PRACTICAL WORK BOOK

For Academic Session 2014

ELECTRONIC-II
(EL-235)

Name : ____________________

Roll Number : ____________________

Batch : ____________________

Department : ____________________

Year : ____________________

Department of Electronic Engineering
N.E.D. University of Engineering & Technology, Karachi -75270
Pakistan

LABORATORY WORK BOOK

FOR THE COURSE

EL-235 ELECTRONIC-II

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The Board of Studies of Department of Electronic Engineering

Electronic-II Experiment

CONTENTS

Laboratory No 1

Objective:

To investigate the operation of Common Emitter Amplifier
To describe the purpose of components present in Common Emitter Amplifier

Introduction:

The CE Amplifier is one of the three basic transistor amplifier circuit used in electronic industry. In this configuration input is applied at the base lead while its output is taken at collector, which is in 180^o phase shift.

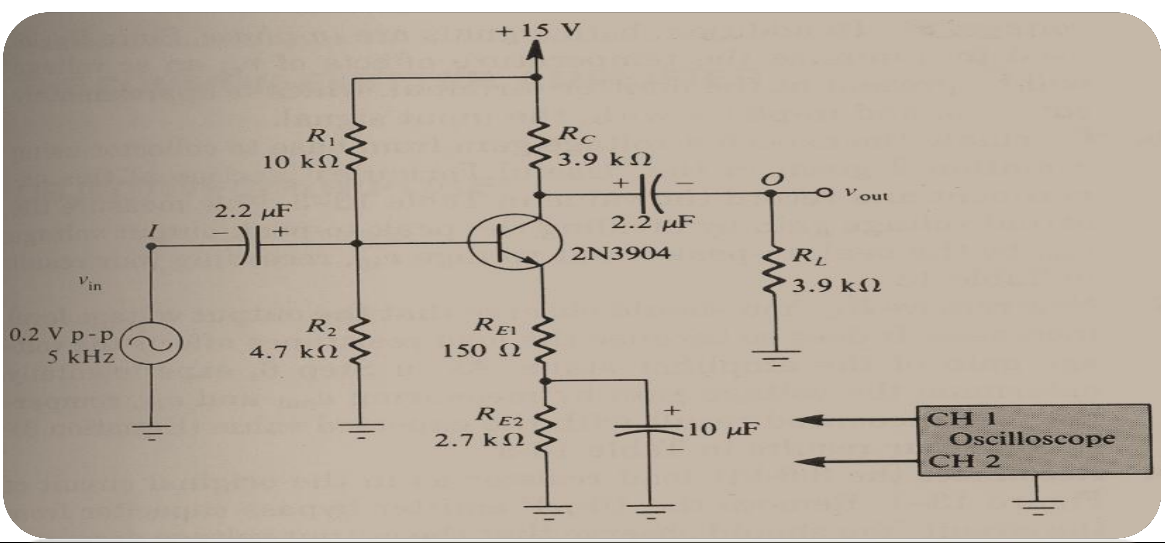
Pre-Lab:

1. Students must know about DC parameters i.e. I_E ,V_E , V_B , V_C , V_{CE}
2. Must able to draw AC equivalent circuit of CE Amplifier
3. Able to find out Voltage Gain(A_V)
4. Purpose of partially by-pass emitter resistance
5. Effect of emitter by-pass capacitor on voltage gain

Apparatus:

Resistors	Capacitors	Signal generator
150KΩ	10µf	**Dual trace oscilloscope**
2.7KΩ	2.2µf	**Breadboard**
3.9KΩ	**2N3904 npn transistor**	**VOM**
4.7KΩ	**0-15 V dc power supply**	**Breadboard Socket**
10KΩ		

Schematic Diagram:



Procedure:

1. Build the circuit given above.
2. Verify the calculated dc parameters values with measured values record them in Table 1-1 and also find percentage error (% Error).
3. Compare the output voltage with by-pass capacitor and without by-pass capacitor and record them in Table 1-2.
4. Verify the calculated voltage gain value with measured value, record them in Table 1-3 and also find percentage error (% Error).

Observation Chart:

Table 1-1

Parameters	**Measured value**	**Expected value**	**% Error**
I_E			
V_E			
V_B			
V_C			
V_{CE}			

Table 1-2

V_{out}(with by-pass capacitor)	**V_{out}(without by-pass capacitor)**

Table 1-3

A_V (Measured) $A_V = V_{out} / V_{in}$	**A_V (Calculated)** $A_V = (Rc // Rv) / (R_{E1} + re)$	**% Error**

Conclusion:

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Review Questions:

1. For linear operation, a common emitter amplifier must ______________
   a. Have a large collector resistor
   b. Operate in middle region of load line
   c. Use a high collector voltage
2. If the load resistor RL in the circuit of Figure 1-1 is made larger, the amplifier voltage gain will_____________
   a. Increase
   b. Decrease
   c. Remain essentially same
3. By removing 10µf capacitor (by pass capacitor) output voltage will______________
   a. Increase
   b. Decrease
   c. Remain constant
4. The output signal of CE amplifier is out-of-phase with the input by______________
   a. 0^o
   b. 45^o
   c. 90^o
   d. 180^o
5. The power gain of CE amplifier is_____________
   a. High
   b. Low
   c. Medium

Experiment No 2

Objective:

To investigate the operation of Common Base Amplifier
To describe the purpose of components present in Common Base Amplifier

Introduction:

In Common base amplifier input is provided at emitter lead while output is taken at Collector, so in common base both input and output signal are in phase. Voltage gain of common base is like that of common emitter.

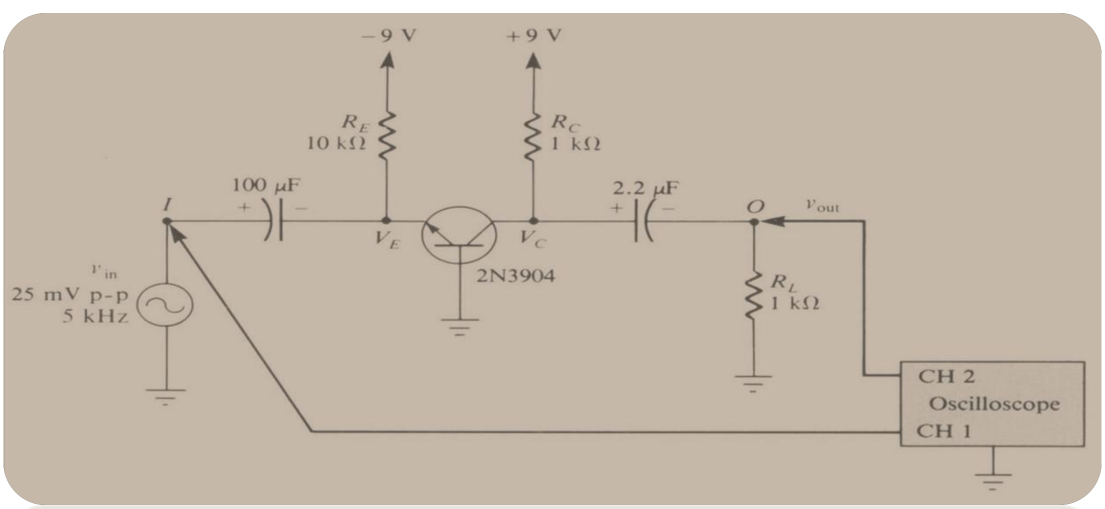
Pre-Lab:

1. Students must know about DC parameters i.e. I_E ,V_E , V_B , V_C
2. Students must know about AC parameters i.e. r_e , A_V
3. Must able to draw AC equivalent and DC equivalent circuit of CB Amplifier
4. Able to find out Voltage Gain(A_V)
5. Purpose of capacitors used in CB Amplifier
6. Effect of load resistance on voltage gain

Apparatus:

Resistors	**Capacitors**	**Signal generator**
470Ω	10µf	**Dual trace oscilloscope**
1KΩ	100µf	**Breadboard**
10KΩ	**2N3904 npn transistor**	**VOM**
		0-15 V dc power supply

Schematic Diagram:



Procedure:

1. Build the circuit given above.
2. Verify the calculated dc parameters values with measured values record them in Table 1-1 and also find percentage error (% Error).
3. Compare the output voltage with load resistor (R_L) and without load resistor (R_L) and record them in Table 1-2.
4. Verify the calculated voltage gain value with measured value, record them in Table 1-3 and also find percentage error (% Error).

Observation Chart:

Table 1-1

Parameters	Measured value	Expected value	% Error
I_E			
V_E			
V_B			
V_C			

Table 1-2

V_{out}(with load resistor)	V_{out}(without load resistor)

Table 1-3

A_V (Measured) $A_V = V_{out} / V_{in}$	A_V (Calculated) $A_V = (Rc // R_L) / r_e$	% Error

Conclusion:

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Review Questions:

1. The current gain in CB Amplifier is ______________.
    a. Less than unity
    b. More than unity
    c. Unity
2. Which of the following is not the characteristic of CB Amplifier
    1. Low input impedance
    2. Output taken from collector
    3. 180^{o} phase shift
3. By removing load resistor output voltage will______________.
    a. Increase
    b. Decrease
    c. Remain constant
4. The output signal of CB amplifier is ______________-of-phase with the input.
    a. in
    b. out
    c. In-out
5. The power gain of CB amplifier is_____________.
    a. High
    b. Low
    c. Medium

Experiment No 3

Objective:

To investigate the operation of Common Collector Amplifier
To describe the purpose of components present in Common Collector Amplifier

Introduction:

The Common Collector amplifier is also known as 'Emitter Follower'. In CC Amplifier input is taken at base while output at emitter. In this configuration output follows input. The input impedance of CC amplifier is much higher than bipolar transistor amplifier.

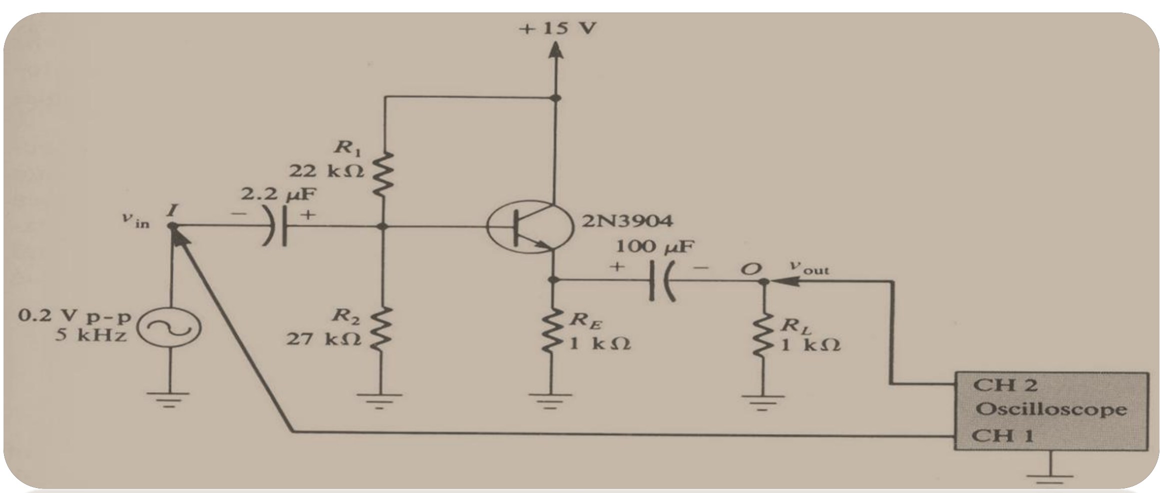
Pre-Lab:

1. Students must know about DC parameters i.e. I_E ,V_E , V_B , V_C
2. Students must know about AC parameters i.e. r_e , A_V
3. Must able to draw AC and DC equivalent circuit of CC Amplifier
4. Able to find out Voltage Gain(A_V)

Apparatus:

Resistors	**Capacitors**	**Signal generator**
68KΩ	100µf	**Dual trace oscilloscope**
1KΩ	2.2µf	**Breadboard**
100Ω	**2N3904 npn transistor**	**VOM**
22KΩ	**0-15 V dc power supply**	
27KΩ		

Schematic Diagram:



Procedure:

1. Build the circuit given above.
2. Verify the calculated dc parameters values with measured values record them in Table 1-1 and also find percentage error (% Error).
3. Compare the output voltage with load resistor (R_L) and without load resistor (R_L) and record them in Table 1-2.
4. Verify the calculated voltage gain value with measured value, record them in Table 1-3 and also find percentage error (% Error).

Observation Chart:

Table 3-1

Parameters	**Measured value**	**Expected value**	**% Error**
I_E			
V_E			
V_B			
V_C			

Table 3-2

V_{out}(with load resistor)	**V_{out}(without load resistor)**

Table 3-3

A_V (Measured) $A_V = V_{out} / V_{in}$	**A_V (Calculated)** $A_V = (R_E // R_L) / \{(R_E // R_L)+r_e\}$	**% Error**

Conclusion:

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Review Questions:

1. Emitter Follower uses ______________
    a. No collector resistor
    b. A forward bias collector-base junction
    c. Degeneration(negative feedback)
2. Voltage gain of CC Amplifier is_____________
    a. Below unity
    b. Unity
    c. Above unity
3. In CC Amplifier input resistance is______________ and output resistance is_____________
    a. Low, high
    b. Low, low
    c. High, low
4. The output signal of CC amplifier is ________________-of-phase with the input
    a. out
    b. in
    c. none of above
5. The power gain of CC amplifier is_____________
    a. High
    b. Low
    c. Medium

Experiment No 4

Objective:

To demonstrate the operation of Combination of CE Amplifier and Emitter Follower (CC) Amplifier

Introduction:

Combination of CE and CC Amplifier is known as phase-splitter or paraphase amplifier which is capable of producing two identical output signals to identical loads except that they are 180^o out-of-phase with each other. The output signal from the collector is simply a CE amplifier having unity voltage gain and also 180^o out-of-phase with the input signal. Output is from the emitter-follower and is in-phase with the input signal.

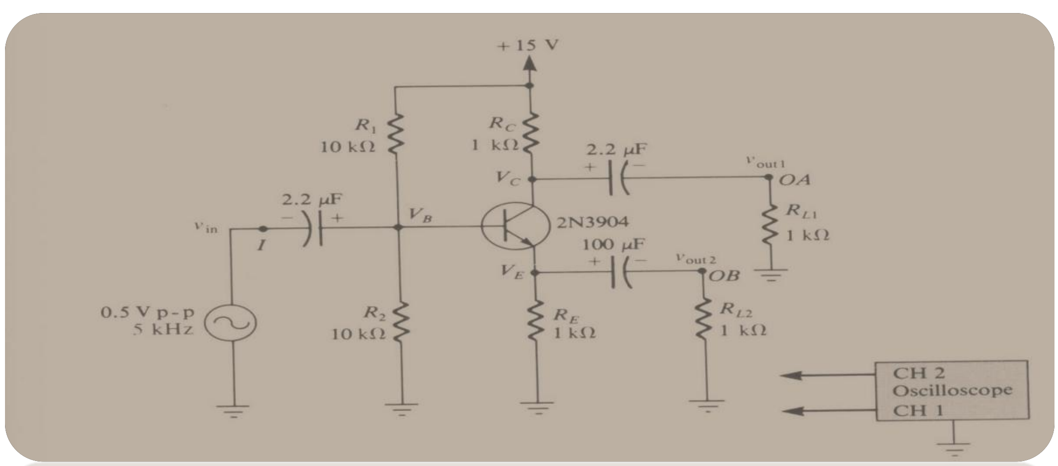
Pre-Lab:

1. Students must know about DC and AC parameters of CE and CC Amplifier
2. Purpose of partially by-pass emitter resistance
3. Effect of emitter by-pass capacitor on voltage gain

Apparatus:

Resistors	**Capacitors**	**Signal generator**
1KΩ	2.2µf	**Dual trace oscilloscope**
10KΩ	100 µf	**Breadboard Socket**
2N3904 npn transistor	**VOM**	
0-15 V dc power supply		

Schematic Diagram:



Procedure:

1. Build the circuit given above.
2. Verify the calculated dc parameters values with measured values record them in Table 1-1 and also find percentage error (% Error).
3. Compare the output voltage with load resistor (R_{L1}) and without load resistor (R_{L1}) and record them in Table 1-2.
4. Compare the output voltage with load resistor (R_{L2}) and without load resistor (R_{L2}) and record them in Table 1-2.
5. Verify the calculated voltage gain value with measured value, record them in Table 1-3 and also find percentage error (% Error).

Observation Chart:

Table 4-1

Parameters	Measured value	Expected value	% Error
I_E			
V_E			
V_B			
V_C			

Table 4-2

V_{out1} (with load resistor)	V_{out1}(without load resistor)
V_{out2} (with load resistor)	**V_{out2}(without load resistor)**

Table 4-3

A_V (Measured) $A_V = V_{out1} / V_{in}$	**A_V (Calculated)** $A_V = (R_C // R_{L1}) / \{(R_E//R_{L2})+r_e\}$	**% Error**
A_V (Measured) $A_V = V_{out2} / V_{in}$	**A_V (Calculated)** $A_V = (R_E //R_{L2}) / \{(R_E //R_{L2})+r_e\}$	**% Error**

Conclusion:

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Review Questions:

1. The voltage gain at either output for the phase-splitter circuit of Figure 4-1 is______________
    a. Increase significantly
    b. Decrease significantly
    c. Remains essentially the same
2. If R_{L1} in the circuit is omitted, output voltage will be_____________
    a. Increase significantly
    b. decrease significantly
    c. remains same
3. If R_{L1} in the circuit is omitted, output voltage will be_____________
    a. Increase significantly
    b. decrease significantly
    c. remains same
4. The two output signals are ________________out-of-phase with each other by
    a. 0^o
    b. 45^o
    c. 90^o
    d. 180^o

Experiment No 5

Objective:

To investigate the operation of inverting and non-inverting op-amp.

Introduction:

Inverting amplifier works in closed-loop mode while its output is invert of its input. The inverting amplifier's closed-loop voltage gain can be less than or greater than or equal to unity. On the other hand, the non-inverting amplifier's closed loop gain is always greater than unity. While input and output signals are always in-phase.

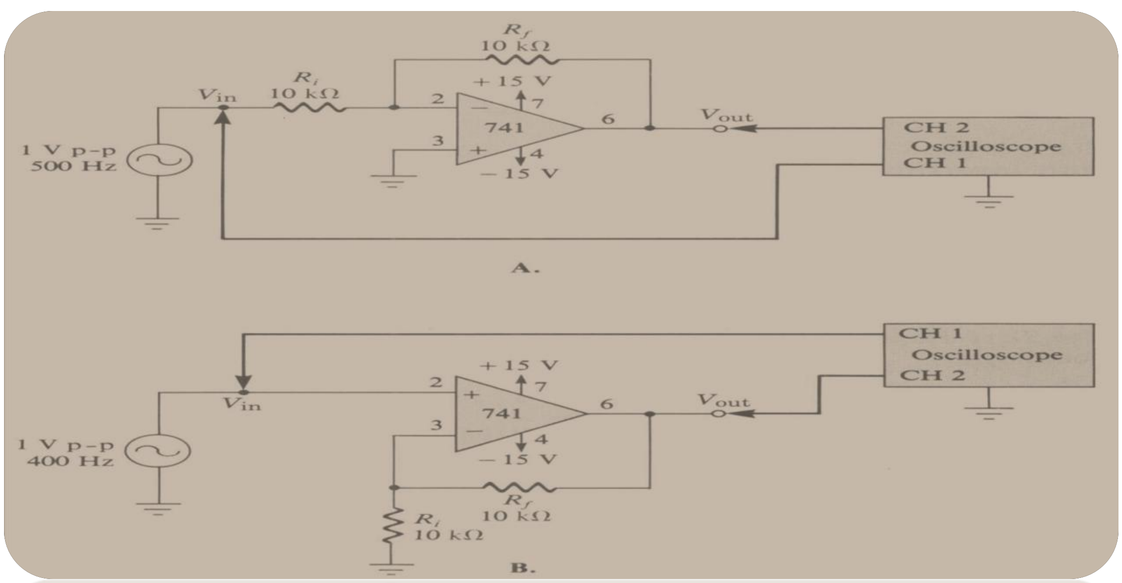
Pre-Lab:

1. Input and output impedance of inverting amplifier
2. Input and output impedance of non-inverting amplifier
3. Able to find out Voltage Gain(A_V)

Apparatus:

Resistors		**Signal generator**
1KΩ	22KΩ	**Dual trace oscilloscope**
4.7 KΩ	47KΩ	**Breadboard Socket**
10KΩ	47KΩ	**2N3904 npn transistor**
100KΩ		**0-15 V dc power supply**

Schematic Diagram:



Procedure:

Inverting Amplifier:

1. Build the circuit given above for inverting amplifier.
2. Adjust the input to 1Vp-p and frequency at 500 Hz. Compare input and output with the help of oscilloscope.
3. Measure the output Vp-p and record it in Table 5-1.
4. Now by changing the resistor R_f record output Vp-p and gain and record it in Table 5-1.

Non-inverting Amplifier:

1. Build the circuit given above for inverting amplifier.
2. Adjust the input to 1Vp-p and frequency at 500 Hz. Compare input and output with the help of oscilloscope.
3. Measure the output Vp-p and record it in Table 5-2.
4. Now by changing the resistor R_f record output Vp-p and gain and record it in Table 5-2.

Observation Chart:

Table 5-1: Inverting Amplifier

R_f	Measured value(V_{out})	Measured Gain	Expected Gain	% Error
10KΩ				
22KΩ				
47KΩ				
100KΩ				
4.7KΩ				
1KΩ				

Table 5-2: Non-inverting Amplifier

R_f	Measured value(V_{out})	Measured Gain	Expected Gain	% Error
10KΩ				
22KΩ				
47KΩ				
100KΩ				
4.7KΩ				
1KΩ				

Conclusion:

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Review Questions:

1. The voltage gain of an inverting amplifier is out-of-phase with its input signal by_____________
    a. 0^o
    b. 45^o
    c. 90^o
    d. 180^o
2. The voltage gain of an inverting amplifier is out-of-phase with its input signal by_____________
    a. 0^o
    b. 45^o
    c. 90^o
    d. 180^o
3. The Voltage gain of inverting amplifier is_____________
    a. Low, high
    b. Low, low
    c. High, low
4. The two output signals are ________________out-of-phase with each other by
    a. 0^o
    b. 45^o
    c. 90^o
    d. 180^o

Experiment No 6

Objective:

To investigate the operation of Common Mode Rejection (CMR) of an op-amp.

Introduction:

By the application of same input signal to both inputs of Op-Amp simultaneously is called Common Mode Rejection (CMR). In this condition, the output voltage of op-amp should be ‘zero’, since op-amp are not ideal devices therefore at this instant a small but a finite output voltage will present. The Common Mode input voltage to the generated output voltage is termed as common mode rejection or CMR. CMR is expressed in decibels. The higher the CMR, the better the rejection and the smaller the output voltage. CMR (noise) are the result of pick-up of radiated energy on the input lines from adjacent lines.

Pre-Lab:

1. Students must know about inverting and non-inverting configurations
2. Able to find out Voltage Gain (A_V)
3. Student also know about Op-amp’s input modes

Apparatus:

Resistors	**LM741 op-amp (8-pin mini-DIP)**	**VOM**
100KΩ	**Dual trace oscilloscopez**	**100-KΩ potentiometer**
10KΩ	**Breadboard Socket**	**Signal generator**
100Ω	**Two 0-15 V dc power supply**	

Schematic Diagram:

Procedure:

1. Build the circuit given above.
2. Set oscilloscope as following:
   Channel 1: 2 V/division, ac coupling. **Channel 2:** 0.02 V/division, ac coupling
   Time base: 5 ms/division
3. Set the signal to 10V peak-to-peak and a frequency of 60 Hz, measure rms common mode input and output voltages with the help of VOM and record in Table 6-1.
4. The CMR can be improved by trimming one or more resistor present in Figure given above. Replace R_4 with a 100-KΩ potentiometer and a 10-KΩ resistor, set all connections.
5. Adjust the 100-KΩ potentiometer for minimum output voltage, then observe the output by using oscilloscope.
6. Repeat step 3 and record the values in Table 6-2.

Observation Chart:

Table 6-1

Parameters	**Value**
Measured common-mode input voltage, $V_{in(cm)}$	V
Measured common-mode output voltage, $V_{out(cm)}$	V
Calculated common-mode voltage gain, $A_{cm} = V_{out(cm)} / V_{in(cm)}$	
Calculated differential voltage gain, $A_{v(d)} = R_2 / R_1$	
Calculated common-mode rejection , $CMR_{(dB)} = 20 \log (A_{v(d)} / A_{cm})$	dB

Table 6-2

Parameters	**Value**
Measured common-mode input voltage, $V_{in(cm)}$	V
Measured common-mode output voltage, $V_{out(cm)}$	V
Calculated common-mode voltage gain, $A_{cm} = V_{out(cm)} / V_{in(cm)}$	
Calculated differential voltage gain, $A_{v(d)} = R_2 / R_1$	
Calculated common-mode rejection , $CMR_{(dB)} = 20 \log (A_{v(d)} / A_{cm})$	dB

Conclusion:

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Review Questions:

1. In differential amplifier, the signal applied simultaneously to both input is the _______________
   a. Non- inverting input
   b. Inverting input
   c. Common mode input
2. Differential amplifier CMR is measured in ______________
   a. V
   b. dB
   c. V/ mS
3. An increase in common mode rejection ratio means increase in voltage By removing 10μf capacitor (by pass capacitor) output voltage will_______________
   1. Increase
   2. Decrease
   3. Remain constant
4. The output signal of CE amplifier is out-of-phase with the input by_______________
   a. 0^o
   b. 45^o
   c. 90^o
   d. 180^o
5. The power gain of CE amplifier is______________
   a. High
   b. Low
   c. Medium

Experiment No 7

Objective:

To measure the Slew rate of Op-amp.

Introduction:

Slew rate of an op-amp is defined as the maximum time rate of change of the output voltage of an op-amp in response to a step input voltage. It is expressed in volts per microsecond; the slew rate depends upon the frequency response of the internal stages of the op-amp. So higher the slew rate, higher will be the frequency response. The measurement of the op-amp‘s slew rate is always accomplished with a large amplifier having unity gain with a high input frequency signal.

Pre-Lab:

1. Student must know basic definition of Slew rate
2. Large signal parameter

Apparatus:

Resistors	**741 op-amp (8-pins mini DIP)**	**Signal generator**
10KΩ	**Dual trace oscilloscope**	**0-15 V dc power supply**
Breadboard		

Schematic Diagram:

Procedure:

1. Build the circuit given above.
2. Set oscilloscope as following:
   Channel 1: 5 V/division, ac coupling. **Channel 2:** 1 V/division, ac coupling
   Time base: 10 μs/division
3. Set the signal to 5V peak-to-peak square wave and a frequency of 10 kHz. Measure the peak-to-peak output voltage ΔV and Δt and record it in Table 7-1

Observation Chart:

Table 7-1

Parameters	Measured value
ΔV	
Δt	
Slew Rate	

Conclusion:

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Review Questions:

1. The maximum time rate of change of the output voltage of the circuit in response to a step input is termed as _______________.
   a. Gain band-width product
   b. Slew rate
   c. Output voltage swing
   d. Common mode rejection(CMRR)
2. The Slew Rate is usually specified in units of
   a. V/s
   b. V/ µs
   c. 180^o phase shift
3. By using 15V supply, the maximum possible output voltage swing is approximately
   a. 5V
   b. 15V
   c. 20V
   d. 30V
4. For an op-amp, the slew rate limits the
   a. Input impedance
   b. Common-mode rejection
   c. Voltage gain
   d. Frequency response
5. For the circuit of Fig. 7-1, if the output voltage swings from +5V to -10V in 0.5µs, the slew rate is
   a. 5 V/µs
   b. 15 V/µs
   c. 20 V/µs
   d. 30 V/µs

Experiment No 8

Objective:

To verify the operation of inverting and non-inverting comparator using op-amp LM741

Introduction:

A comparator determines whether an input voltage is greater than a predetermined reference level. Since a comparator operates in an open loop mode, the output voltage approaches either its positive or its negative supply voltage

Pre-Lab:

1. Comparator using op-amp
2. Inverting and non-inverting Op-amp comparator configuration

Apparatus:

Res istors	**741 op-amp (8-pins mini DIP)**	**Signal generator**
Two 1 kΩ	**0-15 V dc power supply**	
4.7KΩ	**Dual trace oscilloscope**	
Two 10 kΩ	**Breadboard**	
47 KΩ		

Schematic Diagram:

Procedure:

1. Build the circuit given in Fig. 8-1and Fig 8-2.
2. Set oscilloscope as following:
   Channel 1: 1 V/division, dc coupling. **Channel 2:** 10 V/division, dc coupling
   Time base: 1ms/division
3. Set the signal to 5V peak-to-peak square wave and a frequency of 300Hz connect oscilloscope at pin 6 and observe the output waveform.
4. Now build the circuit given in Fig. 8-3.
5. By power on the circuit, LED might glow or not depending potentiometer configuration.
6. If LED is on turn the potentiometer past the point at which LED is off.
7. At this point, measure voltage of op-amp at pin 2 with the help of oscilloscope and record it in Table 8-1.

Observation Chart:

Table 8-1

R_1	Measured V_{REF}	Measured $V_{IN(ON)}$
1KΩ		
10 KΩ		
47 KΩ		

Conclusion:

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Review Questions:

1. The reference voltage for the comparator in Fig.8-1
    a. 0V
    b. +15V
    c. -15V
    d. None of above
2. The circuit of Fig.8-2 is
    a. An inverting comparator
    b. A non-inverting comparator
3. For the circuit of Fig. 8-2-2,if the input signal is a sine wave ,The out put signal look like a
    a. Sine wave
    b. Sine wave, but inverted with respect to the input
    c. Square wave
    d. Square wave, but inverted with respect to the input
4. For the circuit of Fig. 8-3, If R_1 and R_2 are 10k Ω, the LED is lit, when the input voltage is
    a. Less then -7.5V
    b. 0V
    c. Greater than 7.5V
    d. Any voltage between-7.5V and +7.5V
5. For the circuit of Fig. 8-2,if the input voltage is greater than the reference voltage , the output voltage is approximately
    a. -13V
    b. -3V
    c. +3V
    d. +13V

Experiment No 9

Objective:

To verify the operation of differentiator using op-amp

Introduction:

A differentiator is a circuit that calculates the instantaneous slope of the line at every point on waveform. Differentiator and integrator has opposite operation, by integrating a waveform if waveform is differentiated original wave from will be obtained.

Pre-Lab:

1. Basic definition of Differentiator
2. Purpose of differentiator

Apparatus:

Res istors	**741 op-amp (8-pins mini DIP)**	**Capacitor**
2.2 kΩ	**0-15 V dc power supply**	0.0022µF
10KΩ	**Dual trace oscilloscope**	0.0047 µF
22 kΩ	**Breadboard**	
100 KΩ	**Signal generator**	

Schematic Diagram:

Procedure:

1. Build the circuit given in Fig. 9-1and Fig 9-2.
2. Set oscilloscope as following:
   Channel 1: 0.5V/division, dc coupling. **Channel 2:** 0.05 V/division, dc coupling
   Time base: 0.5 ms/division
3. Set the signal to 1V peak-to-peak triangular wave and a frequency of 400Hz connect oscilloscope at pin 6 and observe the output waveform.
4. Now temporarily remove the probe connected to channel 2 of the oscilloscope and adjust resulting straight line (ground level), reconnect the output differentiator and measure the negative peak voltage and record in Table 9-1.
5. Also change the frequency and perform the same steps and record them in Table 9-1.
6. Now by changing oscilloscope setting ;
   Channel 1: 0.5V/division, dc coupling. **Channel 2:** 0.05 V/division, dc coupling
   Time base: 0.5 ms/division
7. Observe the difference and record this observation in Table 9-2.

Observation Chart:

Table 9-1

Input frequency	Measured Peak output	Expected Peak output	% Error
400 Hz			
1 KHz			
30 KHz			

Table 9-1

Input frequency	Measured Peak output	Expected Peak output	% Error
400 Hz			
1 KHz			
30 KHz			

Conclusion:

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Review Questions:

6. The reference voltage for the comparator in Fig.8-1
   d. 0V
   e. +15V
   f. -15V
   g. None of above
7. The circuit of Fig.8-2 is
   d. An inverting comparator
   e. A non-inverting comparator
8. For the circuit of Fig. 8-2-2,if the input signal is a sine wave ,The out put signal look like a
   d. Sine wave
   e. Sine wave, but inverted with respect to the input
   f. Square wave
   g. Square wave, but inverted with respect to the input
9. For the circuit of Fig. 8-3, If R_1 and R_2 are 10k Ω, the LED is lit, when the input voltage is
   e. Less then -7.5V
   f. 0V
   g. Greater than 7.5V
   h. Any voltage between-7.5V and +7.5V
10. For the circuit of Fig. 8-2,if the input voltage is greater than the reference voltage , the output voltage is approximately
   d. -13V
   e. -3V
   f. +3V
   g. +13V

Experiment No 10

Objective:

To verify the operation of integrator using op-amp

Introduction:

An integrator is a circuit that computes the area underneath the curve of a given waveform. Differentiator and integrator are paired mathematical operations in that one has the opposite effect of the other.

Pre-Lab:

1. Basic definition of Integrator
2. Purpose of Integrator

Apparatus:

Res istors	**741 op-amp (8-pins mini DIP)**	**Capacitor**
2.2 kΩ	**0-15 V dc power supply**	0.0022µF
10KΩ	**Dual trace oscilloscope**	0.0047 µF
22 kΩ	**Breadboard**	
100 KΩ	**Signal generator**	

Schematic Diagram:

Procedure:

1. Build the circuit given in Fig. 10-1.
2. Set oscilloscope as following:
   Channel 1: 0.5V/division, dc coupling. **Channel 2:** 0.5 V/division, dc coupling
   Time base: 20 μs/division
3. Set the signal to 1V peak-to-peak triangular wave and a frequency of 10 KHz connect oscilloscope at pin 6 and observe the output waveform.
4. Now temporarily remove the probe connected to channel 2 of the oscilloscope and adjust resulting straight line (ground level), reconnect the output integrator and measure the negative peak voltage and record in Table 10-1.
5. Also change the frequency and perform the same steps and record them in Table 10-1.
6. Now by changing oscilloscope setting ;
   Channel 1: 0.5V/division, dc coupling. **Channel 2:** 0.5 V/division, dc coupling
   Time base: 2 ms/division
7. Observe the difference and record this observation in Table 10-2.

Observation Chart:

Table 10-1

Input frequency	Measured Peak output	Expected Peak output	% Error
400 Hz			
1 KHz			
30 KHz			

Table 10-1

Input frequency	Measured Peak output	Expected Peak output	% Error
400 Hz			
1 KHz			
30 KHz			

Conclusion:

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Review Questions:

11. The maximum frequency below which the circuit of Figure 34-1A acts a differentiator is approximately _______________
    h. 3 kHz
    i. 3.3 kHz
    j. 3.6 kHz
    k. 15 kHz
12. When the circuit of Figure 34-1A is acting as an amplifier, the voltage gain is ______________
    f. -10
    g. -1
    h. 1
    i. 10
13. The minimum frequency above which the circuit of figure 34-1B acts as an integrator is approximately _______________
    h. 720 Hz
    i. 3 kHz
    j. 1.7 kHz
    k. 3.4 kHz
14. A 2-kHz triangle waveform is applied to the circuit of Figure 34-1A. The output signal then looks like a _______________
    i. Triangle waveform with 0^0 phase shift
    j. Triangle waveform with 180^0 phase shift
    k. Square wave with 0^0 phase shift
    l. Square wave with 180^0 phase shift
15. A 2-kHz square wave is applied to the circuit of Figure 34-1B. The output signal then looks like a______________
    h. Triangle waveform with 0^0 phase shift
    i. Triangle waveform with 180^0 phase shift
    j. Square wave with 0^0 phase shift
    k. Square wave with 180^0 phase shift

Experiment No 11

Objective:

To investigate the Weighted Summer Operation

Introduction:

Figure shows that there are number of input signals, V_1, V_2 ……… Vn each applied to a corresponding resistor R1, R2, ………Rn, which are connected to inverting terminal of Opamp

Output is the weighted sum of the input signals V_1, V_2………. Vn. Each summing coefficient may be independently adjusted using R_1, R_2…….Rn

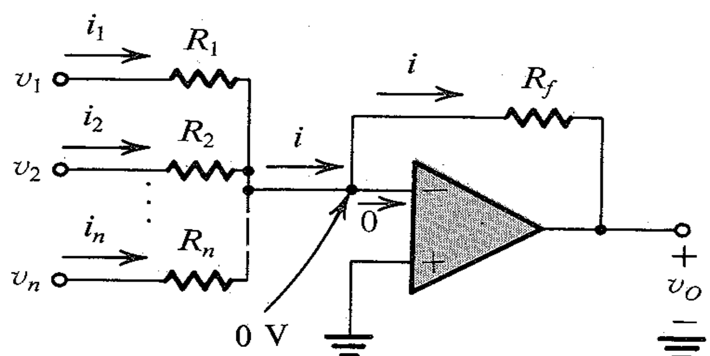
Pre-Lab:

6. Able to find out Voltage Gain(A_V)

Apparatus:

Resistance Sheet **Signal generator**
Dual trace oscilloscope
Breadboard
VOM
0-15 V dc power supply **Breadboard**

Schematic Diagram:



$$v_O = -\left(\frac{R_f}{R_1}v_1 + \frac{R_f}{R_2}v_2 + \cdots + \frac{R_f}{R_n}v_n\right)$$

Procedure:

5. Build the circuit given above.
6. Compare the output voltage with Input voltage-2.
7. Verify the calculated voltage gain value with measured value, record them in Table 1-1

Observation Chart:

Table 1-1

S.No	Input Signal		Output	Gain
	$V_{1(P-P)}$	$V2_{(P-P)}$	$V_{O(P-P)}$	

Conclusion:

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Experiment No 12

Objective:

To illustrate the operation of BJT Differential Pair
As a Swith
As an Amplifier

Introduction:

It consists of two matched transistors, Q1 & Q2, whose emitters are joined together and biased by constant current source I. It is essential that, collector circuits be such that Q1 & Q2 never enter saturation

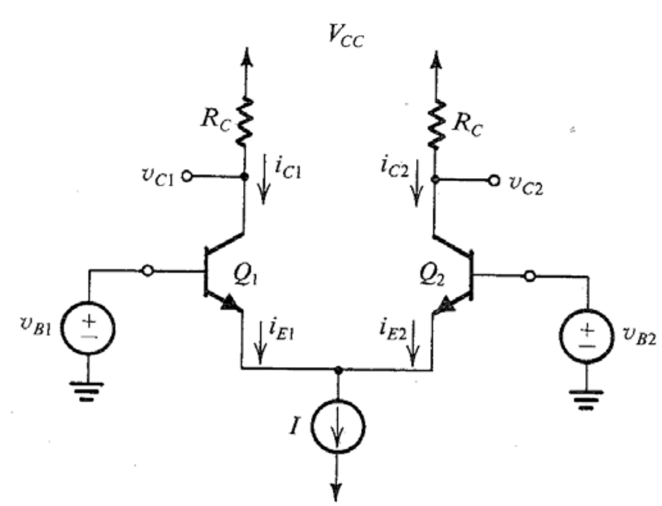
Pre-Lab:

7. Students must know about DC parameters i.e. I_E ,V_E , V_B , V_C
8. Students must know about AC parameters i.e. r_e , A_V
9. Must able to draw AC equivalent and DC equivalent circuit of CB Amplifier
10. Able to find out Voltage Gain(A_V)
11. Purpose of capacitors used in CB Amplifier
12. Effect of load resistance on voltage gain

Apparatus:

Resistance sheet
2N3904 npn transistor
Signal generator
Dual trace oscilloscope
Breadboard
VOM
0-15 V dc power supply

Schematic Diagram:



Procedure:

5. Build the circuit given above.
6. Verify the calculated dc parameters values with measured values record them in Table 1-1

Observation Chart:

Table 1-1

S.NO	V_{B1}	V_{B2}	V_{C1}	V_{C2}	$V_{C1}-V_{C2}$

Conclusion:

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Experiment No 13

Objective:

To investigate the operation of Common Source Amplifier and also determine phase shift

Introduction:

A Common Source Amplifier or Grounded Source Configuration is shown in figure. To establish a signal ground, or ac ground, a large capacitor is connected between source & ground. The signal current bypasses the output resistance of the current source & is called a bypass Capacitor. Cc1 is known as Coupling Capacitor, & acts as a perfect short circuit at all signal frequencies of interest

Pre-Lab:

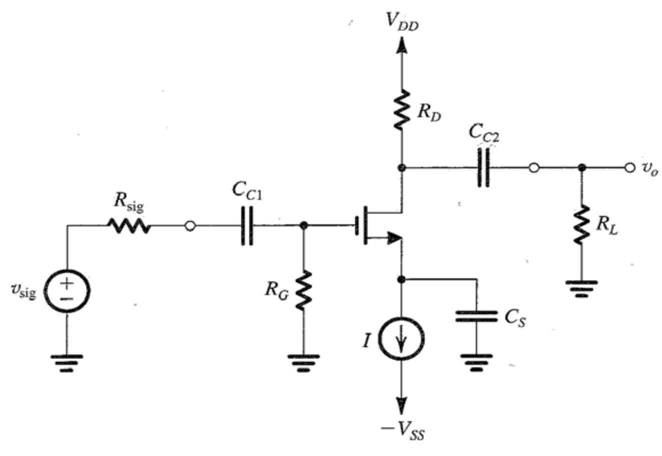
5. Students must know about DC parameters
6. Students must know about AC parameters, A_V
7. Able to find out Voltage Gain(A_V)

Apparatus:

Resistance Sheet
Capacitor: 10µf,0.001nf, 0.1nf

Signal generator
Dual trace oscilloscope
Breadboard
VOM
0-15 V dc power supply

Schematic Diagram:



Procedure:

5. Build the circuit given above.
6. Verify the calculated dc parameters values with measured values record them in Table 1-1

Observation Chart:

Table 1-1

S.NO	Frequency	Input(p-p)	Output(p-p)	gain

Conclusion:

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Experiment No 14

Objective:

To illustrate the operation of Common Gate Amplifier.

Introduction:

By establishing a signal ground on the MOSFET gate terminal, a circuit configuration called Common Gate is obtained. The input is applied to the source and output is taken at the drain terminal, with gate being the common terminal between input & output ports.

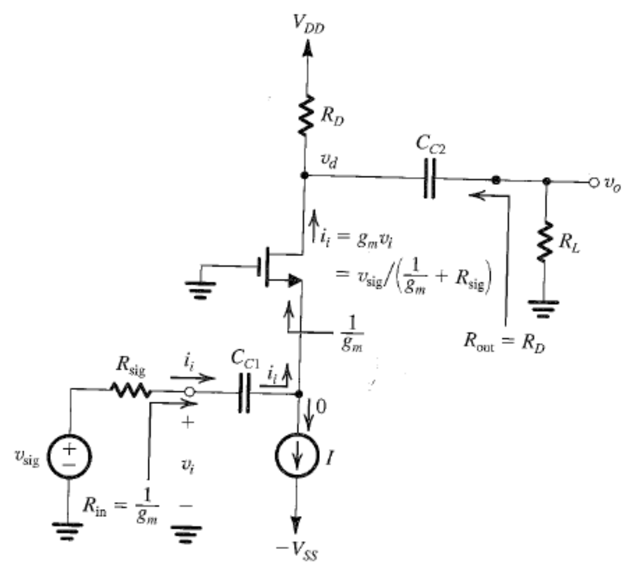
Pre-Lab:

4. Students must know about DC and AC parameters

Apparatus:

Resistance sheet	Capacitors	Signal generator
1KΩ	10µf	Dual trace oscilloscope
10KΩ	100 µf	Breadboard
		VOM
		0-15 V dc power supply

Schematic Diagram:



Procedure:

6. Build the circuit given above.
7. Verify the calculated dc parameters values with measured values record them in Table 1-1

Observation Chart:

Table 1-1

S.No	Frequency	Input(p-p)	Output(p-p)	gain
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Conclusion:

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