EECE208 INTRO TO EE LAB **Dr. Charles Kim**

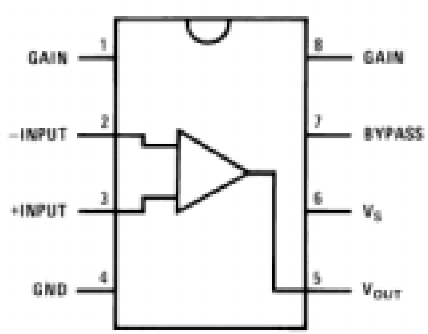
11. Audio Amp

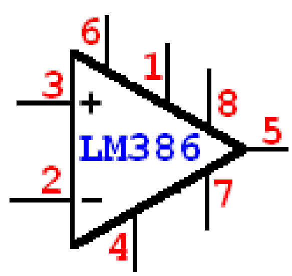
Objectives:
The main purpose of this laboratory exercise is to design an audio amplifier based on the LM386 Low Voltage Audio Power Amplifier chip and to analyze the amplifier in terms of gain, bandwidth, power consumption, and total harmonic distortion for various input levels. Distortion, clipping, and output power will also be evaluated as a function of frequency.

Elements and Equipment:
LM 386 Audio Amplifier
Electret Mike
Speaker
Resistors
Ceramic Capacitors (Non-Polarity)
Electrolytic Capacitors (Polarity)
Power Supplier
Function Generator
Oscilloscope

LM386 Low Power Amplifier:

General Description of LM386
The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value from 20 to 200. The inputs are ground referenced while the output automatically biases to one-half the supply voltage. The quiescent power drain is only 24 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation.





Features

- Battery operation
- Minimum external parts
- Wide supply voltage range: 4V–12V or 5V–18V
- Low quiescent current drain: 4mA

- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion: 0.2% (A_V = 20, V_S =6V,R_L =8Ω,P_O =125mW, f = 1kHz)
- Available in 8 pin MSOP package

Applications
- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

Gain Control of LM386

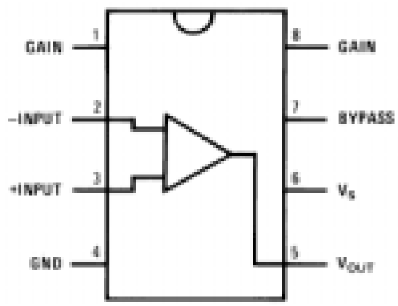
To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open, the internal 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitively coupling a resistor (or FET) from pin 1 to ground. Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15 kΩ resistor). For 6 dB effective bass boost: R ≅ 15 kΩ, the lowest value for good stable operation is R = 10 kΩ if pin 8 is open. If pins 1 and 8 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9.

Input Biasing of LM386

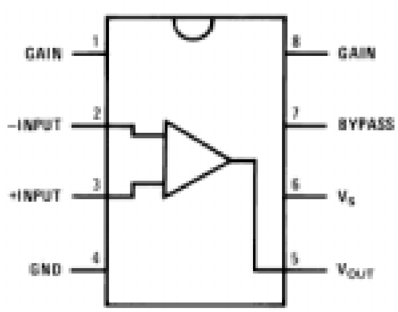
The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transistors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the LM386 is higher than 250 kΩ it will contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output). For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled. When using the LM386 with higher gains (bypassing the 1.35 kΩ resistor between pins 1 and 8) it is necessary to bypass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1 µF capacitor or a short to ground depending on the dc source resistance on the driven input.

PRE-LAB-11 **NAME** **ID**

1. First read the LM386 Data Sheet accompanied by this lab. Then, draw a connection diagram for a Gain 20 audio amplifier. Attach a speaker at the output.



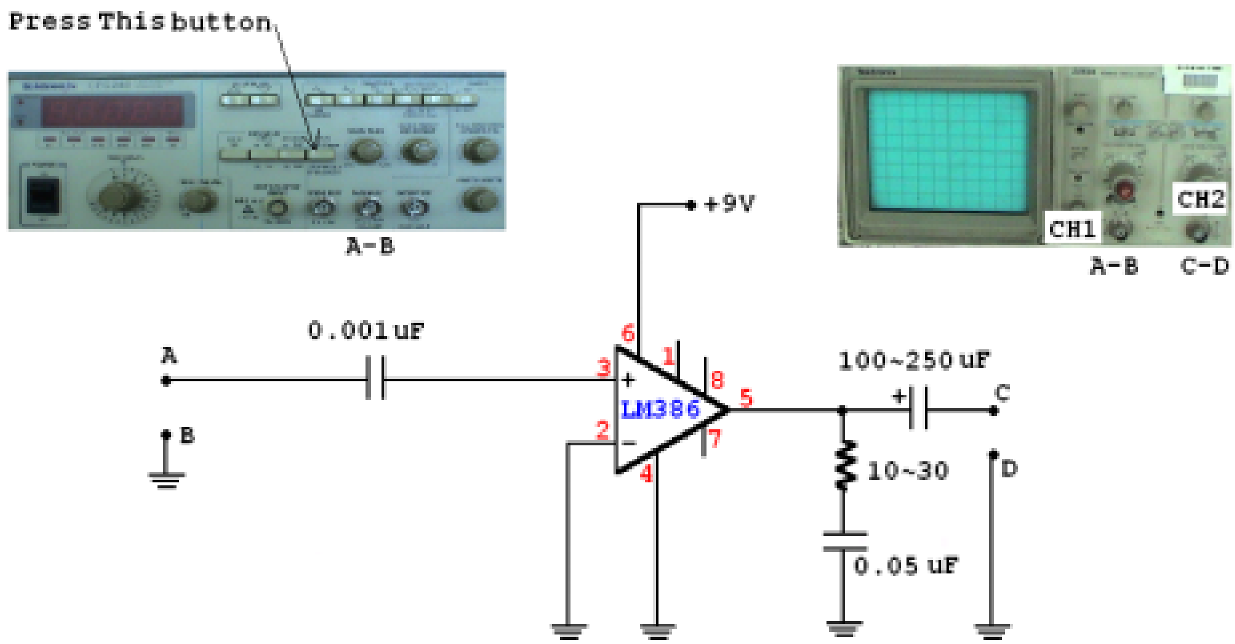
2. Draw a connection diagram for a Gain 200 audio amplifier. Attach a speaker at the output.



LAB PROCEDURE-11

NOTE: This audio amp circuit will be again used for the joint lab (Mobile Studio Lab) scheduled on Friday, April 22. Therefore, keep your circuit on the breadboard after today's lab. Do not disrupt your board or loose elements on it.

1. Create an audio amplifier circuit as shown below. Remember that the capacitor at the very end is polarized one so that we have to make sure the correct polarity of it.
(a) Using a function generator, apply a sinusoidal source with amplitude of 0.1V and frequency of 500Hz to A-B terminal of the circuit.
(b) Using a scope, measure both the input and outputs signals.

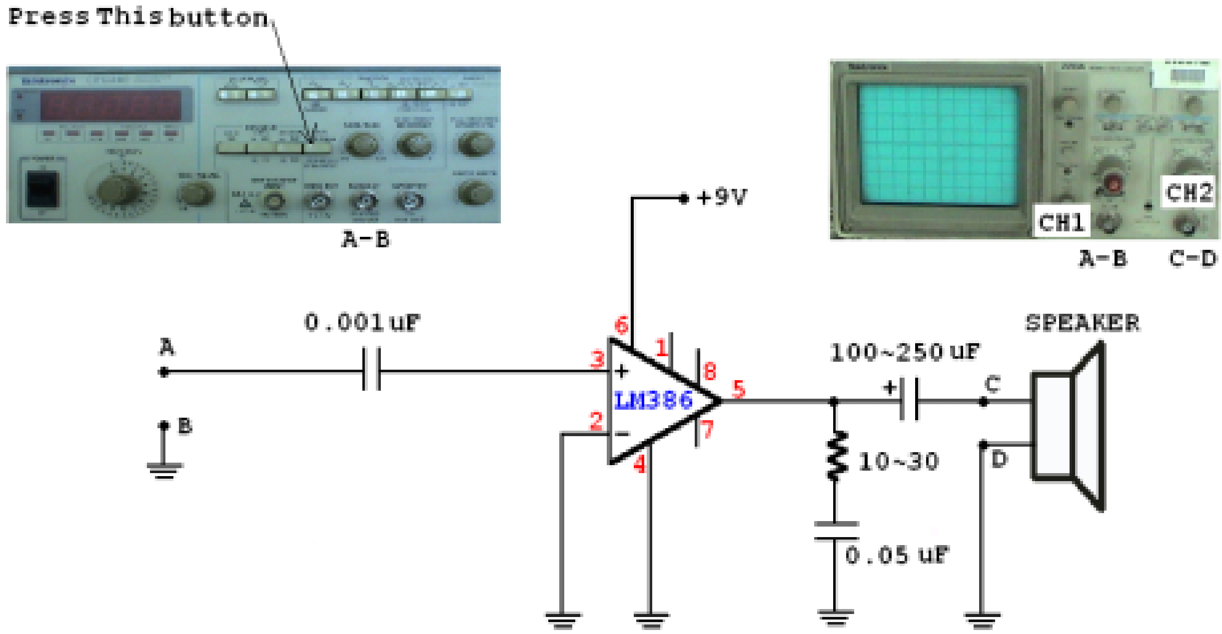


(c) Sketch input and output signals below. And find the **gain** of Output/Input.

(d) Change the V_s (currently set at 9[V]) from 0 - 15[V] and observe the changes in the output.

2. Now connect a speaker at the output.

(a) Using a scope, measure both the input and outputs signals, while listening to the sound.

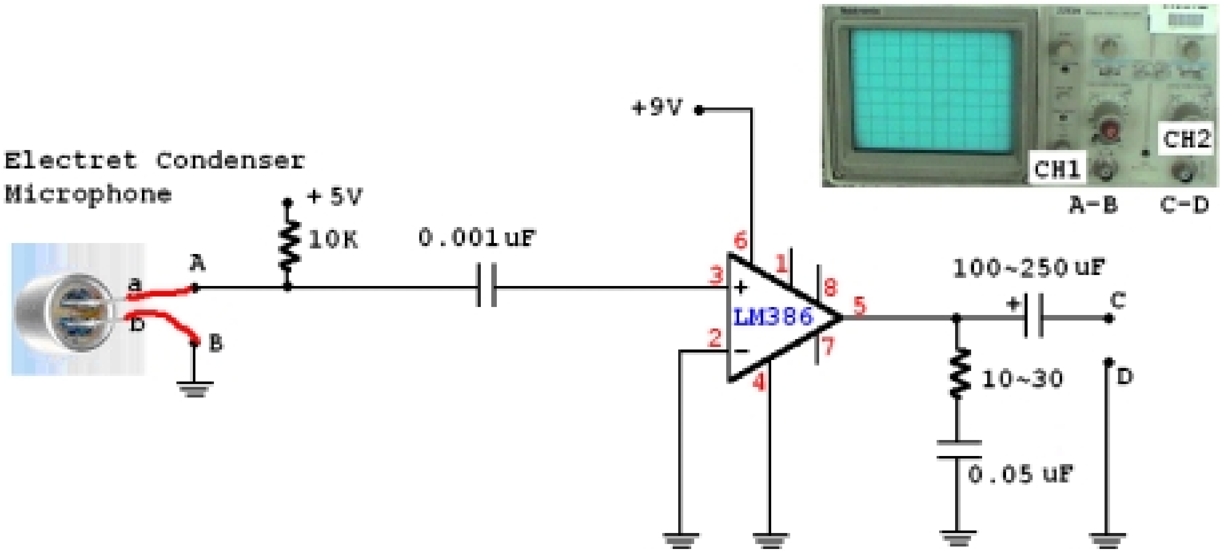


(b) Sketch input and output signals below.

(c) Change the frequency of the sinusoidal signal to 200Hz, 1000Hz, and 2000Hz, and describe the sounds from the speaker.

3. Connect an Electret Microphone as in input device. Also connect a 10K resistor and voltage supply of +5V as indicated.

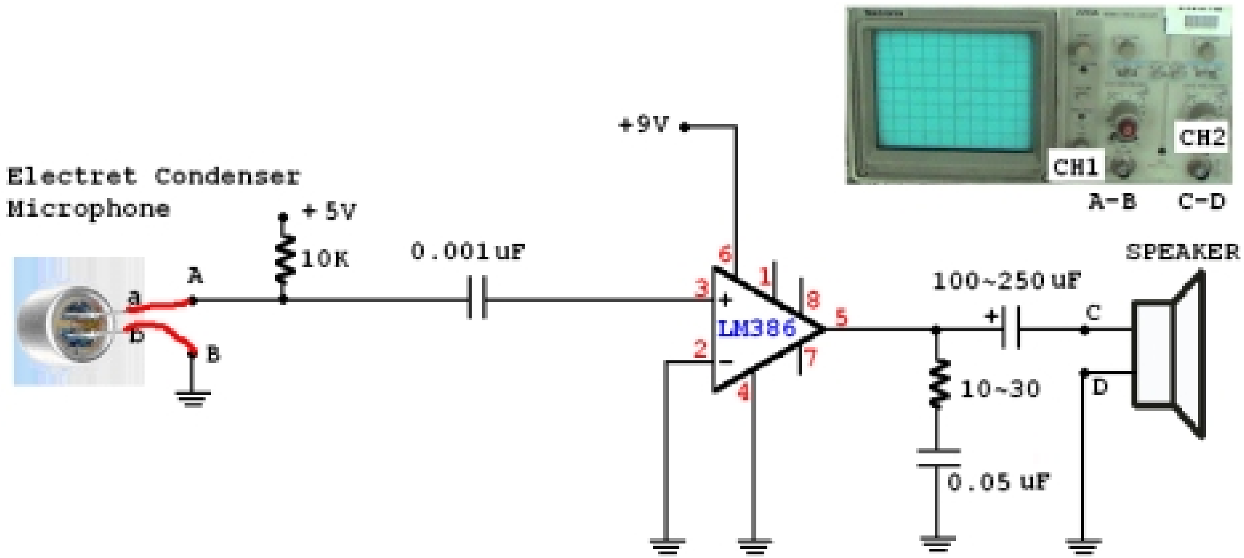
(a) Blow a breath or whistle toward the microphone, and using a scope, measure both the input and outputs signals.



(b) Sketch input and output signals below. And find the **gain** of Output/Input.

4. Now connect the speaker at the output.
(a) Blow a breath or whistle toward the microphone, and using a scope, measure both the input and outputs signals.

***NOTE: If the sound from speaker has noise, cover the speaker with your hand until it quiets. And conduct your experiment with your hand covering the speaker.**



(b) Sketch input and output signals below.