Department of Computer Engineering
Digital Hardware Systems
CpEA 2202 – Electronic Circuits

Laboratory Report

Laboratory Exercise No.:	9	**Date Performed:**	March 28, 2025
Laboratory Exercise Title:	Amplifier and Transistor Switch		
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Part I

Transistors, particularly bipolar junction transistors (BJTs), are commonly utilized as amplifiers in electrical circuits. In the active area, a transistor can convert a small input signal applied to its base terminal into a larger output signal at the collector. This amplification occurs when a modest base current influences a much greater collector current, a phenomenon known as current gain.

For example, in a common-emitter arrangement, the transistor amplifies voltage and current, making it suitable for audio and radio frequency applications. The amplification factor (β) is the change in collector current divided by the change in base current. This enables great amplification of weak signals.

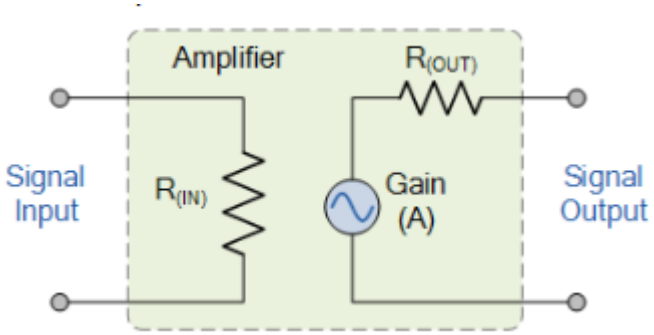


Figure 1.1: Amplifier Model

A common-source FET Amplifier uses junction field effect transistors (FET) as its main active device offering high input impedance characteristics. FETs have the advantage over BJT of having an extremely high input impedance along with a low noise output making them ideal for use in amplifier circuits that have very small input signals. Given that the n-channel JFET is a depletion mode device that is normally "ON" and hence has a negative gate voltage. To modulate or control the drain current, it is necessary to consider the source. The negative voltage can be provided by biasing from a separate power supply voltage or by a self-biasing system, as long as a steady current runs through the JFET even when no input signal is available. VG maintains the reverse bias of the gate-source p-n junction.

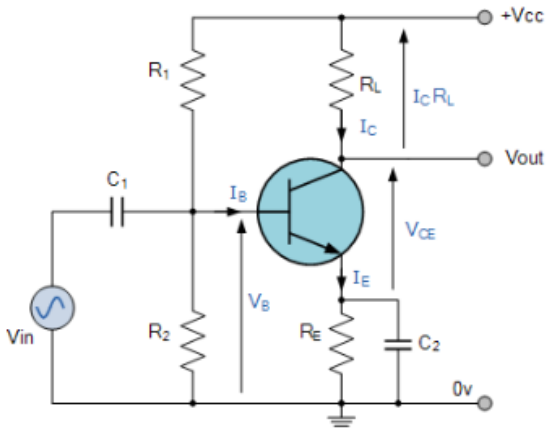


Figure 1.2: Common-Emitter BJT Amplifier Circuit in Voltage-Divider Configuration

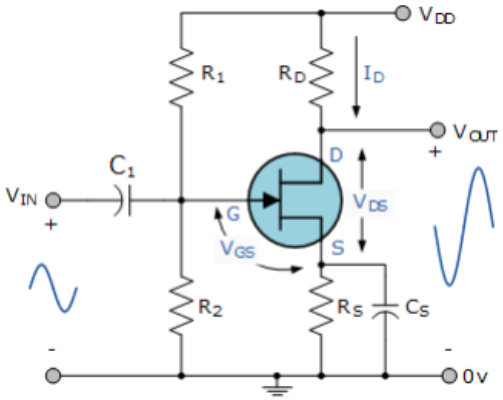


Figure 1.3: Common-Source FET Amplifier Circuit in Voltage-Divider Configuration

Transistors can also serve as electronic switches, working in either the cut-off or saturation states. In the cut-off region, both the base-emitter and base-collector junctions are reverse-biased, causing no current to flow through the collector-emitter path—effectively turning the switch "off." In the saturation region, both junctions are forward-biased, allowing maximum current flow—turning the switch "on."

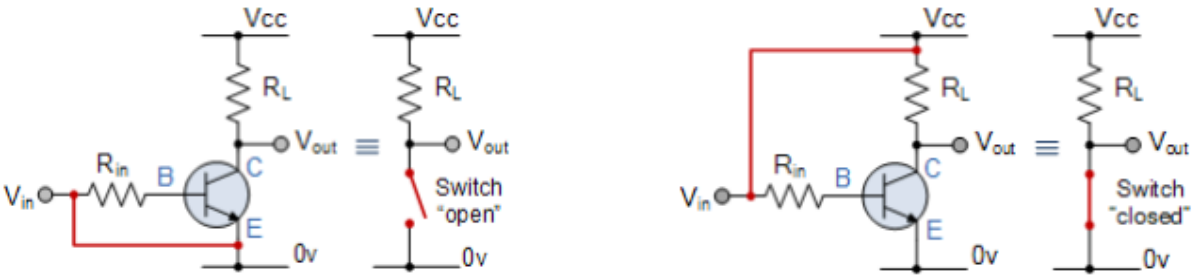


Figure 1.4: Cut-off (left) and Saturation Configuration and Equivalent Circuits

This switching feature is critical in digital circuits, where transistors control the flow of current in response to input signals, allowing binary computations. For example, when a high voltage is given to the base, the transistor approaches saturation, allowing current to flow freely from collector to emitter. Removing the base voltage causes the transistor to enter the cut-off state, which stops current flow.

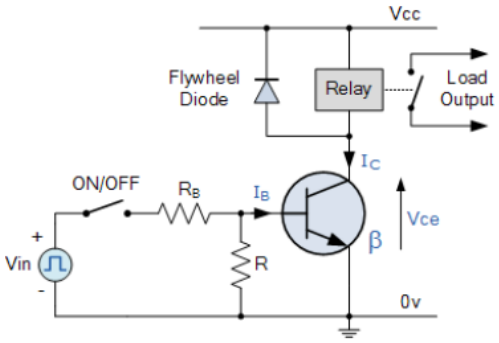


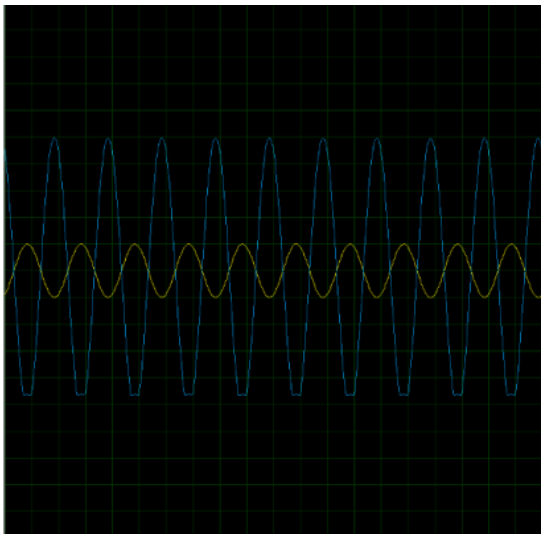
Figure 1.5: NPN Transistor Switching Circuit

Part IIa:

Table 2.1: JFET Small-Signal Amplifier Voltage Input and Output

V_G	V_{GS}	V_{DS}	V_D	**Gain**
1 V	1.0583 V	7.498 V	7.51 V	7.08
2 V	2.0629 V	5.305 V	5.31 V	2.57
3 V	2.788 V	2.803 V	2.81 V	1.01
4 V	4.046 V	3.27 V	3.27 V	0.81
5 V	5.636 V	4.399 V	4.40 V	0.78

Table 2.2: Plot for the Small Signal Amplifier



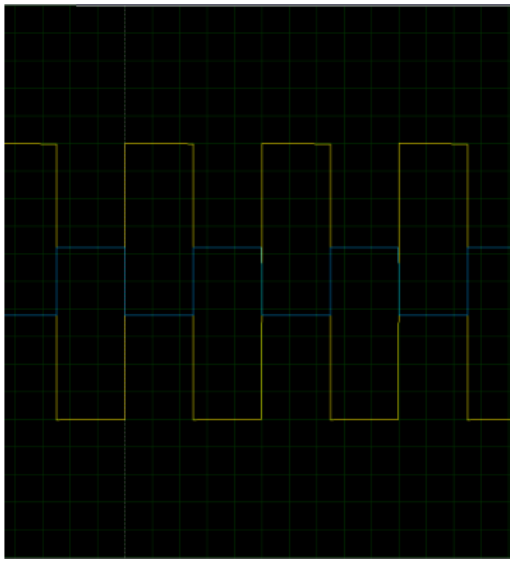
Time per division (s) :	0.5ms
Voltage per division (V):	1V
T (s):	1.25ms
Instantaneous Voltage @	
time T (input):	1V
Instantaneous Voltage @	
time T (output):	1V
VPEAK (input):	1V
VPEAK (output):	4.97V

Part IIb:

Table 2.3: Data for the Transistor Switch

Input Switch	Ic(mA)	LED Status
Close	15	On
Open	0	Off

Table 2.4: Plot of the PNP Transistor Switch Output



VPEAK-PEAK (input): 5V

VPEAK-PEAK (output): 49mV

Part III. Observations

1. **Observe the data (graph) in Figure 2.1. What can you conclude on the input and output signals in terms of gain? What type of signal amplifier have you constructed and what is its classification?**
   -
   - The output signal has a higher amplitude than the input signal. This indicates that the circuit amplifies the input signal, implying that the amplifier delivers positive voltage gain.

2. **Observe the data in Table 3. What can you conclude of the output voltage with respect to the input voltage?**
   - The results show that the amplifier works best with moderate input signals. When the input voltage gets too high, the transistor starts to behave nonlinearly—either saturating or cutting off—which makes the amplifier less efficient and reduces its gain. This means the output doesn't increase as smoothly with the input anymore, and the circuit can't amplify as well as it did at lower levels.

3. **From the data in Figure 2.4, what can you conclude on the function of this transistor switch?**
   - The transistor functions as a switch, controlling the flow of current based on the input conditions. When a tiny input signal (or control action) is applied, more current can flow through the load (the LED).

4. **Aside from driving an LED, what are other applications for a transistor switch?**
   - Transistor switches are essential components in modern electronics, enabling efficient control over various devices and systems. They are employed in numerous applications, including controlling relays, switching power supplies, handling signals in communication systems, driving motors, and activating alarms. Their versatility and reliability make them integral to the functionality and efficiency of diverse electronic systems.

References

[1] "Transistor as a Switch," *Electronics Tutorials*. [Online]. Available: https://www.electronics-tutorials.ws/transistor/tran_4.html. [Accessed: May 2, 2025].

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