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EE1101: Circuits and Network Analysis

Lecture 11: Dependent Sources

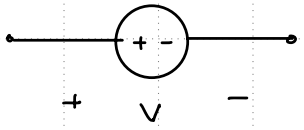
August 22, 2025

Topics :

1. Dependent Sources
2. Three Terminal Circuit Elements

Dependent Sources

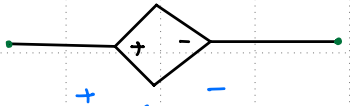
So far: Voltage | Current Source (independent Sources)



Voltage across is not dependent on external CKt

Dependent Sources: → Value is determined based on Voltage | Current in an External CKt element.

① Voltage Controlled Voltage Source



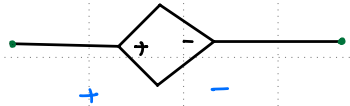
$v_s = A_v v_x$.

$A_v v_x$ ← Voltage across an ext. CKt elem (or) Controlling parameter: Voltage.

gain (V/V)

Used to model an Operational Amplifier (OpAmp)

② Current Controlled Voltage Source



$v_s = R i_x$

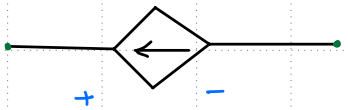
$R i_x$ ← Current through an ext. CKt elem (or) Controlling parameter: Current

gain (Ω)

Can be constructed using an OpAmp

Dependent Sources

③ Voltage Controlled Current Source



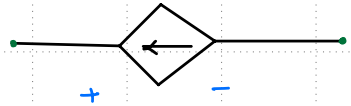
$i_s = G\, v_x$

$G\, v_x$ ← Voltage across an ext. ckt elem (or) Controlling parameter : Voltage.

gain (S)

model MOSFET

④ Current Controlled Current Source



$i_s = A_i\, i_x$

$A_i i_x$ ← Current through an ext. ckt elem (or) Controlling parameter : Current

gain (A/A)

model a BJT

BJT, MOSFET & OpAmp ⟶ 3-Terminal devices.

2 modes

- Switch (BJT & MOSFET) ← 2 States (ON & OFF) ← Controlled Switching at high freq.
- Amplifier.

Three Terminal Circuit Elements (as a Switch)

Example: A 3 terminal ckt elem operating as a switch.

↓

Control Port is b/w A & C.

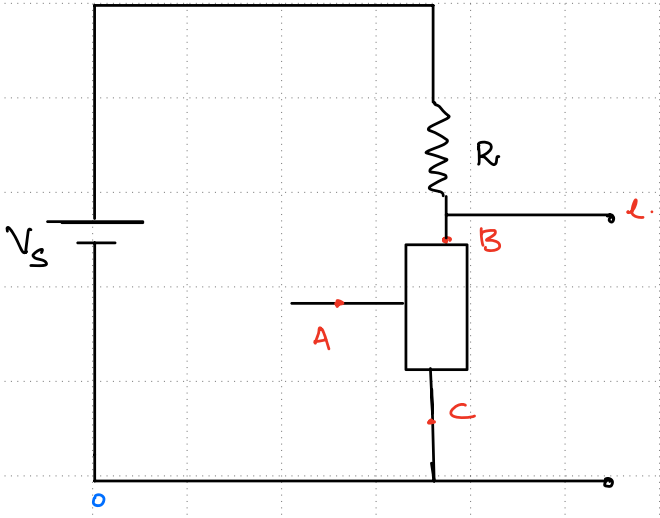
↓

if $V_{AC} > 0$: ON state

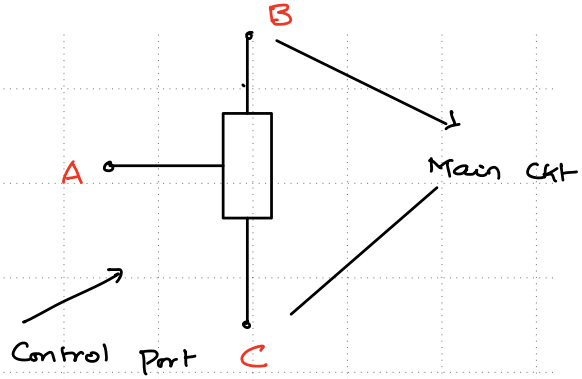
B & C → Short ($R_i \to 0$)

if $V_{AC} < 0$:

B & C → Open ($R \to \infty$)



$$v_L = \begin{cases} 0 \text{ (assuming ideal)} & \text{when } V_{AC} > 0 \\ V_s \text{ (OC)} & \text{when } V_{AC} < 0 \end{cases}$$



determines the current/voltage across the other two terminals.

for any 3-terminal element

a) def Control Port & main ckt (A-C) (B-C)

b) Conditions on Control port (& main ckt)

(i) Switch (ON & OFF) ↓ Short. ↓ Open

(ii) Amplifier

Three Terminal Circuit Elements (as a Switch)

Example: A 3 Terminal CKT elem operating as a Switch.

↓

Control Port is b/w A & C.

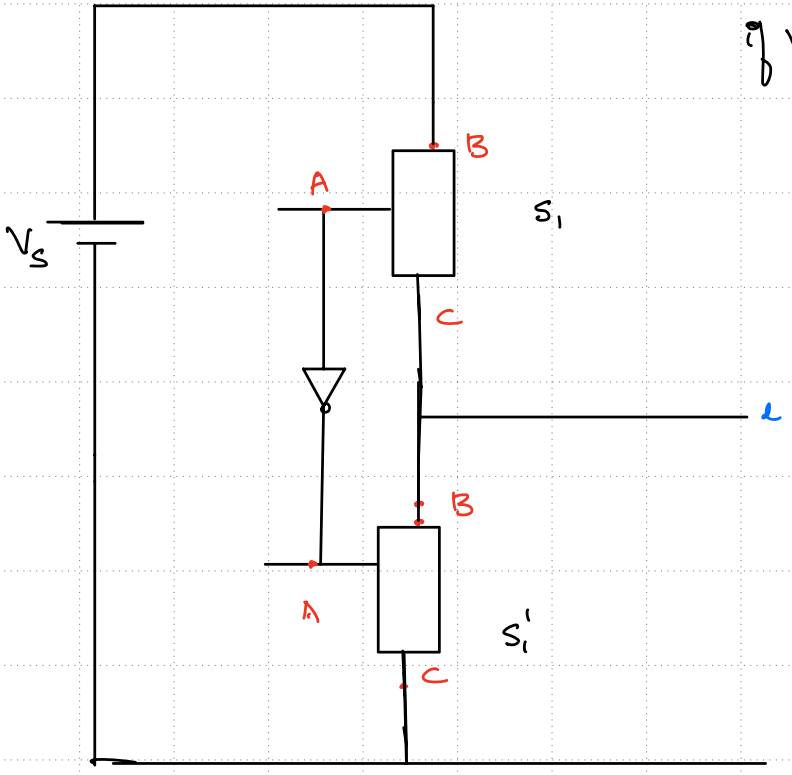
↓

if $V_{AC} > 0$: ON state

B & C → Short ($R_i \to 0$)

if $V_{AC} < 0$:

B & C → Open ($R \to \infty$)



when $V_{AC} > 0$ (S_1) ⇒ $V_{AC} < 0$ (S_1')

$v_L = V_s$

when $V_{AC} < 0$ (S_1) ⇒ $V_{AC} > 0$ (S_1')

$v_L = 0$