

Lecture 5 : Class AB Stages

0. Review

1. Class AB Stage

2. Class AB Design

- Today : PreLab 2 due

- HW2 due Fri

- Lab 1 report due next Tue (10/1)

- Quiz next Tue (10/1)

- PreLab 3 due next lab session

↳ Two week design project

(1) Breadboard prototype
+ testing

(2) Soldering

Burna will be
out of town
Oct 4 - 13

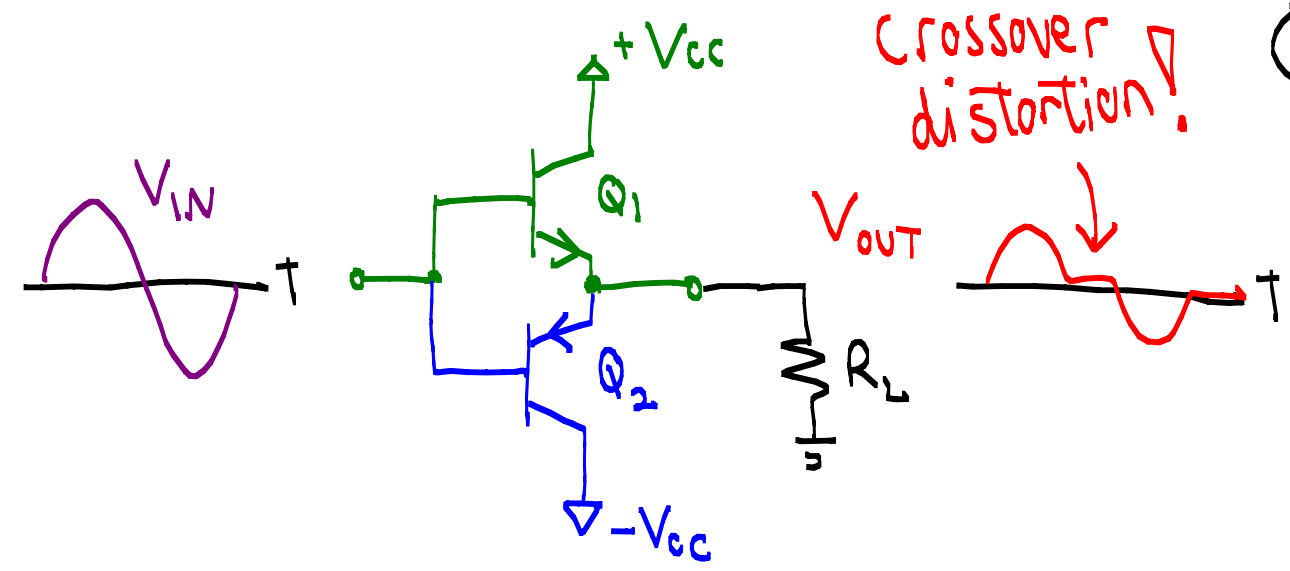
0. Review

← "totem pole"
"class B"

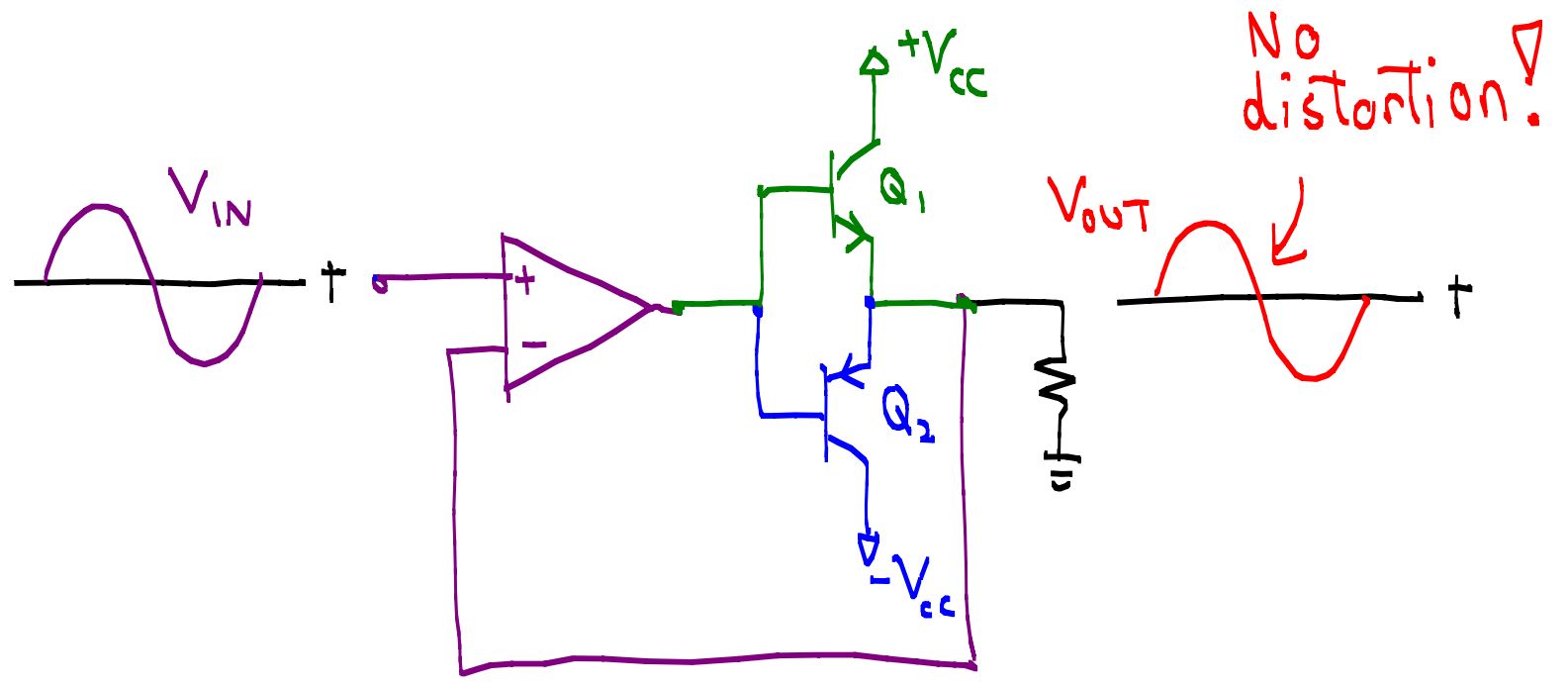
• Push-Pull Stage

Q_1 : ON during (+) output

Q_2 : ON during (-) output

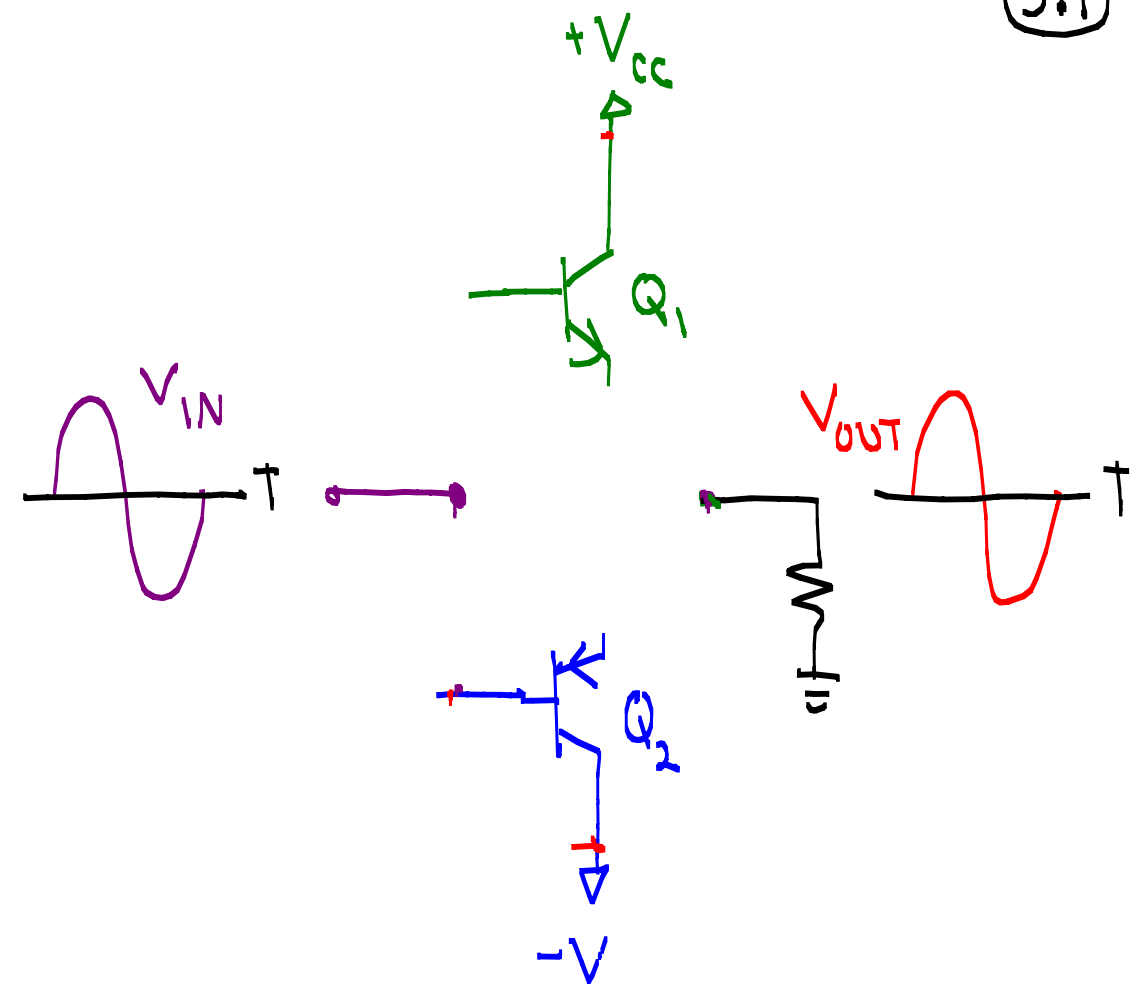


5.0

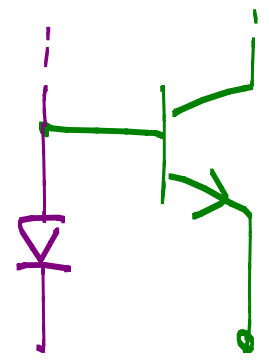


1. Class AB Stage

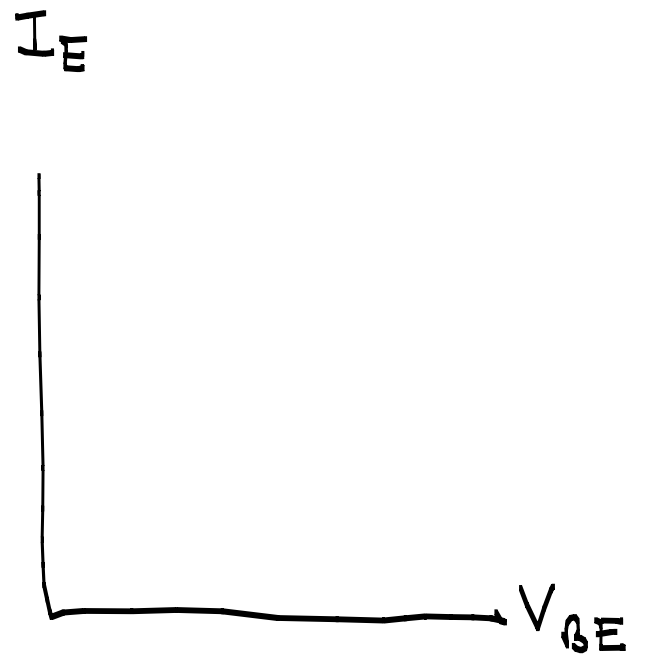
- Crossover distortion is due to both Q_1 and Q_2 being OFF when $|V_{IN}| < V_{BE}$.
- Class AB stage avoids this problem



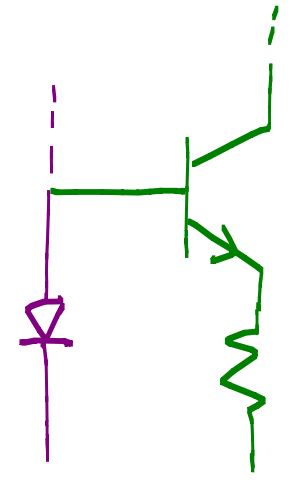
No emitter resistor



When BJT gets warm,



with emitter resistor

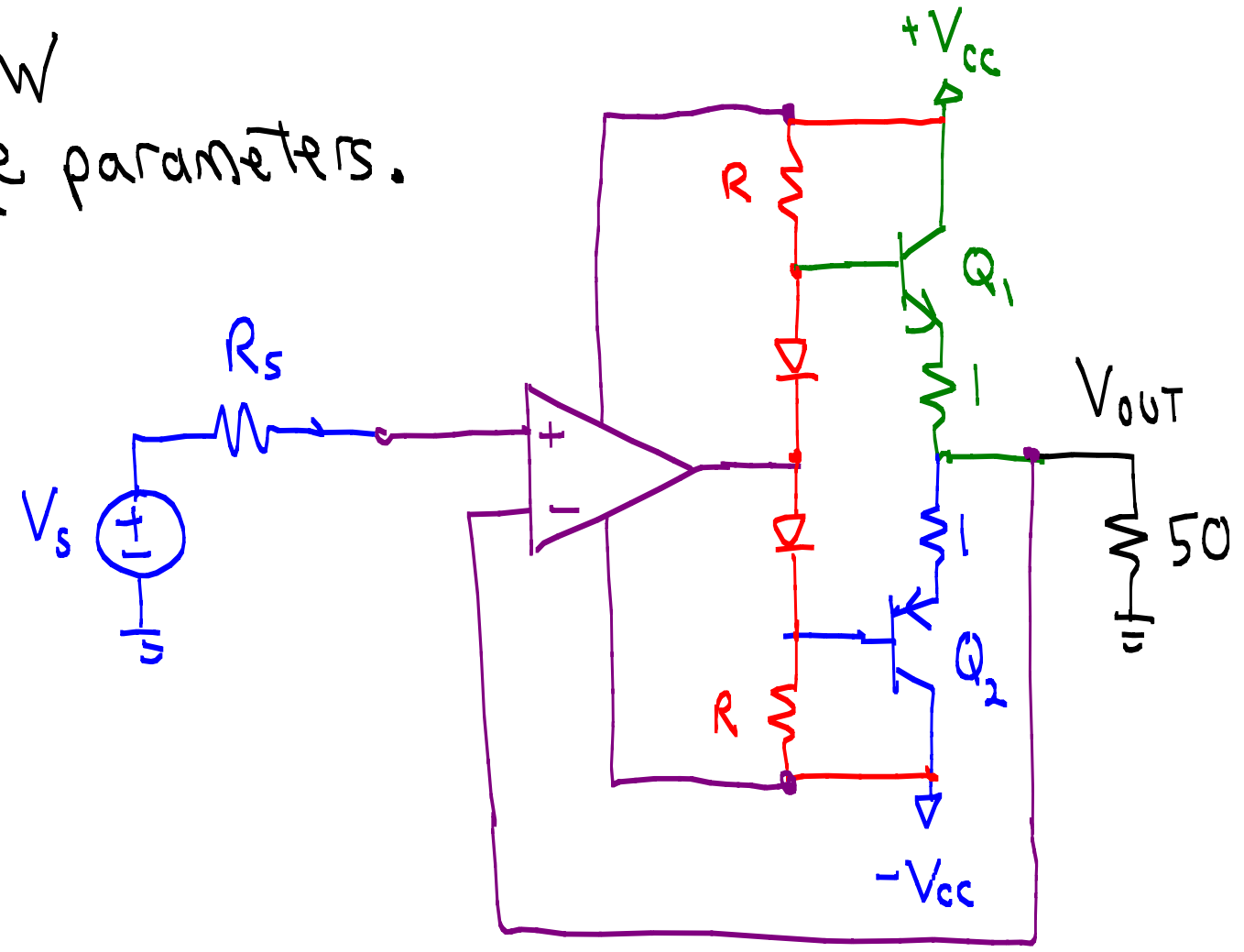


★ If i_E tries to increase,

2. Class AB Design Example

$V_{CC} = 5, 7, 9, \text{ or } 11V$

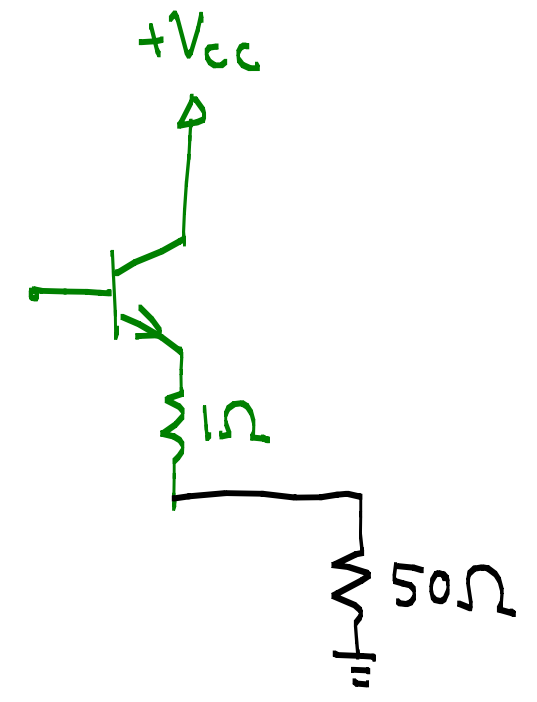
- Drive a 50Ω load with up to $250mW$ of sinusoidal signal. Use worst-case parameters.
- Start with desired max output



- Choose V_{cc} :

★ Make sure max load voltage does not saturate Q_1 !

$V_{cc} >$

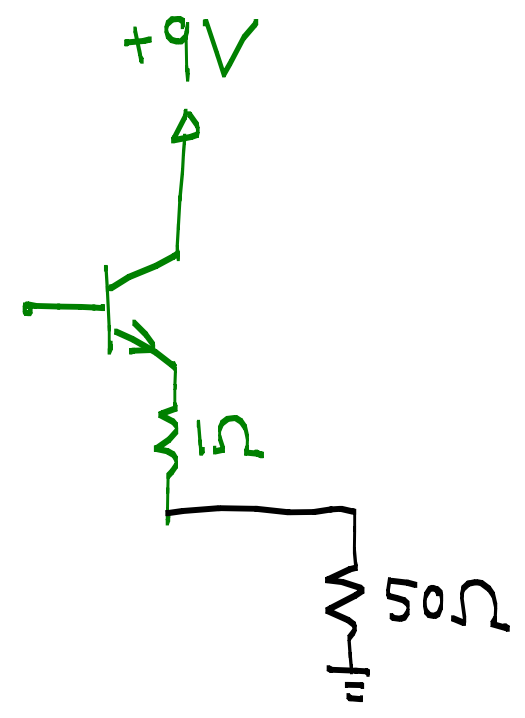


• Choose Transistor First, do quick analysis:

Max $i_E =$

$V_{CE} =$

$P =$

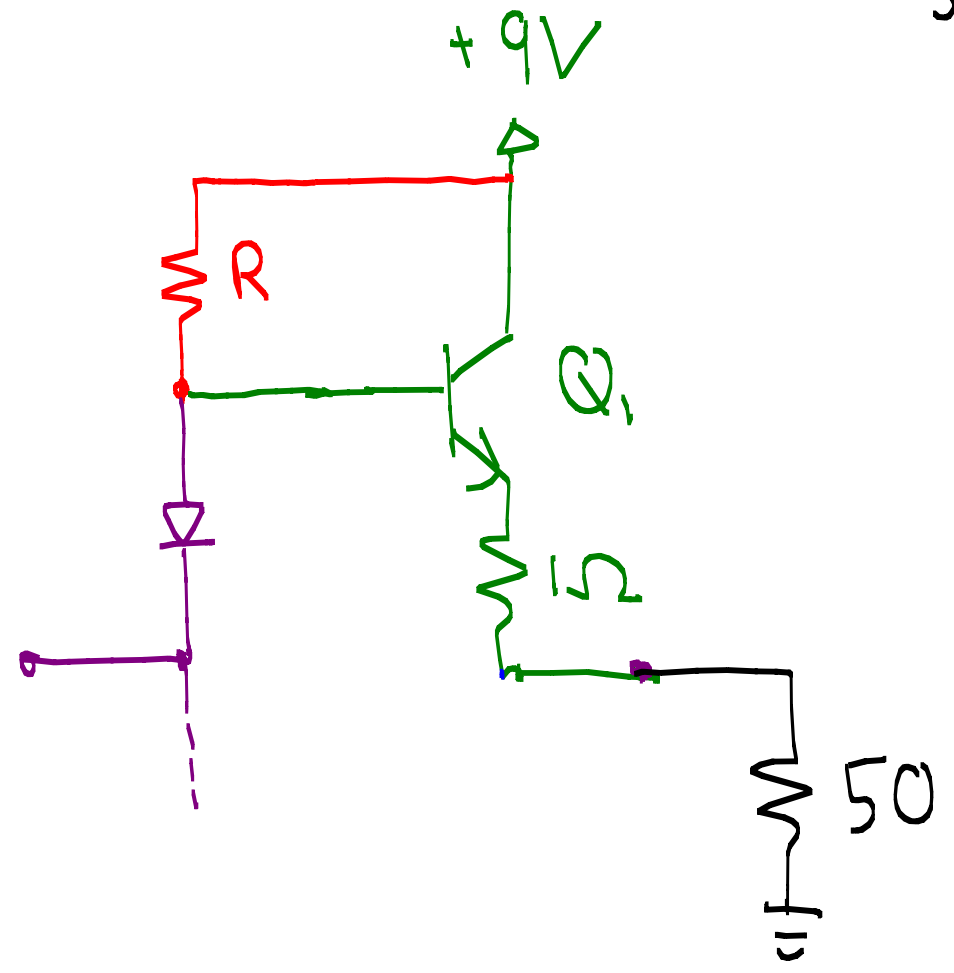


	<u>Max I_c</u>	<u>Max V_{CE}</u>	<u>P_{rating}</u> (no HS)	<u>P_{rating}</u> (w/HS)
2N4401	600 mA	40V	.625W	1.5W
TIP29	1A	40V	2W	

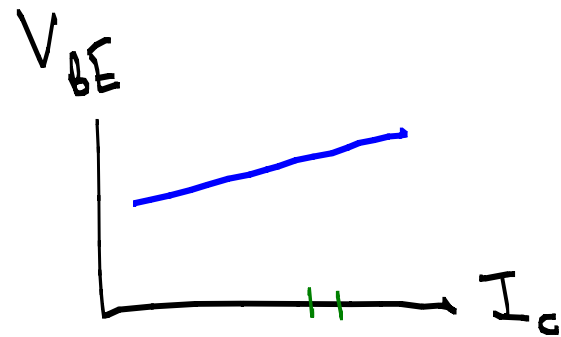
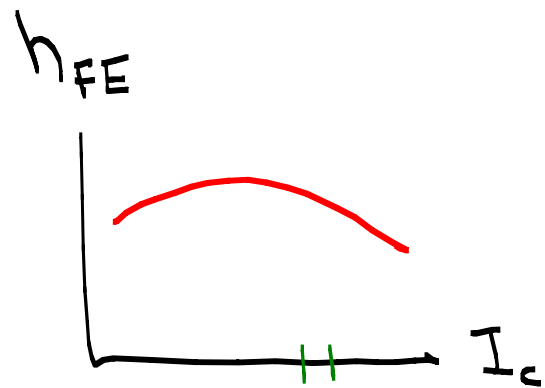
★ R must be small enough to deliver ...

①

②



2N4401 worst-case parameters



h_{FE}

MIN

5.7

$(I_C = 0.1 \text{ mA}, V_{CE} = 1.0 \text{ V})$	20
$(I_C = 1.0 \text{ mA}, V_{CE} = 1.0 \text{ V})$	40
$(I_C = 10 \text{ mA}, V_{CE} = 1.0 \text{ V})$	80
$(I_C = 150 \text{ mA}, V_{CE} = 1.0 \text{ V})$	100
$(I_C = 500 \text{ mA}, V_{CE} = 2.0 \text{ V})$	40

Collector-Emitter Saturation Voltage	$I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$		0.4	V
	$I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$		0.75	V

MAX

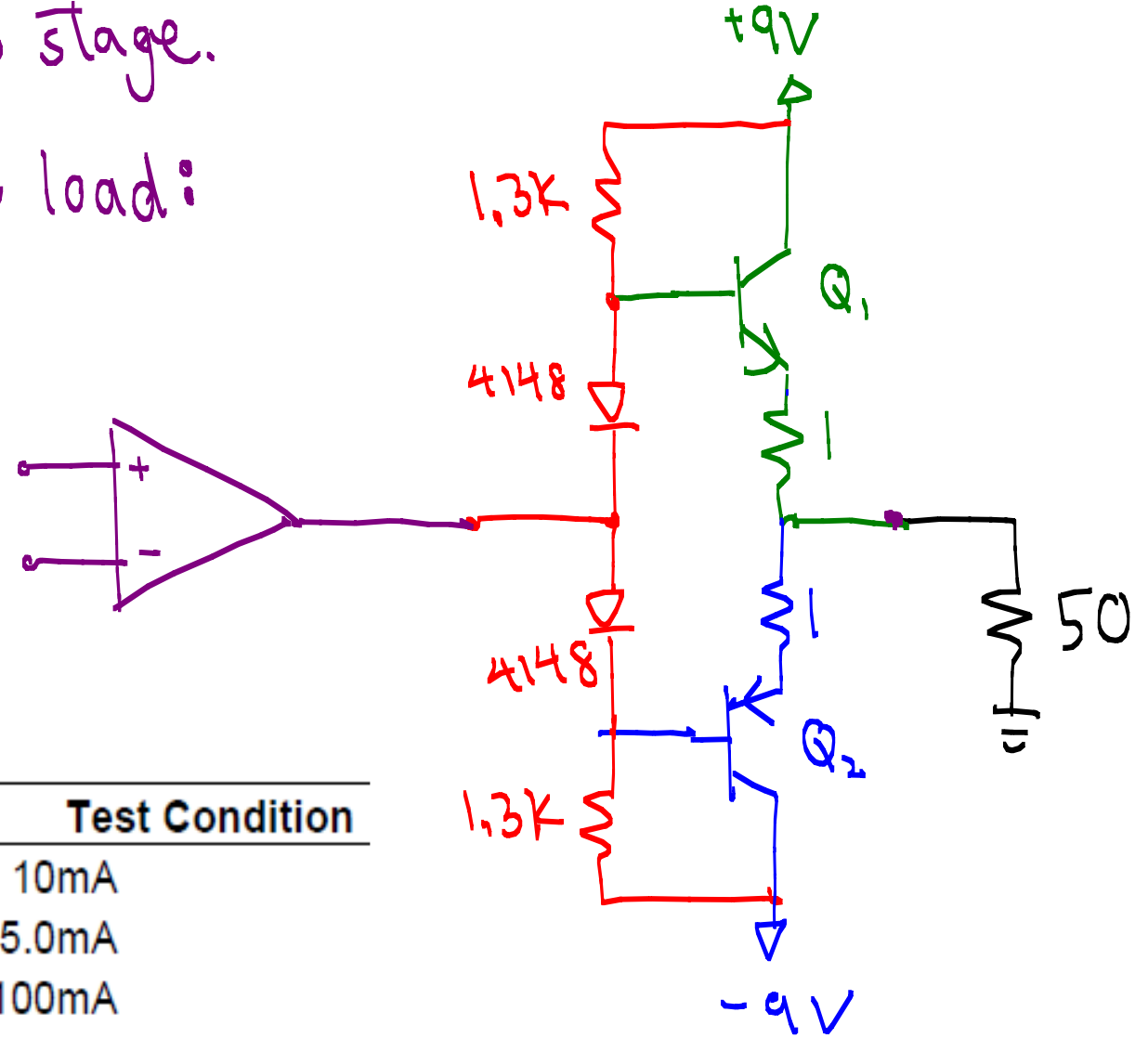
Base-Emitter Saturation Voltage	$I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$	0.75	0.95	V
	$I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$		1.2	V

MAX

- op amp must be able to provide enough voltage and current to the Class AB stage.

Need to estimate for max output to load:

① V_o

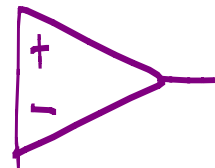
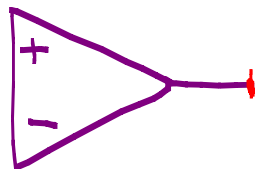
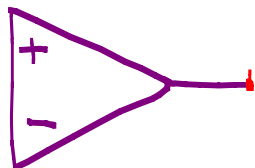


IN4148 data sheet

Min	Max	Unit	Test Condition
—	1.0	V	$I_F = 10\text{mA}$
0.62	0.72		$I_F = 5.0\text{mA}$
—	1.0		$I_F = 100\text{mA}$

② i_o

AC
Equivalent
circuit



$$R_{in} = \infty$$

Q: When $V_{cc} = \pm 9V$, can the op amp produce _____ ?

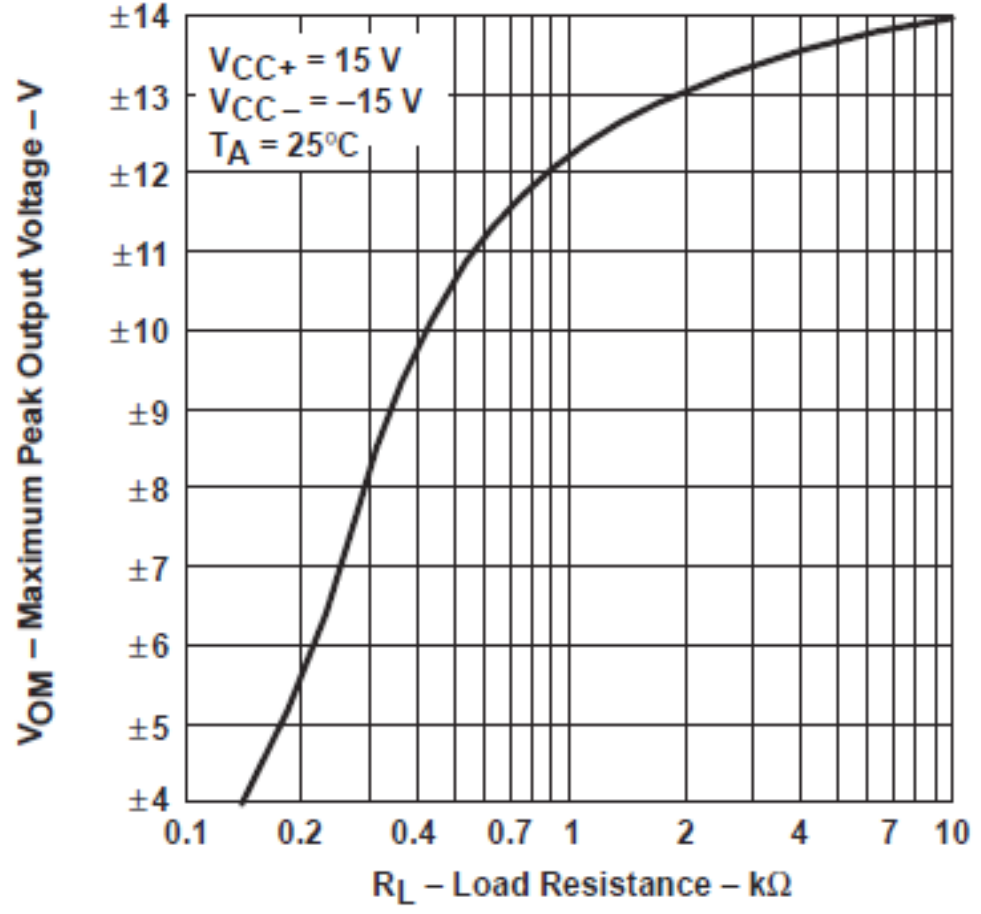
using the 741 op amp as an example

At $V_{cc} = 15V$,

max $V_o =$

MAXIMUM PEAK OUTPUT VOLTAGE

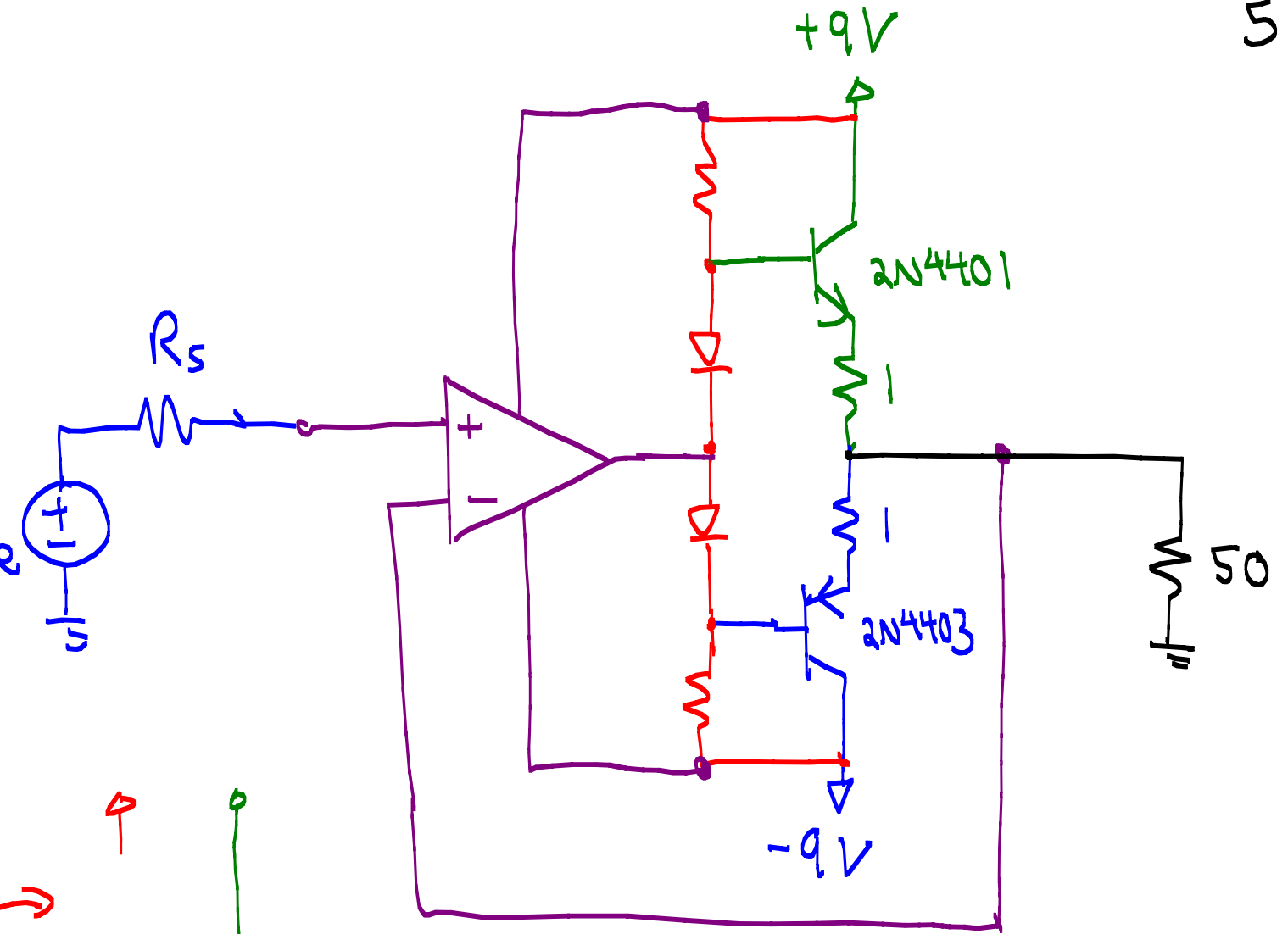
VS
LOAD RESISTANCE



• SO, our final design is:

- Good idea to simulate the circuit to confirm proper operation

5V_p
sine wave



NOTE: Better to use a to
bias a Class AB stage

