Electrical Engineering Workshop (ইলেকিট্রিকাল ইঞ্জিনিয়ারিং) 3 hours/day

Week 2: Designing Basic Circuits ()

Lesson 2.2: Push-Pull Amplifers ()

• OVERVIEW: Today we're going to be making something really fun! By the end of the class you guys will all have built something that can play loud music! It's going to be a pretty advanced class, so hold on tight and keep your brains engaged!
• NEW CONCEPT: So far, we've dealt with positive voltages only. But did you know that there is such a thing as a negative voltage? Instead of 9V for example, we can have -9V. What does this mean? It doesn't mean much really, because voltage is all relative. All it means is the -9V is at a lower voltage than ground so if you place a resistor between ground and -9V, current will flow, can anyone tell me which direction? (Hint: current flows from higher voltage to lower voltage always) → Yes, current flows from 0V to -9V.
• EXPLAIN: How can we make a negative voltage, -9V for example? Any ideas?
  o POSE QUESTION + DRAW CKT: Well, say we start with a regular 9V battery. Then we have 0V at the – and 9V at the +. What can we attach to the – terminal to get a voltage that's lower than 9V? Any ideas? (Hint: What produces 9V?)
  o Yes, we can attach another 9V battery!! Do we attach the + or the – to 0V? → Yes, the +! Why? Let's label the – of this battery as V. What is V? Let's set up an equation. V + 9 = 0. So V = -9V right?? Yay! We solved it!
• POSE QUESTION: When do you think it would be nice if we had a positive and a negative voltage available to source power in our circuits?
  o GUIDE: Let's recall what we know about AC waveforms.
  o DRAW: AC waveform graph on time scale. Do you all see how this voltage goes positive and negative but the middle voltage, the center is 0V? Right! So that means there are negative voltages in the AC waveform.
  o ASK: What happens if we try to work with this AC signal with only a 9V positive source, and no -9V negative source?? Will the signal carry through? → No! Because our negative voltages will be confused! There is nothing that can give it any current!
  o EXPLAIN: So, what are our options? One is to make the AC waveform ride on top of a DC voltage that is not 0V so that the whole signal fits inside 0V and 9V, right? What would be a good voltage for this? → Exactly halfway in between 0V and 9V: 4.5V!
  o VOCABULARY: This is called a DC offset.
  o WORKSHEET: Explain what a DC offset voltage is and what we could use it for.
  o PROBLEM: But what if what we output to does not like having a DC voltage average?
  o EXAMPLE: For example, if we want to play music, what do we need? A speaker! But a speaker has a magnetic coil inside of it, kind of like an inductor, and if we give it a DC voltage, then there will be constant current flowing in one direction through the speaker, and the speaker will blow up! Speakers do NOT like DC voltages!! So we need to make sure our average is 0V. We can't do the first option then.
  o ASK: What else can we do? Any ideas??
  o GUIDE: Yes! We can use a negative voltage to make sure that the AC waveform can pass through to the speaker without a DC offset.
  o WORKSHEET: Explain in your own words why we might sometimes want to use negative voltages.
• POSE QUESTION: So why won't it work if I try to connect the music (audio) output of a phone or an MP3 player directly to a speaker? (Hint: The speaker is a 5W speaker!)
  o GUIDE: A 5W speaker needs quite a bit of current to actually play sounds. The problem with the output of a phone is that it provides very little current ☹ at a small voltage.
  o RECALL: How did we calculate power? P = VI. So if we have small V and small I, then we don't have enough P!
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○ POSE QUESTION: So what do we need to do in order to play music from our phones? ○ EXPLAIN: Yes, we need to increase the voltage and the current of the AC signal of the audio coming out of our phones in order to "drive" the speaker! ○ VOCABULARY: This concept is called amplification. • POSE QUESTION: So we know now that we need to amplify our audio signal in order to hear it on a speaker. Now the question is: How can we amplify an audio signal with components we know how to use? Anyone have any idea what kind of components we could try to use? ○ GUIDE/RECALL: Yes a transistor! Remember how we talked about earlier how a BJT needs only a little bit of current at the gate to close a circuit and make a lot of current flow in that path? We can do exactly that! • NEW CONCEPT: This circuit will be a little bit complicated so we will need to divide it up into functional blocks. ○ VOCABULARY: A functional block is just another way we can represent a circuit without drawing a schematic. Each block tells you what the circuit inside will do. ○ DRAW/EXAMPLE: Of functional blocks. • POSE QUESTION: Let's make a • Yay that's it! Everyone's exit ticket is a piece of paper with their (1) rating of the class, (2) list of up to three things they liked a lot, and (3) list of up to three things they didn't like and what they would like instead.	