NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

Electronic Circuit Design (EE-313)

Assignment # 1

Common Emitter Amplifier Design

Submitted to:	Dr. Shakeel Alvi
Submitted by:	Muhammad Umer
Class:	BEE-12C
Semester:	5^{th}
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CMS ID:	345834

1 Assignment Solution

1.1 MATLAB Code

Following code is treated as a boilerplate for plotting both single stage and cascaded CE amplifier graphs on MATLAB. Appropriate comments are added for the reader's understanding.

```
% Transient Plot
WaveData = importdata('waveform/waveform.txt');
time = WaveData.data(:, 1);
Vin = WaveData.data(:, 2);
Vout = WaveData.data(:, 3);

figure('Name', 'Transient Plot');
% Vout vs t
subplot(2, 1, 1)
plot(time, Vout, 'r')
title('V(Out)')
grid
xlabel('Time (s)')
ylabel('Voltage (V)')
xticks(0:0.1:1.5)
% Vin vs t
subplot(2, 1, 2)
plot(time, Vin)
title('V(In)')
grid
xlabel('Time (s)')
ylabel('Voltage (V)')
xticks(0:0.1:1.5);

%%
% Bode Plot
BodeData = readtable('bode_plot/bode.txt', 'VariableNamingRule', 'preserve');
Vn = BodeData.('V(out)');
f = BodeData.('Freq.');

for k = 1:numel(Vn)
    V(:, k) = sscanf(Vn{k}, '(%fdB,%f)');
end

figure('Name', 'Bode Plot');
% Decibel vs Freq.
subplot(2, 1, 1)
semilogx(f, V(1, :), 'r-o', 'MarkerIndices', 1:50:length(V(1, :)))
grid
xlabel('Frequency (Hz)')
ylabel('Magnitude (dB)')
% Phase vs Freq.
subplot(2, 1, 2)
semilogx(f, V(2, :), '-o', 'MarkerIndices', 1:50:length(V(1, :)))
grid
xlabel('Frequency (Hz)')
ylabel('Phase (°)')
sgtitle('V(out)')
```

1.2 Single Stage CE Amplifier

1.2.1 Circuit

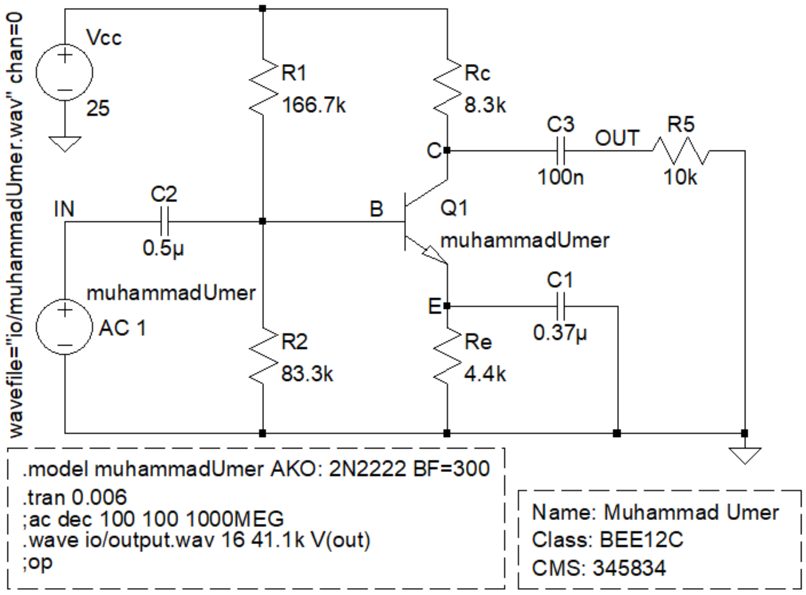
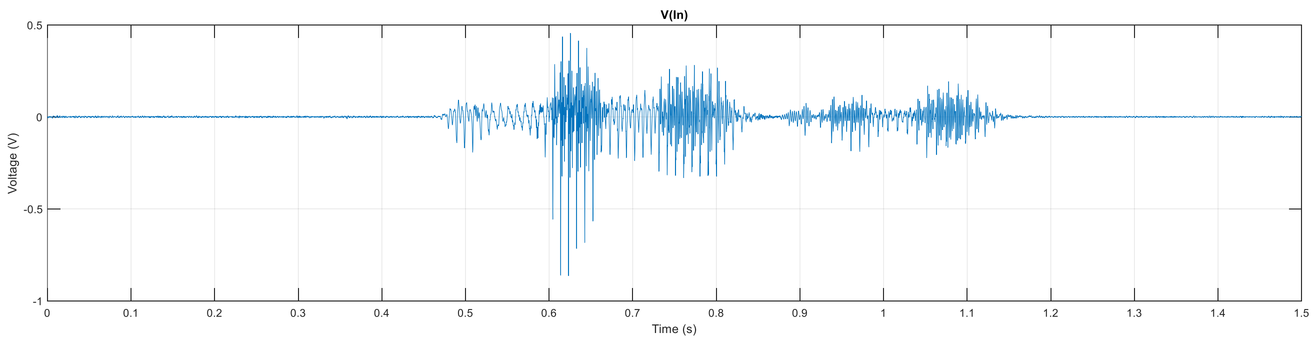
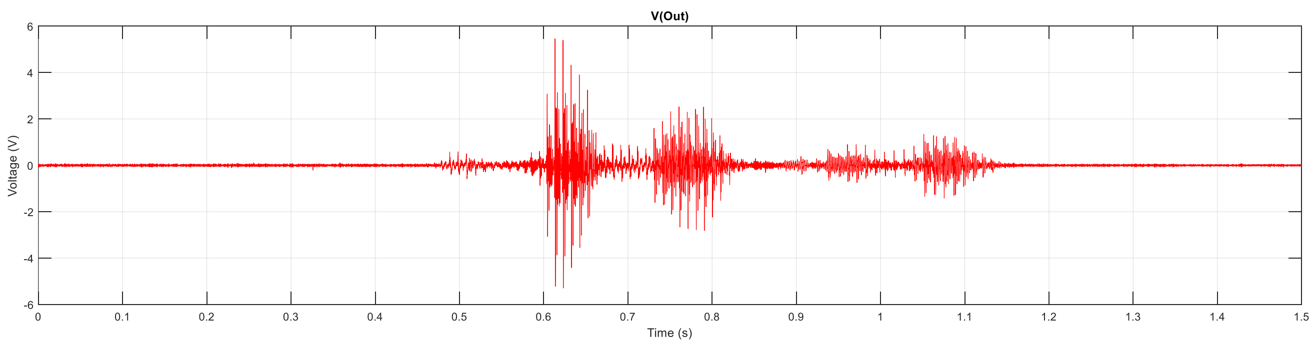


Figure 1.2.1-a Schematic

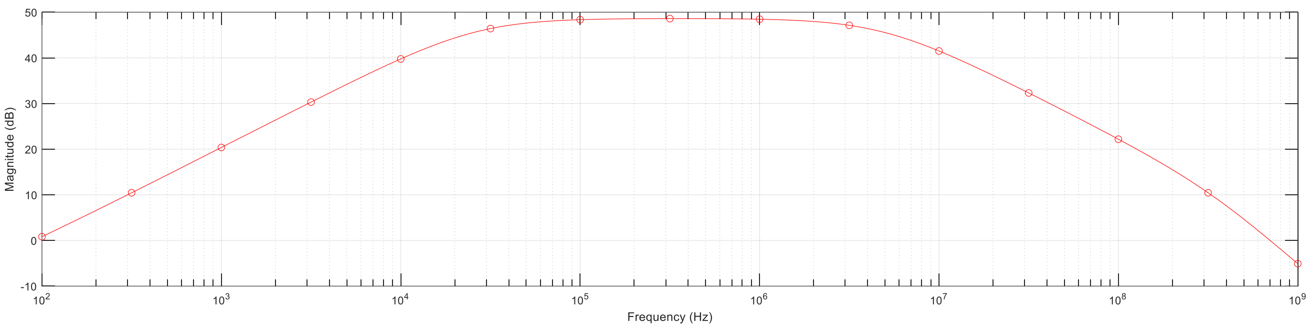
1.2.2 Waveforms

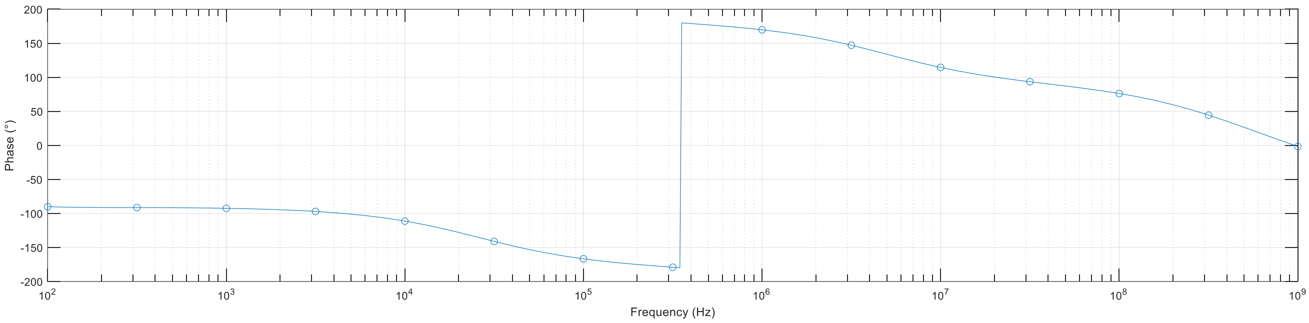




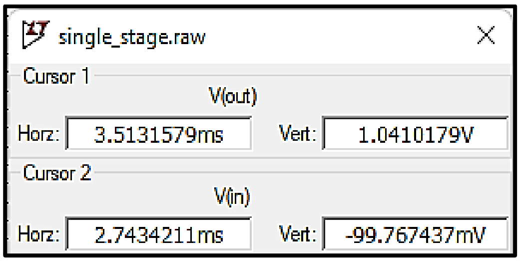
Comments: From the transient analysis, we can observe that our input signal (in blue) [range: +0.5V to -0.8V] gets amplified by the designed common emitter amplifier to the output signal (in red) [range: +5.8V to -5.8V] with little noise.

1.2.3 Bode Plot

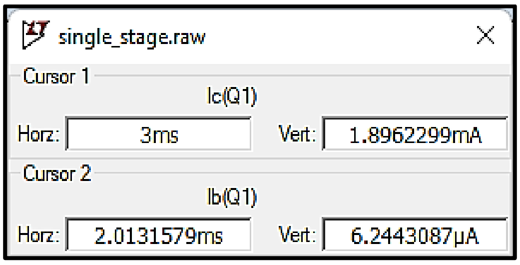




1.2.4 Gain



Voltage Cursor



Current Cursor

By applying a sinusoidal signal and performing transient analysis, we can get the value of voltage gain directly by using the formula: $G_V = \frac{V_{OUT}}{V_{IN}}$

Addition of the bypass capacitor, although introduces noise, but it allows for a larger gain, essentially making it a trade-off. Substituting values from the figure, we obtain:

$$\boldsymbol{G_V = -10.51\ V/V}$$

Following the same line of thought for calculating current gain, I_C/I_B, we obtain the value:

$$\boldsymbol{\beta = 316.67\ A/A}$$

1.3 Cascaded CE Amplifier

1.3.1 Circuit

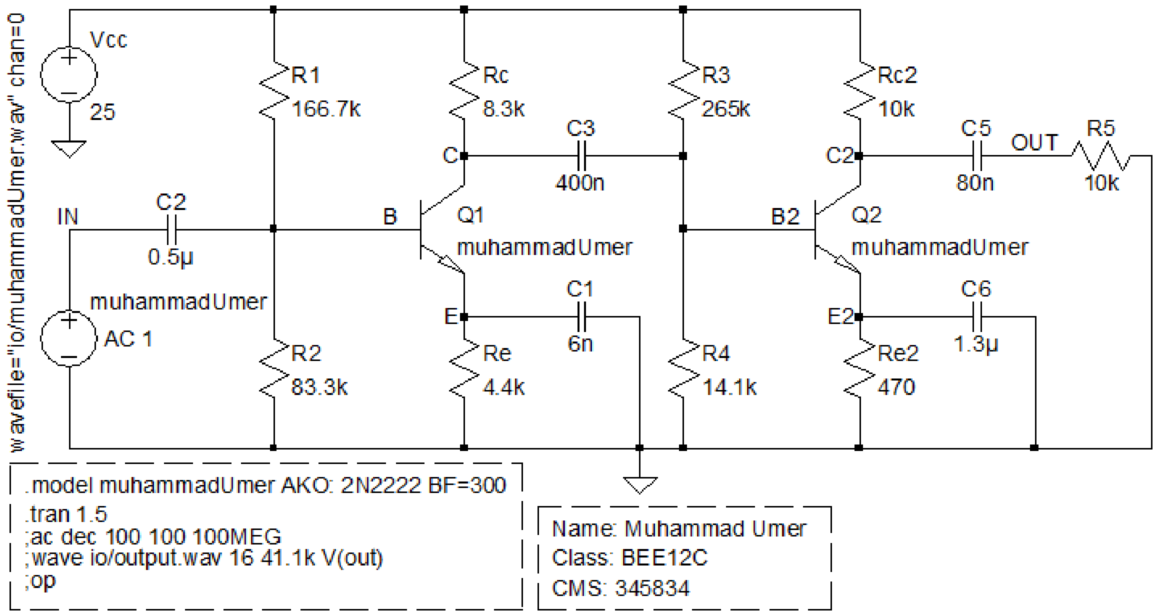
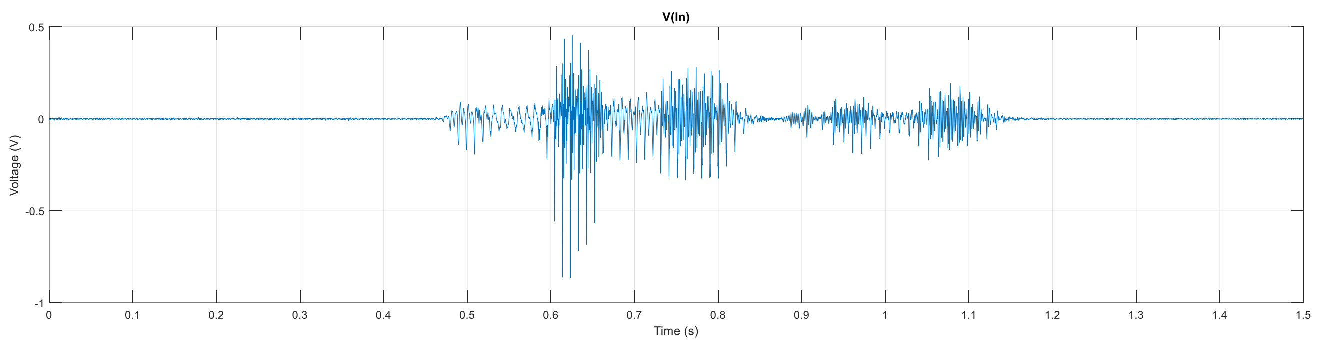
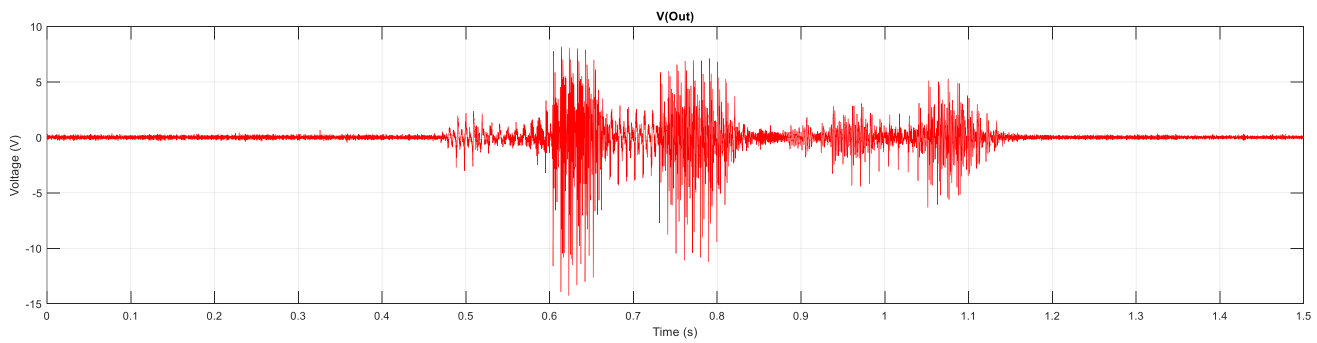


Figure 1.3.1-a Schematic

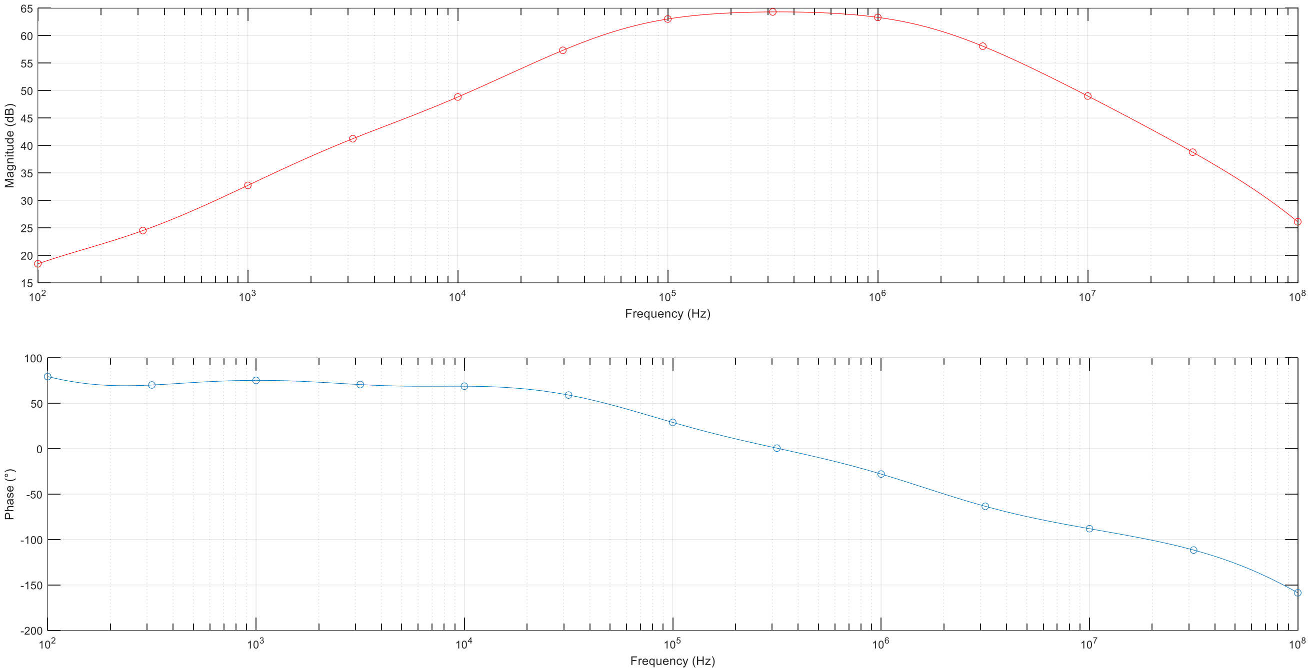
1.3.2 Waveforms



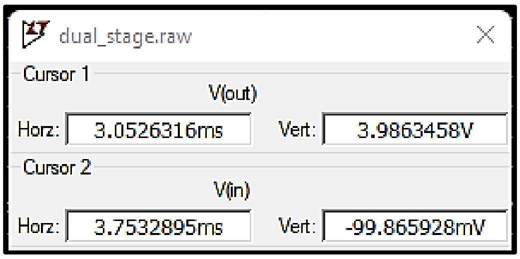


Comments: From the transient analysis, we can observe that our input signal (in blue) [range: +0.5V to -0.8V] gets amplified by the cascaded common emitter amplifier to the output signal (in red) [range: +8.2V to -14.76V] with little noise, albeit a bit more compared to that of single stage.

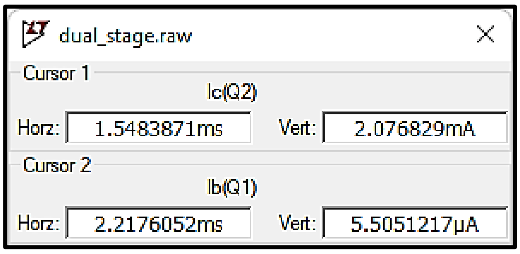
1.3.3 Bode Plot



1.3.4 Gain



Voltage Cursor



Current Cursor

By applying a sinusoidal signal and performing transient analysis, we can get the value of voltage gain directly by using the formula: $G_V = \frac{V_{OUT}}{V_{IN}}$

Addition of the bypass capacitor, although introduces noise, but it allows for a larger gain, essentially making it a trade-off. Substituting values from the figure, we obtain:

$$\boldsymbol{G_V = -39.48\ V/V}$$

Following the same line of thought for calculating current gain, I_C/I_B, we obtain the value:

$$\boldsymbol{\beta = 376.67\ A/A}$$

2 Conclusion

In this assignment, students learnt about the steps and procedures necessary to design a classical discrete arrangement biased common emitter voltage amplifier and used it to amplify a recorded signal. LTSpice was used to simulate the circuits, and the extracted simulated data was then fed into MATLAB for plotting purposes. Lastly, we cascaded a common emitter stage onto a common emitter amplifier and verified that the overall voltage gain G_V increases through cascading.