EECS 100/43
Lab 5 – Nonlinear Op-Amp Circuits

1. Objective

In this lab, you will learn about how to build oscillator circuits.

2. Equipment

a. Breadboard
b. Wire cutters
c. Wires
d. Oscilloscope
e. Function Generator
f. Power supply
g. 1k resistor x 2
h. 10k resistor x 2
i. 8.2 mH inductor
i. LMC6482 op-amp
j. Various connectors for power supply, function generator and oscilloscope.

3. Theory

a. Circuit

Figure 1 shows the circuit that you will build in this lab. To get the 5k resistors, use two 10k resistors in parallel. You will build the circuit in lab, so **MAKE SURE THAT YOU FINISH YOUR PRELAB BEFORE COMING TO LAB!** Figure 2 has the LMC6482 pinout for reference.

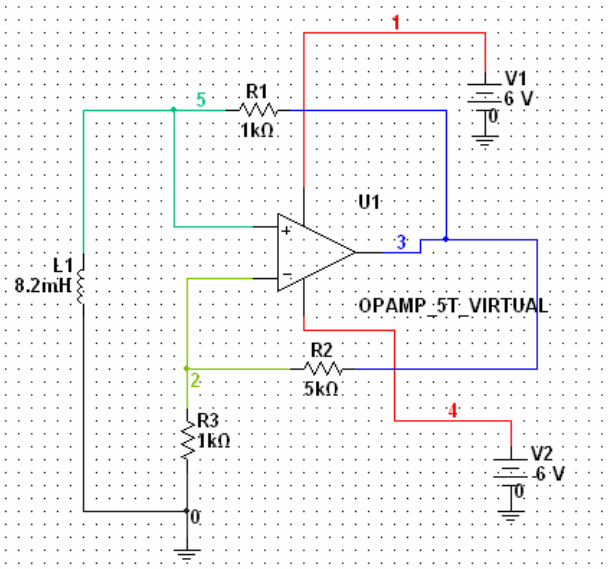
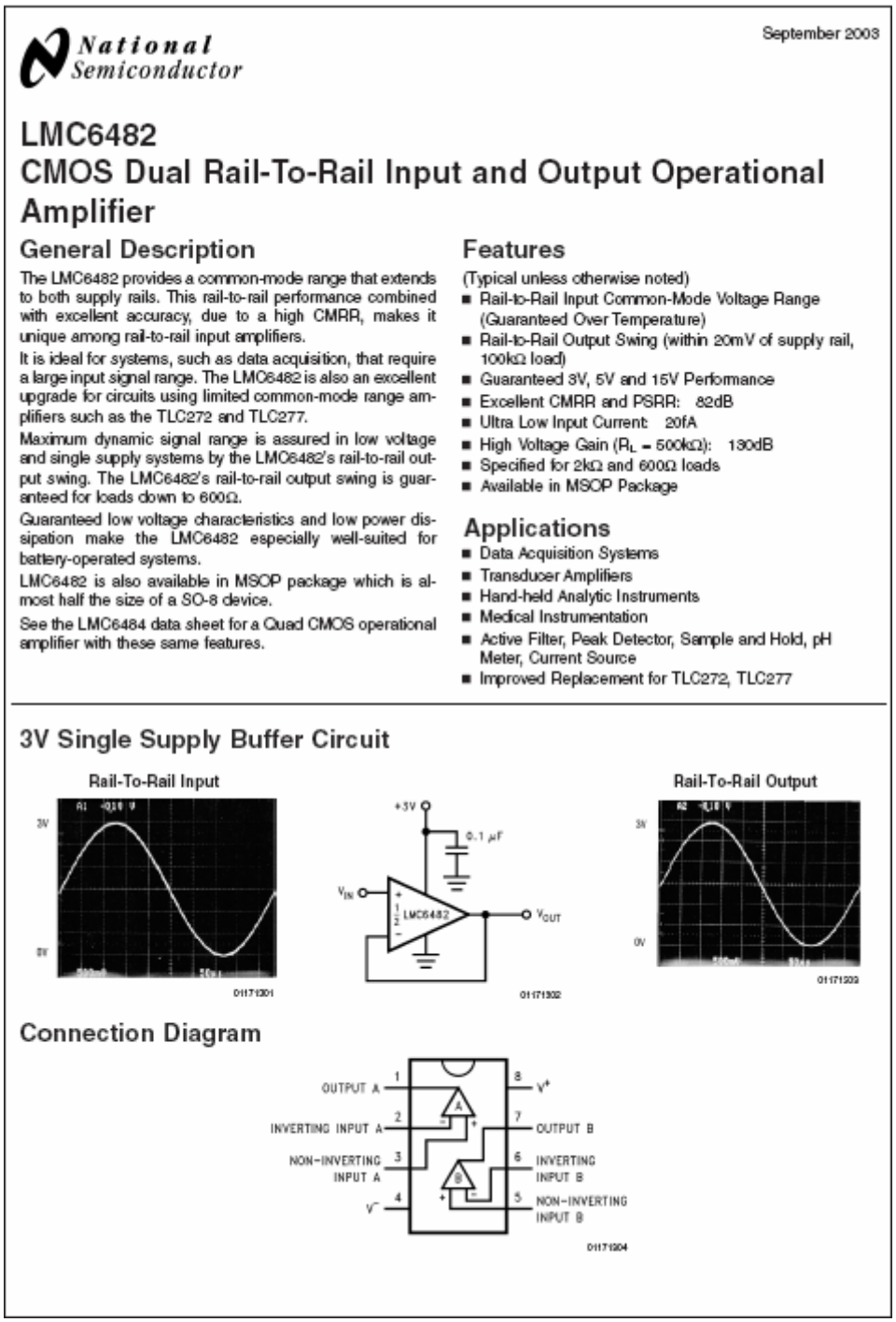


Figure 1. Inductor based op-amp oscillator



National Semiconductor

September 2003

LMC6482
CMOS Dual Rail-To-Rail Input and Output Operational Amplifier

General Description

The LMC6482 provides a common-mode range that extends to both supply rails. This rail-to-rail performance combined with excellent accuracy, due to a high CMRR, makes it unique among rail-to-rail input amplifiers.

It is ideal for systems, such as data acquisition, that require a large input signal range. The LMC6482 is also an excellent upgrade for circuits using limited common-mode range amplifiers such as the TLC272 and TLC277.

Maximum dynamic signal range is assured in low voltage and single supply systems by the LMC6482's rail-to-rail output swing. The LMC6482's rail-to-rail output swing is guaranteed for loads down to 600Ω.

Guaranteed low voltage characteristics and low power dissipation make the LMC6482 especially well-suited for battery-operated systems.

LMC6482 is also available in MSOP package which is almost half the size of a SO-8 device.

See the LMC6484 data sheet for a Quad CMOS operational amplifier with these same features.

Features

(Typical unless otherwise noted)

- Rail-to-Rail Input Common-Mode Voltage Range (Guaranteed Over Temperature)
- Rail-to-Rail Output Swing (within 20mV of supply rail, 100kΩ load)
- Guaranteed 3V, 5V and 15V Performance
- Excellent CMRR and PSRR: 82dB
- Ultra Low Input Current: 20fA
- High Voltage Gain (R_L = 500kΩ): 130dB
- Specified for 2kΩ and 600Ω loads
- Available in MSOP Package

Applications

- Data Acquisition Systems
- Transducer Amplifiers
- Hand-held Analytic Instruments
- Medical Instrumentation
- Active Filter, Peak Detector, Sample and Hold, pH Meter, Current Source
- Improved Replacement for TLC272, TLC277

3V Single Supply Buffer Circuit

Connection Diagram

Figure 2. Page 1 from the LMC6482 datasheet

Derive the driving point plot for the circuit shown in figure 1 (task 1 of your prelab). Build and simulate the circuit in MultiSim (task 2 of your prelab).

b. LABVIEW scope capture

You will use LABVIEW to printout a screenshot of your oscilloscope waveform and attach it to your lab report. Go through the "Getting Started with LABVIEW" document available on the EE100 homepage under handouts. You don't have to master LABVIEW inside-out. Just get an idea of what the program does. Here are the steps for printing the scope screen using LABVIEW:

1. Download the HP54645 library from the EE100 lab homepage. There is a VI link next to Lab 5 under Lab Documents on the EE100 lab homepage. Download this VI to your U:\ network drive. **NOTE: IF YOU SAVE ANYTHING ON YOUR DESKTOP, IT WILL BE ERASED ONCE YOU LOG OFF!**
2. LABVIEW communicates with your instruments using the GPIB bus (General Purpose Input Output bus). The first thing you need to do is figure out the address of your oscilloscope on the GPIB bus. To do this:
   a. Turn on the oscilloscope
   b. Double click on the 

Measurement and Automation (MAX) icon on your desktop. Figure 3 will pop up.

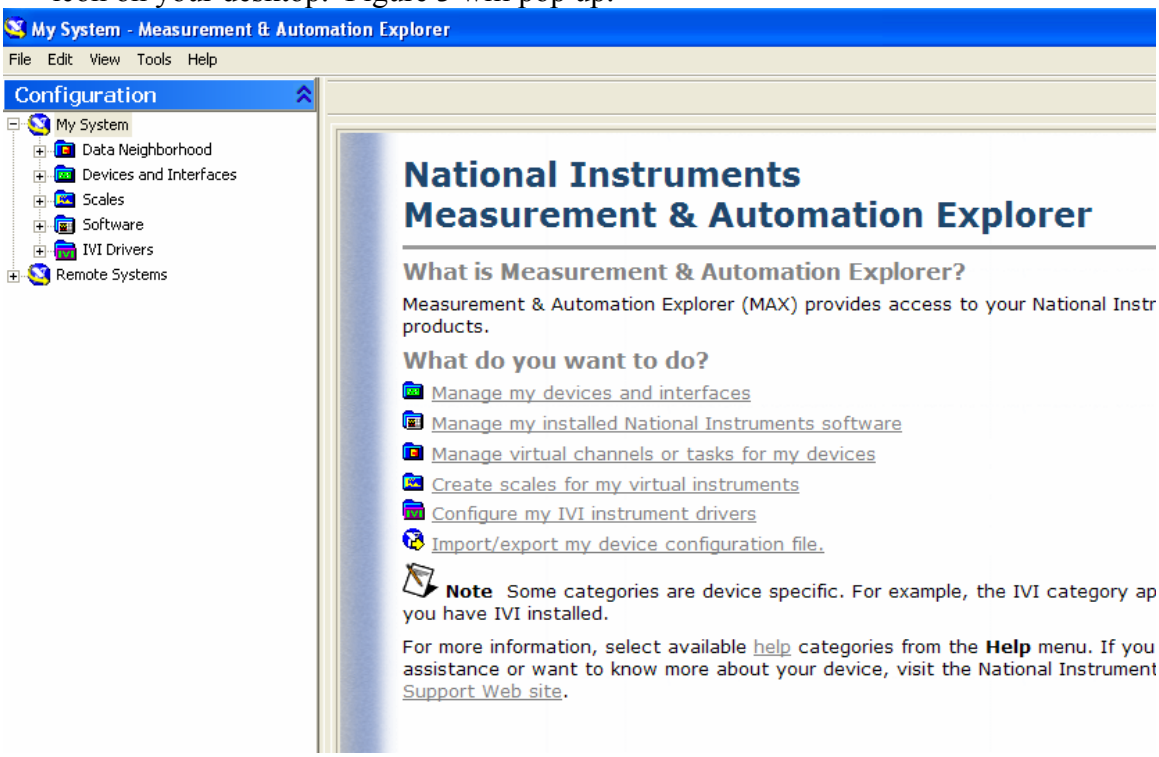


Figure 3. MAX main window

   c. Left-Click on the "+" next to Devices and Interfaces
   d. Left-Click on GPIB0 (PCI-GPIB). Figure 4 will pop up.

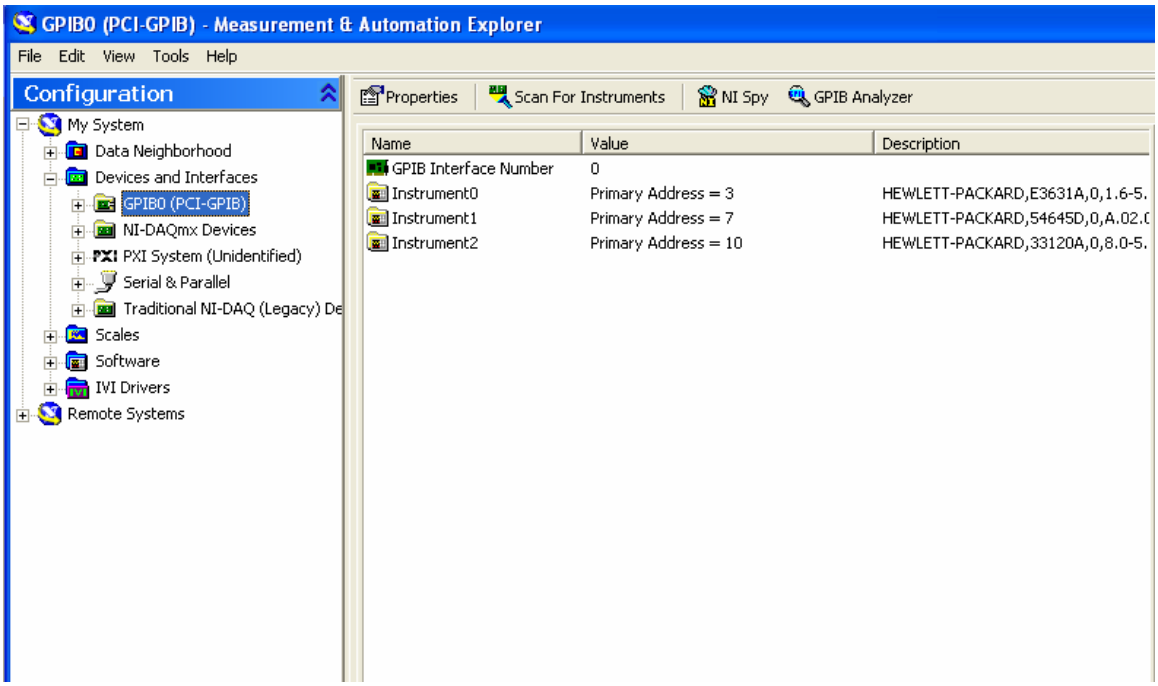


Figure 4. GPIB instrument addresses

e. Depending on the number of instruments you have switched on, MAX will display their addresses. Left-Click Scan For Instruments to make sure the address displayed by MAX is correct. **NOTE DOWN THE ADDRESS OF YOUR OSCILLOSCOPE – THE HEWLETT-PACKARD, 54645D.**

f. Close MAX.

3. Select Start → Programs → National Instruments → LabVIEW 8.2 → LabVIEW to start LABVIEW. Figure 5 will pop up.

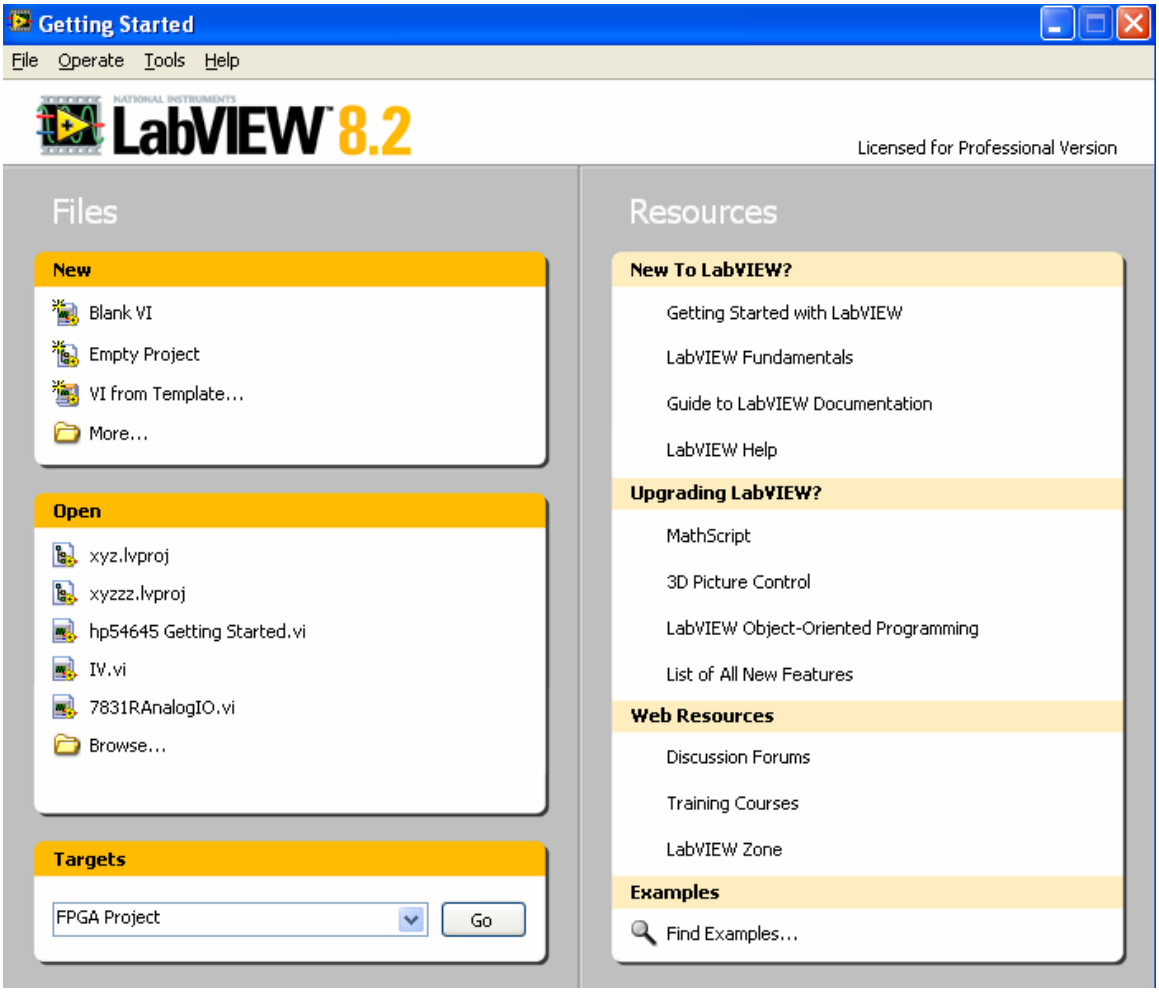


Figure 5. LabVIEW startup screen

4. Left-Click Browse...
5. Navigate to the HP54645 folder you downloaded. Double-click on the folder and double click on the Hp54645 library.
6. Left-Click on hp54645 Getting Started.vi and then Left-Click OK. Figure 6 should pop up.

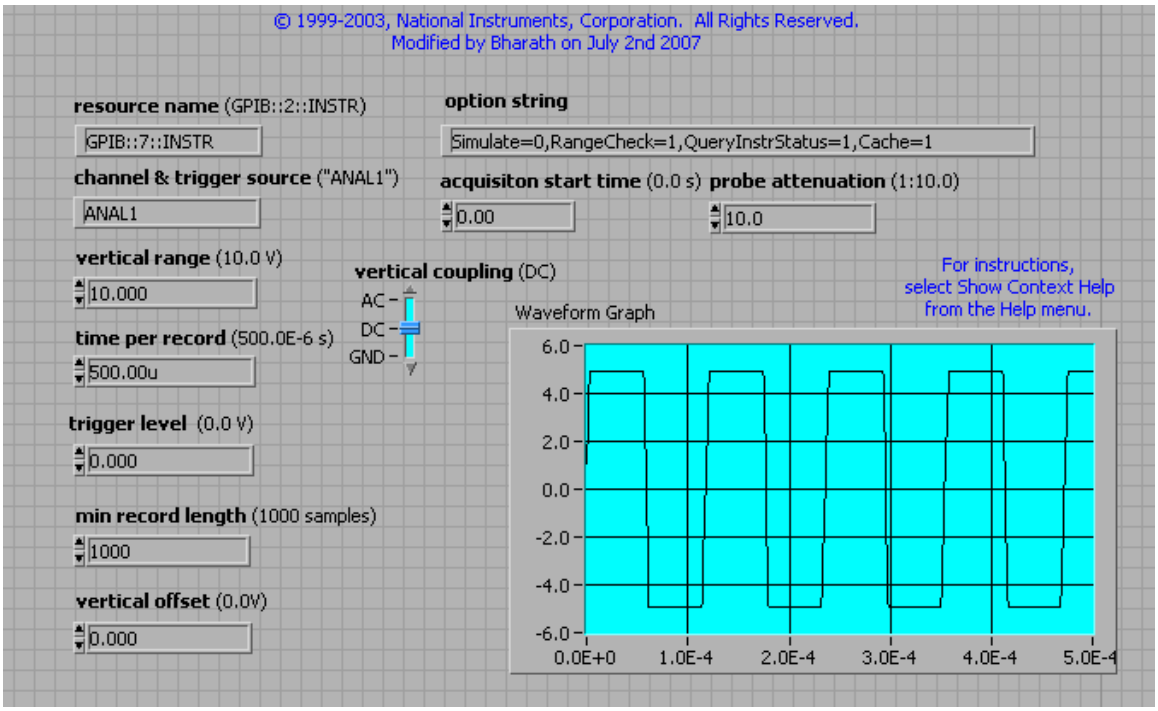


Figure 6. LABVIEW scope interface

7. **MAKE SURE THAT THE CORRECT GPIB ADDRESS APPEARS UNDER RESOURCE NAME ON YOUR VI.**
8. **MAKE SURE YOUR CIRCUIT IS POWERED UP AND SCOPE PROBE A1 IS CONNECTED TO YOUR CIRCUIT**. In this case, connect probe A1 to the output of your op-amp.
9. Left-Click the Run icon. LABVIEW will capture the scope data.
10. To print the screen, Left-Click File and then Left-Click Print.
11. You can keep the defaults (Left-Click Next > to go through the screens). Once you get to the Page Setup screen (figure 7), Left-Click Preview... to make sure that the output is what you want.
12. On the last screen, Left-Click Print... to send output to the 140 Cory printer. **TURN IN A COPY OF YOUR SCREEN SHOT WITH YOUR LAB REPORT.**

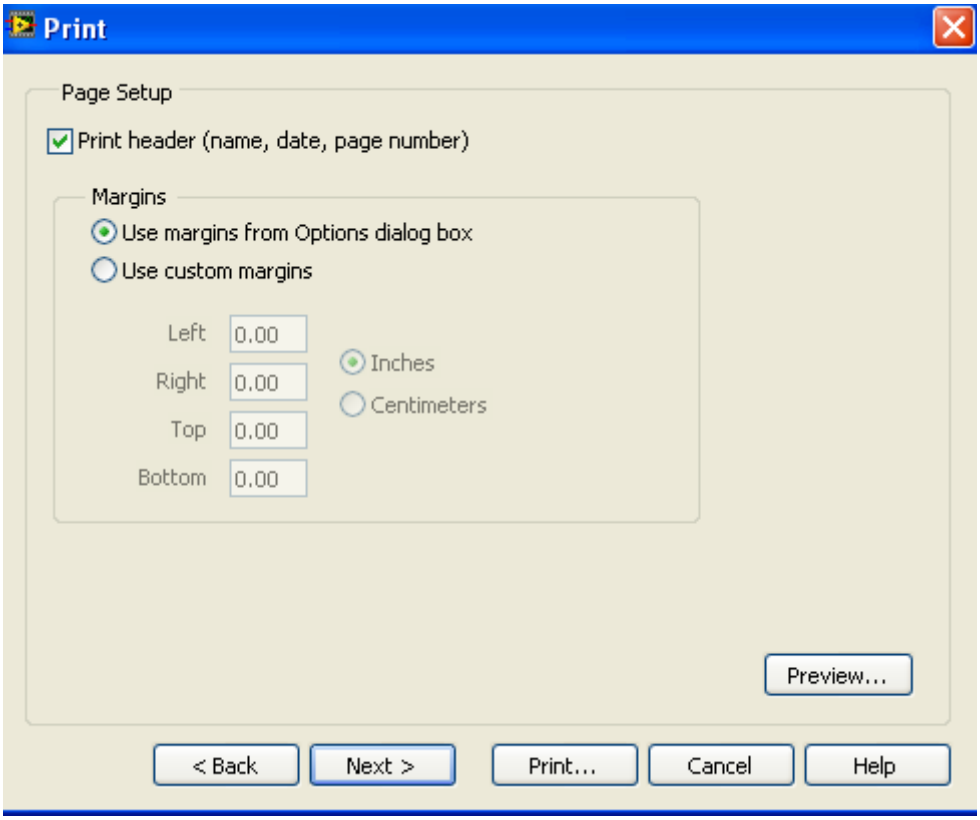


Figure 7. LABVIEW page setup screen

4. PRELAB NAME:_____/SECTION____

Please turn in **INDIVIDUAL COPIES** of the prelab. They are due **10 MINUTES** after start of lab, **NO EXCEPTIONS!**

a. TASK 1: Draw the driving point plot below for the circuit given in figure 1. Justify your driving point plot by showing the derivation.

b. TASK 2: Build and simulate the circuit in figure 1 from MultiSim.

c. TASK 3: Go through the "Getting Started with LABVIEW" document available on the EE100 homepage (under handouts).

PRELAB COMPLETE: _____ (TA CHECKOFF)

5. REPORT NAME(S):_____/SECTION____

a. TASK 1: Build the circuit from prelab task 2 on the breadboard. Use the oscilloscope cursor keys to measure the frequency of oscillation, record it in table 1 and compare to the theory and simulation.

Parameter	Theory	Simulation	Experiment	% error
Frequency				

Table 1. Frequency measurements

b. TASK 2: Printout a screenshot of your LABVIEW scope vi and attach it to your lab report (refer to the Theory section, part (b) LABVIEW scope capture for instructions).

TURN IN ONE REPORT PER GROUP AT THE END OF YOUR LAB SESSION. THERE IS NO TAKE HOME REPORT.

6. REVISION HISTORY

Date/Author	Revision Comments
Spring 2007/Bharathwaj Muthuswamy	Typed up source documentation, organized lab report, typed up solutions.