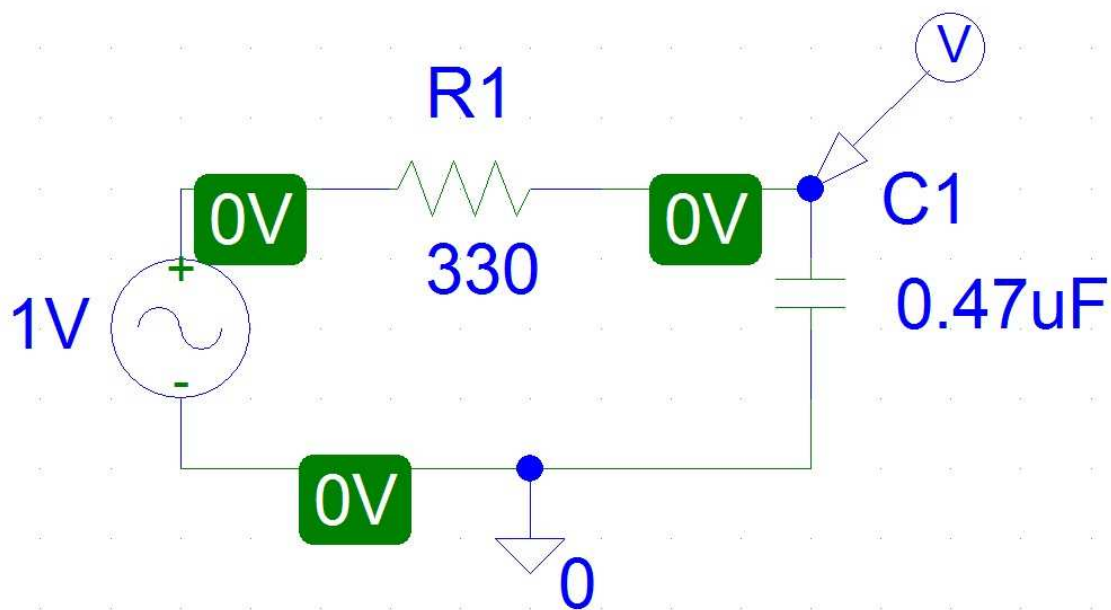
Click on **H:** drive.

Navigate to your **ELE1EDP\PSpice** folder.

File name: **RC**

Click on **Save**.

Now enter the RC circuit given in the first diagram.



Part	Quantity
VAC	1
R	1
C	1
GND_ANALOG	1

Double click on each component to set its parameter values.

For the AC Voltage source V1:

Parameter	Value
DC	0V
ACMAG	1V
ACPHASE	0

R1 is **330** and C1 is **0.47uF**. (Ignore their other parameters.)

**Save** this schematic. (Regularly!)

Place a voltage marker at the junction between the resistor and the capacitor.

To plot the voltage across the capacitor as the source frequency varies (this is called an **AC sweep**), do this:

1. **Analysis -> Setup -> AC Sweep**
2. Set the AC Sweep Type to **Decade**.
3. Enter these three parameter values:

Parameter	Value
Pts/Decade	101
Start Freq	10
End Freq	100K

Start the simulation by pressing the **F11** key.

This opens the Probe window and produces a plot of V(R1:2) versus frequency, with the frequency (X-axis) on a log scale. But this is **not** yet a Bode plot, because the voltage (Y-axis) is on a linear scale. So stay inside the Probe window, and select:

- **Plot -> Y Axis Settings**
- Scale: **Log**

Now we have a **Bode plot** — of the amplitude of the *voltage* across C1 as a function of the *frequency* of the input signal.

Notice the straight line *asymptotes* at the *low* and *high* extremities of frequency.

Select the menu item **Tools->Cursor->Display**. This shows the *coordinates* of *points* on the curve: in the RC plot this gives frequency and voltage. You can *move* the cursor along the curve by using the *arrow* keys ( $\uparrow \leftarrow \downarrow \rightarrow$ ) on your computer's keyboard.

### Questions:

1. What is the approximate frequency of the **-3 dB** point on the graph? (This occurs where the capacitor voltage is  $\frac{1}{\sqrt{2}} \approx 70.7\%$  of its maximum value.)
2. Calculate the time constant  $\tau = RC$ .
3. Calculate the cutoff frequency  $f_c = \frac{1}{2\pi\tau}$ .
4. Compare the calculated  $f_c$  with the measured  $-3$  dB point.

**Have a demonstrator check your Bode plot for the RC circuit.**

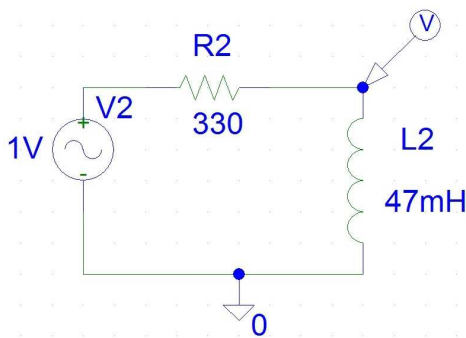
**File -> Save (or Ctrl+S).**

**File -> Close.**

## 1.2 INDUCTOR Voltage in an RL circuit

Now create a new file named **RL**.

Draw the schematic for the RL circuit in the second diagram.



Perform the same analysis as for the previous circuit, in order to produce a Bode plot.

**Ensure that a demonstrator sees the plot and marks your work.**

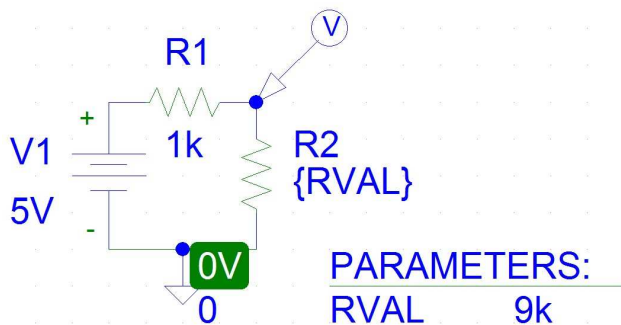
### Questions:

1. What is the approximate frequency of the **-3 dB** point on this graph?
2. Calculate the time constant  $\tau = \frac{L}{R}$ .
3. Determine the cutoff frequency  $f_c = \frac{1}{2\pi\tau}$ .
4. Compare  $f_c$  with the  $-3$  dB point.

## 2 POWER Plot

Create a new file named **Power**.

Draw the schematic of the third diagram.



Types of parts: **note** that the voltage source is a **DC battery**, VDC.

Part	Quantity
VDC	1
R	2
GND_ANALOG	1

Details of the parts' designators and values:

Designator	Value
V1	5V
R1	1k
R2	{RVAL}

Notice that the value of resistor R2 is a name with braces (curly brackets) around it: **{RVAL}**. This represents a *variable* quantity.

Place a voltage marker (as shown above) at the junction between R1 and R2.

**Analysis -> Setup -> DC Sweep**

Swept Variable Type: **Global** Parameter.

Parameter	Value
Name	RVAL
Start Value	10
End Value	10K
Increment	10

The next step is essential to define the RVAL parameter so that analysis can proceed.

**Ctrl+G -> Libraries**

Library: **SPECIAL.slb**

Part: **PARAM**

Parameter	Value
NAME1	<b>RVAL</b>
VALUE1	<b>9k</b>

Ignore the other parameters.

Press **F11** to commence the simulation.

**Trace -> Add**

Trace Expression: since the power dissipated by a resistor equals its current multiplied by its voltage drop, this formula should produce a plot for the power dissipated by R2:

$$I(R2)*(V(R2:1)-V(R2:2))$$

**Notes:**

1. **If** the power curve is **negative**, then change the sign of the trace expression.
2. You *must* keep only one trace on the graph. (Otherwise the Y scale would be wrong.) To **delete** an unwanted trace, click on its expression (under the graph) to select it, then press the Delete key on your computer's keyboard.

**Questions:**

1. What is the value of the **maximum power transfer**? (Use **Tools->Cursor->Display**, then **Tools->Cursor->Maximum** to locate the maximum point of the power curve.)
2. At what value of **R2** does this maximum power occur?
3. What's **special** about that value of R2?

**Ensure that a demonstrator sees the plot and marks your work.**

Version 7, Tuesday 28 August 2007, Geoffrey Tobin.