EE 40

Lecture 26

Analyzing Linear/Nonlinear/Digital Circuits

In the last few lectures, we will **combine** our tools from linear circuit analysis, amplifier design, nonlinear circuit analysis (transistors and diodes) and digital circuits.

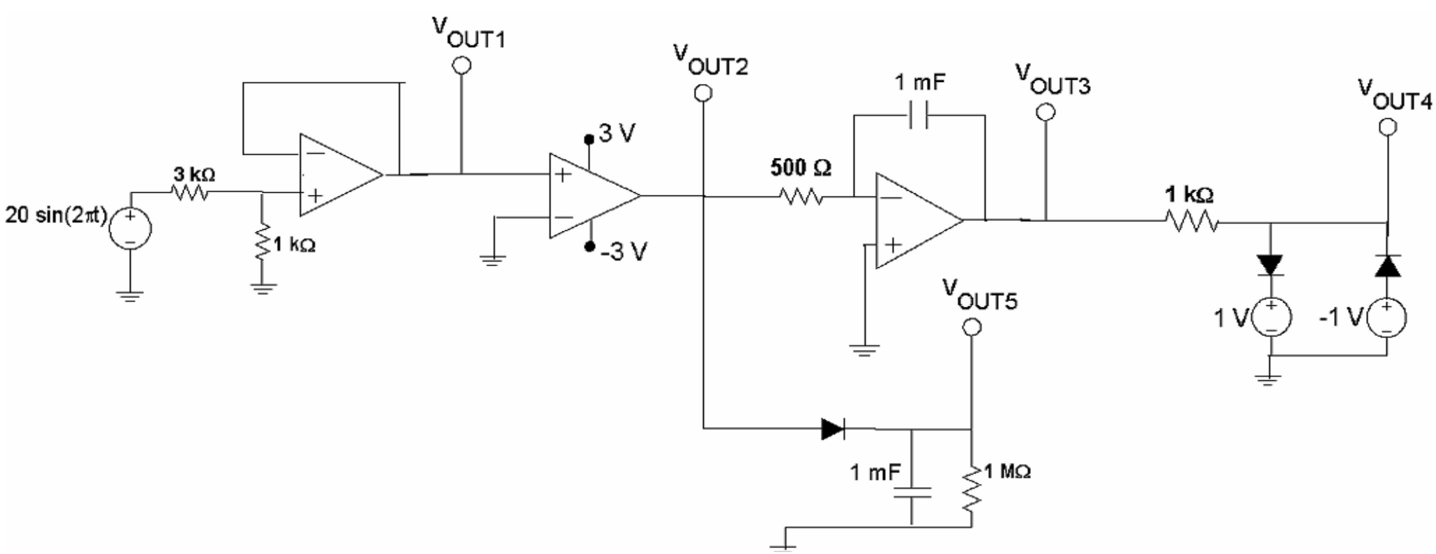
Today, we will analyze larger circuits incorporating all of these elements.

Outline for the next few lectures:

Lecture 26	April 29	Analyzing Linear/Nonlinear/Digital Circuits
Lecture 27	May 1	Linearization of a Transistor: The Small-Signal Model
Lecture 28	May 6	Circuit Analysis Using Spice
Lecture 29	May 8	Fun Designs
Lecture 30	May 13	Mathematical Issues in Circuit Analysis

We will analyze circuits from last semester's "killer" final exam (which, as you will see, was really not so "killer").

<u>Circuit 1</u>:



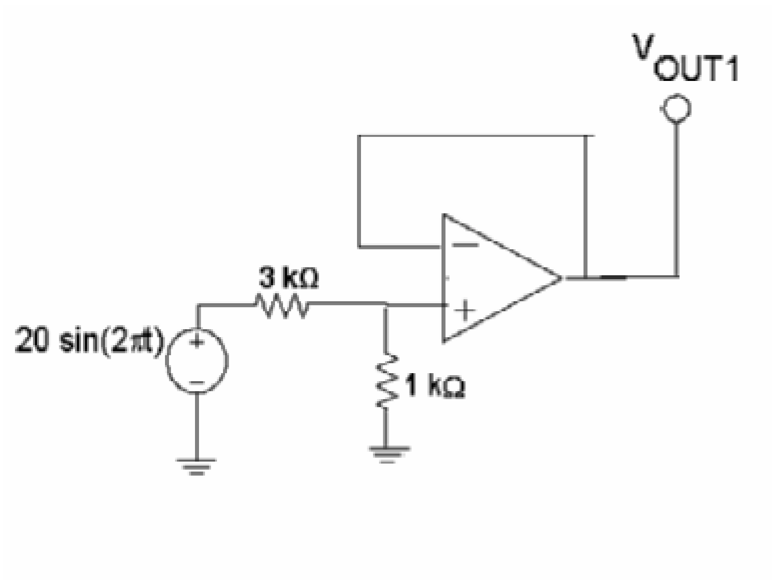
We can analyze this circuit in parts.

First, we see what V_{OUT1} is: how the first section of the circuit transforms 20 sin(2πt).

Then, we analyze the second part of the circuit: what does this section do to V_{OUT1} to get V_{OUT2}?

It would be great if we could recognize the basic function that each section performs.

Circuit 1, Part 1:

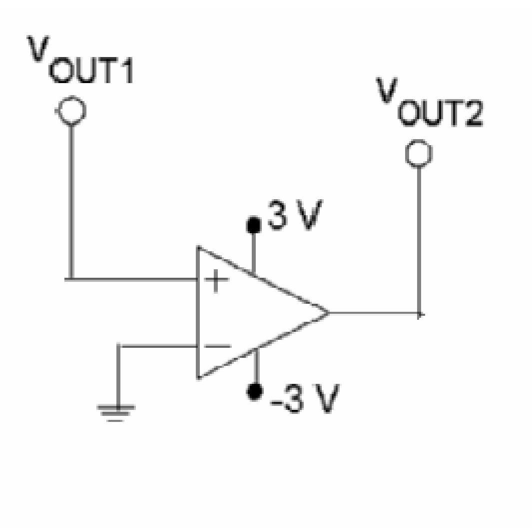


What kind of circuit is this?

What is $V_{OUT1}(t)$?

Sketch V_{OUT1} and 20 sin(2πt).

Circuit 1, Part 2:

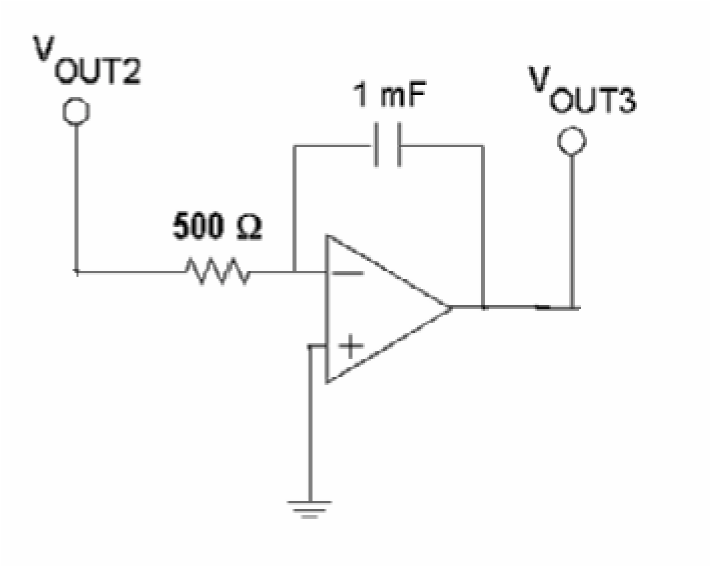


What kind of circuit is this?

What is $V_{OUT2}(t)$ in terms of $V_{OUT1}(t)$?

Sketch V_{OUT2} and V_{OUT1}.

Circuit 1, Part 3:

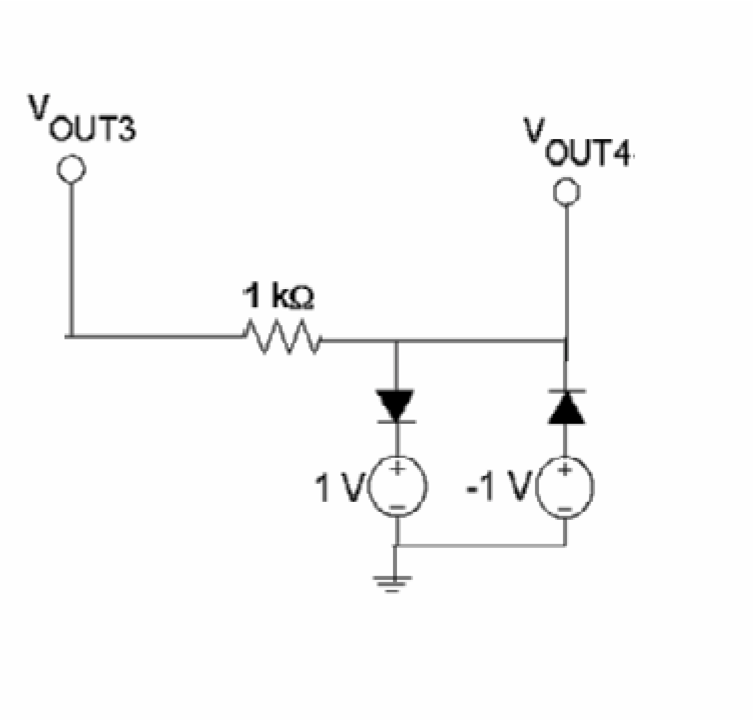


What kind of circuit is this?

What is $V_{OUT3}(t)$ in terms of $V_{OUT2}(t)$?

Sketch V_{OUT3} and V_{OUT2}.

Circuit 1, Part 4:

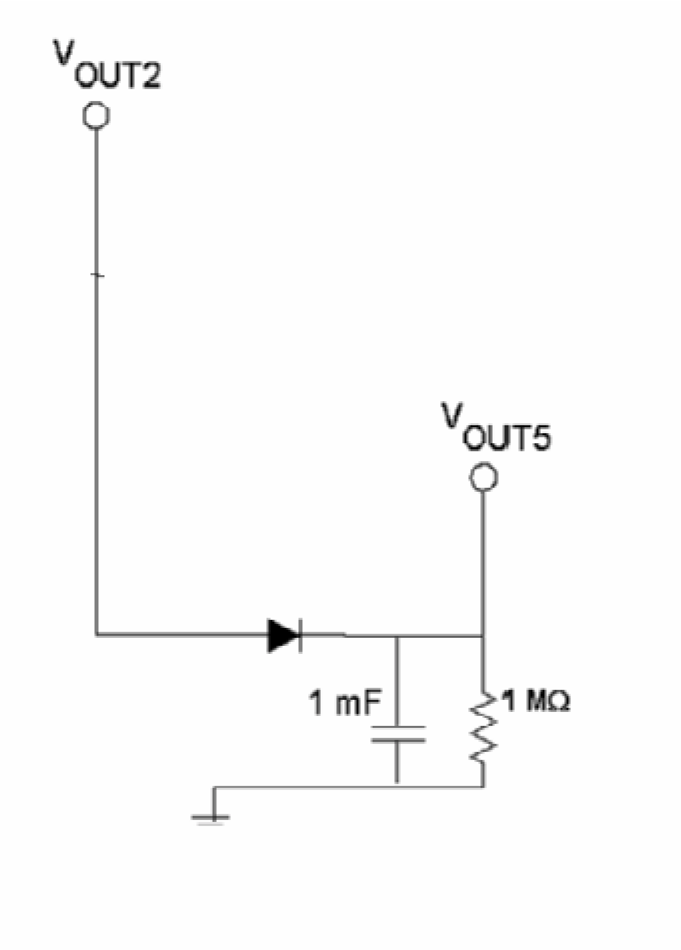


What kind of circuit is this?

What is $V_{OUT4}(t)$ in terms of $V_{OUT2}(t)$?

Sketch V_{OUT4} and V_{OUT3}.

Circuit 1, Part 5:

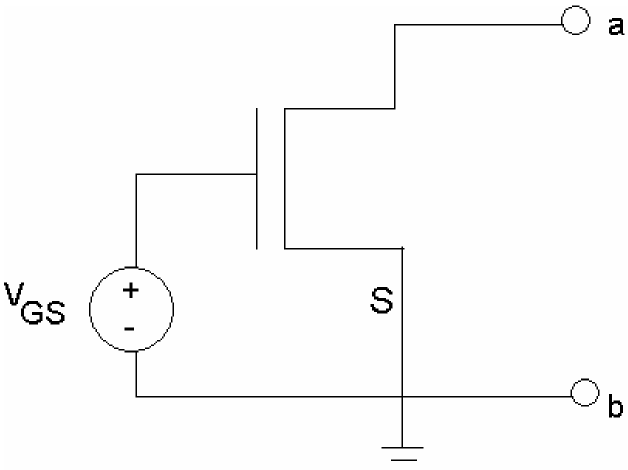


What kind of circuit is this?

What is $V_{OUT5}(t)$ in terms of $V_{OUT2}(t)$?

Sketch V_{OUT2} and V_{OUT5}.

Circuit 2a:

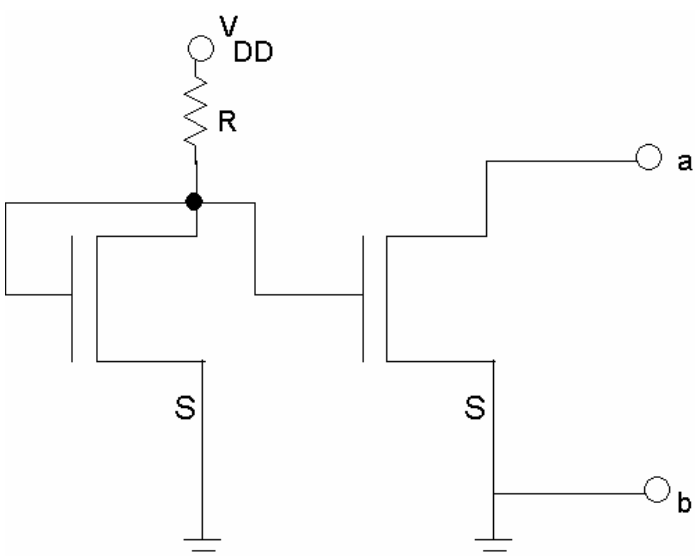


When the transistor is in saturation mode, there is an equivalent linear circuit for this nonlinear circuit with respect to terminals a and b.

What is the equivalent linear circuit ($\lambda = 0$)?

What is the equivalent linear circuit if nonzero λ is taken into account?

Circuit 2b:



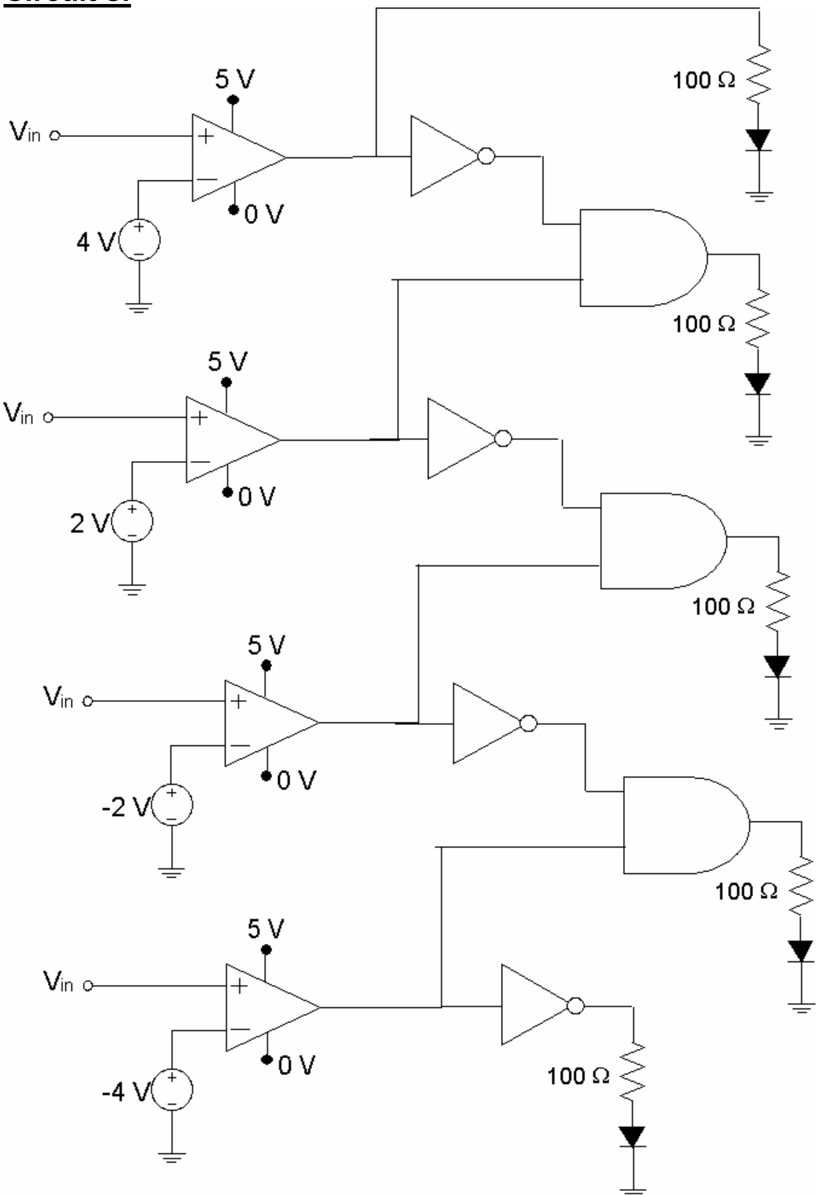
Consider the behavior of the following modified circuit, with the transistor on the right in saturation mode.

What is the equivalent linear circuit with $\lambda = 0$ for the transistor on the right?

What is the equivalent linear circuit if nonzero λ is taken into account?

Suppose operating temperatures increase. What advantage does Circuit 2b have?

Circuit 3:



Suppose V_{in} = 10 sin(t). What does this circuit do?

With V_F = 2 V for each diode, what is the diode current when a diode is on?