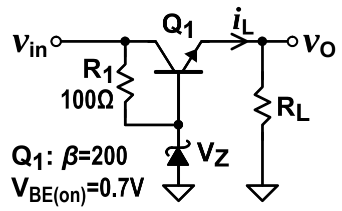
EE203 - Electrical Circuits Laboratory

Experiment - 9
Feedback Circuits

Objectives

1. Observe operation of simple voltage regulator and oscillator circuits with feedback configurations.

Preliminary Work



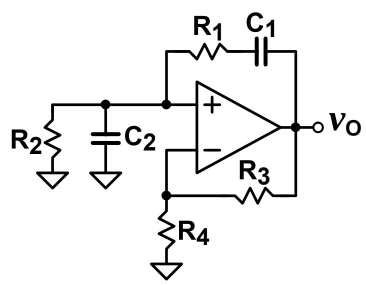
1. Consider the voltage regulator on the right.

1.a) Determine the zener voltage V_Z to obtain **4 V DC** output.

1.b) Simulate the designed circuit.

Measure line regulation when v_{in} has **+/-0.5V** variation around **6.0 V DC**. Repeat line regulation measurement when DC value of v_{in} is **8.0 V**.

Measure load regulation when i_L changes from **0.4 mA** to **100 mA** for v_{in} **= 6.0V** and v_{in} **= 8.0V**.



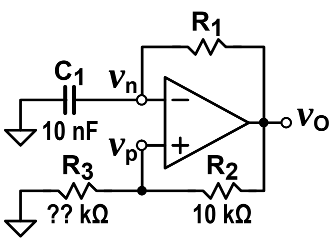
2. Consider the **Wien bridge oscillator** on the right.

2.a) Express the oscillation frequency in terms of circuit parameters.

2.b) Determine R_1 and R_2 to obtain **16 kHz** oscillation frequency when $C_1 = C_2 = 1$ **nF**.

2.c) Describe the oscillation criterion and determine R_3 accordingly when $R_4 = 10$ **kΩ**.

2.d) Simulate the designed circuit by using **AD795** opamp model with **+/-12 V** supplies. Change R_2 and plot the oscillation frequency as a function of R_2.



3. Consider the **Schmitt trigger oscillator** on the right.

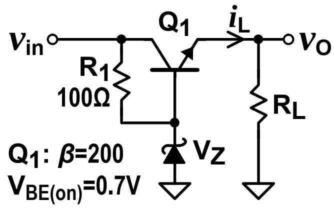
3.a) Determine the value of R_3 to obtain **4 Vp-p** amplitude at v_n. Assume that v_O changes between **-10 V** and **+10 V** in your calculation.

3.b) Determine the value of R_1 to obtain **1 kHz** oscillation frequency. Express period of the v_n waveform in terms of the $\tau = R_1C_1$ time constant and the peak values of v_n and v_O.

3.c) Simulate the oscillator circuit with the calculated values by using **AD795** opamp model with **+/-12 V** supplies. Plot v_p, v_n and v_O.

Procedure

1. Build the voltage regulator circuit given on the right using **BC237** or **BC238** as **Q1**. Initially connect a **10 kΩ** resistor in place of $\mathbf{R_L}$.



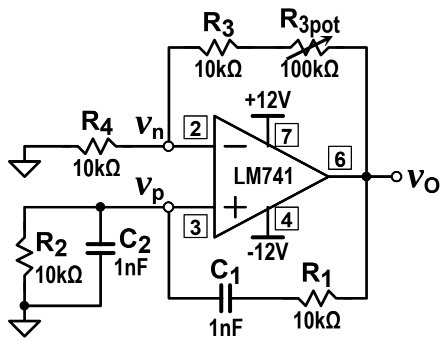
1.1 Determine line regulation when middle value of v_{in} is $\mathbf{V_{inDC} = 6.0\ V}$. Set $\mathbf{v_{in} = 6.5\ V}$ and $\mathbf{v_{in} = 5.5\ V}$ using the multimeter and measure v_O for both of the v_{in} settings. Repeat line regulation measurement when $\mathbf{V_{inDC}}$ is **8.0 V**. Compare your measurements with the simulation results.

V_{inDC} value of v_{in} (V)	v_O (V) measured at V_{inDC} + 0.5V	v_O (V) measured at V_{inDC} - 0.5V	**line regulation (V/V)**
6.0			
8.0			

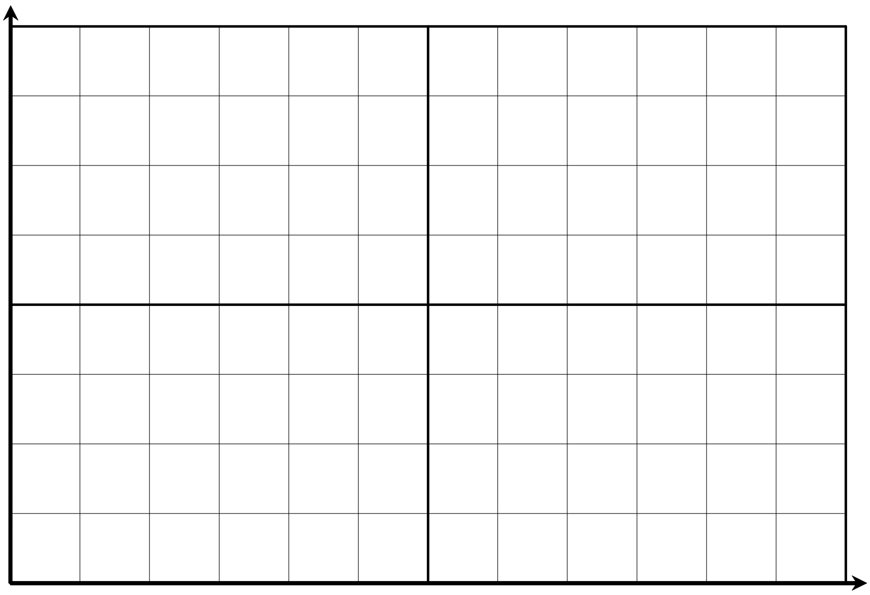
1.2 Determine load regulation when $\mathbf{R_L = 100\ \Omega}$ is connected instead of **10 kΩ** for $\mathbf{v_{in} = 6.0V}$ and $\mathbf{v_{in} = 8.0V}$.

V_{inDC} value of v_{in} (V)	v_O (V) measured for R_L = 10 kΩ	v_O (V) measured for R_L = 100 Ω	**load regulation (mV/mA)**
6.0			
8.0			

2. Build the **Wien bridge oscillator** given on the right. Set the DC supply output voltages using the multimeter to obtain **+12 V** and **–12 V** required for the opamp.



2.1 Set **R_{3pot} = 0 Ω** first, and then increase it just to the point where oscillations start at v_O. Plot v_n, v_p and v_O waveforms below. Indicate units of amplitude and time axes on your plot. Measure and record the peak-to-peak output voltages and the oscillation frequency.



v_n : ________ v_p : ________ v_O : ________ **F_{osc} =** ________

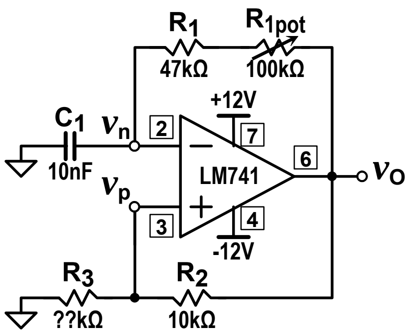
2.2 Turn off DC supplies, disconnect and measure the resistance of **$R_3 + R_{3pot}$**. Does this result agree with your prediction in the preliminary work?

$R_3 + R_{3pot}$ = __________

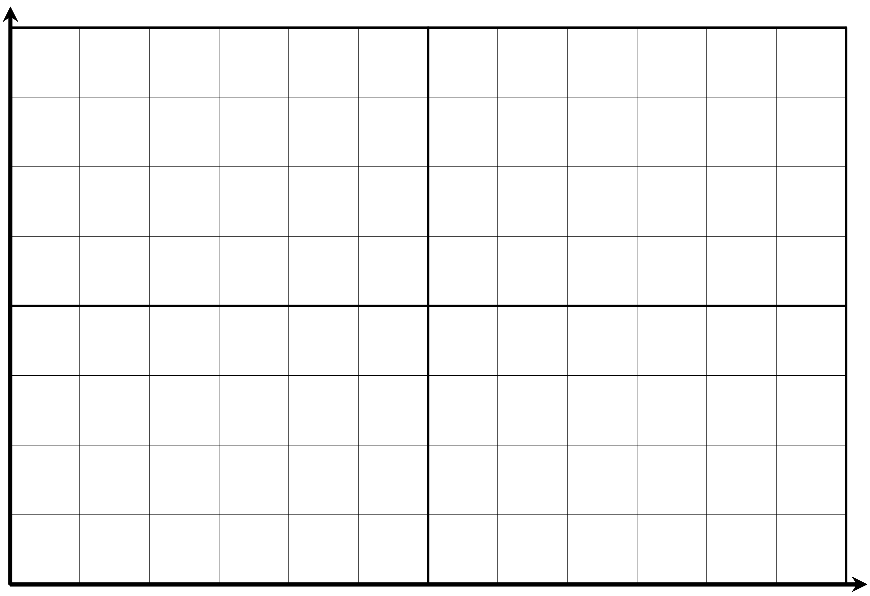
2.3 Reconnect **$R_3 + R_{3pot}$** and measure the oscillation frequency obtained with the **R_2** resistance values listed in the following table. How does **R_2** affect the oscillation frequency? Compare your measurements with the frequency values obtained in the preliminary work.

R_2 (kΩ)	F_{osc} (Hz)
10	
22	
33	
47	

3. Build the **Schmitt trigger oscillator** circuit given on the right. Use a standard resistor value closest to the **R_3** calculated in the preliminary work.



3.1 Adjust **100 kΩ R_{1pot}** to obtain **1 kHz** oscillation frequency at v_O. Plot v_n, v_p and v_O waveforms below indicating all critical amplitude and timing information. Compare your measurements with the results obtained in the preliminary work.



Questions

Q1. List the steps in designing a Wien bridge oscillator.

Q2. List the steps in designing a Schmitt trigger oscillator.

Q3. Modify the circuit used in step-3 so that the opamp works with a single positive supply without significant change in the oscillation frequency.

Hint: Input waveforms should be centered around half the positive supply voltage. There is no DC level control on the negative opamp input. DC level of the positive opamp input depends on where $\mathbf{R_3}$ is connected to.