#	Question	Answer(s)
1	we know the capacitance of C_ref, right?	Yes
2	Is this the same 4-phase switch process that we see in lab?	It is similar. I think it lab, we make explicit when the switches are off at the same time and when we reset the caps
3	How C_ref would be discharged if S3 is closed?	When a switch is closed, it becomes a wire, so C_ref can be discharged since it is shorted.
4	what is after the circuits module?	We will look at some advanced linear algebra in the context of GPS and basic ML
5	What is the purpose of s3?	To make sure Cref has no charge before phase 2.
6	s3 discharges both capacitors right or does it only discharge cref	In phase 1 S2 is open, so only Cref is discharged.
7	What is the difference between an op-amp and comparator?	op-amps have a little more "versatility" when used in negative feedback. But when drawn just own its own like this, it is the same as a comparator.
8	how do we determine Vth?	That is a design choice. We need to solve the circuit for Vout when we have a touch and when we don't have a touch, then we can pick something in the middle.
9	Why do we need Cref? Seems like this could work without it	If we don't have Cref, the voltage on Ceq will always be Vs.
10	why did we need a resistor in series with Vref in lab?	not a lab TA, but looking at the lab doc, I don't see any resistors in series with Vref / Vx...if you're talking about the 100KOhm resistors in parallel with Cref, that has to do with some time domain effects, to help stabilize the signal at V+.
11	How do we make sure c_eq is uncharged if s2 is open in phase 1	We don't need to make sure Ceq is uncharged. When it is connected to Vs in phase 1, we set its voltage and charge by the voltage source.
12	Is Vthresh the same as the flipping point?	yes
13	is the comparator change in voltage going to be instant or a linear change	For an ideal comparator, it is instant. But for real implementations, there is some change in the middle, often linear.
14	Why does Vss have to be negative?	It can be 0 or even positive, depending on the comparator specs, as long as Vss<Vdd. Here is just an example.
15	How do we discharge capacitors?	We can connect its two plates by a wire (set the voltage across it to 0) to discharge it.
16	is C delta the capacitor created with the finger in parallel with Co?	yes
17	What does loading mean?	When we have a circuit with "Vout", if we connect something (e.g. a resistor) to it, the output value may change because the circuit has changed (i.e. there is a new resistors in parallel). This is the loading effect.
18	What does isolating mean	It means one part of the circuit does not affect the other part, so the isolated part of the circuit functions in the same way no matter how we change the other part.
19	Isn't Vss 0 because it is connected to ground?	Vss is also connected to a voltage source, as shown in the left diagram. The dependent voltage source we shown in the right diagram is the equivalent circuit inside the op-amp, not the Vss.
20	what's gain?	Gain is a scalar multiplier. Here is a A. We're taking the difference of the inputs and multiplying it (gaining it)
21	is there a maximum value for the gain?	In practice, yes, and it depends on circuit design. For ideal op amps though, we want "large" gain, approaching infinity in the limit
22	Gain means that A>1 ?	Yes. For an op-amp A is typically very large.
23	Is Vout another voltage source?	Nope, it's the output of the op-amp. We can model it as the output of a dependent voltage source A(V+ - V-) as shown in the right diagram.
24	Can we use op-amps to convert analog signals to digital?	yes! we will usually use the op amp as comparator, but we may do some other processing first with op amp circuits
25	Sorry, what's A again?	A is the op-amp gain. Its an intrinsic property of the op-amp (like R is a property of a resistor), and we assume that is a very large.
26	Shouldn't the wire with V out be connected ground as well so that the circuit becomes a loop	Not exactly. We would connect it to a voltmeter to complete the circuit / loop, and the voltmeter won't affect the value at Vout
27	Vdd = - Vss, and Vss is negative right?	Yes, this is our default setting.
28	Why do we go from ground when calculating Vout? Do we not have to consider the +- end of the voltage source?	For the dependent voltage source in the equivalent circuit of op-amp, the - end is connected to ground, and the + end is Vout.
29	Do DACs use batteries?	They need some voltage source. Battery is one of the choices.
30	whats the difference between a DAC and an op amp?	DACs have some digital signals / wires (basically a number) coming in and reproduce an analog value related to that. Op-amps just have 2 wires coming in and takes the difference of them
31	when we change the volume, what exactly are we changing? the voltage?	In this model, it would be changing the maximum voltage from Vdac. A "quiet" signal would have a small difference between maximum and min. A "loud" signal would have a large difference.
32	what does op-amp stand for?	operational amplifier
33	Why do we amplify in that specific position in the circuit?	The DAC is limited by the VDD voltage, and its not enough to meet the full swing input of the speaker. So we need to do something between those two components.
34	Where are the power rails in the op-amp	There are separate terminals, like with the comparator. For short hand, we often skip drawing them and assume VDD and VSS are such that we get all the swing and behavior we want
35	how did we arrive at three times aplification of Vout instead of by another factor?	We will use a negative feedback to achieve the 3x factor we want. We will get to that part soon.

36	Is A a constant factor we engineer ourselves or is it something that changes all the time?	live answered
37	why does no current enter the op-amp	Its part of the rules of the op-amp. Like the comparator, no current flows into the input terminals.
38	Why do we want A to be 3?	This came from our DAC having a maximum VDD of 3.3V but we want to drive a speaker that can take up to 10V
39	Why does A change all the time?	It can change a lot vs the temperature fluctuation and other factors. It's not a stable number.
40	Are power amplifiers and op-amps the same thing?	Generally no. Power amplifiers have some very specific designs in order to deliver a lot of power. Op-amps are only designed for a small to moderate amount of power.
41	can you re explain why negative?	Negative means if something is too much, we want to turn it down. For example when driving if we go too fast, we want to become slower instead of going even faster.
42	can you re explain the isolation part of op amp?	Isolation is when one part of the circuit does not affect another part with loading. The inputs to the op-amp have no current, so there can be no loading effect. Hence the inputs to the op-amp are isolated from the output of the opamps.
43	Why is V_out * f subtracted from V-in	live answered
44	Why is f*Vout negative?	We want to subtract f*Vout from Vin to make a negative feedback loop.
45	Is f*Vout negative also because f block is the negative direction of x?	No, its only because we have a - sign at that arrow into the (+) addition symbol
46	Is f fixed?	It will be fixed in the circuit. It is something we design
47	why is V_in = f*V_out? isnt that supposed to be V_fb?	The first equation comes from solving the loop and look in the limit when A = infinity. The takeaway is that the loop tries to make Vfb = Vin.
48	why only when A —> inf then V in = V fb if they have the same equation?	So when A != inf, V_out = 1/ (1/A + f) * V_in. So we only get V_out = 1/f * V_in when A = inf.
49	what's the initial v- in this negative feedback system	If you're asking about what it initially is in time, it actually won't matter for determining the final output.
50	would that imply there is some fluctuation before we have a steady A?	A is still unstable. This system with feedback will come to Vout = Vin. There will be some fluctuation, but it's typically very short so we will ignore that.
51	Is AVerr = Vout?	yes
52	When the error goes to 0, does this make Vout go to 0 as well?	yes
53	what does "A is unstable" mean?	We mean that A is unpredictable. We want to it be very large, but the actual value may be changing a bit
54	Where does the 3x amplification from before come in?	We got the 3x from having a 3.3V maximum output from our DAC, and we desired 10V for our speaker. We're going to use that to design an amplifier in feedback. We haven't seen that circuit just yet.
55	why is it called "negative" feedback? Is there something liked a +ve feedback too?	live answered
56	What does the positive sign with a circle around itdenote in our negative feedback loop diagram	That's just an addition block. It says that Verr = Vin - Vfb
57	How do you change Vout to make it larger to make this test?	So in this diagram, Vout will always become smaller, because we are in negative feedback. If we were in positive feedback, Vout would get bigger. You can do this by making Verr = Vin + Vfb, instead of Vin - Vfb
58	where did the second Vout equation come from	live answered
59	why is vout equal to 1 + a	live answered
60	Hoe come Vout = 1 + A	Will fix before notes release
61	^	live answered
62	1+A	live answered
63	Press f for amplification	
64	where did the relationship vout = (1 + A) come from?	live answered