Common Drain Amplifier

In this circuit shown in figure 3.3.1, input is applied between gate and source and output is taken between source and drain.

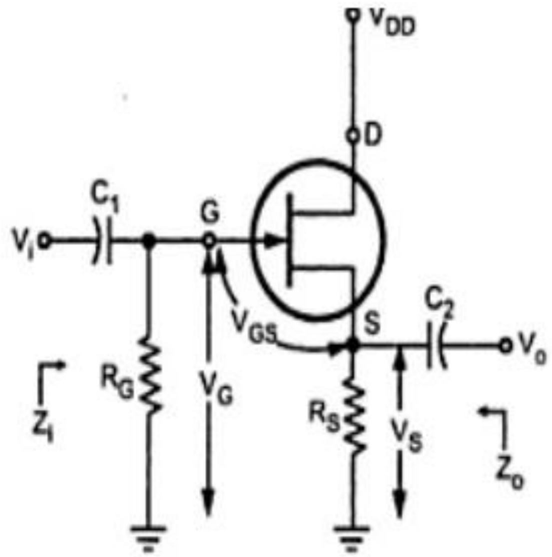

Figure 3.3.1 Common Drain Amplifier

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In this circuit, the source voltage is

$$V_s = V_G + V_{GS}$$

When a signal is applied to the JFET gate via C_1 ,VG varies with the signal. As VGS is fairly constant and $V_s = V_G + V_{GS}$, Vs varies with Vi. The following figure 3.3.2 shows the low frequency equivalent model for common drain circuit.

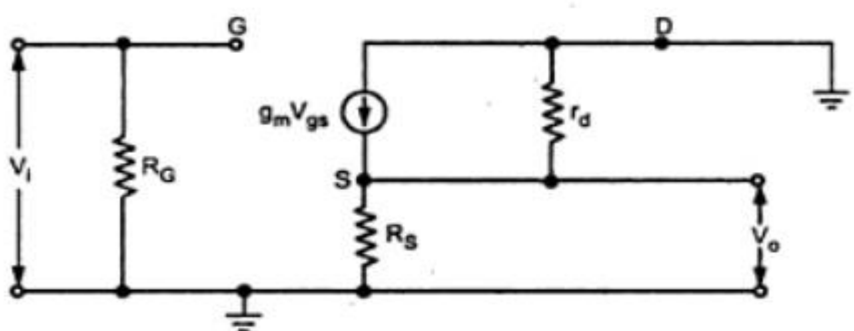

Figure 3.3.2 Small model of common Drain Amplifier

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Input Impedance Z_i

Figure 3.3.3 shows the simplified small model of common Drain Amplifier.

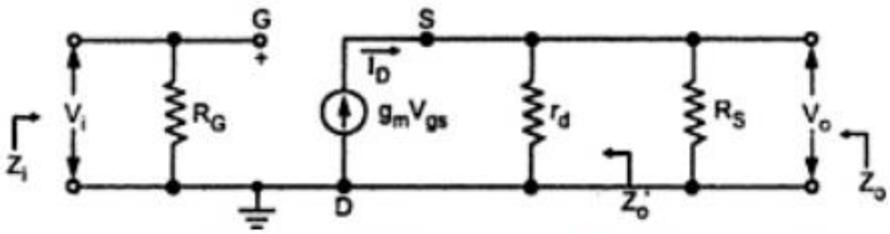

Figure 3.3.3 Simplified small model of common Drain Amplifier

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Zi = RG

Output Impedance Z_o

It is given by

$$Z_o = Z'_o || R_s$$

where $$Z'_o = \left.\frac{V_o}{I_d}\right|_{V_i = 0}$$

Applying KVL to the outer loop we can have,

$$V_i + V_{gs} - V_o = 0$$

As $$V_i = 0,$$

$$V_{gs} = V_o$$

Looking at Fig. we can write that,

$$g_m V_{gs} = I_d$$

But Vgs = Vo, so

$$g_m V_o = I_d$$

$$Z_o' = \frac{V_o}{I_d} = \frac{1}{g_m}$$

$$\therefore \quad Z_o = \frac{1}{g_m} || R_s$$

Voltage gain (A_v)

It is given by

$$A_v = \frac{V_o}{V_i}$$

Looking at Fig. we can write that,

$$V_o = -I_d \ (r_d \ || R_s)$$

and $$I_d = g_m V_{gs}$$

$$\therefore \quad V_o = -g_m V_{gs} \ (r_d \ || R_s)$$

But

$$V_i = -V_{gs} + V_o$$

$$= -V_{gs} + [-g_m V_{gs} \ (r_d \ || R_s)]$$

Substitute the value V_o and V_i. Then

$$A_v = \frac{-g_m V_{gs} (r_d \parallel R_s)}{-V_{gs}(1 + g_m (r_d \parallel R_s))}$$

$$= \frac{g_m (r_d \parallel R_s)}{1 + g_m (r_d \parallel R_s)}$$

if $r_d >> R_s$

$$A_v = \frac{g_m R_s}{1 + g_m R_s}$$

if $g_m R_s >> 1$

$A_v \approx 1$, but it is always less than one.

Common drain circuit does not provide voltage gain.& there is no phase shift between input and output voltages.

Table summarizes the performance of common drain amplifier

	Exact	$r_d >> R_D$
Z_i	R_G	R_G
Z_o	$\frac{1}{g_m} \parallel R_s$	$\frac{1}{g_m} \parallel R_s$
A_v	$\frac{g_m (r_d \parallel R_s)}{1 + g_m (r_d \parallel R_s)}$	$\frac{g_m R_s}{1 + g_m R_s}$