

3. Design and Troubleshooting of Clippers and Clampers

Course: ECE1008 – Electronic Hardware Troubleshooting LAB

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VIT[®]
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)
CHENNAI

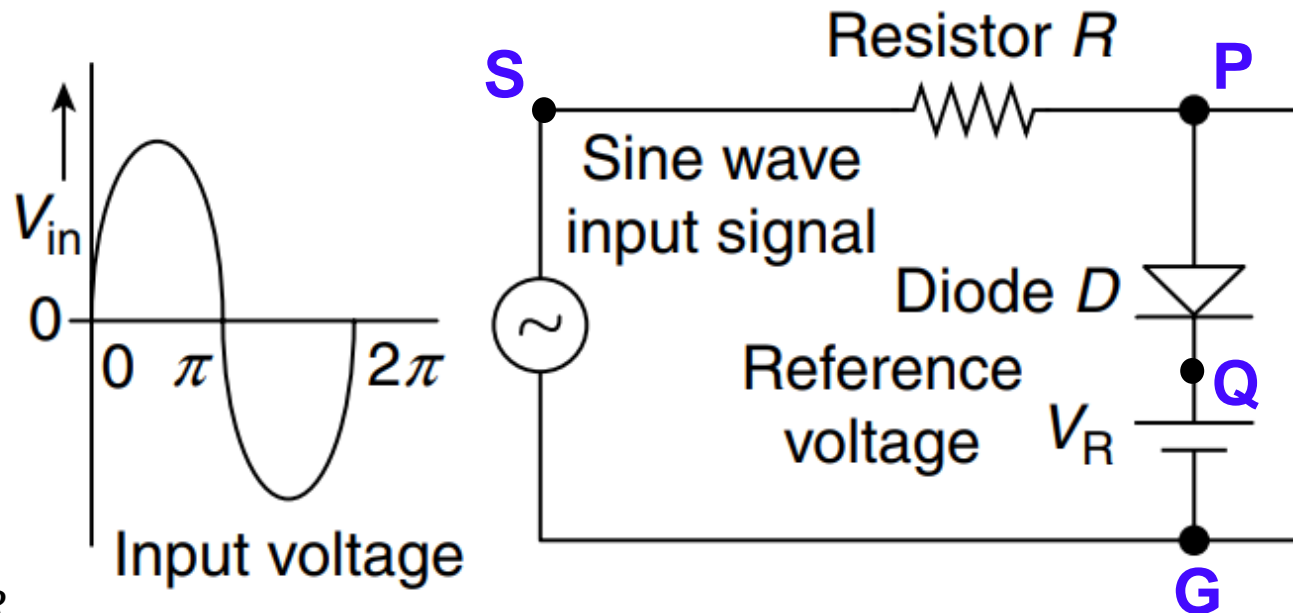


1. Introduction to Clippers

- Circuit designed to prevent a signal from exceeding a predetermined reference voltage level



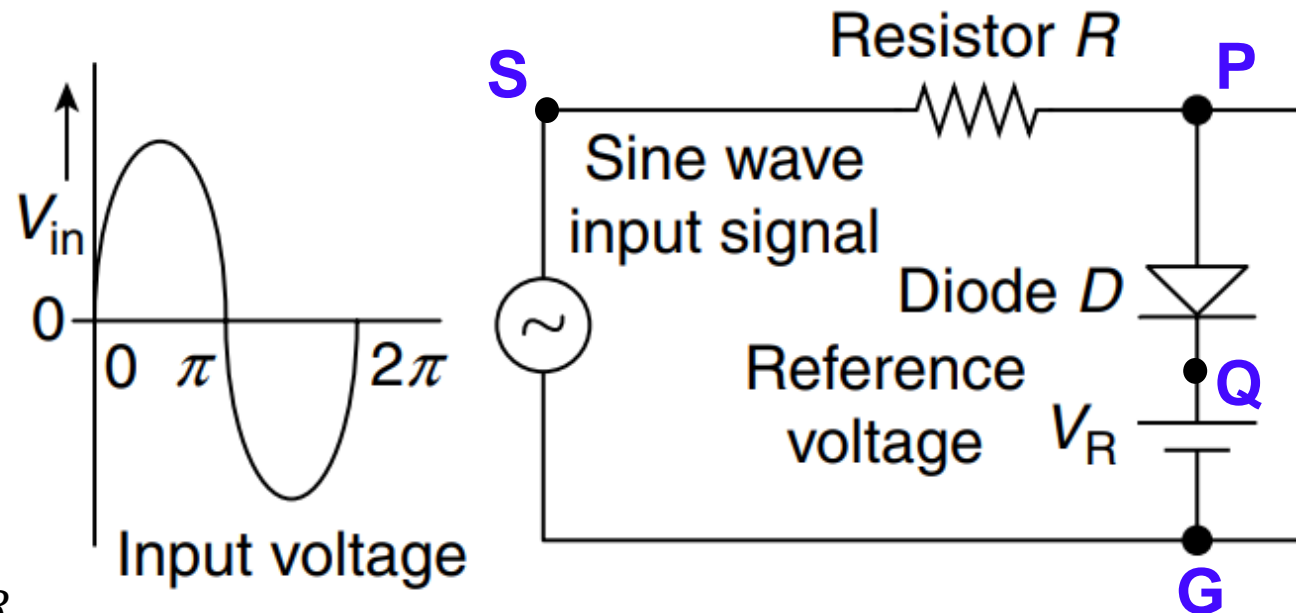
2. General Positive clipper circuit



$$V_{SQ} = V_{in} - V_R$$

When will the diode be forward biased?

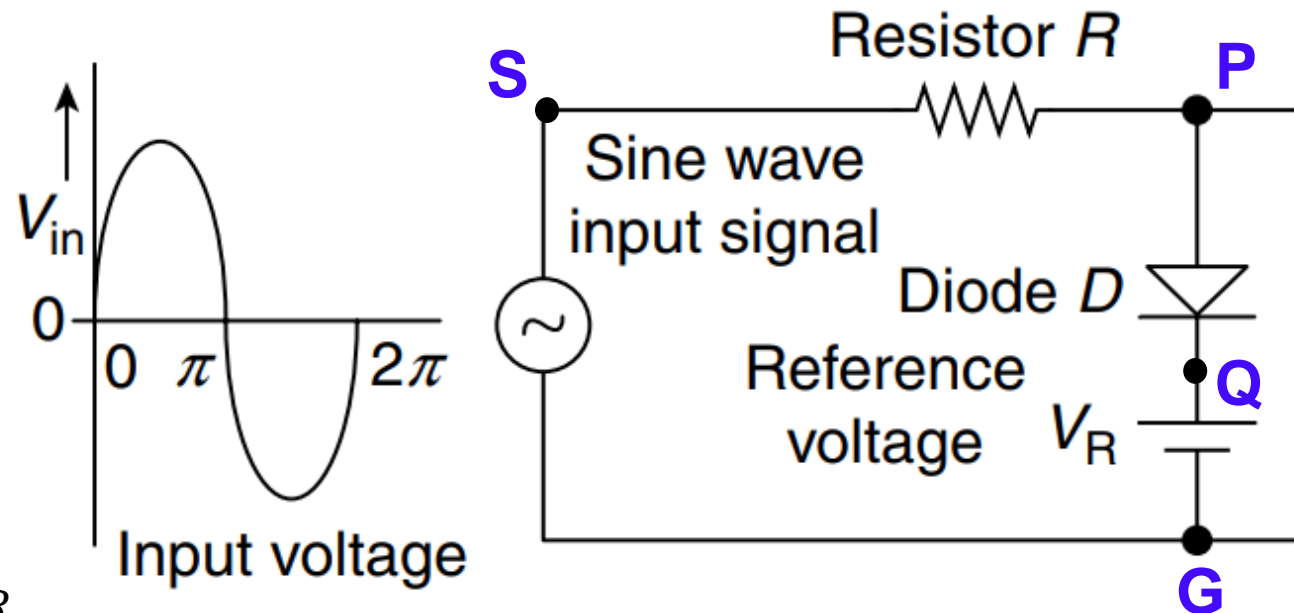
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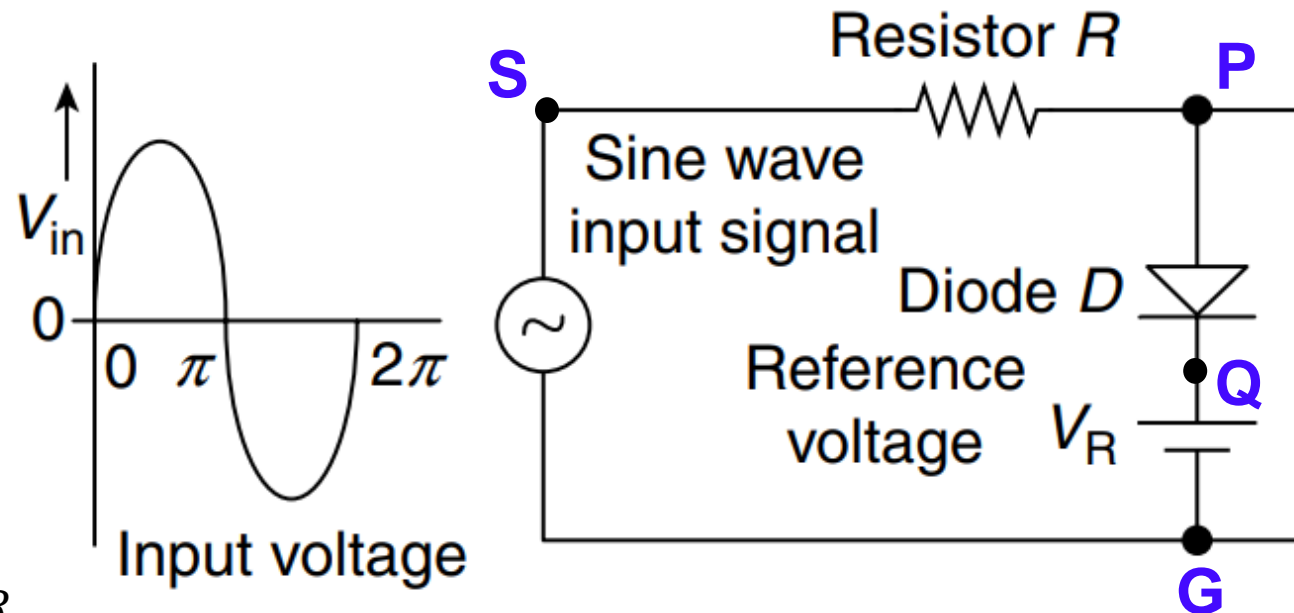


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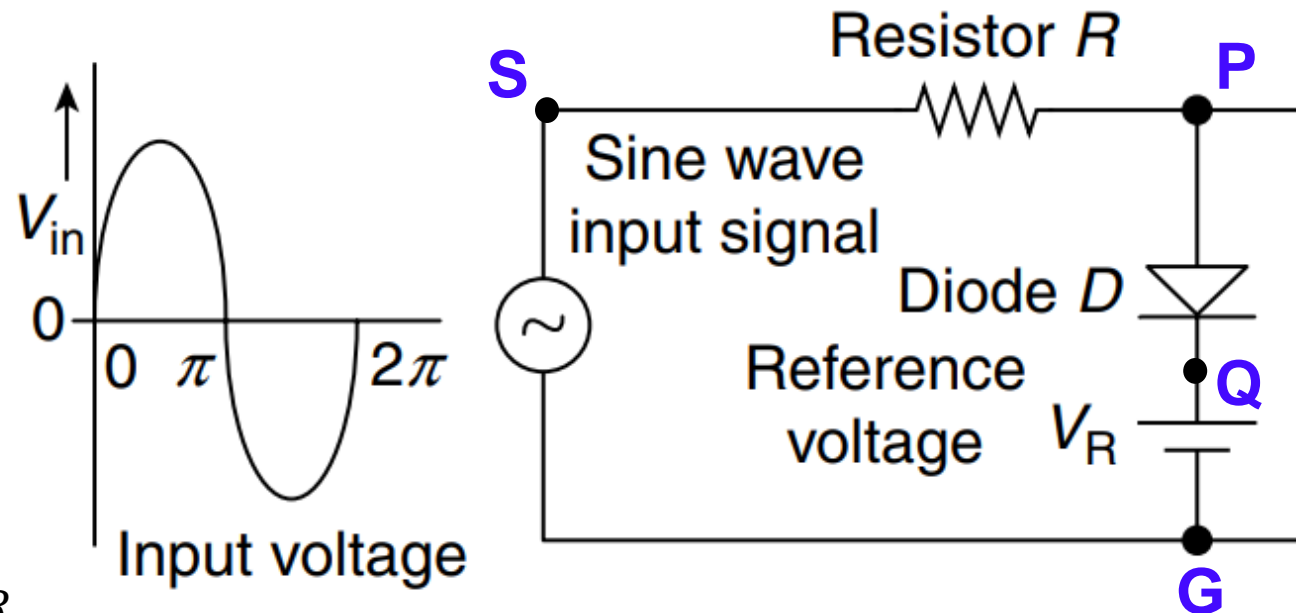


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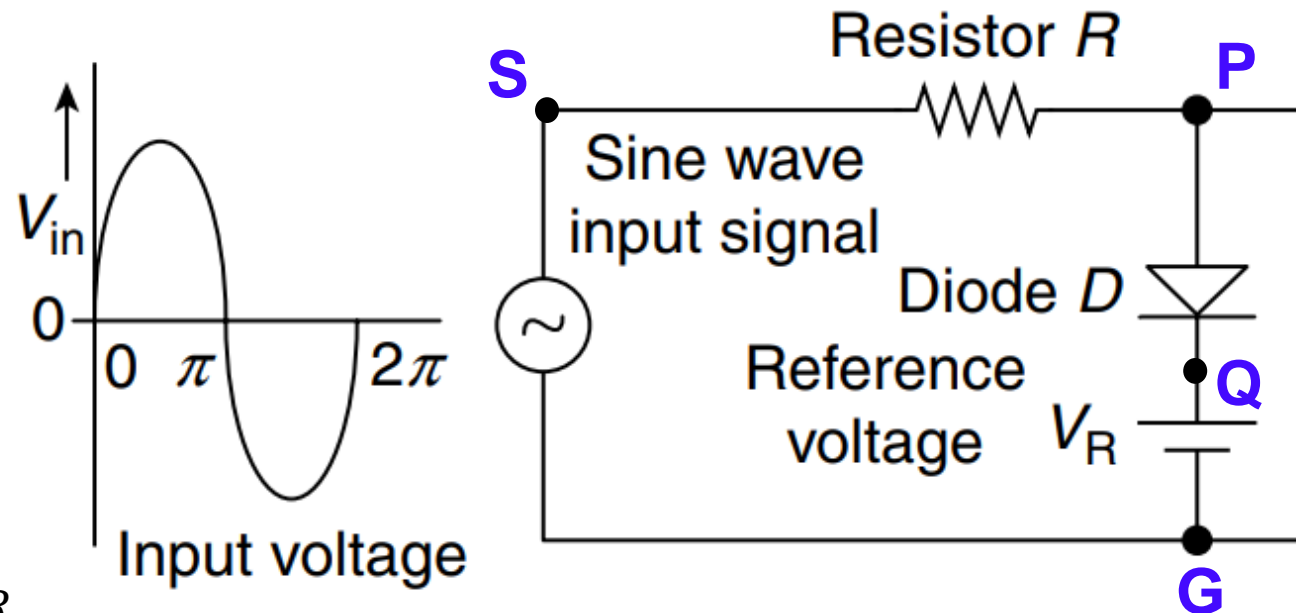
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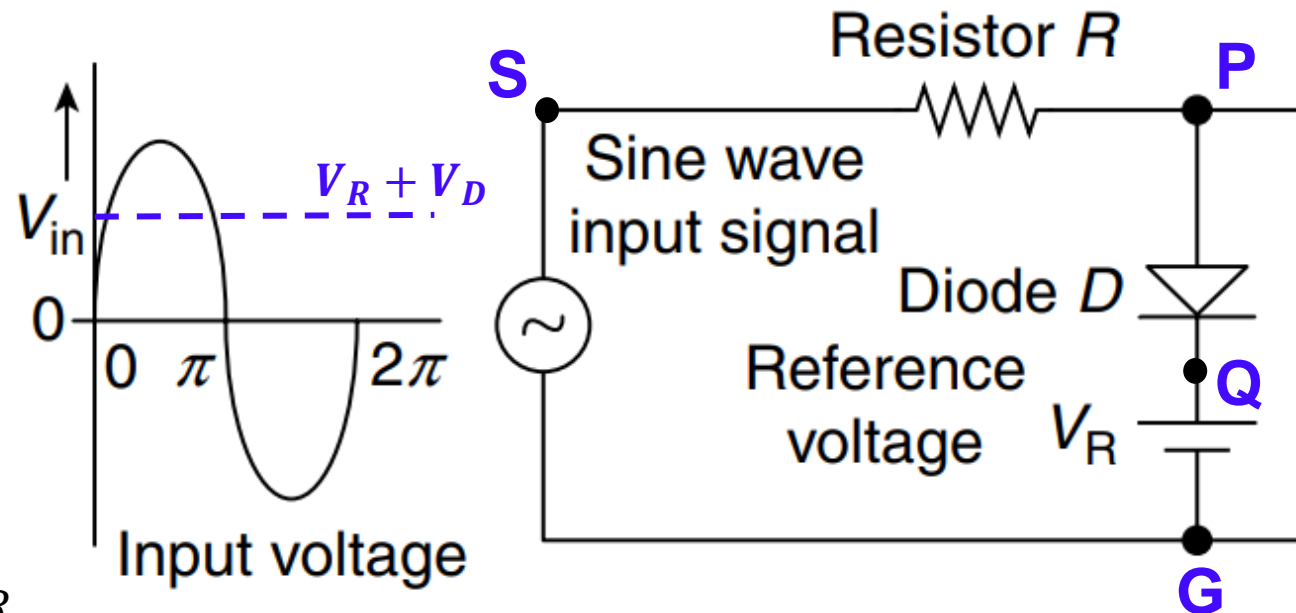
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 $= V_{in}$



2. General Positive clipper circuit



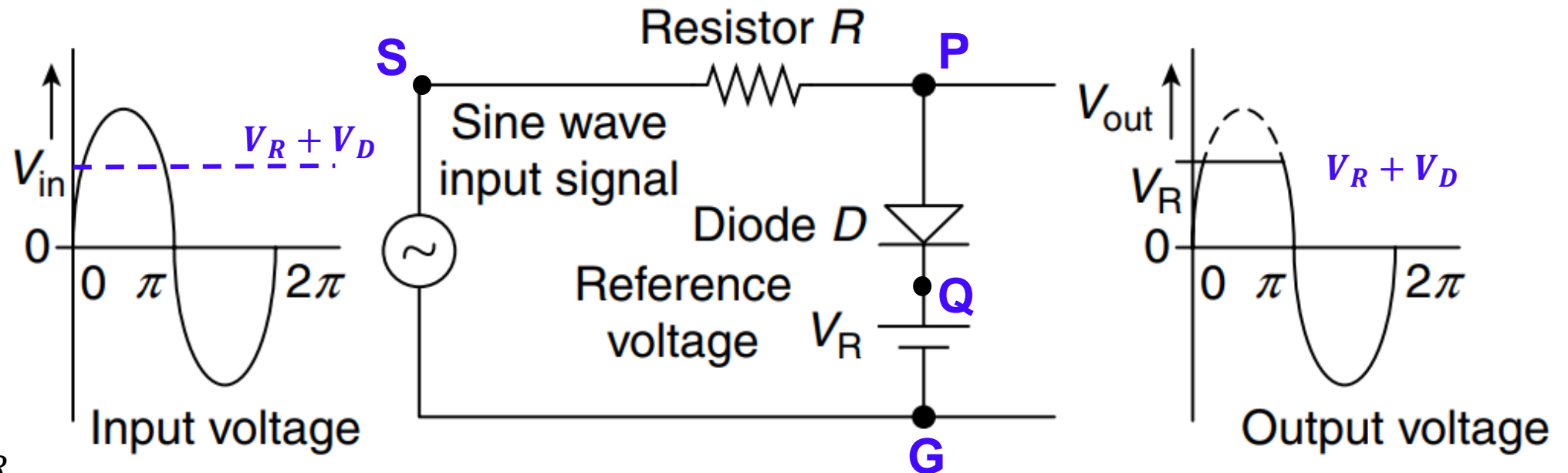
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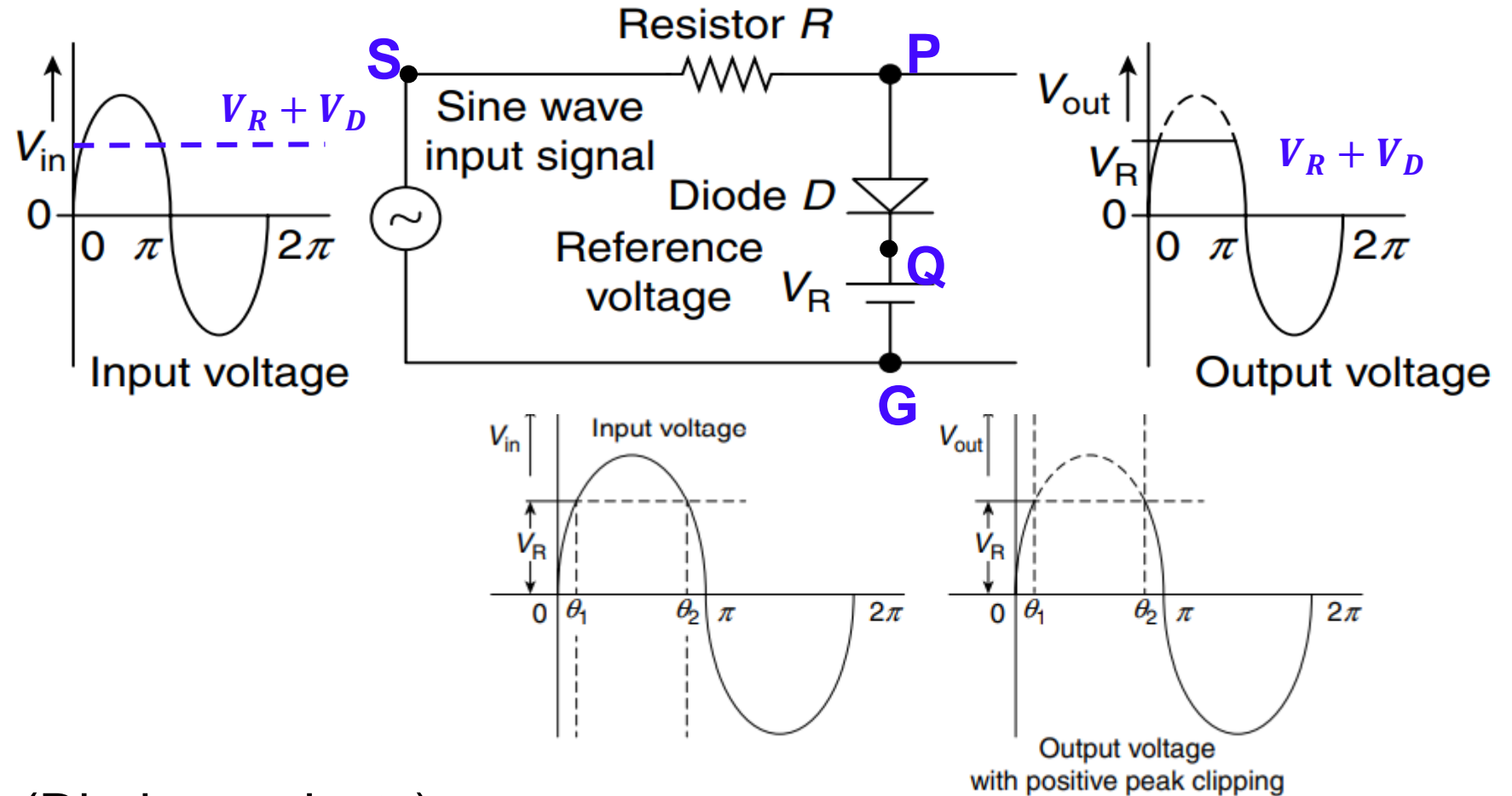
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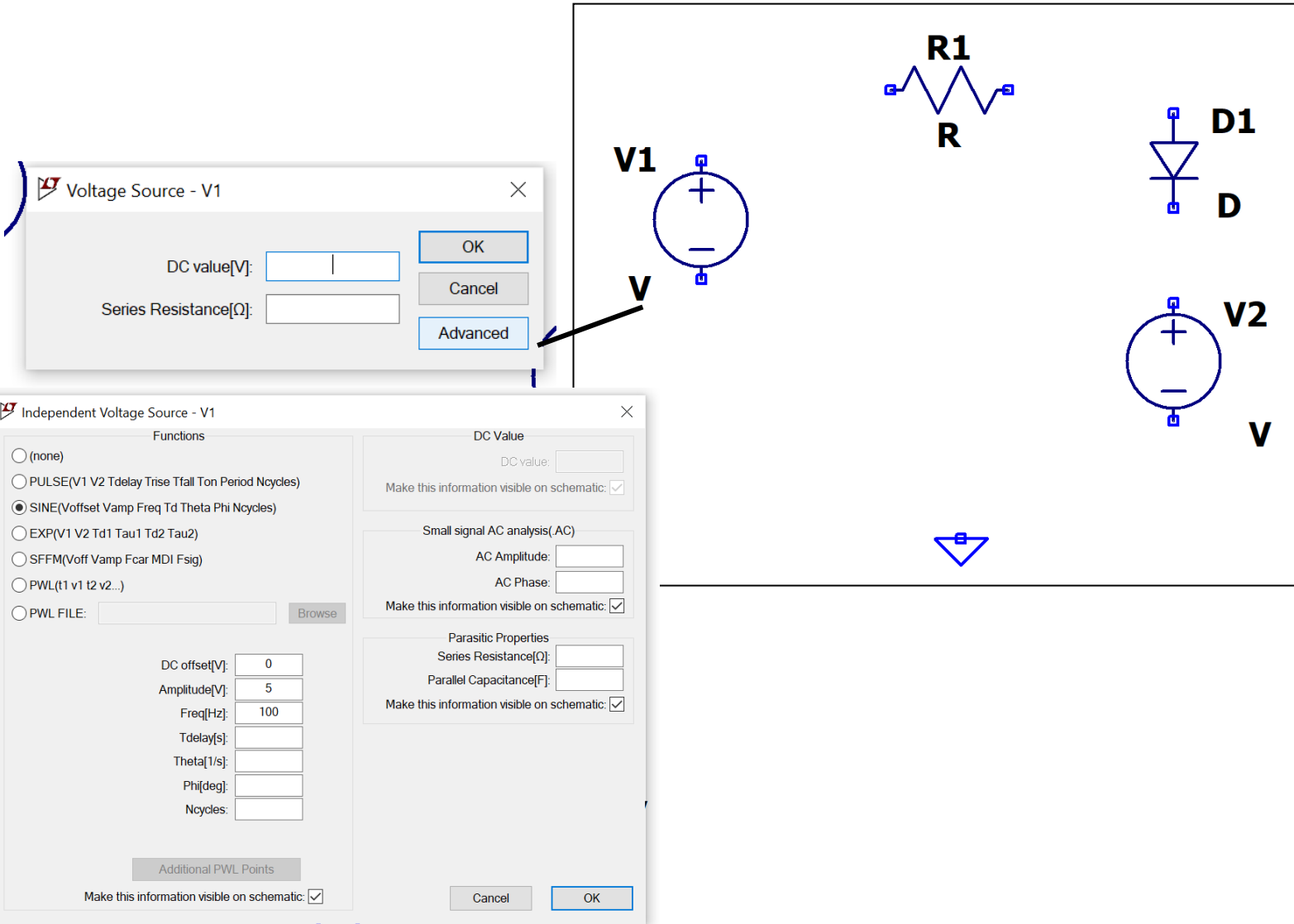


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- In diode forward bias: (Diode conducts)
- $V_{in} > V_R + V_D$ $V_{out} = V_D + V_R$
- In diode reverse bias ($I = 0$)
- $V_{in} < V_R + V_D$ $V_{out} = V_{in}$

2.2 Steps in LT Spice



2.2 Steps in LT Spice

The screenshot displays the LT Spice software interface with a circuit diagram and three open dialog boxes.

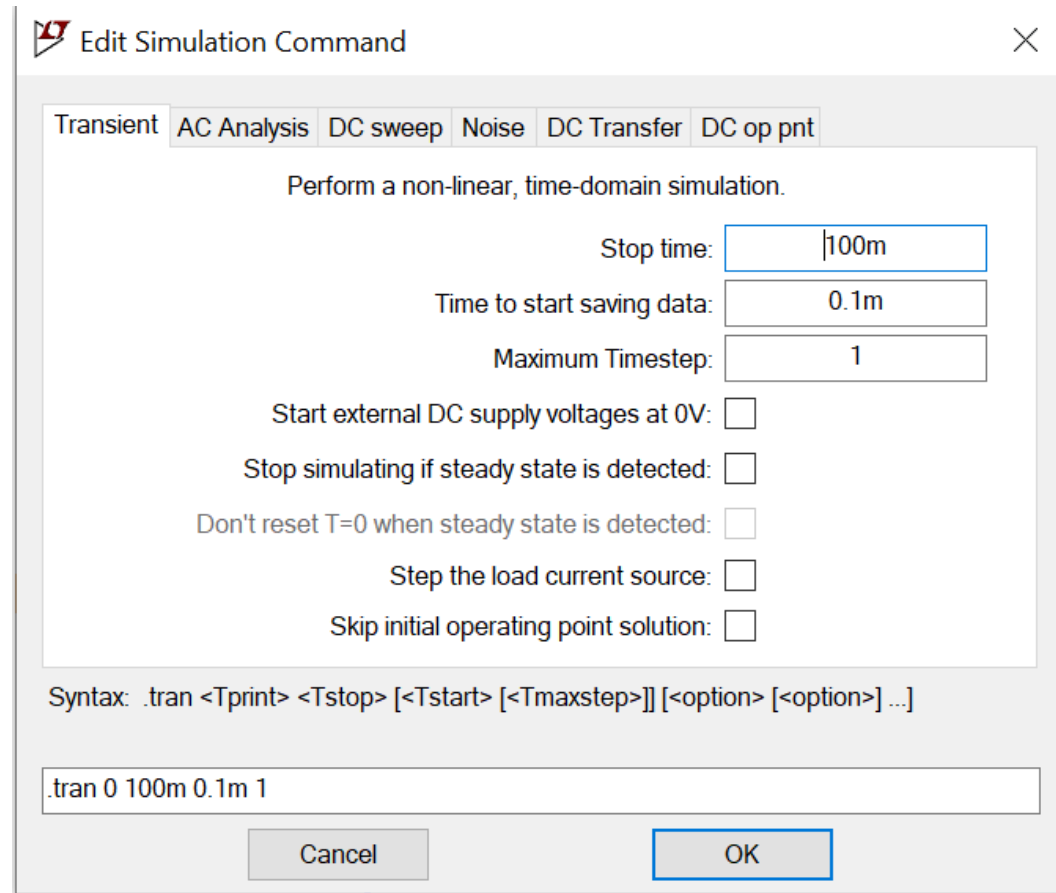
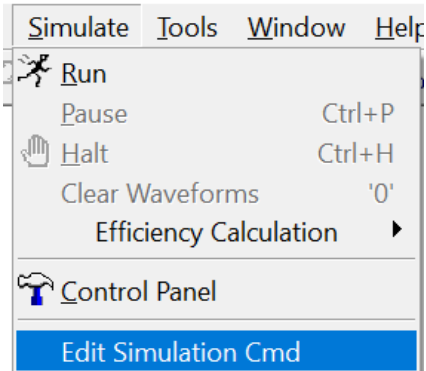
Circuit Diagram: The circuit includes a voltage source **V1**, a resistor **R1** (labeled **R**), a diode **D1** (labeled **D**), and another voltage source **V2** (labeled **V**). A ground symbol is also present.

Voltage Source - V1 Dialog: This dialog box is open for the voltage source **V1**. It shows the **DC value[V]:** field and the **Series Resistance[Ω]:** field. The **Advanced** button is highlighted.

Independent Voltage Source - V1 Dialog: This dialog box is open for the independent voltage source **V1**. It shows the **Functions** section with **SINE(Voffset Vamp Freq Td Theta Phi Ncycles)** selected. The **DC Value** section shows **DC value:** and **Make this information visible on schematic:** (checked). The **Small signal AC analysis(AC)** section shows **AC Amplitude:** and **AC Phase:** fields, with **Make this information visible on schematic:** (checked). The **Parasitic Properties** section shows **Series Resistance[Ω]:** and **Parallel Capacitance[F]:** fields, with **Make this information visible on schematic:** (checked). The **Additional PWL Points** button is also visible.

Diode - D1 Dialog: This dialog box is open for the diode **D1**. It shows the **Diode Properties** section with the following values: **Diode:** 1N914, **Manufacturer:** OnSemi, **Type:** silicon, **Average Forward Current[A]:** 0.2, and **Breakdown Voltage[V]:** 75. The **Pick New Diode** button is highlighted.

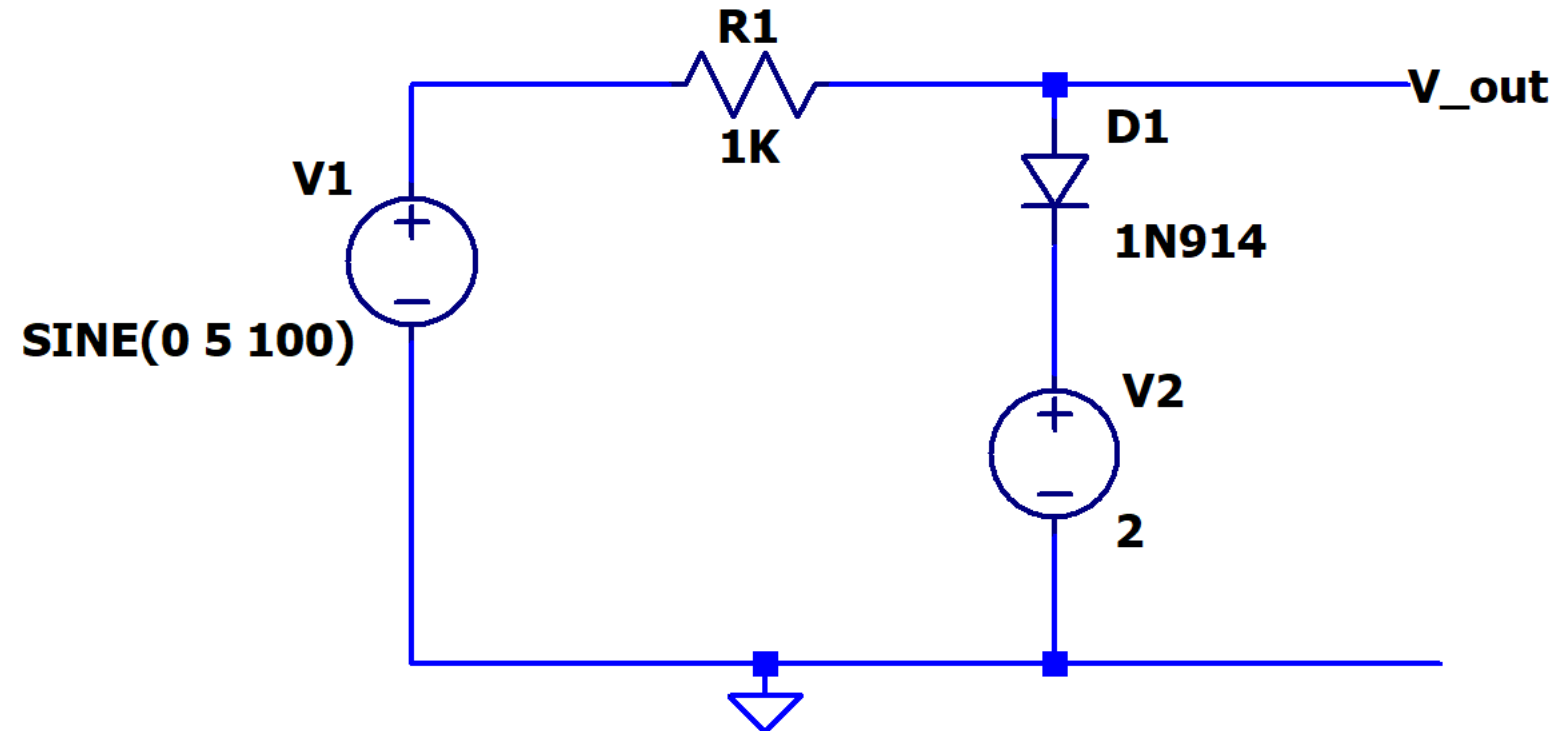
2.2 Steps in LT Spice



.tran 0 100m 0.1m 1

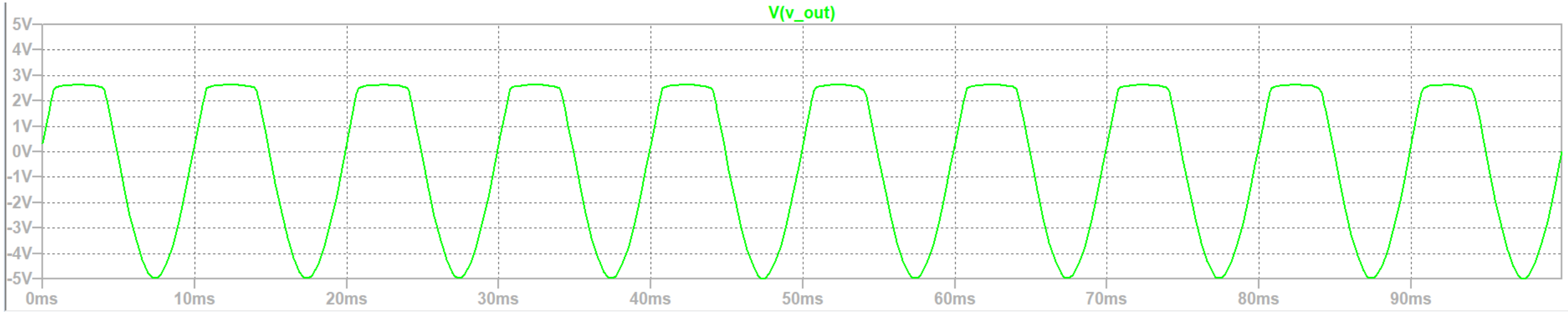
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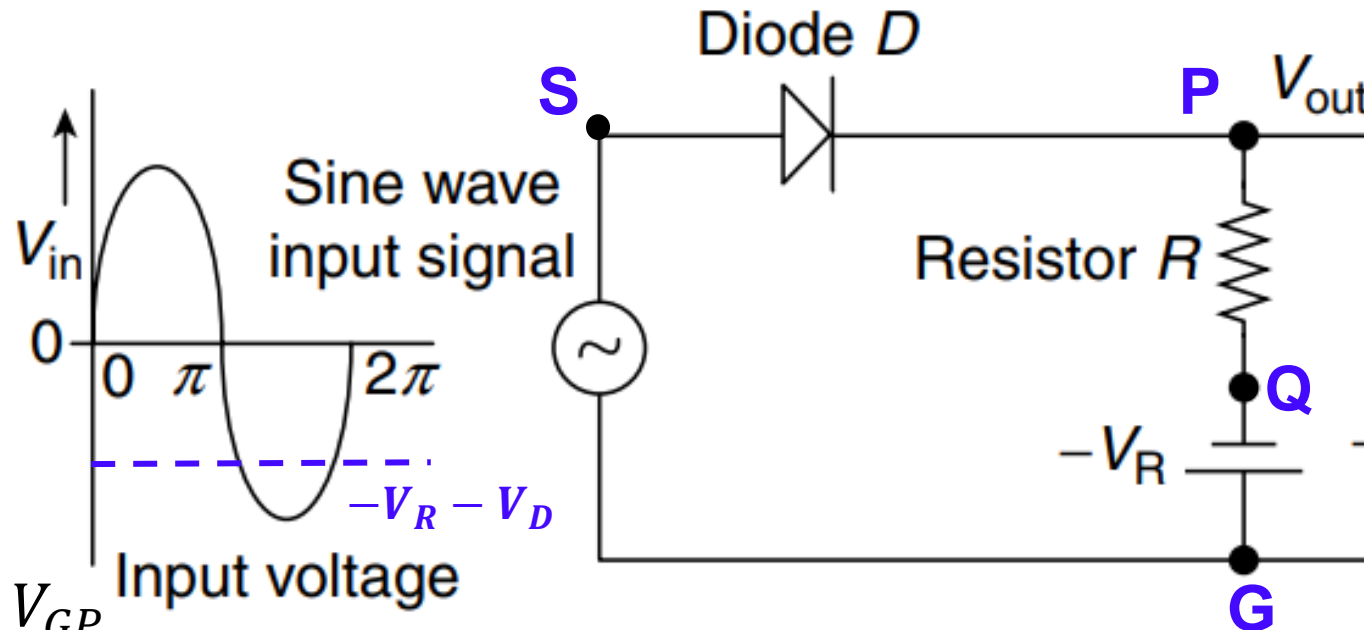


2.2 Steps in LT Spice

- Output:



3. General Negative clipper circuit



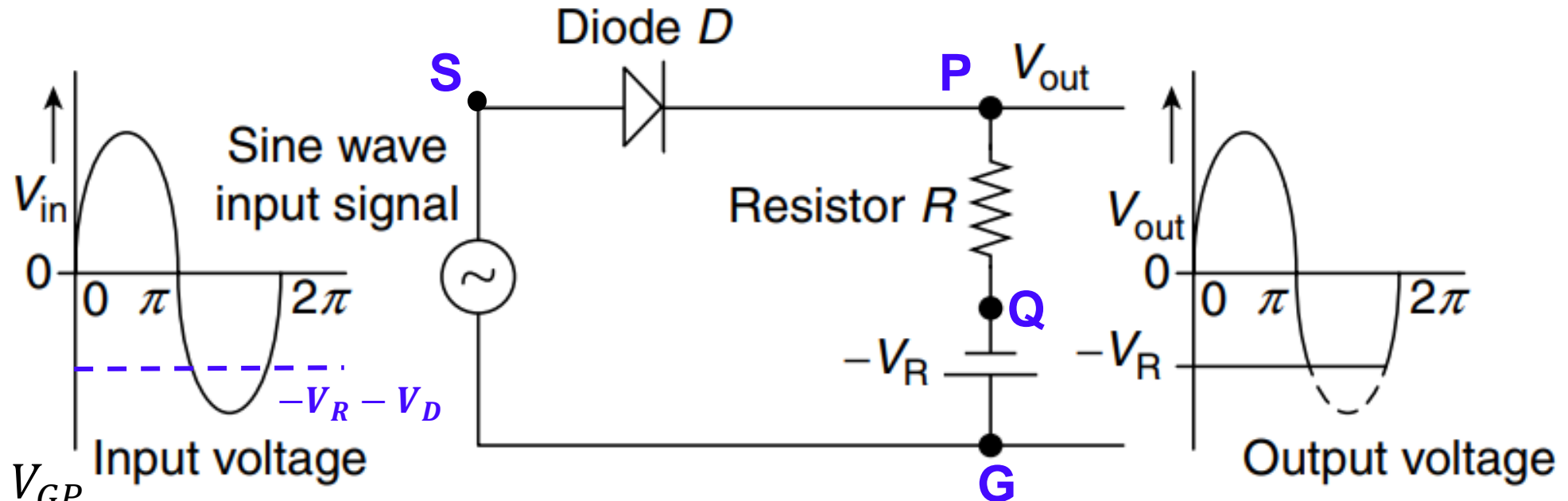
$$V_{SQ} = V_{in} + V_{GP}$$

When will the diode be forward biased? $V_{SQ} > V_D$

- In diode forward bias: (Diode conducts)
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- $V_{out} = V_{PS} + V_{SG}$
 $= -V_D + V_{in}$
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4. About Clampers

- **Clamper circuit:** A Circuit that fixes the positive or negative peaks of a signal (generally sine or square waves) at a required voltage level.
- A prescribed level of DC voltage is introduced at the output of the clamper circuit.



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- **Clamper circuit:** A Circuit that fixes the positive or negative peaks of a signal (generally sine or square waves) at a required voltage level.
- A prescribed level of DC voltage is introduced at the output of the clamper circuit.
- The DC voltage may be +ve or –ve
- Two types of clamping circuits: 1) Negative clamping circuit, and 2) Positive clamping circuit



5. Why do you need clamping circuits

- A signal that passes through a capacitive coupling (capacitor allows high frequency signals only), the DC component is lost.



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- A signal that passes through a capacitive coupling (capacitor allows high frequency signals only), the DC component is lost.
- To restore the DC component, Clamping circuits is necessary
- Other names of Clamper: DC Restorer, DC Reinsertor, Baseline stabilizer

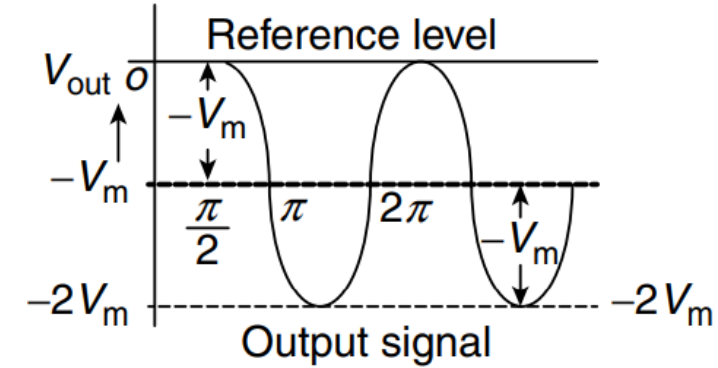
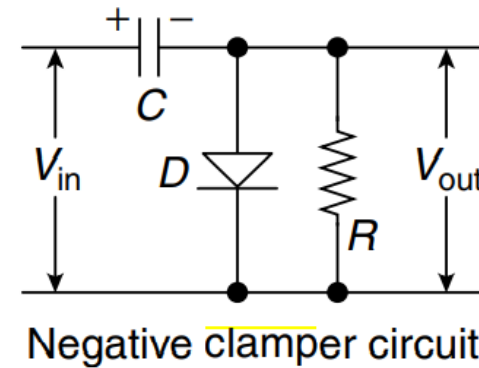
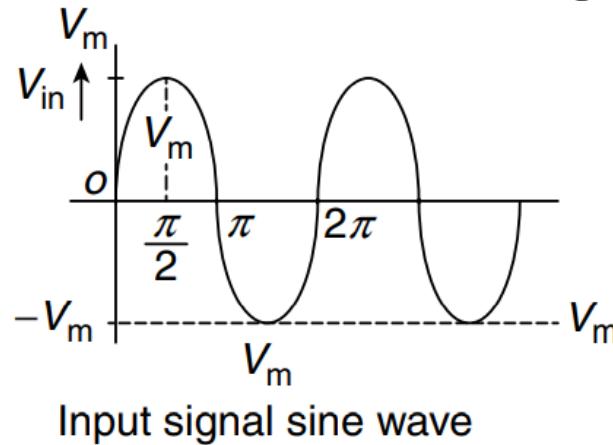


6.1 Negative clamping circuit: Basics

V_{in} Sinusoidal input
with zero DC level

- Output: V_{out}

Output DC level: $-V_m$

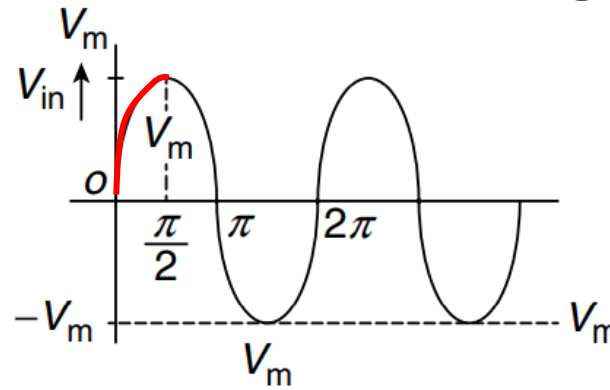


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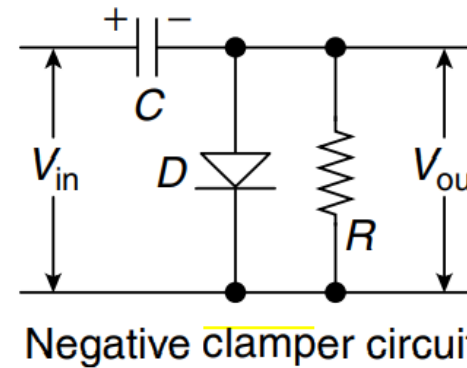
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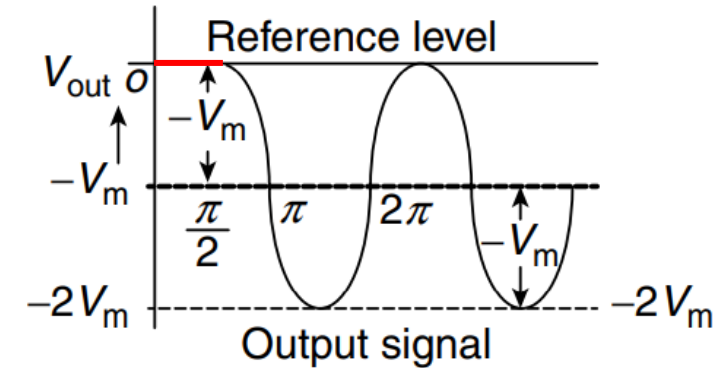
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Input signal sine wave



Negative clamper circuit



Output signal

1) Consider uncharged capacitor during the start $t = 0$.

When input is applied, V_c does not change instantaneously (Takes time to charge).

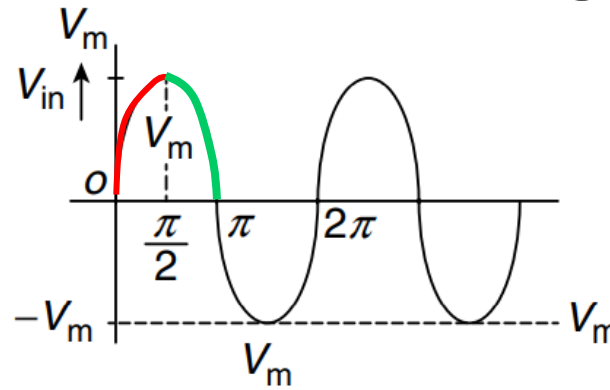
Semiconductor diode is forward biased in $t = 0$ to $\frac{\pi}{2}$: Complete input voltage V_{in} is across the capacitor, and capacitor is charged upto ($V_c = V_m$) and $V_{out} = 0$.

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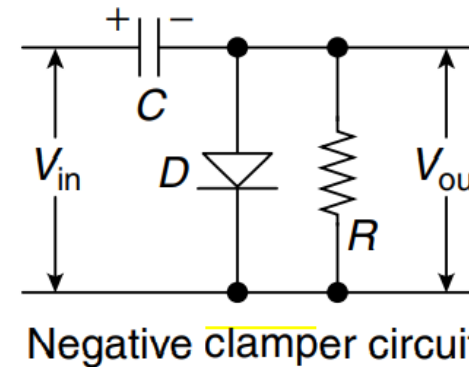
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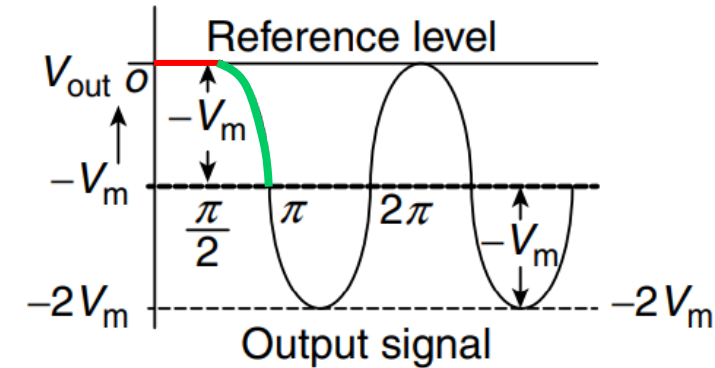
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Input signal sine wave



Negative clamper circuit



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Semiconductor diode is forward biased in $t = 0$ to $\frac{\pi}{2}$: Complete input voltage V_{in} is across the capacitor, and capacitor is charged upto ($V_c = V_m$) and $V_{out} = 0$.

2) At $t = \frac{\pi}{2}$ to $t = \pi$, When capacitor is charged $V_c = V_m$, Output voltage V_{out} which is across the diode is $V_{out} = -V_c + V_{in} = -V_m + V_{in}$

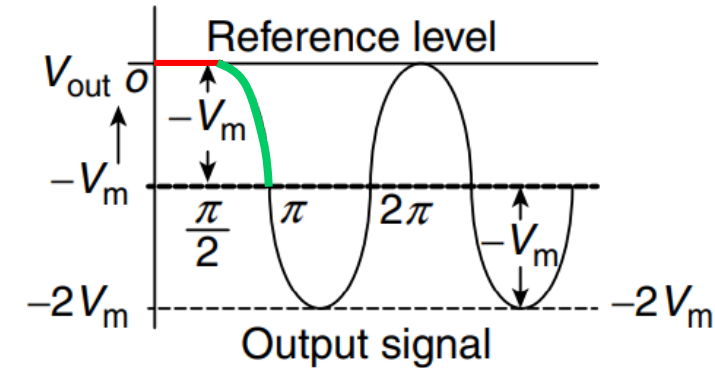
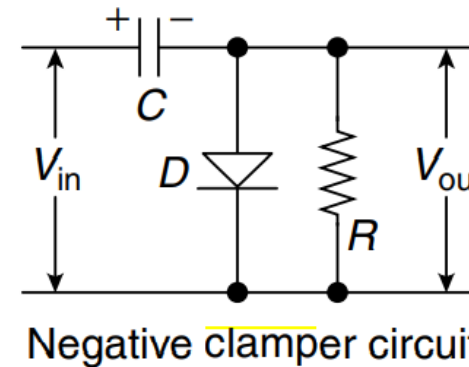
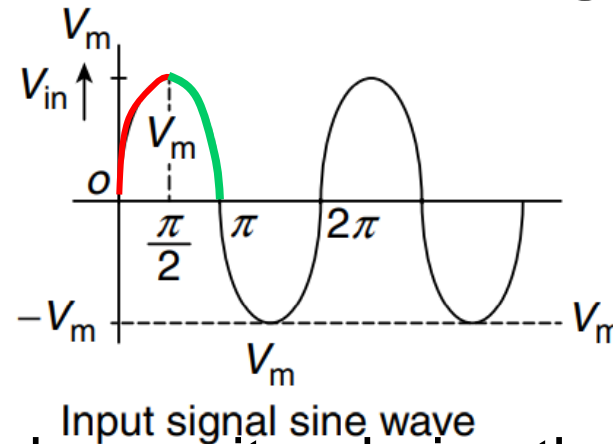


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• Output: V_{out}

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2) At $t = \frac{\pi}{2}$ to $t = \pi$, When capacitor is charged $V_c = V_m$, Output voltage V_{out} which is across the diode is $V_{out} = -V_c + V_{in} = -V_m + V_{in}$ Note: $V_{in} \leq V_m$ at all times. Then $V_{out} \leq 0$. Diode is reverse biased at all times.



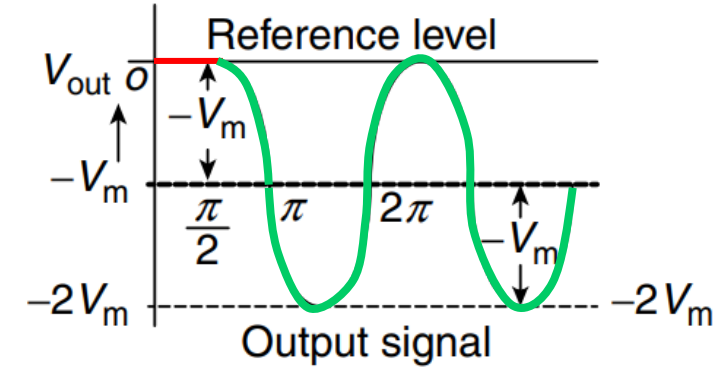
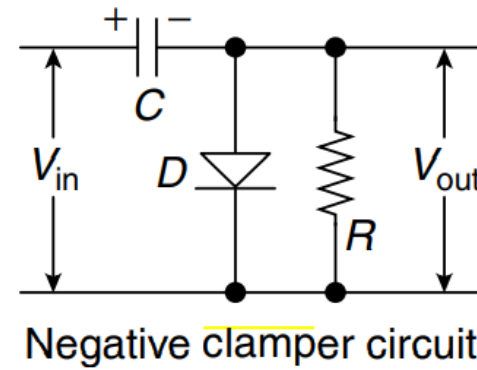
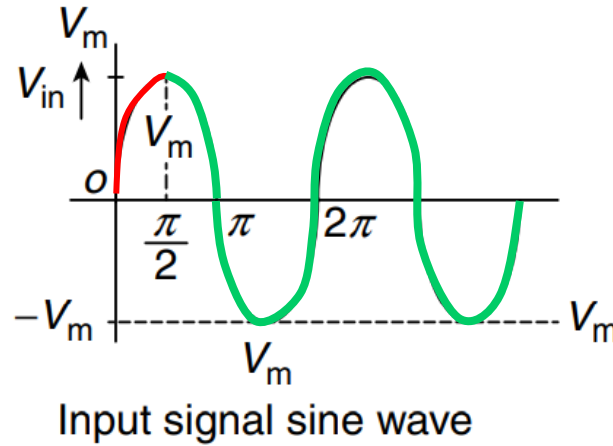
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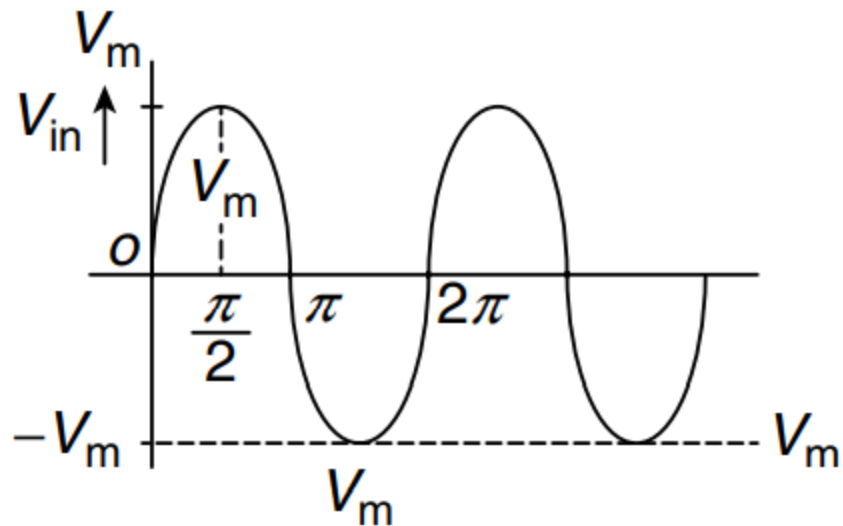
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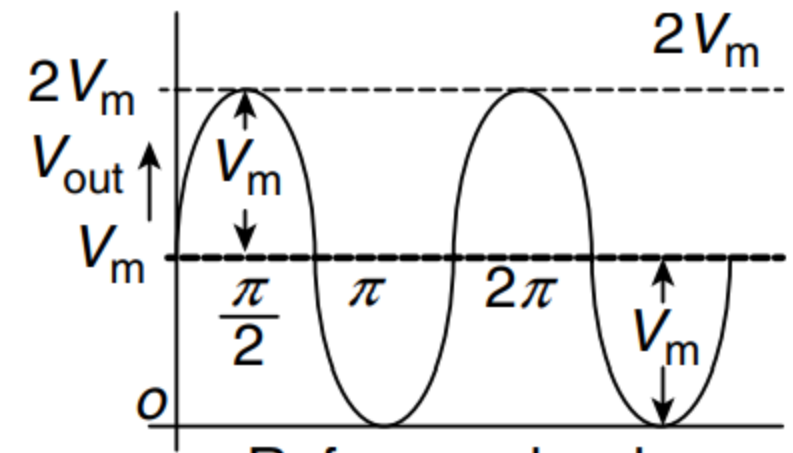
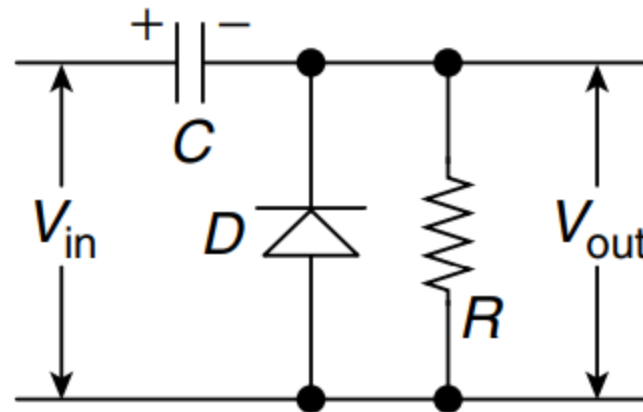
$$V_{out} = V_{in} - V_m$$



7. Positive clamping circuit: Basics

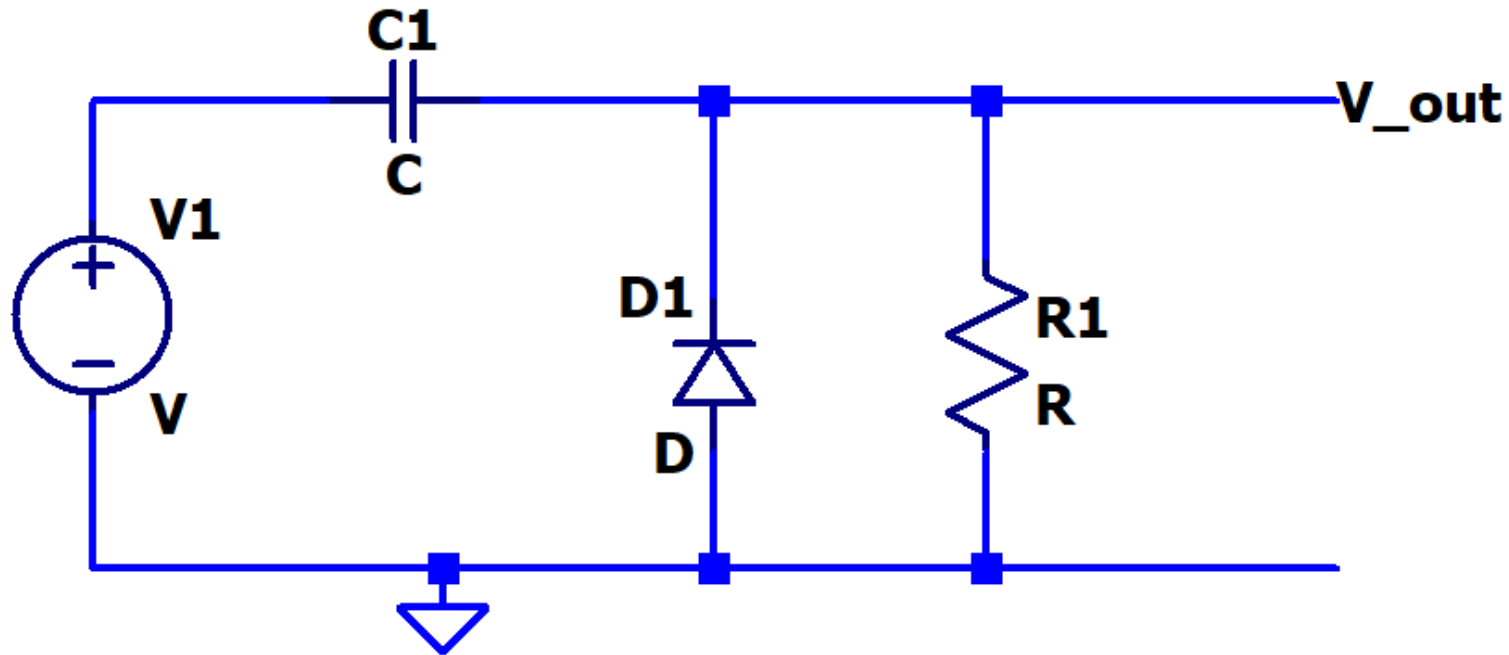


Input signal sine wave



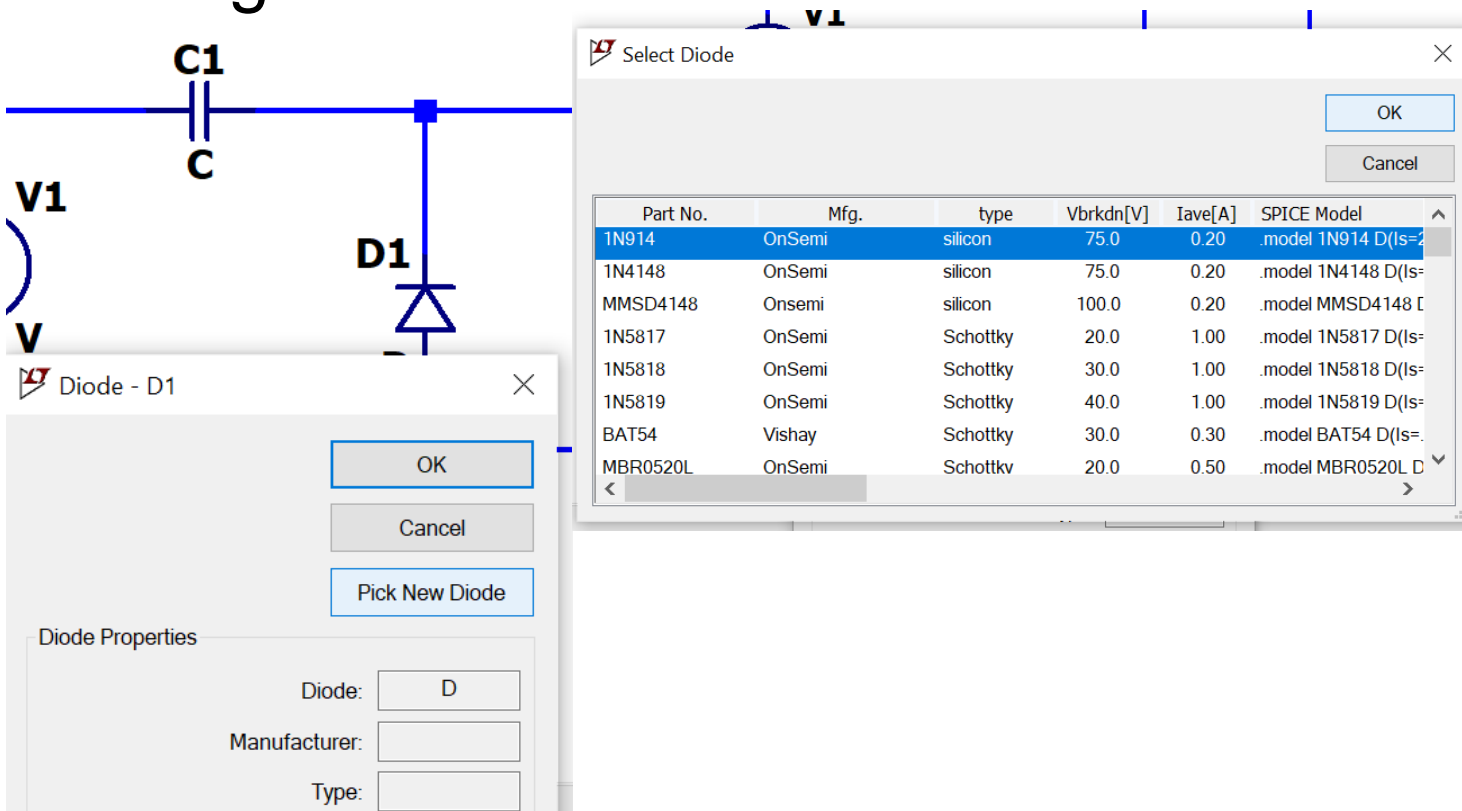
Output signal

7.2 Steps in LT Spice



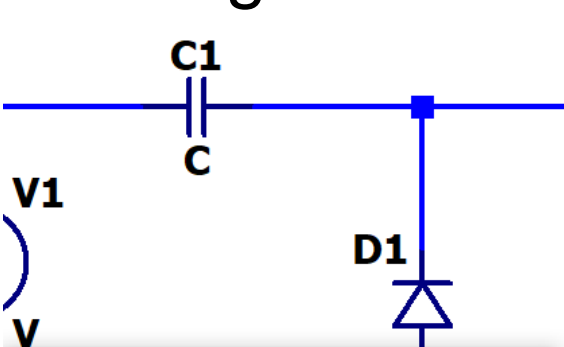
7.2 Steps in LT Spice

- Right click at diode:



7.2 Steps in LT Spice

- Right click at diode:



Select Diode

Part No.	Mfg.	type	Vbrkdn[V]	Iave[A]	SPICE Model
1N914	OnSemi	silicon	75.0	0.20	.model 1N914 D(Is=2
1N4148	OnSemi	silicon	75.0	0.20	.model 1N4148 D(Is=
MMSD4148	Onsemi	silicon	100.0	0.20	.model MMSD4148 D
1N5817	OnSemi	Schottky	20.0	1.00	.model 1N5817 D(Is=
1N5818	OnSemi	Schottky	30.0	1.00	.model 1N5818 D(Is=
1N5819	OnSemi	Schottky	40.0	1.00	.model 1N5819 D(Is=
BAT54	Vishay	Schottky	30.0	0.30	.model BAT54 D(Is=
MBR0520L	OnSemi	Schottkv	20.0	0.50	.model MBR0520L D

Diode - D1

Diode Properties

Diode: D

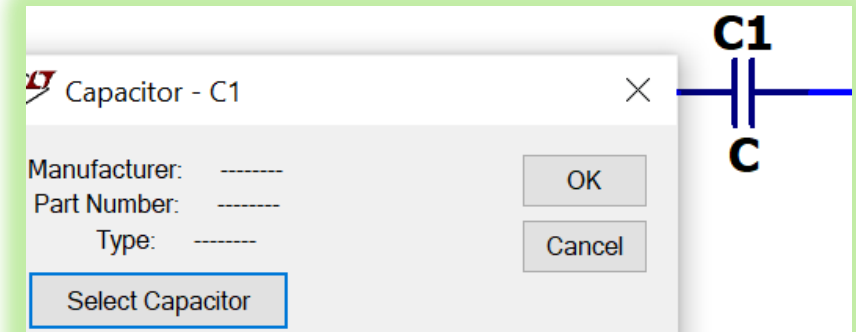
Manufacturer:

Type:

Select Stock Capacitor

C[μF]	Mfg.	type	Part No.	Voltage[V]	Rser[Ω]
27.0	Panasonic	Al electrolytic	ECA1HFQ270	50.0	0.900
270.0	Panasonic	Al electrolytic	ECA1HFQ271	50.0	0.090
33.0	Panasonic	Al electrolytic	ECA1HFQ330	50.0	0.600
330.0	Panasonic	Al electrolytic	ECA1HFQ331	50.0	0.080
390.0	Panasonic	Al electrolytic	ECA1HFQ391	50.0	0.084
390.0	Panasonic	Al electrolytic	ECA1HFQ391L	50.0	0.075
470.0	Panasonic	Al electrolytic	ECA1HFQ471	50.0	0.070

- Right click at capacitor:



Capacitor - C1

Manufacturer: -----

Part Number: -----

Type: -----

Select Capacitor

Capacitor Properties

Capacitance[F]: C

Voltage Rating[V]:

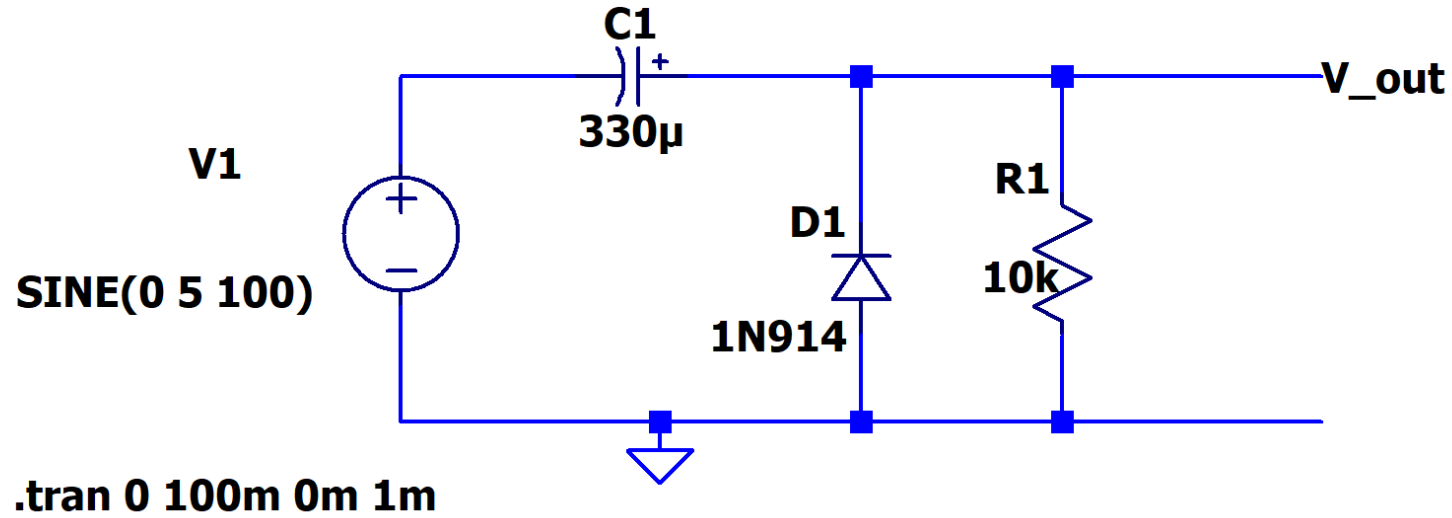
RMS Current Rating[A]:

Equiv. Series Resistance[Ω]:

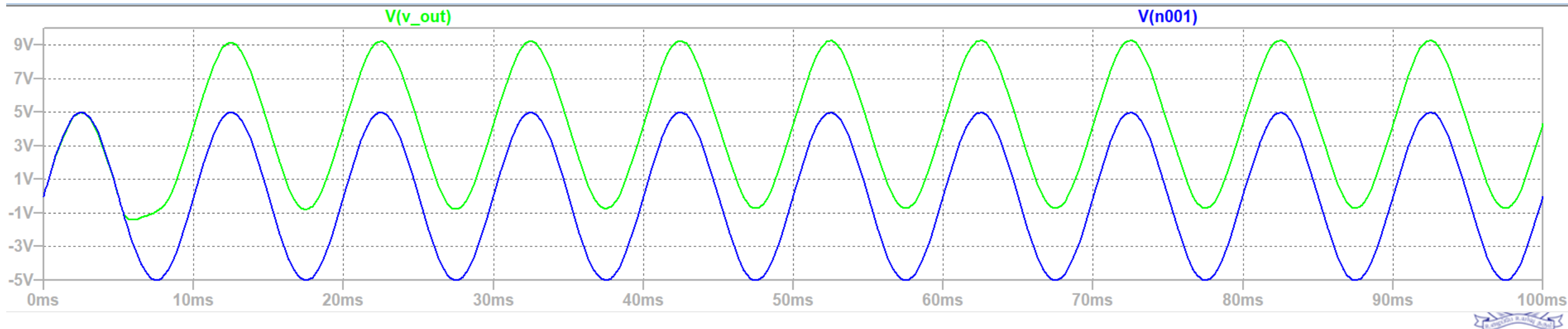
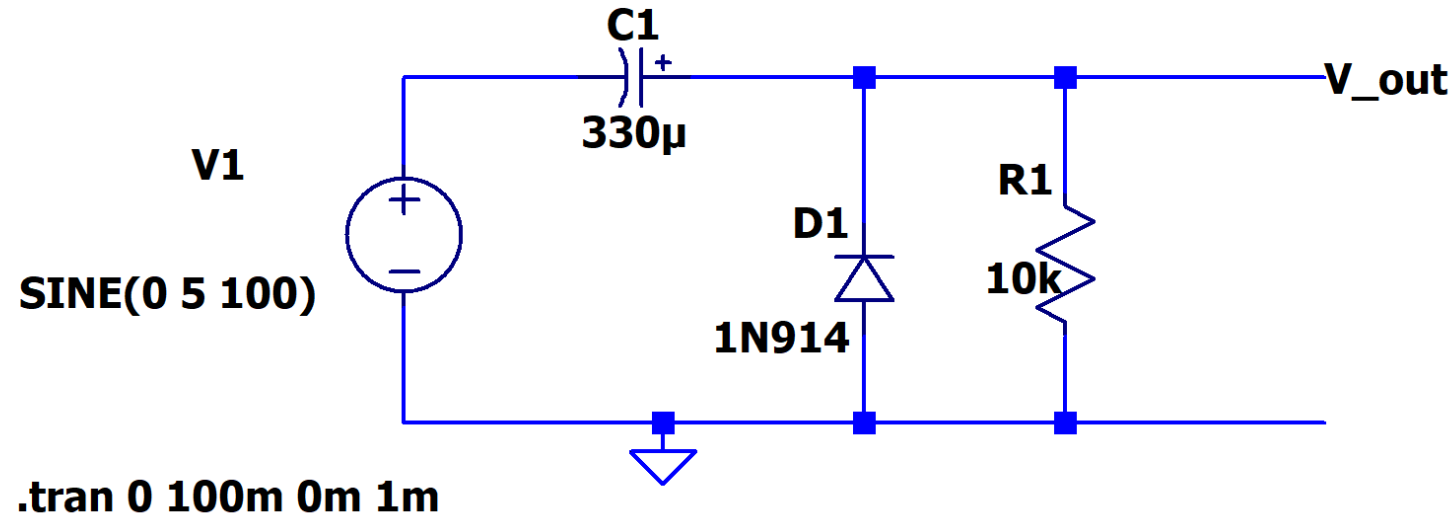
Equiv. Series Inductance[H]:

Equiv. Parallel Resistance[Ω]:

7.2 Steps in LT Spice



7.2 Steps in LT Spice



8. Tasks on Clipper: Design the following

- 1) +ve clipper at 2V
- 2) Clip complete +ve cycle
- 3) -ve clipper at -4V
- 4) Clip complete -ve cycle



9. Tasks on Clampers: Design the following clampers

Task	Clamper	+ve Peak of V_{in}	+ve peak of V_{ref}	+ve peak of V_{out}	-ve peak of V_{out}	How much the reference level was shifted (volts)
T1	Negative	5V	0V			
T2	Negative	5V	2V			
T3	Positive	5V	0V			
T4	Positive	5V	2V			

For each task in the record: Paste the circuit, plots with V_{in} , V_{ref} , V_{out}



Important NOTE

- Enter your **registration number** and **Full Name** next to
all your circuits and
the **output plots**.
- Keep the background of circuit and plot
as white.



LAB record instructions:

For the lab experiment,

- Write the **Aim**.
- Complete the **Software/Hardware components used**.
- **Obtain the expression for the outputs.**
- Place the respective **circuits in LT Spice**.
- Connect the inputs and outputs. Name them and **write the same in the lab copy(inputs and outputs section)**.
- Use probe in LT spice to plot all possible combinations.
- Write a **concluding statement for each circuit**.
- **Submit** the document's soft copy **on time** in lms.vit.ac.in when available.

