I

Name _____

Roll No. _____ Year 20____20____

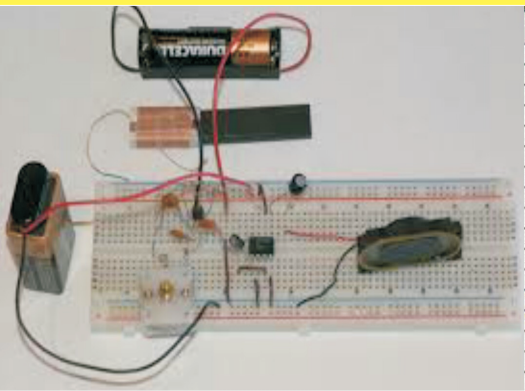
Exam Seat No. _____

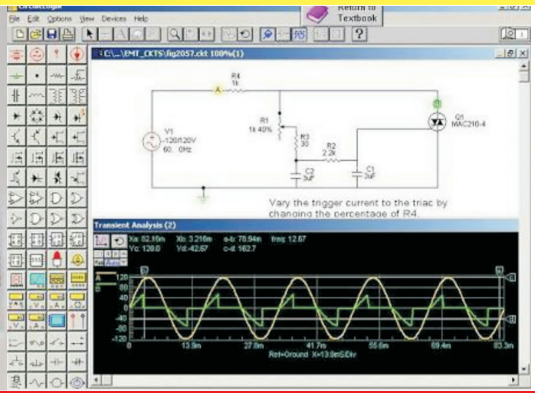
ELECTRONICS GROUP | SEMESTER - III | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

APPLIED ELECTRONICS (22329)





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(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

for

Applied Electronics

(22329)

Semester-III

(DE/EJ/IE/IS/IC/EJ/ET/EN/EX/EQ)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
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(Printed on June, 2018)

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Certificate

This is to certify that Mr. / Ms. ……..…… Roll No. ……..…., of Third Semester of Diploma in ……..…… of Institute, ……..……..…. (Code: ……...) has completed the term work satisfactorily in course **Applied Electronics (22329)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:.……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Enhanced use of electronic gadgets has made electronics engineers to deal with the various types of electronic circuits which generate the required analog/digital output. Transistor has remarkably expanded the utility of electronic equipment. Discrete components are widely used in amplifiers and other electronic systems which the engineering diploma holders (also called as technologist) have to use or maintain. The learning of basic operating principles of electronic circuits will help the students to troubleshoot electronic equipment. This course is developed in such a way that, students will be able to apply the knowledge of basic electronic circuit working to solve broad electronic engineering application problems.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course:-

PO1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.

PO2. **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.

PO3. **Experiments and practice:** Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

PO4. **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

PO5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Electronics and Telecommunication engineering.

PO6. **Environment and sustainability:** Apply Electronics and Telecommunication engineering solutions also for sustainable development practices in societal and environmental contexts.

PO7. **Ethics:** Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Electronics and Telecommunication engineering.

PO8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO9. **Communication:** Communicate effectively in oral and written form.

PO10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry.

Program Specific Outcomes (PSO) :-

PSO1. Electronics and Telecommunication Systems: Maintain various types of Electronics and Telecommunication systems.

PSO2. EDA Tools Usage: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits.

List of Industry Relevant Skills

The following industry relevant skills of the competency '**Use discrete electronic devices and voltage regulators**' are expected to be developed in students by undertaking the practicals of this laboratory manual.

1. Identify the electronic component.
2. Test electronic component
3. Select the electronic component of proper value as per the requirement.
4. Select the appropriate BJT/FET with the help of data sheet.
5. Use the heat sink for relevant active component.
6. Mount the electronic component on breadboard as per circuit diagram.
7. Test the circuit for the given application.
8. Compare the observed output with the expected output.
9. Find faults and trouble shoot the given circuit
10. Use appropriate EDA tool for simulation of electronic circuit

Practical- Course Outcome matrix

Course Outcomes (COs)

a. Use Transistor as low Power amplifier.
b. Use BJT as high Power amplifier.
c. Use BJT as feedback amplifier.
d. Use BJT as waveform generator.
e. Maintain IC voltage regulator and SMPS.

S. No.	Practical Outcomes(PRO)	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Build/ test the performance of single stage Low power common emitter amplifier.	√	-	-	-	-
2.	Simulate/test output Waveform of single stage common emitter (CE) amplifier using simulation software (like spice, multisim).	√	-	-	-	-
3.	Simulate/test the output Waveform of single stage common source FET amplifier using simulation software	√	-	-	-	-
4.	Build/ test the performance of single stage common source FET amplifier.	√	-	-	-	-
5.	Build/test the performance of two stage RC coupled common emitter amplifier using transistor.	√	-	-	-	-
6.	Build/ test the performance of two stage direct coupled amplifier using transistor.	√	-	-	-	-
7.	Build/Test the performance of transformer coupled amplifier. (Part-I)	√	-	-	-	-
8.	Build/Test the performance of transformer coupled amplifier.(Part-II)	√	-	-	-	-
9.	Build/test the performance of single tuned amplifier using transistor.	√	-	-	-	-
10.	Build/ test performance of double tuned common emitter amplifier. (Part-I)	√	-	-	-	-
11.	Build/ test performance of double tuned common emitter amplifier. (Part-II)	√	-	-	-	-
12.	Build/test performance parameters of single stage	-	√	-	-	-

	class A power amplifier.					
13.	Build/test performance parameters of class B push pull amplifier using transistor.	-	√	-	-	-
14.	Build/ test the performance of Audio power amplifier.	-	√	-	-	-
15.	Use transistor to build /test voltage series feedback amplifier parameters with and without feedback.	-	-	√	-	-
16.	Use transistor to built /test voltage shunt feedback amplifier parameters with and without feedback.	-	-	√	-	-
17.	Test the effect of positive and negative feedback on the given amplifier.(Part-I)	-	-	√	-	-
18.	Test the effect of positive and negative feedback on the given amplifier.(Part-II)	-	-	√	-	-
19.	Build RC phase shift oscillator and measure the generated frequency using CRO.	-	-	-	√	-
20.	Build Crystal oscillator and measure the generated frequency using CRO.	-	-	-	√	-
21.	Simulate Hartley oscillator using any relevant simulation software. (Like spice, multisim, Lab view, LTspice, Octeva).	-	-	-	√	-
22.	Generate a waveform Using Miller's sweep generator and measure sweep time and retrace time.	-	-	-	√	-
23.	Simulate dual voltage regulator using IC 78XX and 79XX for the specified regulated output voltage	-	-	-	-	√
24.	Build dual voltage regulator for the specified regulated output voltage.	-	-	-	-	√
25.	Build low voltage regulator using IC 723 for the given regulated output voltage.(2v to7v)	-	-	-	-	√
26.	Build high voltage regulator using IC 723 for the given regulated output voltage.(7v to 37v)	-	-	-	-	√
27.	Test the performance parameters of voltage regulator using IC LM 317.	-	-	-	-	√

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each practical
3. Involve students in performance of each practical.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.
9. If practical is in two parts -Part I and Part II it should be conducted in two turns.
10. Teacher is expected to refer complete curriculum document and follow guidelines for implementation
11. Assess the skill achievement of the students and COs of each unit.
12. At the beginning Teacher should make the students acquainted with any of the simulation software environment as few experiments are based on simulation.
13. Teacher is expected to refer complete curriculum document and follow guidelines for implementation before start of curriculum

Instructions for Students

1. Listen carefully the lecture given by teacher about course, curriculum, learning structure, skills to be developed.
2. Before performing the practical student shall read lab manual of related practical to be conducted.
3. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher***.
4. Organize the work in the group and make record of all observations.
5. Students shall develop maintenance skill as expected by industries.
6. Student shall attempt to develop related hand-on skills and gain confidence.
7. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
8. Student shall refer technical magazines, IS codes and data books.
9. Student should develop habit to submit the practical on date and time.
10. Student should well prepare while submitting write-up of exercise.

Content Page

List of Practicals and Progressive Assessment Sheet

18.	Positive and negative feedback (Part-II)	126					
19.	RC phase shift oscillator .	134					
20.	Crystal oscillator	142					
21.	Simulation of Hartley oscillator .	150					
22.	Miller sweep generator	158					
23.	Simulation of dual voltage regulator	166					
24.	Dual voltage regulator	174					
25.	Low voltage regulator using IC723	180					
26.	High voltage regulator using IC723	192					
27.	Voltage regulator using IC LM 317.	203					
Total							

- To be transferred to Proforma of CIAAN-2017.

Practical No.1: Single Stage Common Emitter Amplifier

I Practical Significance

Single stage low power amplifiers are generally used for small signal amplification in the electronic circuit. Low power amplifier is used in various electronic appliances and electronic communication. This practical will help the students to develop skills to build and test single stage low power common emitter amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic active and passive components.
2. Test BJT, resistors and capacitors.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Build/ test the performance of single stage low power common emitter amplifier.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Low power amplifier is an electronic device that can increase the power of a signal. An amplifier uses electric power from a power supply to increase the amplitude of a signal by an amplifier but not all amplifiers are the same as they are classified according to their circuit configurations and methods of operation. The classification of an amplifier depends upon the size of the signal, large or small, its physical configuration and how it processes the input signal, which is the relationship between input signal and current flowing in the load.

There are three different kinds of amplifier gain which can be measured and these are: *Voltage Gain* (Av), *Current Gain* (Ai) and *Power Gain* (Ap) depending upon the quantity being measured.

Voltage Gain, $A_v = V_{out}/V_{in}$

Current Gain, $A_i = I_{out}/I_{in}$

Power Gain, $A_p = A_v \times A_i$

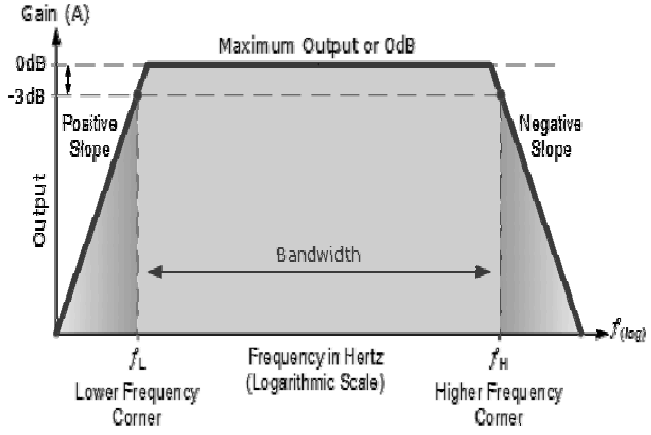

Figure 1.1 Frequency Response

VIII Practical Circuit diagram :

a) **Sample**

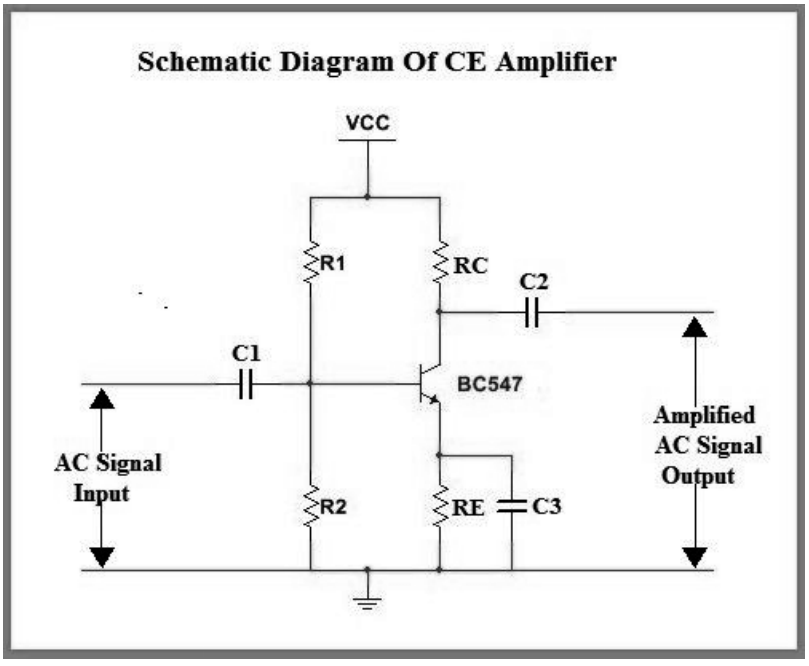

Figure 1.2 CE AMPLIFIER

Courtesy : https://www.google.co.in/search?q=practical+set+up+of+low+power+CE+amplifier&dcr=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjvqqqHsuHYAhWFr48KHQdkCZ8Q_AUICigB&biw=1242&bih=602#imgrc=JwowgGJ2x0azuM:

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
3.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
4.	Transistor	BC 547 or equivalent Transistor	1 No.	
5.	Resistors	R1=33KΩ,R2=3.3KΩ,RC=1.5KΩ, RE=470Ω	1 No.	
6.	Capacitors	C1=0.1µf, C2=0.1µf C3=10 µf	1 No.	
7.	Breadboard	5.5 cm X 17 cm	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the use of proper settings of function generator and CRO.

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Select appropriate amplitude (10 mV to 20 mV) and frequency (1 KHz) of sine wave input signal on function generator.
3. Connect function generator output to CRO and observe input sine wave signal on CRO.
4. Connect function generator at input terminals and CRO at output terminals of circuit.
5. Switch on DC Power Supply.
6. Observe output waveform on CRO.
7. Vary input frequency (100 Hz to 2 MHz) and note down output voltage from CRO.
8. Calculate Gain. Repeat step 7 for twenty readings.
9. Plot frequency response on semi-log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 1.1 Observation Table

Input Voltage in mV at 1 KHz (To be kept Constant), Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage,Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

Calculations:

i. Voltage Gain: Vo/Vi

ii. Gain in dB =20 log (Vo/Vi)

iii. 3 dB Bandwidth (B.W) = F_H-F_L

XVI Results

1. Bandwidth = ……(Hz/KHz/MHz)
2. Av(max)= ……dB

XVII Interpretation of Results (Give meaning of the above obtained results)

.....
.....
.....
.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

.....
.....
.....
.....

XIX Practical Related Questions :- (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Identify type of biasing used in circuit.
2. Suggest the changes required in circuit if PNP transistor is used.
3. Suggest equivalent transistor using datasheet.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. https://www.youtube.com/watch?v=NEiVSbPYWNE
5. https://www.sparkfun.com/datasheets/Components/BC546.pdf
6. https://www.google.co.in/search?q=semilog+paper+paper&dcr=0&tbm=isch&source=iu&ictx=1&fir=MoeylTf3DjG41M%253A%252CduGhD8XXNMsn8M%252C_&usg=__ROLCPnZZraikYL1pkpZgKnGHfRY%3D&sa=X&ved=0ahUKEwiI35-XquPYAhVFsI8KHe3 EAIMQ9QEIdDAR# imgrc= Moey lTf3DjG41M:

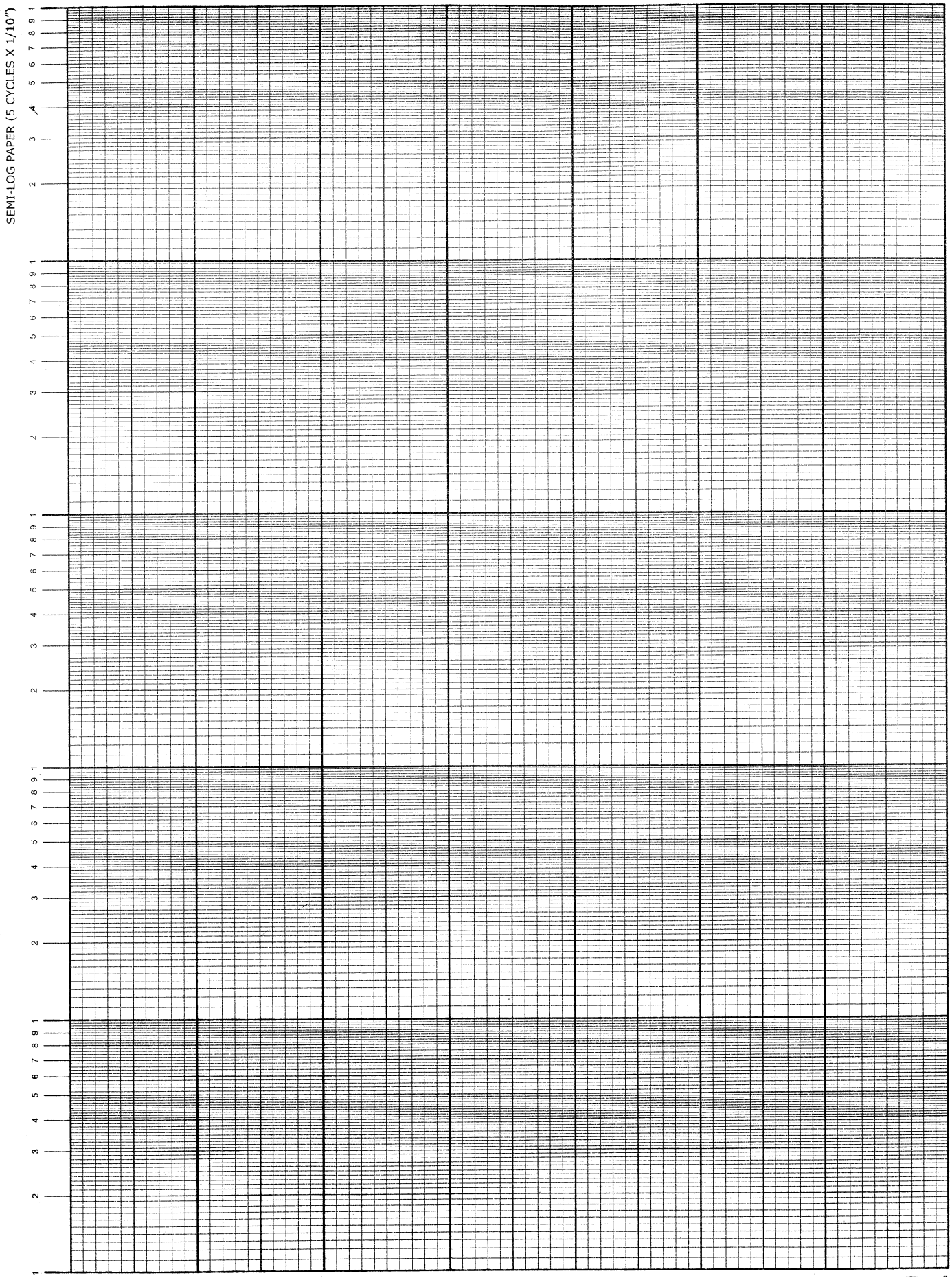
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the components	10 %
2	Mounting of component	20 %
3	Measuring value using CRO	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculation of Gain and Bandwidth	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions, Graph	15 %
9	Submitting the journal in time	05%
Total : 25 Marks		**100 %**

Names of Student Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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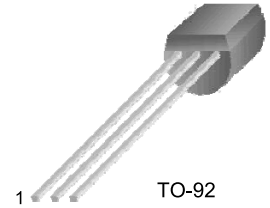


TO-92

1. Collector 2. Base 3. Emitter

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25° C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage : BC546	80	V
	: BC547/550	50	V
	: BC548/549	30	V
V_{CEO}	Collector-Emitter Voltage : BC546	65	V
	: BC547/550	45	V
	: BC548/549	30	V
V_{EBO}	Emitter-Base Voltage : BC546/547	6	V
	: BC548/549/550	5	V
I_C	Collector Current (DC)	100	mA
P_C	Collector Power Dissipation	500	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C

Electrical Characteristics T_a=25° C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}=30V, I_E=0			15	nA
h_{FE}	DC Current Gain	V_{CE}=5V, I_C=2mA	110		800	
V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA		90	250	mV
		I_C=100mA, I_B=5mA		200	600	mV
V_{BE} (sat)	Base-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA		700		mV
		I_C=100mA, I_B=5mA		900		mV
V_{BE} (on)	Base-Emitter On Voltage	V_{CE}=5V, I_C=2mA	580	660	700	mV
		V_{CE}=5V, I_C=10mA			720	mV
f_T	Current Gain Bandwidth Product	V_{CE}=5V, I_C=10mA, f=100MHz		300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		3.5	6	pF
C_{ib}	Input Capacitance	V_{EB}=0.5V, I_C=0, f=1MHz		9		pF
NF	Noise Figure : BC546/547/548	V_{CE}=5V, I_C=200∝ A		2	10	dB
	: BC549/550	f=1KHz, R_G=2KΩ		1.2	4	dB

Rev. A2, August 2002

Practical No.2: Simulation of Single Stage Common Emitter Amplifier

I Practical Significance

This practical will help the students to use EDA tools to build and test simple Electronics circuits such as single stage low power common emitter. Simulation of circuit is advantageous for Study the behavior of a system without building it, Results are accurate in general, compared to analytical model. Simulation modeling solves real-world problems safely and efficiently.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **EDA Tools Usage**: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant simulation software for designing and testing of electronic circuit.
2. Build the electronic circuit in software as per circuit diagram.
3. Test common emitter amplifier with help of simulation.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Simulate/test output Waveform of single stage common emitter (CE) amplifier using simulation software (like spice, multisim, LT spice, Labview, Octeva etc).

VI Relevant Affective domain related Outcome(s)

- Follow ethical practices.
- Demonstrate working as a leader/a team member
- Use of computer.

VII Minimum Theoretical Background

Electronic Design Automation (EDA) is a powerful technology in the field of modern Electronics technology. It does not have only strong design capabilities, but also has the testing, analysis and management capabilities. According to the EDA service objects, EDA software is classified into four kinds depend on circuit design and analysis, digital circuit design, radio frequency circuit design and printed circuit board (PCB) design such as Pspice, Multisim, Quartus II and Protel. It contains many kinds of components, which can be chosen to use in experiments, in the component database. At the same time, the new components can

be designed to expand the component database. It provides all kinds of virtual instruments that include universal instruments (multimeter, function generator, wattmeter and oscilloscope) and special instruments (bode plotter, word generator, logic analyzer, distortion analyzer and.

VIII Practical Circuit diagram :

a) Sample

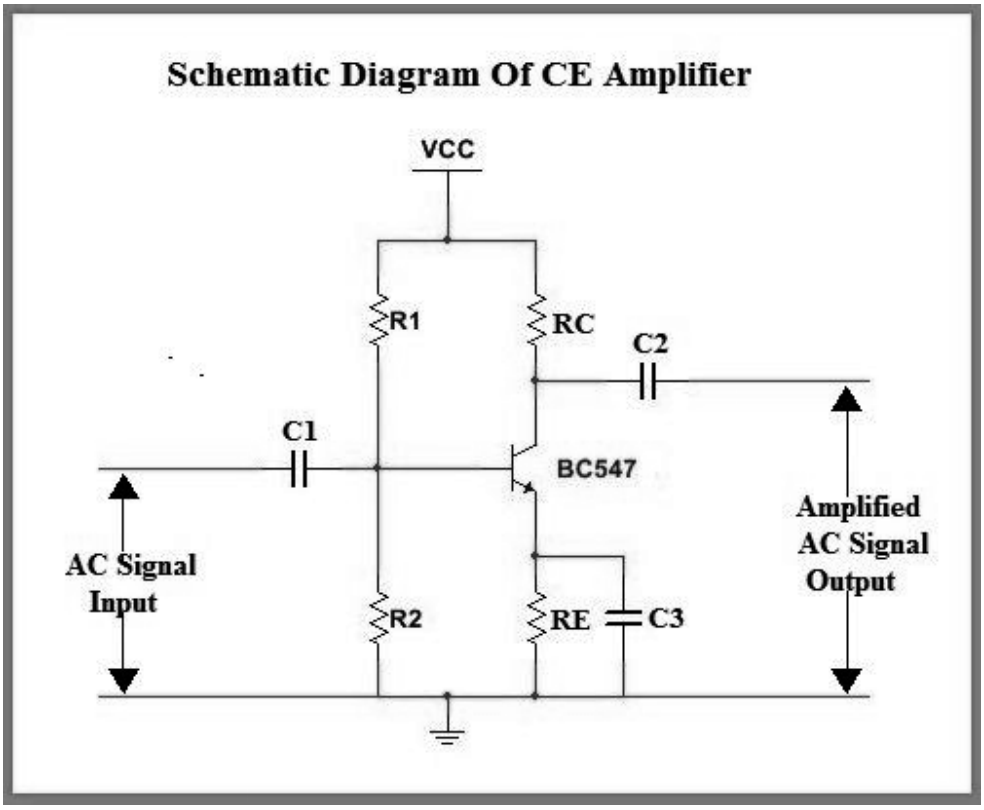


Figure 2.1 CE AMPLIFIER

(Courtesyhttps://www.google.co.in/search?q=practical+set+up+of+low+power+CE+amplifier&dcr=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjvqqqHsuHYAhWFr48KHQdkCZ8Q_AUICigB&biw=1242&bih=602#imgrc=JwowgGJ2x0azuM:)

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Computer with advanced Configuration	Latest Processor	1 No.	
2.	Simulation software	LT Spice /Lab view/H Spice /P Spice /HS Spice / Multisim/ Proteus/Octeva or any other relevant open source software	1 No.	

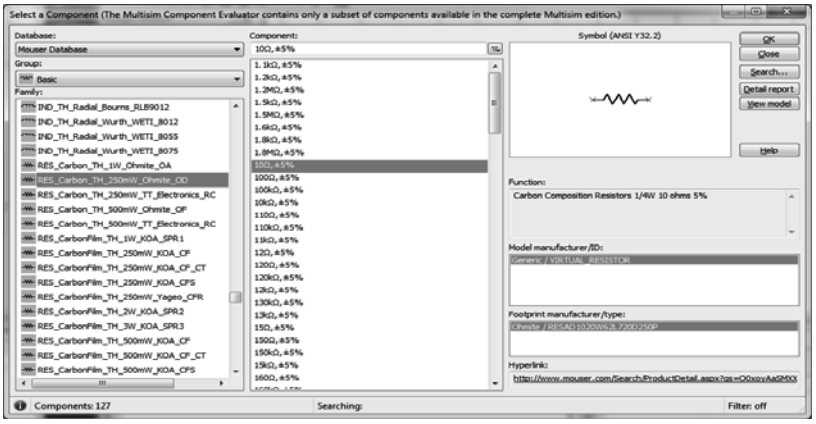
X Precautions to be Followed

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

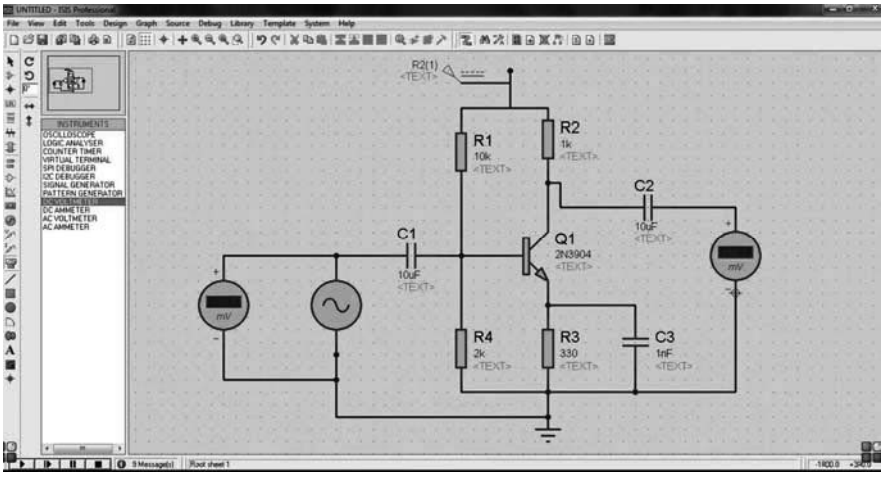
XI Procedure

1. Perform step by step Installation process of simulation software.

2. Select relevant electronic components from software library.



3. Build the common emitter amplifier in simulation software as per diagram.



4. Apply Input signal sine wave to the circuit.
5. Simulate /run the circuit.
6. Note down output voltage for input frequency (100Hz to 1MHz).
7. Take printouts of simulated circuit and frequency response on A-4 Paper

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 2.1 Observation Table

Input Voltage in mV (To be kept Constant),Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				

5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

Calculations:

i. Voltage Gain: Vo/Vi

ii. Voltage Gain in dB : 20log (Vo/Vi)

XVI Results

1. Bandwidth (B.W) = ……(KHz/MHz)
2. Av (max) = ……..dB

XVII Interpretation of Results (Give meaning of the above obtained results)

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.....
.....
.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

.....
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.....
.....

XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Write down the procedure of Installation of available Simulation Software.
2. Suggest the equivalent software to simulate single stage CE Amplifier circuit.

3. Calculate input resistance and output resistance using software practically.
4. ……
5. ……

[Space for Answers]

XX References / Suggestions for further reading

1. NI Multisim Lab Manual for Electricity and Electronics, Howard H. Gerrish, William E. Dugger Jr , Richard M. Roberts, Goodheart-Wilcox Publisher; ISBN :1590708830
2. http://chettinadtech.ac.in/storage/12-07-03/12-07-03-15-46-01-1581-mugaa08.pdf
3. https://www.youtube.com/watch?v=NEiVSbPYWNE
4. https://www.youtube.com/watch?v=Z3fTmABKzOE
5. https://link.springer.com/chapter/10.1007/978-3-642-27296-7_82
6. https://www.sparkfun.com/datasheets/Components/BC546.pdf
7. https://www.google.co.in/search?q=semilog+paper+paper&dcr=0&tbm=isch&source=iu&ictx=1&fir=MoeylTf3DjG41M%253A%252CduGhD8XXNMsn8M%252C_&usg=__ROLCPnZZraikYL1pkpZgKnGHfRY%3D&sa=X&ved=0ahUKEwiI35-XquPYAhVFsI8KHe3 EAIMQ9QEIdDAR# imgrc= Moey lTf3DjG41M:

XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of simulation software	10 %
2	Building of circuit diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculation of Gain and Bandwidth	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions, Graph	15 %
9	Submitting the journal in time	05%
Total : 25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. ……...
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Paste here printouts of Frequency response

Practical No.3: Simulation of Single Stage Common Source FET Amplifier

I Practical Significance

Common source FET configuration is the most widely used of all the FET circuit configurations for many applications, providing a high level of all round performance. This practical will help the students to build the single stage common source amplifier using EDA tool.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **EDA Tools Usage**: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Test field effect transistor, resistor, and capacitor.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Simulate/test the output Waveform of single stage common source FET amplifier using simulation software.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

The common source FET amplifier circuit provides a medium input and output impedance levels. Both current and voltage gain are medium, but the output is the inverse of the input, i.e. 180° phase change. This provides a good overall performance and hence the most widely used configuration.

VIII Practical Circuit diagram:

a) Sample

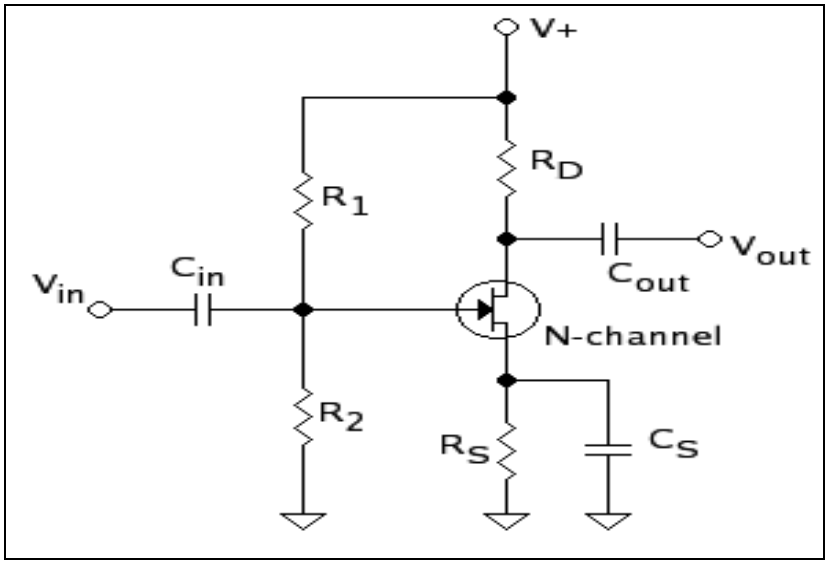


Figure 3.1 FET Amplifier

(Courtesy:
https://www.google.co.in/search?q=images+of+Common+source+amplifier&dcr=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj17Liw4-PYAhVCuY8KHYWuAMsQ_AUICigB&biw=1242&bih=602#imgrc=9f2oLkurIDI3SM:.)

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

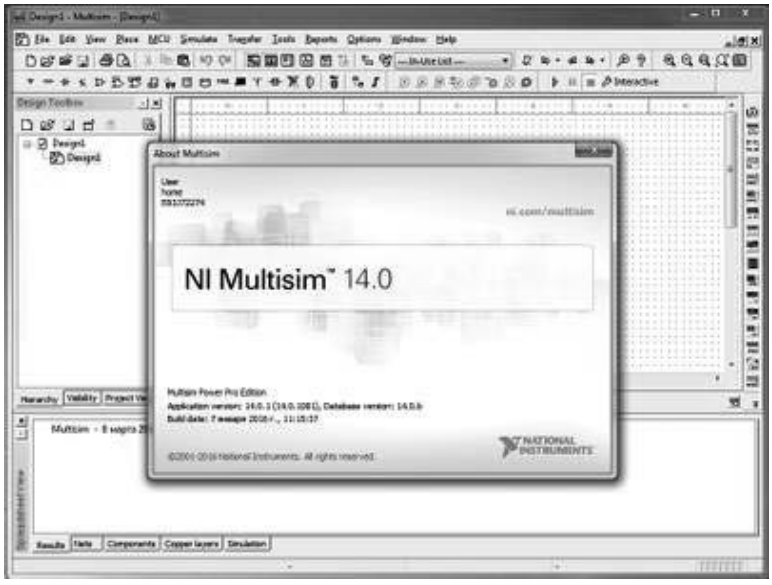
S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Computer with advanced Configuration	Latest Processor	1 No.	
2.	Simulation software	LT Spice /Lab view/H Spice /P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1 No.	

X Precautions to be Followed

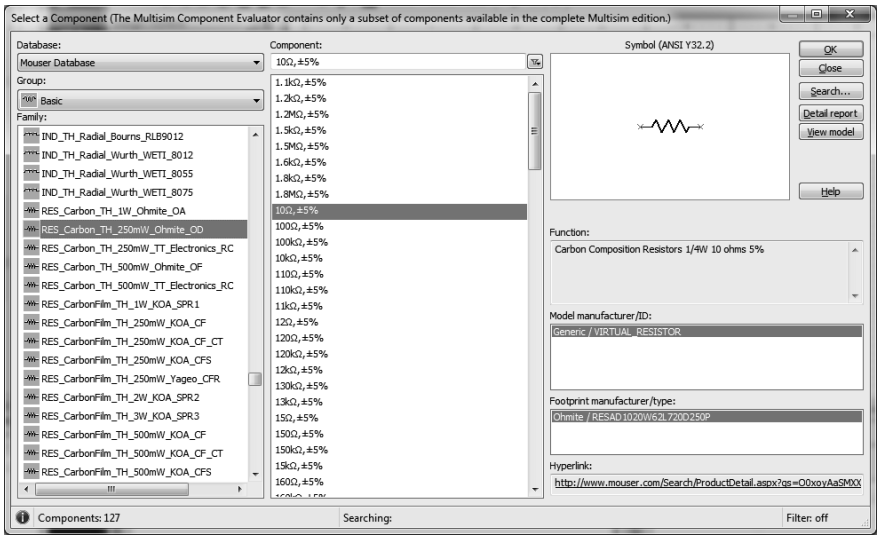
1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

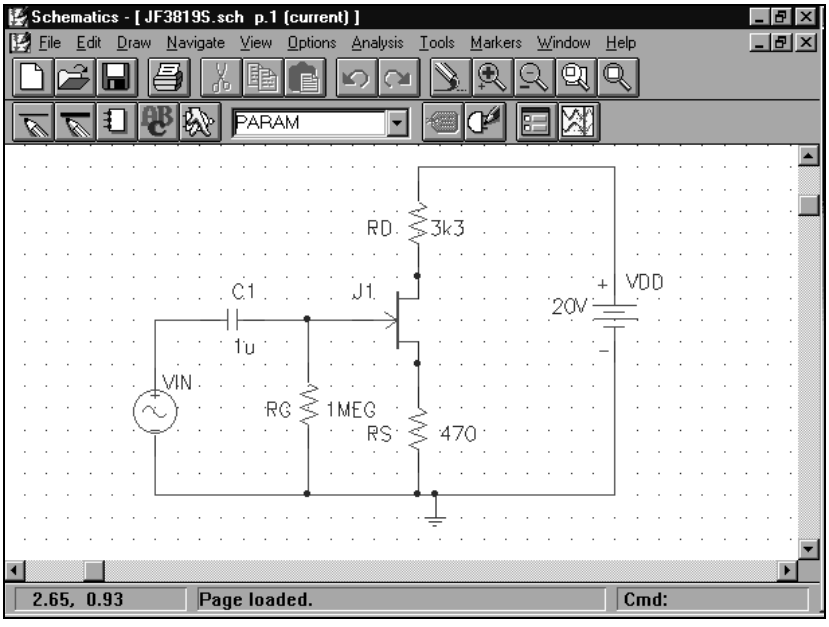
1. Perform step by step Installation process of simulation software.



2. Select relevant electronic components from software library.



3. Build the common Source amplifier in simulation software as per diagram.



4. Apply Input signal to the circuit.
5. Simulate /run the circuit.
6. Note down output voltage for input frequency (100Hz to 1MHz).
7. Take printouts of simulated circuit and frequency response on A-4 Paper

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 3.1 Observation Table

Input Voltage in mV(To be kept Constant),Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage,Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Calculations:

i. Voltage Gain : Vo/Vi

ii. Voltage Gain in dB : 20log (Vo/Vi)

XVI Results

1.Bandwidth (B.W) = ……(Hz/KHz/MHz)

2. Av(max) = ……dB

XVII Interpretation of Results (Give meaning of the above obtained results)

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.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

.....

.....

.....

XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. If P Channel FET is used in the circuit, what changes are to be made in the circuit?
2. The amplifier has voltage gain of 200, calculate gain in decibel.
3. Calculate 6 dB bandwidth using simulation software.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. NI Multisim Lab Manual for Electricity and Electronics, Howard H. Gerrish, William E. Dugger Jr , Richard M. Roberts, Goodheart-Wilcox Publisher; ISBN :1590708830
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. https://www.google.co.in/search?q=Text+book+on+simulation+of+common+source+FET+amplifier&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiekbvB6tfZAhVJQY8KHdavCysQ_AUICigB&biw=1600&bih=794#imgrc=4ZFqsITx21TVhM:
5. https://www.youtube.com/watch?v=MQJ0wkvqq8Q

XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of simulation software	10 %
2	Building of circuit diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculation of Gain and Bandwidth	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions, Graph	15 %
9	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..…….
2. ……..…..…
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Paste here printouts of Frequency response

Practical No. 4: Single Stage Common Source FET Amplifier

I Practical Significance

Common source FET configuration is probably the most widely used of all the FET circuit configurations for many applications, providing a high level of all round performance. A FET amplifier is an amplifier which uses one or more field-effect transistors (FETs). The main advantage of an FET used for amplification is that it has very high input impedance and low output impedance. This practical will help the students to develop practical skills to build circuit of single stage common source amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronic components i.e. active and passive
2. Test field effect transistor, resistor, and capacitor.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Build/test the performance of single stage common source FET amplifier.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

The field-effect transistor (FET) is a transistor that uses an electric field to control the electrical behavior of the device. FETs are also known as unipolar transistors. The common source circuit provides a medium input and output impedance levels. In electronics, a common-drain amplifier, also known as a source follower, is one of three basic single-stage field effect transistor (FET) amplifier topologies, typically used as a voltage buffer. These devices have the advantage over bipolar transistors 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.

VIII Practical Circuit diagram:

a) Sample

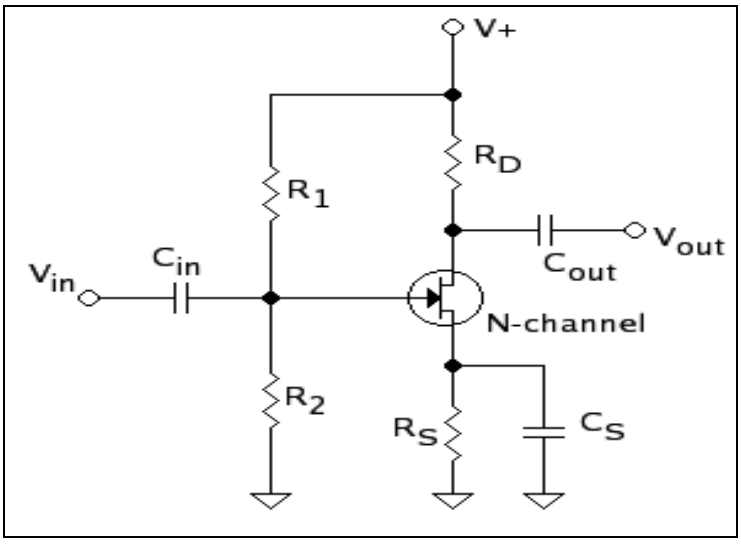

Figure 4.1 FET Amplifier

(Courtesy:
https://www.google.co.in/search?q=images+of+Common+source+amplifier&dcr=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj17Liw4-PYAhVCuY8KHYWuAMsQ_AUICigB&biw=1242&bih=602#imgrc=9f2oLkurIDI3SM:.)

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
3.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
4.	Field Effect Transistor	BFW10/BFW11 or any equivalent FET	1 No.	
5.	Resistors	R_1=300KΩ R_2=200KΩ Rs=2KΩ R_D=3KΩ	1 No.	
6.	Capacitors	C_1=50µf, C2=10µf, Cs=100µf,	1 No.	
7.	Breadboard	5.5 cm X 17 cm	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in ‘off’ condition initially.
3. Ensure the use of proper settings of function generator and CRO.

XI Procedure

1. Make circuit connections as per diagram.
2. Connect function generator at input and CRO at the output terminals of circuit.
3. Select appropriate amplitude and frequency on function generator.
4. Switch on DC Power Supply, function generator and CRO.
5. Vary input frequency and note down output voltage on CRO.
6. Observe output waveform of CRO
7. Calculate Gain. Repeat step 5 & 6.
8. Plot frequency response on semilog paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 4.1 Observation Table

Input Voltage in Mv (To be kept Constant),Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

Calculations :

i. Voltage Gain : Vo/Vi

ii. Voltage Gain in dB : 20 Log (Vo/Vi)

iii. 3 dB Bandwidth (B.W) = F_H-F_L

XVI Results

1. Bandwidth =…..……(Hz/KHz/MHz)
2. Av(max)= ……dB

XVII Interpretation of Results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Identify type of biasing used in FET amplifier circuit.
2. Suggest equivalent Field Effect Transistor using datasheet.
3. State operating and storage junction temperature range of BFW10 from using datasheet

[Space for Answers]

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XX References / Suggestions for further reading

1. Design of FET by Edmar Camango
2. Semiconductor Devices and Circuits Paperback- 2015 by Prof. C.S. Murlidhara Sharma
3. https://coefs.uncc.edu/dlsharer/files/2012/04/J6.pdf
4. https://www.electronics-tutorials.ws/amplifier/amp_3.html
5. https://www.youtube.com/watch?v=Z86n3mOGM-Q

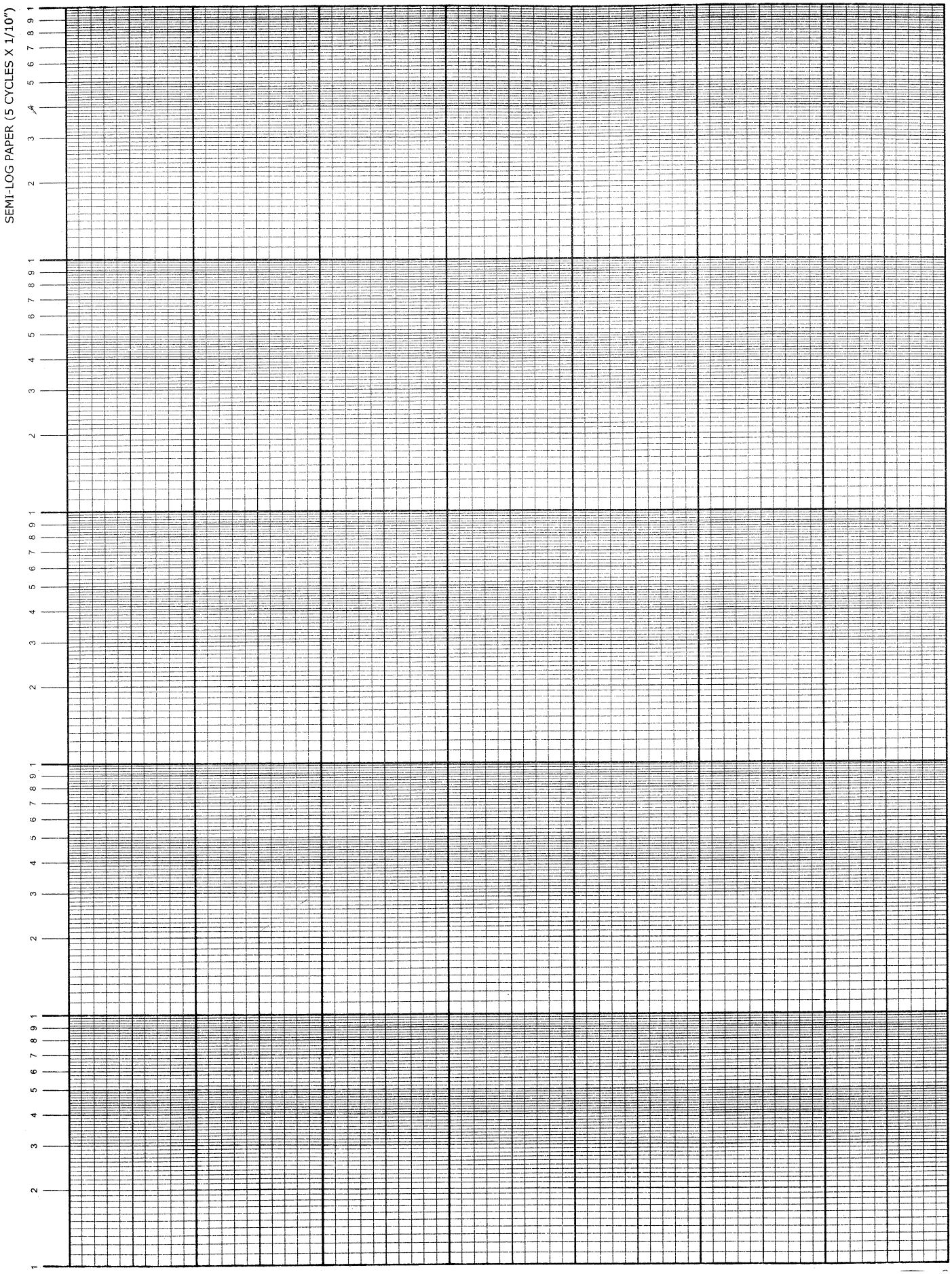
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the components	10 %
2	Mounting of component	20 %
3	Measuring value using CRO	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculation of gain and bandwidth	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions, Graph	15 %
9	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

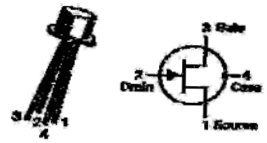
1. ……..
2. ……..…….
3. ……
4. ……..…….

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


SEMI-LOG PAPER (5 CYCLES X 1/10")

BFW10
BFW11

CASE 20-03, STYLE 1
TO-72 (TO-206A)



JFET
VHF/UHF AMPLIFIER

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	−30	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	—	—	Vdc
Gate-Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 0.5 nAdc)	BFW10 BFW11	$V_{GS(off)}$	—	—	8 6	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSS}	—	—	0.1	nAdc
Gate-Source Voltage (V_{DS} = 15 Vdc, I_D = 400 μAdc)	BFW10	V_{GS}	2	—	7.8	Vdc
Gate-Source Voltage (V_{DS} = 15 Vdc, I_D = 50 μAdc)	BFW11	V_{GS}	1.25	—	4	Vdc
ON CHARACTERISTICS						
Zero-Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	BFW10 BFW11	I_{DSS}	8 4	—	20 10	mAdc
SMALL-SIGNAL CHARACTERISTICS						
Forward Transadmittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	BFW10 BFW11	Y_{fs}	2.5 3.0	— —	6.5 6.5	mmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	BFW10 BFW11	Y_{os}	— —	— —	80 50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0 Vdc, f = 1.0 MHz)		C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0 Vdc, f = 1.0 MHz)		C_{rss}	—	—	0.8	pF
Forward Transadmittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)		Y_{fs}	3.2	—	—	mmhos
Equivalent Noise Voltage (V_{DS} = 15 Vdc, V_{GS} = 0, f = 25 Hz)		e_n	—	—	75	nV/√Hz
Noise Figure (V_{DS} = 15 Vdc, V_{GS} = 0 V, see Figures 1, 2, 3)		NF	—	—	2.5	dB

Practical No. 5: Two Stage Rc Coupled Common Emitter Amplifier

I Practical Significance

An amplifier is the basic building block of most electronic systems. Just as one brick does not make a house, a single stage amplifier is not sufficient to build a practical electronic system. The gain of the single stage is not sufficient for practical applications. The voltage level of a signal can be raised to the desired level if we use more than one stage. When a number of amplifier stages are used in succession (one after the other) it is called a multistage amplifier or a cascade amplifier. Much higher gains can be obtained from the multi-stage amplifiers. This practical will help the students to use appropriate coupling of amplifiers.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Test transistor, resistor and capacitor.
3. Build multistage amplifier using BJT .

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Build/test the performance of two stage RC coupled common emitter amplifier using transistor.

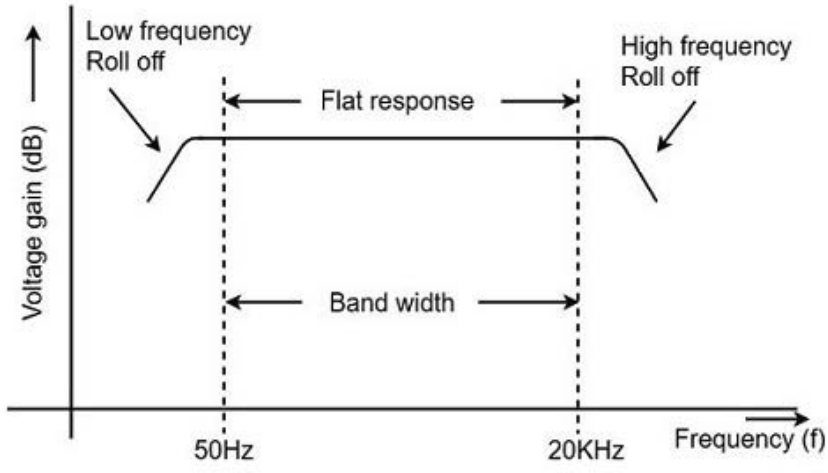
VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

In a multi-stage amplifier, the output of one stage makes the input of the next stage. We must use a suitable coupling network between two stages so that a minimum loss of voltage occurs when the signal passes through this network to the next stage. Also, the dc voltage at the output of one stage should not be permitted to go to the input of the next. If it does, the biasing conditions of the next stage are disturbed.

Frequency response curve is a graph that indicates the relationship between voltage gain and function of frequency. The frequency response of a RC coupled amplifier is as shown in the following graph.



From the above graph, it is understood that the frequency decreases for the frequencies below 50Hz and for the frequencies above 20 KHz. whereas the voltage gain for the range of frequencies between 50Hz and 20 KHz is constant.

VIII Practical Circuit diagram :

a) Sample

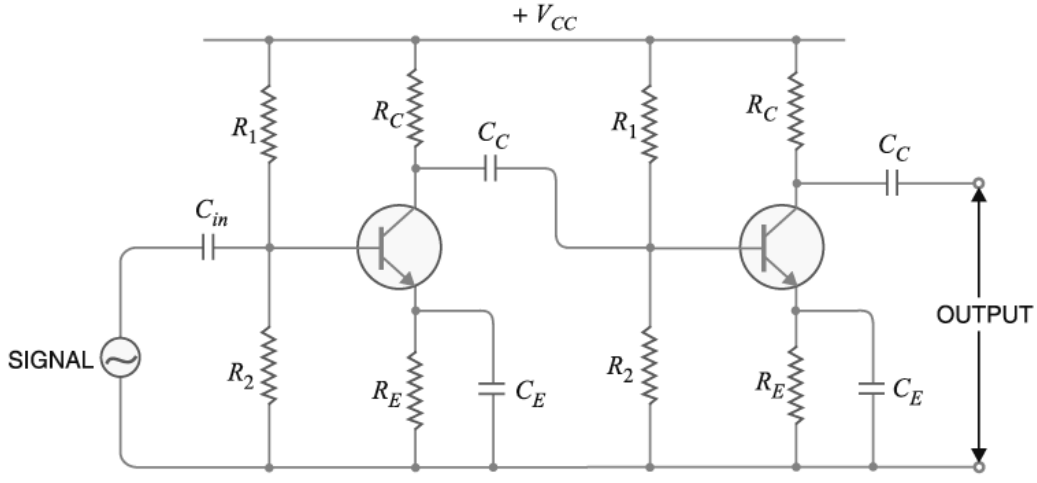
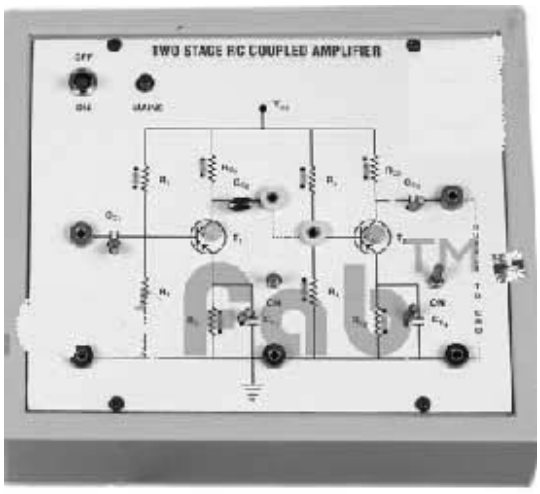


Figure 5.1 Two stage RC coupled Amplifier

Courtesy:https://www.google.co.in/search?q=two+stage+rc+coupled+amplifier+circuit+diagram&source=lnms&tbm=isch&sa=X&ved=0ahUKEwimzufShNjZAhUKtY8KHcfpAggQ_AUICigB&biw=1600&bih=794#imgrc=eSCguv9rihWt5M

b) Actual Circuit used in laboratory/ Actual Experimental set up used in laboratory



IX Resources Required

S. No.	Instrument/ Component	Specification	Quantity	Remark
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
3.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
4.	Transistor	BC 547 or equivalent Transistor	2 No.	
5.	Resistors	R1=33KΩ,R2=3.3KΩ,RC=1.5KΩ, RE=470Ω	2 No.	
6.	Capacitors	C1=0.1µf, C2=0.1µf C3=10 µf	2 No.	
7.	Breadboard	5.5 cm X 17 cm	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the use of proper settings of function generator and CRO.

XI Procedure

1. Make circuit connections as per diagram.
2. Connect function generator at input and CRO at the output terminals of circuit.
3. Set appropriate amplitude and frequency of sine wave signal on function generator.
4. Switch on DC Power Supply, function generator and CRO.

5. Vary input frequency and note down output voltage on CRO.
6. Observe output waveform of CRO
7. Calculate Gain. Repeat step 5 & 6.
8. Plot frequency response on semi log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 5.1 Observation Table

Input Voltage in mV(To be kept Constant),Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				
5.				
6.				

7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

Calculations :

i. Voltage Gain : Vo/Vi

ii. Voltage Gain in dB : 20 log (Vo/Vi)

iii. 3 dB Bandwidth (B.W) = F_H-F_L

Results

1. Bandwidth =…..……(Hz/KHz/MHz)
2. Av(max) = ……dB

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Identify type of coupling used in circuit.
2. Calculate gain of Two Stage Amplifier if gain of amplifier 1 is 100 & gain of amplifier 2 is 200?
3. Suggest equivalent Transistor for multistage amplifier using datasheet.

[Space for Answers]

XIX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. https://www.youtube.com/watch?v=44UNkKddNdw
4. https://www.youtube.com/watch?v=7HxGCFMCNYE

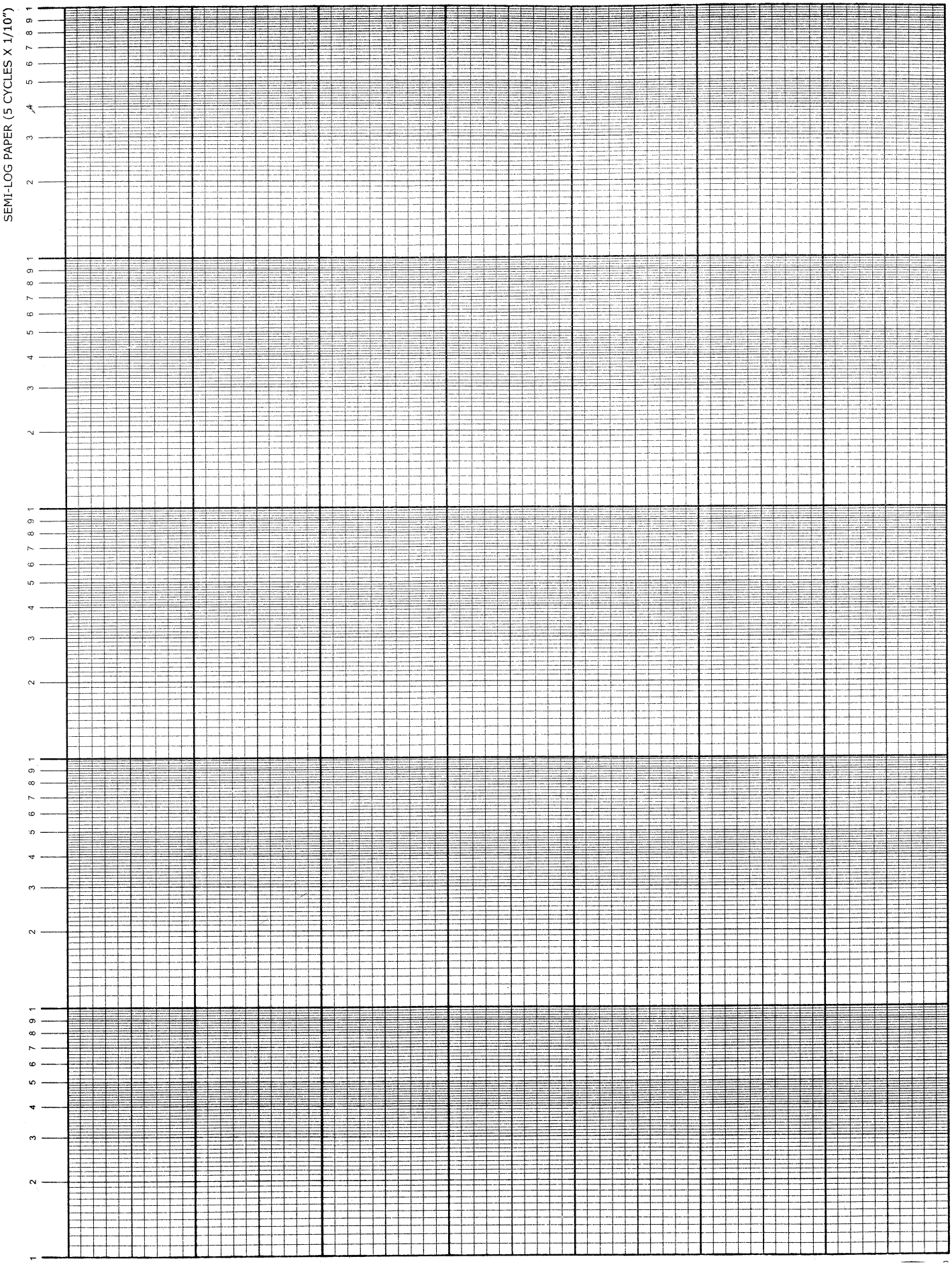
XX Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of gain and bandwidth	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total:25 Marks		**100 %**

Names of Student Team Members

1. ……..…..
2. …….
3. ……..……
4. ……..…..…

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


SEMI-LOG PAPER (5 CYCLES X 1/10")

Practical No. 6: Two Stage Direct Coupled Amplifier

I Practical Significance

The frequency response of the direct coupled amplifier is similar to low pass filter and hence it is also known as "Low-Pass Amplifier". The amplification of DC (zero frequency) is possible only by this amplifier; hence it later becomes the building block for differential amplifier and operational amplifier. This practical will help the students to use appropriate coupling of amplifiers and differentiate between types of coupling.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronic components i.e. active and passive
2. Test transistor, resistor, and capacitor.
3. Build and test direct coupled amplifier using BJT
4. Select multistage amplifier for relevant application

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Build/test the performance of two stage Direct Coupled common emitter amplifier using transistor.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

Direct-coupled amplifiers are used in TV receivers, computers and other electronic instruments. It also forms a building block for differential amplifiers and operational amplifiers. There are several advantages of using this type of amplifier, including:

- Simple circuit arrangement as there are minimum number of components
- For above reason, also quite inexpensive
- Can be used to amplify zero and low frequency signals

Frequency response curve is a graph that indicates the relationship between voltage gain and function of frequency. The frequency response of a DC coupled amplifier is as shown in the following graph.

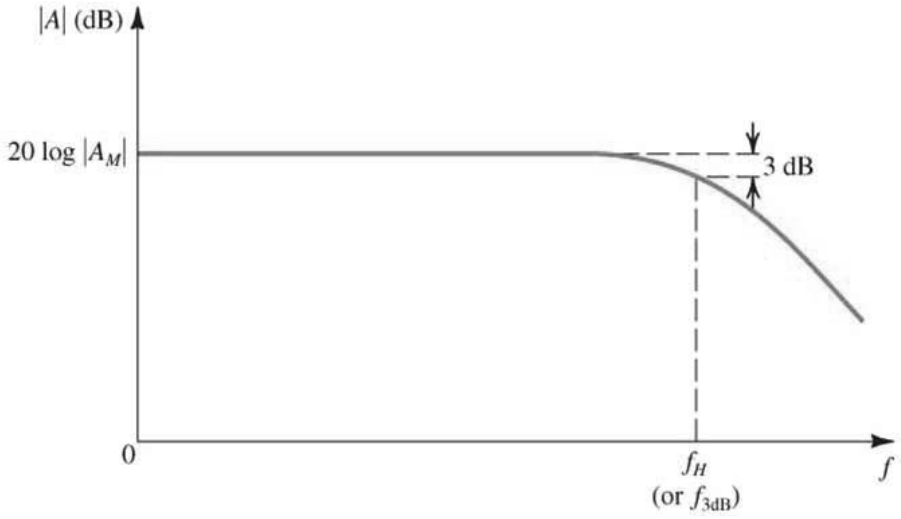


Figure 6.1 : Frequency Response of Direct Coupled amplifier

VIII Practical Circuit diagram :

a) Sample

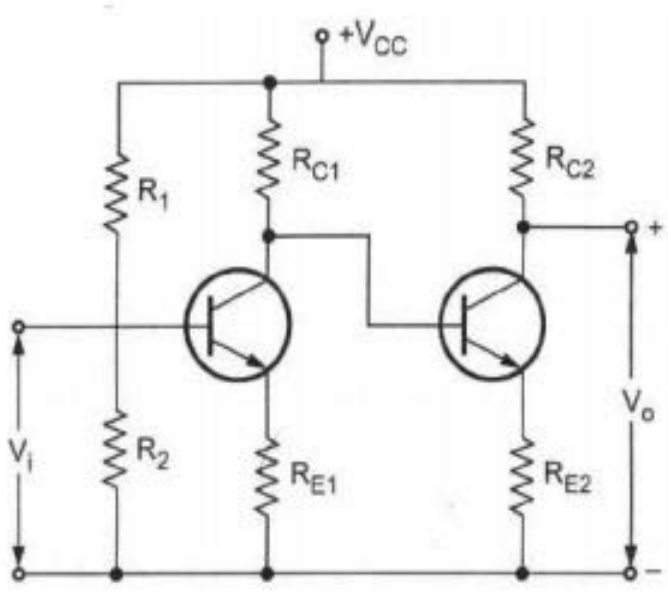


Figure 6.2 Two stage Direct coupled Amplifier

Courtesy:
https://www.google.co.in/search?tbm=isch&q=two+stage+DIRECT+coupled+amplifier+circuit+diagram&chips=q:two+stage+direct+coupled+amplifier+circuit+diagram,online_chips:multistage&sa=X&ved=0ahUKEwiKp7nGidjZAhXFgI8KHVAFAaIQ4lYILigJ&biw=1600&bih=794&dpr=1#imgrc=JZRUOCrawjiYTM:

b) Actual Circuit used in laboratory /Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument/ Component	Specification	Quantity	Remark
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
3.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
4.	Transistor	BC 547 or equivalent Transistor	2 No.	
5.	Resistors	R1=33KΩ,R2=3.3KΩ,RC=1.5KΩ, RE=470Ω	2 No.	
6.	Breadboard	5.5 cm X 17 cm	1 No.	
7.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the use of proper settings of function generator and CRO.

XI Procedure

1. Make circuit connections as per diagram.
2. Connect function generator at input and CRO at the output terminals of circuit.
3. Select appropriate amplitude and frequency of sine wave input on function generator.
4. Switch on DC Power Supply, function generator and CRO.
5. Vary input frequency and note down output voltage on CRO.
6. Observe output waveform of CRO
7. Calculate Gain. Repeat step 5 and 6.
8. Plot frequency response on semi log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 6.1 Observation Table

Input Voltage in mV (To be kept Constant), Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

Calculations:

i. Voltage Gain : Vo/Vi

ii. Voltage Gain in dB : 20 log (Vo/Vi)

iii. 3 dB Bandwidth, (B.W) = F_H-F_L

XVI Results

1. Bandwidth =……(Hz/KHz/MHz)
2. Av(max) = ……..dB

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. List type of coupling. Identify type of coupling used in circuit.
2. Compare frequency response of two stage RC coupled and DC coupled Amplifier?
3. Suggest type of multistage amplifier used in TV receivers, computers etc.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. https://www.youtube.com/watch?v=nLEvB3aZrrs

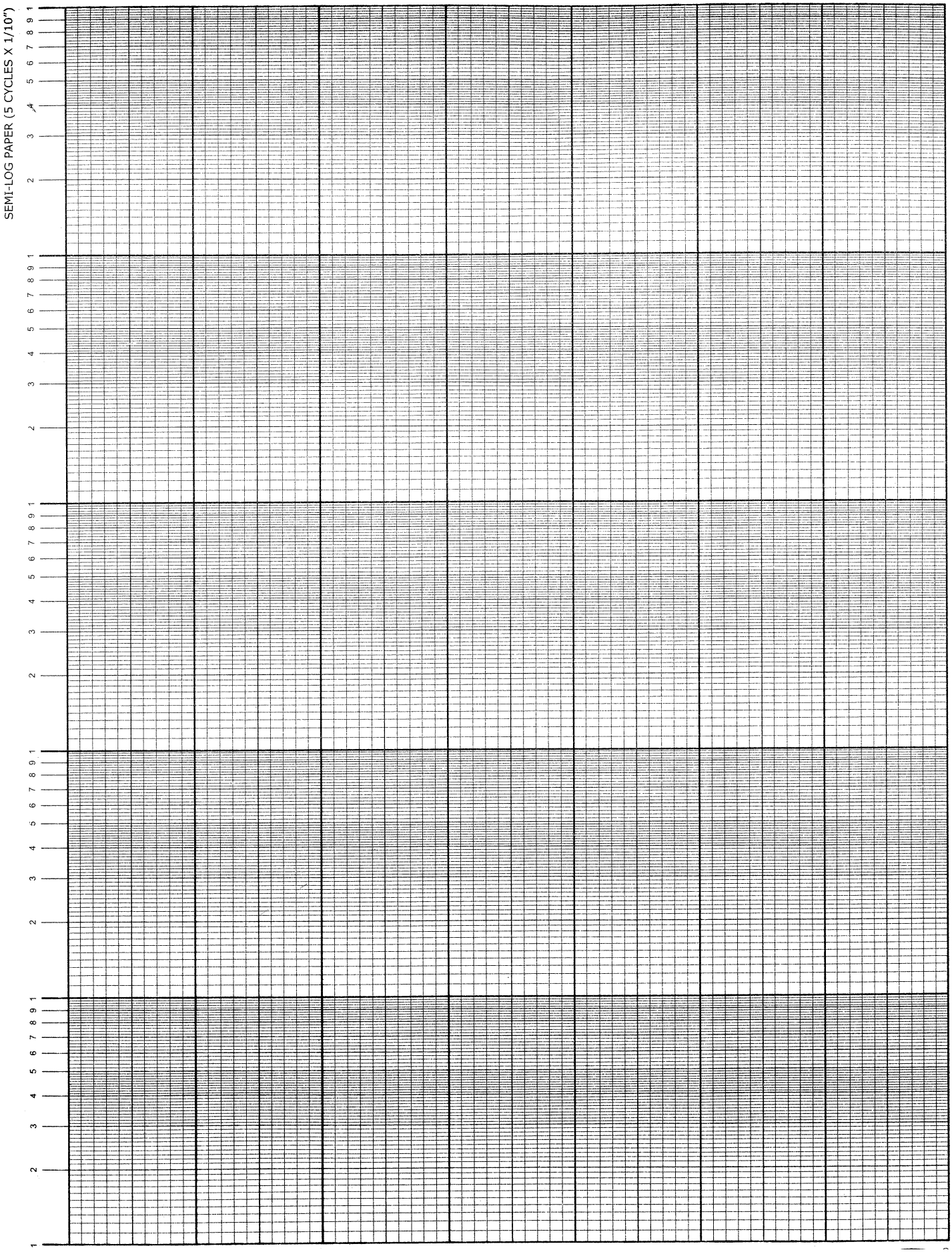
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of gain and bandwidth	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..……..
2. ……
3. ……..……
4. ……..…

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


SEMI-LOG PAPER (5 CYCLES X 1/10")

Practical No.7 and 8: Transformer Coupled Amplifier (Part-I and II)

I Practical Significance

Transformer coupled amplifier are generally used for impedance matching and power amplification in the electronic circuit. This practical will help the students to develop skills to build and test transformer coupled amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronic components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

Build/Test the performance of transformer coupled amplifier.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Maintain tools and equipment.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The amplifier circuit in which, the output of first stage is feed to the input of next stage amplifier through various coupling technique is known as coupled amplifier. If the transformer is used to feed the out of first stage to the next stage the resulting amplifiers combination is called transformer coupled amplifier.

The coupling transformer T_1 is used to feed the output of first stage to the input of second stage as shown in the fig.1. The collector load of the first stage amplifier is replaced by the primary winding of the transformer T_1. The secondary winding is connected between the potential divider and the base of second stage amplifier, which provides the input to the second stage. Transformer coupled amplifier is used for the low frequency amplifier.

VIII Circuit diagram

a. Sample

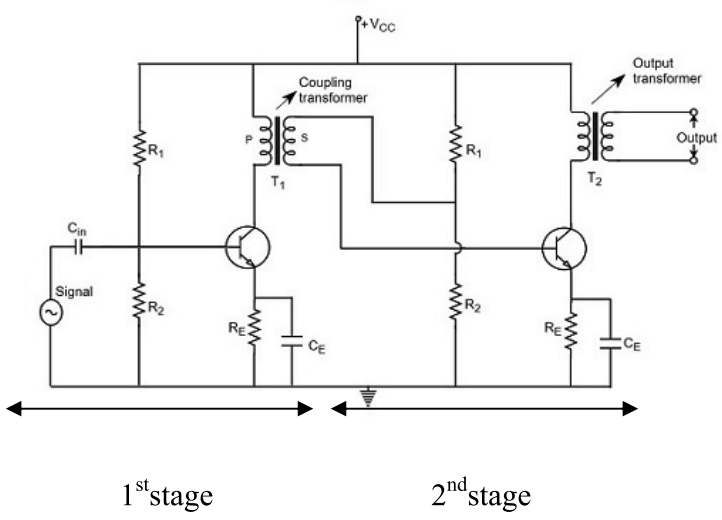


Figure 7.1: Transformer coupled amplifier

Courtesy:*https://www.tutorialspoint.com/amplifiers/transformer_coupled_amplifier.htm*

b. Actual Circuit used in laboratory/ Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Transistor	BC107	1 No.	
4.	Resistors	R_1=68KΩ, R_2=12KΩ R_E=560Ω	1 No. each	
5.	Capacitors	C_{in}= 1µf, C_E =10 µf	1 No. 2No.	
6.	Transformer	AF ferrite core 1:2 transformer	2No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are to be made to as per setup.
2. Ensure the power switch is in 'off' condition initially while connecting the circuit.
3. Ensure Settings proper range of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per figure 1.
2. Set frequency and amplitude of sine wave input signal on function generator with the help of CRO.
3. Connect Function generator at input terminals of circuit.
4. Connect DC supply to the amplifier circuit.
5. Switch on DC Power Supply, function generator and CRO.
6. Vary input frequency from function generator and note down output voltage on CRO.
7. Calculate the Gain using the given formula.
8. Repeat step 6 and note down the readings in the table no.1.
9. Plot frequency response on semi-log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 7.1 Observation Table

Input Voltage in mV (To be kept Constant), Vi = **---------**

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log Vo/Vi)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Calculations :

i. Voltage Gain : Vo/Vi

ii .Gain in dB =20 log(Vo/Vi)

iii. 3 dB Bandwidth (B.W) = F_H-F_L

XVI Results

1. Bandwidth =……(Hz/KHz/MHz)
2. Av (Max) =……..

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. State the significance of coupling transformer.
2. State the desired coupling ratio of transformer used in circuit.
3. List the applications of transformer coupled amplifier.
4. ……
5. ……

[Space for Answers]

XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. http://www.clarisonus.com/Archives/Amp_Design/SH_trans_coupled.pdf
4. https://www.tutorialspoint.com/amplifiers/transformer_coupled_amplifier.htm
5. https://www.youtube.com/watch?v=ZM6eQ7uIAzE

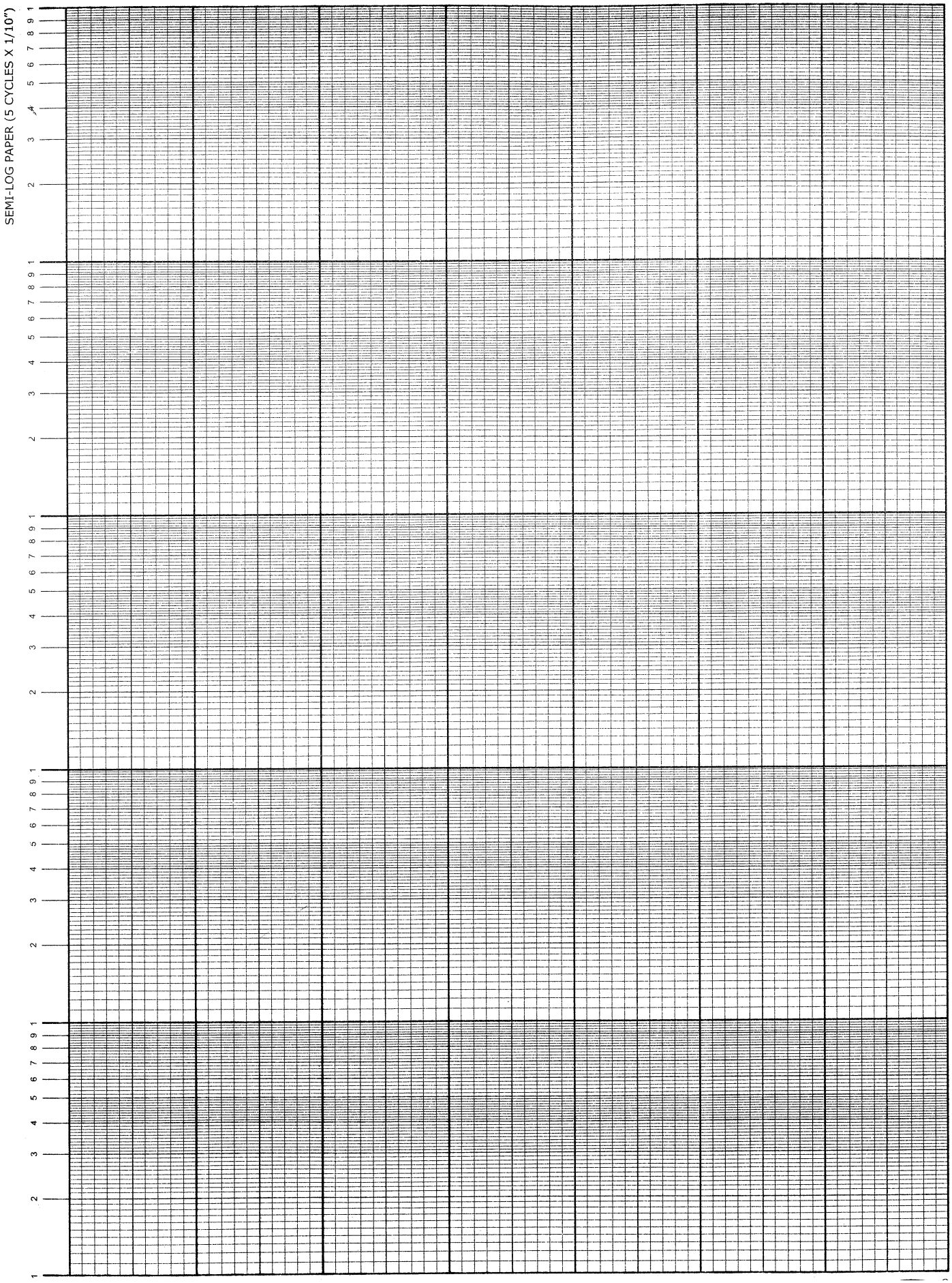
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of Gain and Bandwidth	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total:25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. ……..…….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


SEMI-LOG PAPER (5 CYCLES X 1/10")

BC107,A,B
BC108B,C
BC109B,C

NPN SILICON TRANSISTOR

TO-18 CASE

DESCRIPTION: The CENTRAL SEMICONDUCTOR BC107, BC108, BC109 series types are small signal NPN silicon transistors, manufactured by the epitaxial planar process, designed for general purpose amplifier applications.

MAXIMUM RATINGS: (T_A=25°C)	**SYMBOL**	**BC107**	**BC108**	**BC109**	**UNITS**
Collector-Base Voltage	V_{CBO}	50	30	30	V
Collector-Emitter Voltage	V_{CEO}	45	25	25	V
Emitter-Base Voltage	V_{EBO}	6.0	5.0	5.0	V
Continuous Collector Current	I_C		200		mA
Power Dissipation	P_D		600		mW
Operating and Storage Junction Temperature	T_J, T_{stg}		-65 to +200		°C
Thermal Resistance	ΘJC		175		°C/W

SYMBOL	**TEST CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNITS**
ICBO	V_{CB}=45V (BC107)			15	nA
ICBO	V_{CB}=45V, T_A=125°C (BC107)			4.0	μA
ICBO	V_{CB}=25V (BC108, BC109)			15	nA
ICBO	V_{CB}=25V, T_A=125°C (BC108, BC109)			4.0	μA
BVCEO	I_C=2.0mA (BC107)	45			V
BVCEO	I_C=2.0mA (BC108, BC109)	25			V
BVEBO	I_E=10μA (BC107)	6.0			V
BVEBO	I_E=10μA (BC108, BC109)	5.0			V
$V_{CE(SAT)}$	I_C=10mA, I_B=0.5mA			0.25	V
$V_{CE(SAT)}$	I_C=100mA, I_B=5.0mA			0.6	V
$V_{BE(SAT)}$	I_C=10mA, I_B=0.5mA		0.7	0.83	V
$V_{BE(SAT)}$	I_C=100mA, I_B=5.0mA		1.0	1.05	V
$V_{BE(ON)}$	V_{CE}=5.0V, I_C=2.0mA	0.55		0.7	V
$V_{BE(ON)}$	V_{CE}=5.0V, I_C=10mA			0.77	V
hFE	V_{CE}=5.0V, I_C=10μA (BC107B, BC108B, BC109B)	40			
hFE	V_{CE}=5.0V, I_C=10μA (BC108C, BC109C)	100			

Practical No.9: Single Tuned Amplifier

I Practical Significance

Single tuned amplifier is generally used in the radio and television station receivers to pick up and amplify the desired radio frequency signal. This practical will help the students to develop skills to build and test single tuned amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.
4. Use CRO and function generator.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

Build/Test the performance of single tuned amplifier using transistor.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The amplifier should select a desired frequency and amplify it to the desired level. In order to pick up and amplify the desired radio frequency signal, the resistive load in the audio amplifier is replaced by a tuned circuit. The tuned circuit is capable of selecting as particular frequency and rejecting others. The use of tuned circuit in the transistor amplifier circuit, make possible the selection and amplification of a desired radio frequency. Such an amplifier is called a tuned amplifier.

There are two main types of tuned amplifiers.

- Single tuned amplifier
- Double tuned amplifier

Single tuned amplifier: An amplifier circuit with a single tuner section at the collector of the amplifier circuit is called as Single tuner amplifier circuit. The values of capacitance and inductance of the tuned circuit are selected such that its resonant frequency is equal to the frequency to be selected and amplified.

The parallel resonance occurs at resonant frequency f_r when the circuit has a high Q. the resonant frequency f_r is given by At resonant frequency f_r the impedance of parallel tuned circuit is very high and is purely resistive.

VIII Practical Circuit diagram

a. Sample

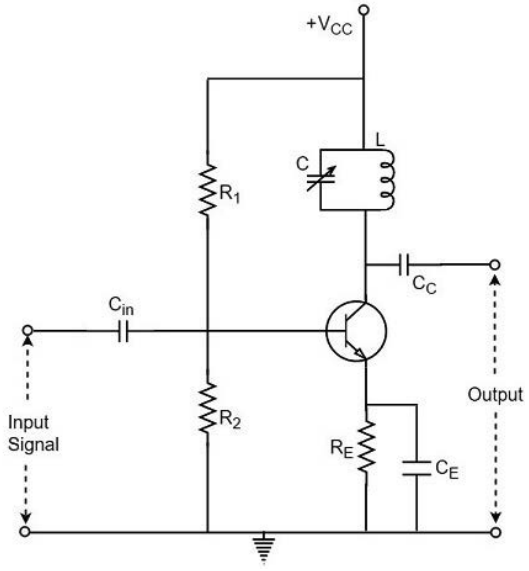


Figure 9.1: Single tuned amplifier

***Courtesy**:https://www.tutorialspoint.com/amplifiers/single_tuned_amplifier.htm*

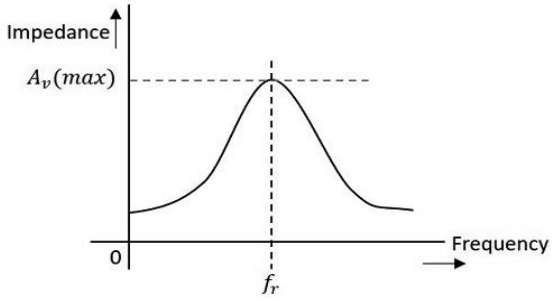


Figure 9.2: frequency response of a single tuned amplifier

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Transistor	BC107	1 No.	
4.	Resistors	R_1=68KΩ, R_2 =12KΩ, R_E=100Ω	1 No.	
5.	Capacitors	Cin= 1µf, C_E =10µf Cc=10µf, C=47nf	1 No. each	
6.	Inductor	100µH	1 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are to be made to as per setup.
2. Ensure the power switch is in 'off' condition initially while connecting the circuit.
3. Ensure settings proper range of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per figure 1.
2. Set frequency and amplitude of sine wave input signal on function generator with the help of CRO.
3. Connect Function generator at input terminals of circuit.
4. Connect DC supply to the amplifier circuit.
5. Switch on DC Power Supply, function generator and CRO.
6. Vary input frequency from function generator and note down output voltage on CRO.
7. Calculate the Gain using the given formula.
8. Repeat step 6 and note down the readings in the table no.1.
9. Plot frequency response on semi-log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 9.1 Observation Table

Input Voltage in mV (To be kept Constant), Vi = ---------

Sr. No.	Input Frequency(Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Calculations:

i. Voltage Gain =Vo/Vi

ii .Gain in dB =20 log(Vo/Vi)

iii. Resonant frequency (Th) f_r=1 / ($2\pi\sqrt{LC}$)

iv. 3 dB Bandwidth (B.W) = F_H-F_L

XVI Results

1. Resonance frequency (TH) =……
2. Resonance frequency (PR) =…….
3. Bandwidth =……KHz/MHz.

XVII Interpretation of Results (Give meaning of the above obtained results)

.....
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.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Calculate the resonance frequency for tuned amplifier L=20mH, C =470 pf
2. List any two active devices used in single tuned amplifier instead of transistor?
3. Define Q factor?
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. https://www.youtube.com/watch?v=1V-JRfgmhUI
4. https://www.tutorialspoint.com/amplifiers/types_of_tuned_amplifiers.htm

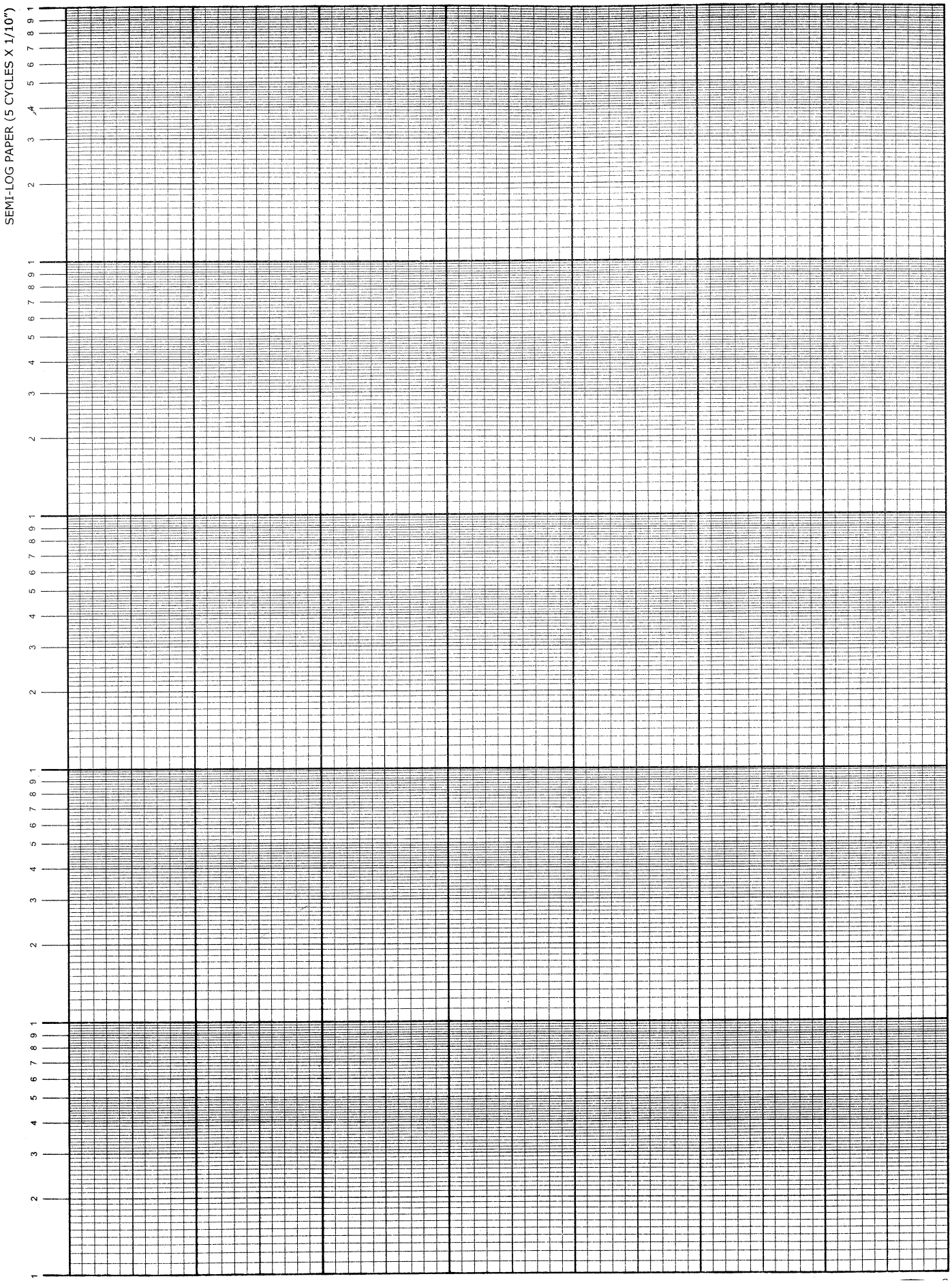
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate Gain , resonance frequency and bandwidth	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Practical No.10 and 11: Double Tuned Common Emitter Amplifier (PART-I and II)

I Practical Significance

Double tuned amplifier is generally used in the wireless communication system. This practical will help the students to develop skills to build and test transformer coupled amplifier for desired frequency in radio receiver and T.V receiver.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use Transistor as low Power Amplifier.

V Practical Outcome

- Build/ test performance of double tuned common emitter amplifier.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

A double-tuned amplifier is a with coupling between the amplifier stages in which the of both the primary and secondary are tuned separately with a across each. The double tuned amplifier has the special feature of coupling which is important in determining the frequency response of the amplifier. The amount of mutual inductance between the two tuned circuits states the degree of coupling, which determines the frequency response of the circuit. An IFT usually has two windings in it so it does contain variable inductors, but these may be tuned to a fixed frequency by placing capacitors across the inductors. If there are two parallel tuned circuits close enough to each other, then they will pass energy between them but only at a

very limited range of frequencies. Other frequencies are mostly rejected. A common IF frequency range of AM radio receiver is 455 KHz.

The equation for bandwidth is given as

$$B.W = K*Fr$$

Where
B.W = bandwidth for double tuned circuit
K = coefficient of coupling
F_r = resonant frequency.

$$K = M_1 * M_2$$

Where M_1 and M_2 are the mutual inductance of coil 1 and coil 2.
The resonant frequency:

$$f = \frac{1}{2\pi \sqrt{LC}}$$

Where $L = (L_1 * L_2) / (L_1 + L_2)$

$$C = C_1 + C_2$$

VIII Circuit diagram

a. Sample

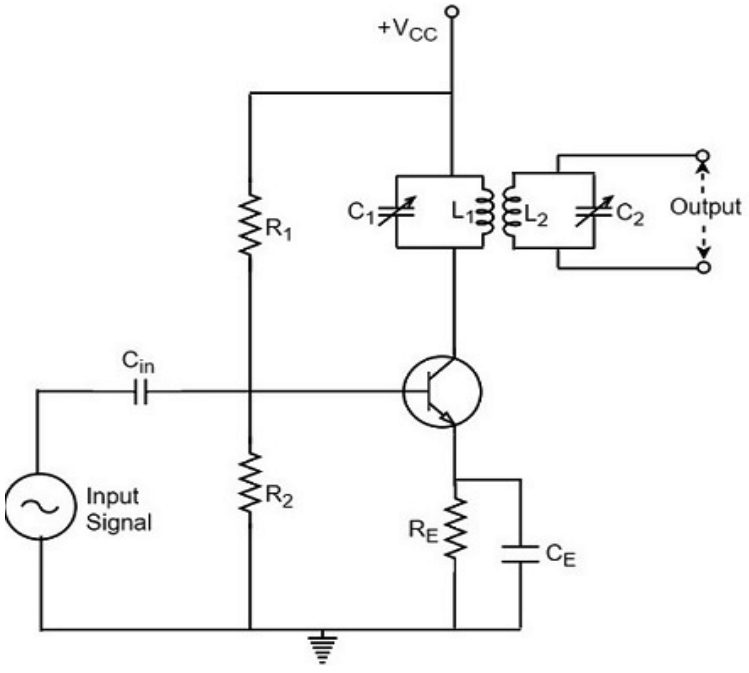

Figure 10.1: Double tuned amplifier

***Courtesy**:https://www.google.co.in/search?q=double+tuned+amplifier+circuit+diagram&tbm.htm*

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
3.	Transistor	BC107	1 No.	
4.	Resistors	R_1=68KΩ,R_2=12KΩ R_E =560 Ω	1 No.	
5.	Capacitors	C_{in} = 1µf ,C_E =10 µf C= 10 µf	1 No.	
6.	IFT	Yellow colour (low frequency)six terminal(455Khz)	1 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per diagram.
2. Set frequency and amplitude of sine wave input signal on function generator with the help of CRO.
3. Connect Function generator at input terminals of circuit.
4. Connect DC supply to the amplifier circuit.
5. Switch on DC Power Supply, function generator and CRO.
6. Vary input frequency from function generator and note down output voltage on CRO.
7. Calculate the Gain using the given formula.
8. Repeat step 6 and note down the readings in the table no.1.
9. Plot frequency response on semi-log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 10.1 Observation Table

Input Voltage in mV (To be kept Constant), Vi = ---------

Sr. No.	Input Frequency (Hz)	Output Voltage, Vo (Volts)	Voltage Gain (A= Vo/Vi)	Gain in dB 20 log(Vo/Vi)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16.				

Calculations:

i. Theoretical Resonant frequency: $Fr_{(TH)} = 1 / (2\pi \sqrt{LC})$

ii. Practical resonant Frequency: $Fr_{(PR)}$ =

XVI Results

1. Theoretical resonant frequency $Fr_{(TH)}$ = …….
2. Practical resonant frequency $Fr_{(PR)}$ =……..

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions(Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. State the method to tuned the IFT (Intermediate frequency transformer).
2. List the different ranges of IFT with colour code.
3. State the effect of change in value of capacitor on resonant frequency
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. https://www.youtube.com/watch?v=8A9CAmULrbM
4. https://en.wikipedia.org/wiki/Double-tuned_amplifier

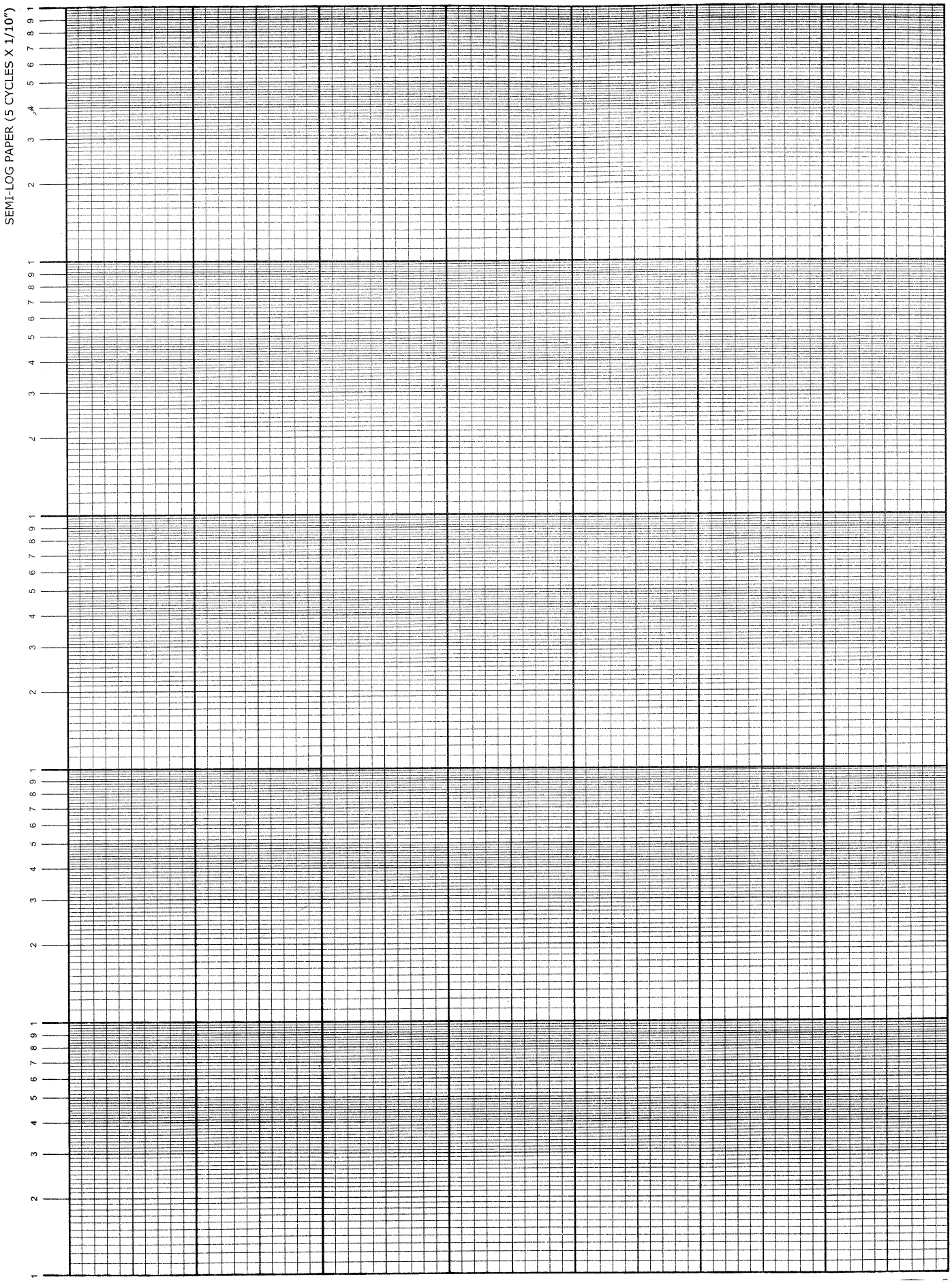
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of theoretical and practical Resonant frequency	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. …….
2. …….
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Practical No.12: Class- A Power Amplifier

I Practical Significance

Class A amplifier is used in the PA system. Class A power amplifier is the simplest of all power amplifier configurations. They have high fidelity and are totally immune to crossover distortion. This practical will help the students to develop skills to build and test performance of class A amplifier generally used in various consumers electronic product.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as high Power Amplifier.

V Practical Outcome

- Build/test performance parameters of single stage class A power amplifier..

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Transistor power amplifiers handle large signals. Many of them are driven so hard by the input large signal that collector current is either cut-off or is in the saturation region during a large portion of the input cycle. Therefore, such amplifiers are generally classified according to their mode of operation i.e. the portion of the input cycle during which the collector current is expected to flow. On this basis, they are classified as:

(i) Class A power amplifier. If the collector current flows at all times during the full cycle of the signal, the power amplifier is known as class A power amplifier.

(ii) Class B power amplifier. If the collector current flows only during the positive half-cycle of the input signal, it is called a class B power amplifier.

(iii) Class C power amplifier. If the collector current flows for less than half-cycle of the input signal, it is called class C power amplifier

The power amplifier is said to be Class A amplifier if the Q point and the input signal are selected such that the output signal is obtained for a full input signal cycle. For all values of input signal, the transistor remains in the active region and never enters into cut-off or saturation region. When an a.c signal is applied, the collector voltage varies sinusoidally hence the collector current also varies sinusoidally. The collector current flows for 360^0 (full cycle) of the input signal i e the angle of the collector current flow is 360^0

VIII Practical Circuit diagram

a. Sample

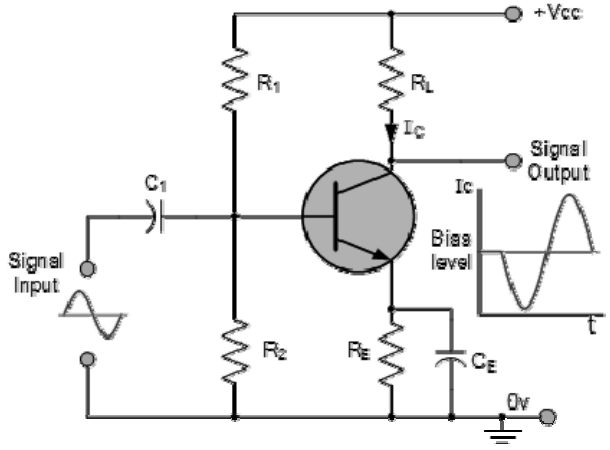

Figure 12.1: Class A power amplifier

Courtesy:https://www.tutorialspoint.com/amplifiers/class A_power_amplifier.html

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
4.	Transistor	SL/CL100 or BC558 or BD115	1 No.	
5.	Resistors	R_1=47kΩ,R_2=33Ω, R_E=560 Ω R_L=220Ω,	1 No.	
6.	Capacitors	47 µF , 10 µF	1 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are to be made to as per setup.
2. Ensure the power switch is in ‘off’ condition initially while connecting the circuit.
3. Ensure proper settings of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per diagram.
2. Set frequency and amplitude of sine wave input signal on function generator with the help of CRO
3. Connect Function generator at input terminal of circuit.
4. Connect DC supply to the amplifier circuit.
5. Switch ON the DC Power Supply, function generator and CRO.
6. Vary the amplitude of sine waveform from function generator at different value and measure the output voltage on CRO.
7. Calculate the P_{ac} , P_{dc} and % □ using the given formula.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

6.			
7.			
8.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient**)**

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 12.1 Observation Table

Sr. No.	Input Voltage [V_i] (Volts)	Output Voltage [Vo] (Volts)	$P_{ac} = V_O^2 / 2R_L$ (watts)	$P_{dc} = V_{CC} * I_{CQ}$	% □ = P_{ac} / P_{dc} * 100
1					
2					
3					

Where I_{CQ} **is the current measured at collector terminal when AC input signal is zero.**

Calculations:

i. $P_{ac} = V_O^2 / 2R_L$

ii. $P_{dc} = V_{CC} * I_{CQ}$

iii. **% □ = P_{ac} / P_{dc}* 100**

XVI Results

1. **%** □ (efficiency of class A amplifier) =……..(When Vi-10V)

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. List the low power transistor and high-power transistor using datasheet.
2. List the ratings of low power transistors and high power transistors using datasheet.
3. ……
4. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. http://www.becbapatla.ac.in/ece/lab/EC%20261%20EC-1%20Lab%20Manual.pdf

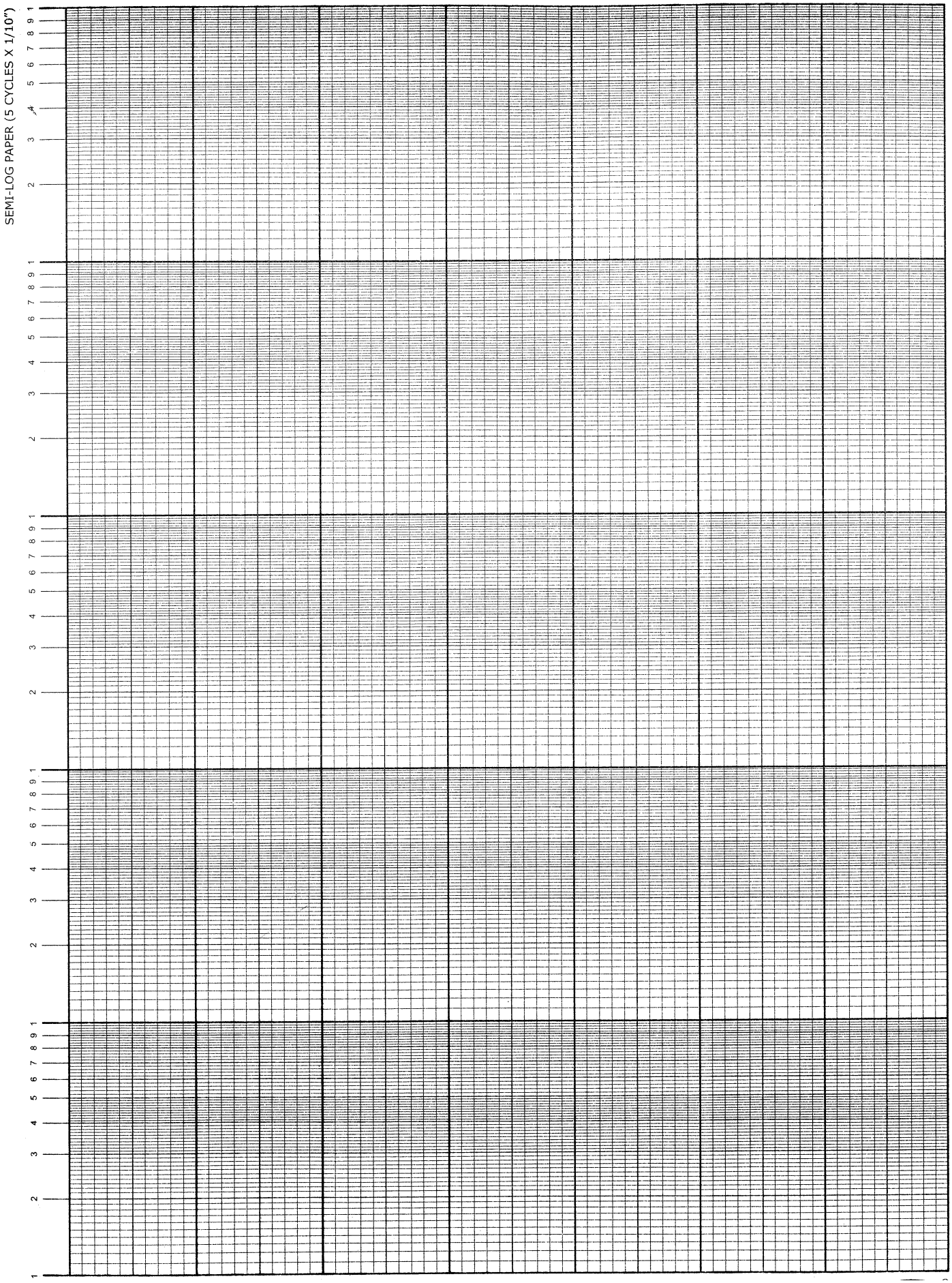
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of Percentage Efficiency	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..…..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

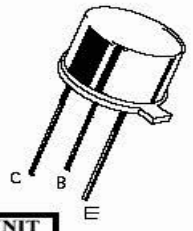

SEMI-LOG PAPER (5 CYCLES X 1/10")

TEAMASIA LAKHI SEMICONDUCTORS LTD

File No. : 4100
Rev. No. : A

DEVICE SPECIFICATION

TYPE : SL100
POLARITY : N P N
APPLICATION : General Purpose Medium Power Transistor
PACKAGE : TO - 39



MAXIMUM RATINGS:

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Collector - Emitter Voltage	BV_{CEO}	50	-	V
Collector - Base Voltage	BV_{CBO}	60	-	V
Emitter - Base Voltage	BV_{EBO}	5.0	-	V
Total Power Dissipation @ T_A= 25°C	P_D		800	mW
Collector Current	I_C		0.5	A
Operating & Storage Junction Temperature	T_j, T_{stg}		- 65 to 200	°C

Electrical characteristics (TA = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS				
Collector - Emitter Breakdown Voltage (I_C = 10 mA dc, I_B = 0)	BV_{CEO}	50	-	V
Collector - Base Breakdown Voltage (I_C = 100 µA, I_E = 0)	BV_{CBO}	60	-	V
Emitter - Base Breakdown voltage (I_E = 100 µA, I_C = 0)	BV_{EBO}	5	-	V
Collector Cut - off Current (V_{CB} = 40V dc, I_E = 0)	I_{CBO}	-	50	nA
Emitter - Cut off current (V_{EB} = 4V dc, I_C= 0)	I_{EBO}	-	25	nA

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
ON CHARACTERISTICS *				
DC Current gain				
(I_C = 10mA dc, V_{CE} = 10V dc)	hFE (1)	25	-	
(I_C = 150mA dc, V_{CE} = 10V dc)	hFE	40	300	
Collector - Emitter saturation Voltage (I_C = 150mA dc, I_B = 15mA dc)	VCE(sat)	-	0.6	V
Base - Emitter saturation voltage (I_C = 150mA dc, I_B = 15mA dc)	VBE(sat)	-	1.3	V

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
SMALL SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 140KHz)	C_{obo}	-	20	pf

hFE Classification	SL 100B
hFE (1)	100 - 300

* Pulse Test : Pulse width ≤ 300 µs , Duty Cycle ≤ 2.0%

Practical No.13: Class - B Push Pull Amplifier

I Practical Significance

A push pull amplifier is an amplifier which has an output stage that can drive a current in either direction through the load. Push pull amplifiers are superior over single ended amplifiers in terms of distortion and performance. This practical will help the students to understand the working of Push Pull Amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as high Power Amplifier.

V Practical Outcome

- Build/test performance parameters of class B push pull amplifier using transistor.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.

VII Minimum Theoretical Background

Push pull amplifiers are commonly used in situations where low distortion, high efficiency and high output power are required. The basic operation of a push pull amplifier is as follows: The signal to be amplified is first split into two identical signals 180° out of phase. The Class B push pull amplifier is almost similar to the Class A push pull amplifier and the only difference is that there are no biasing resistors for a Class B push pull amplifier. This means that the two transistors are biased at the cutoff point. The Class B configuration can provide better power output and has higher efficiency (up to 78.5%). Since the transistor is biased at the cutoff point, they consume no power during idle condition and this adds to the efficiency. The advantages of Class B push pull amplifiers are able to work in limited power supply

conditions with absence of even harmonics in the output and simple circuitry when compared to the Class A configuration.

VIII Practical Circuit diagram

a. Sample

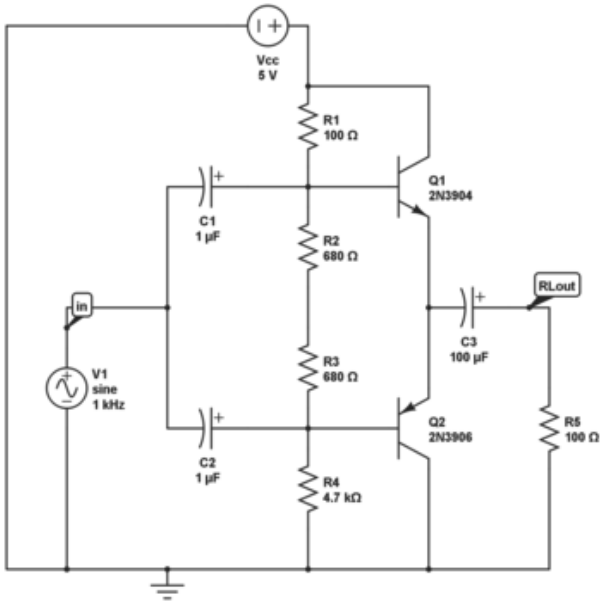


Figure 13.1: Class- B Push Pull Amplifier

b. Actual Circuit used in laboratory /Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Signal Generator	(0-3)MHz	1 No.	
4.	Transistor	BC147 and BC148	1 No.	
5.	Resistors	R1=33kΩ,R2=3.3Ω,Rc= 1.5kΩ RE=330Ω R_L=1kΩ,	1 No.	
6.	Capacitors	10 μF	3 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.
4. Ensure the terminals of transistor.

XI Procedure

1. Make the connection as per circuit diagram.
2. Connect the input supply with appropriate polarity
3. Connect DC power supply as per circuit diagram .Set Vcc=5V
4. Connect CRO at the Output. Switch ON CRO.
5. Observe input and output waveforms on CRO.
6. Note down reading of input voltage and output voltage from CRO.
7. Calculate efficiency of amplifier.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 13.1 Observation Table

R_i = ……(Input resistance measured at the input of Class –B amplifier using DMM)
R_o = ……(Output resistance measured at the output of Class –B amplifier using DMM)

Sr. No.	Input Voltage (Vi)	Output Voltage (Vo)	$P_i = Vi^2 / R_i$	$P_o = Vo^2 / R_o$	% Efficiency = $P_o / P_i * 100$
1.	10 V				
2.					
3.					

Calculations:

i. % Efficiency = ……

XVI Results

1. % Efficiency =……(When Vi= 10 Volt)

XVII Interpretation of Results (Give meaning of the above obtained results)

……..……
……..……
……..…
……..……..….

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

……...……

……..……

……..…

……..……..….

XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. What is mean by Cross Over Distortion?
2. State the applications of class B Push Pull Amplifier.
3. State the difference between a voltage and a Power amplifier.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. http://www.becbapatla.ac.in/ece/lab/EC%20261%20EC-1%20Lab%20Manual.pdf

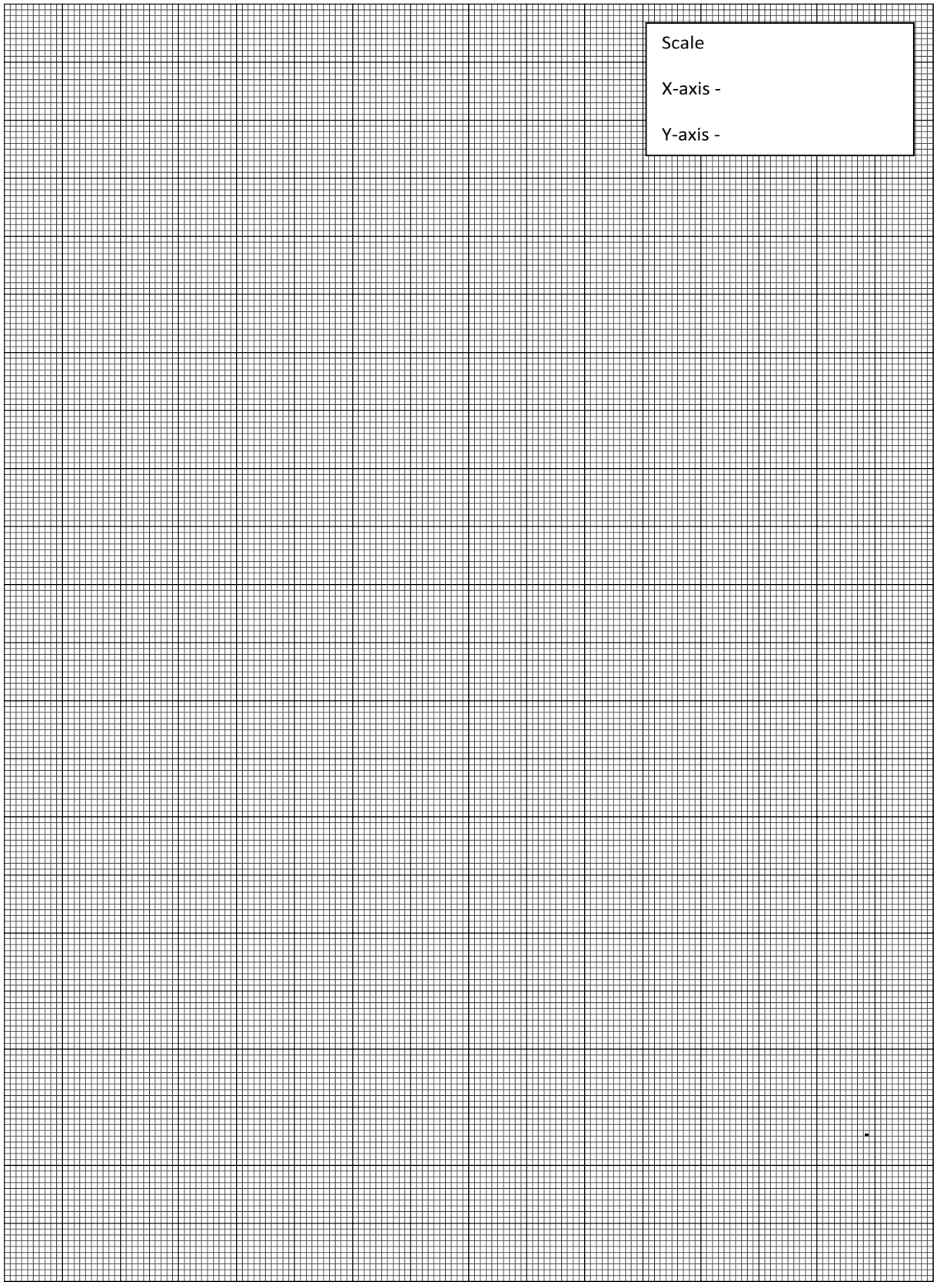
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of Percentage Efficiency	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……....
2. ……..….
3. ……
4. ……..…

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

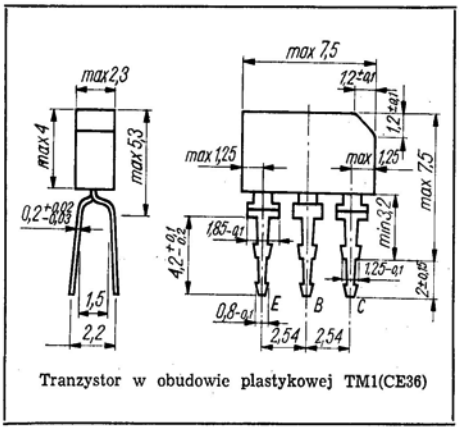

Scale
X-axis -
Y-axis -

TRANZYSTORY *n-p-n*
* BC147, BC148 i BC149

2-74/2

SWW 1156-211

Tranzystory krzemowe epiplanarne małej mocy małej częstotliwości.
Tranzystory BC147 i BC148 są przeznaczone do stosowania w zakresie częstotliwości akustycznej w układzie przedwzmacniacza oraz w stopniach napędzających (driver).
Tranzystor BC149 jest przeznaczony do stosowania w stopniach wejściowych wzmacniaczy o niskim poziomie szumów.
Tranzystory BC147, BC148 i BC149 są komplementarne do tranzystorów BC157, BC158 i BC159.



Tranzystor w obudowie plastykowej TM1(CE36)

DANE TECHNICZNE

Wartości dopuszczalne parametrów eksploatacyjnych

Typ		BC147	BC148 BC149	
Napięcie kolektor-emiter	U_{CE0}	45	20	V
Napięcie kolektor-emiter	U_{CES}	50	30	V
Napięcie emiter-baza	U_{EB0}	6	5	V
Prąd kolektora	I_C	100	100	mA
Prąd szczytowy kolektora	I_{CM}	200	200	mA
Prąd bazy	I_B	50	50	mA
Moc całkowita	P_{tot}	300	300	mW
Temperatura złącza	t_j	398 K (125°C)		
Zakres temperatury składowania	t_{stg}	218 .... 398 K (−55...+125°C)		

TRANZYSTOR BC147

Parametry statyczne

			min.	typ.	maks.	
przy t_{amb} = 298 K (25°C)						
Prąd resztkowy kolektor-emiter						
przy U_{CES} = 50 V	I_{CES}		—	0,2	15	nA
przy U_{CES} = 50 V, t_{amb} = 398 K (125°C)	I_{CES}		—	0,2	4	µA
Napięcie przebicia kolektor-emiter						
przy I_B = 0, I_C = 2 mA	$U_{(BR)CE0}$		45	—	—	V
przy R_{BE} = 0, I_C = 10 µA	$U_{(BR)CES}$		50	—	—	V
Napięcie przebicia emiter-baza						
przy I_C = 0, I_E = 10 µA	$U_{(BR)EB0}$		6	—	—	V
Współczynnik wzmocnienia prądowego*						
przy I_C = 10 µA, U_{CE} = 5 V	h_{21E}	kl. A	—	90	—	—
		kl. B	—	150	—	—
przy I_C = 2 mA, U_{CE} = 5 V	h_{21E}	kl. A	110	—	240	—
		kl. B	200	—	480	—
przy I_C = 100 mA, U_{CE} = 5 V	h_{21E}	kl. A	—	120	—	—
		kl. B	—	200	—	—
Napięcie nasycenia kolektor-emiter						
przy I_C = 10 mA, I_B = 0,5 mA	U_{CEsat}		—	0,1	0,2	V
przy I_C = 100 mA, I_B = 5 mA	U_{CEsat}		—	0,2	0,6	V
Napięcie nasycenia baza-emiter						
przy I_C = 10 mA, I_B = 0,5 mA	U_{BEsat}		—	0,7	0,83	V
przy I_C = 100 mA, I_B = 5 mA	U_{BEsat}		—	0,9	1,05	V
Napięcie stałe między bazą a emiterem przy I_C = 2 mA, U_{CE} = 5 V	U_{BE}		0,55	0,62	0,7	V

* Podziału na klasy dokonuje się na życzenie odbiorcy określone w zamówieniu.

Practical No.14: Audio Power Amplifier.

I Practical Significance

An audio power amplifier (or power amp) is reproduces low-power electronic audio signals such as the signal from radio receiver or electric guitar at a level that is strong enough for driving (or powering). This practical will help the students to develop skills to build and test audio power amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as high Power Amplifier.

V Practical Outcome

- Build/ test the performance of Audio power amplifier.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

An audio power amplifier is an amplifier that reproduces low-power electronic audio signals such as the signal from radio receiver or electric guitar at a level that is strong enough for driving. This includes both amplifiers used in home audio systems and musical like guitar amplifier. It is the final electronic stage in a typical audio playback before the signal is sent to the loudspeakers.

VIII Practical Circuit diagram

a. Sample

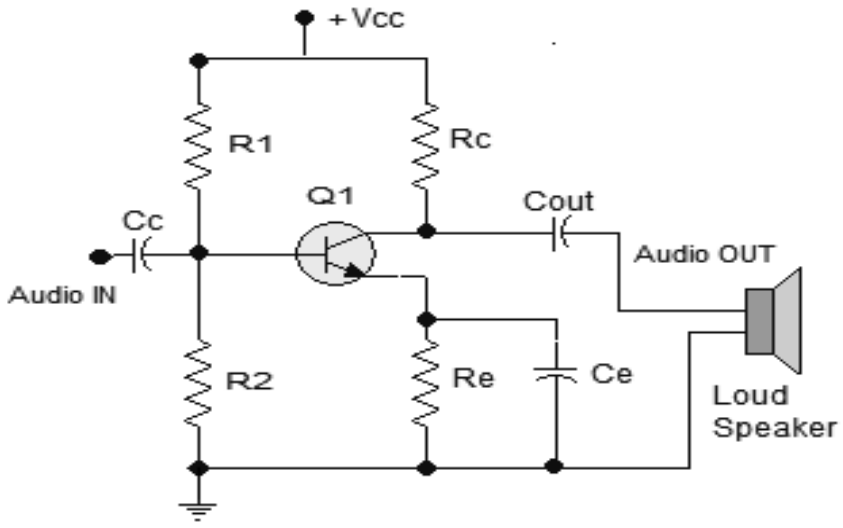


Figure 14.1: Audio power amplifier

Courtasy:https://www.google.co.in/search?q=audio+power+amplifier+circuit&dcr=0&tbm

b. Actual Circuit used in laboratory /Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type) / dB meter	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Signal Generator	(0-3)MHz	1 No.	
4.	Transistor	2N6292	1 No.	
5.	Resistors	R_1=68KΩ,R_2=12KΩ,Rc=1.5KΩ, Rc=470Ω	1 No.	
6.	Capacitors	Cc= 1µf ,C_E =10 µf Cout= 1µf	1 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	
9.	Loudspeaker	6Ω or 8 Ω	1 No.	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per Figure 1.
2. Connect dB meter across the loudspeaker.
3. Measure Sound level of speaker using dB meter.
4. Take the 4-5 readings by increasing input amplitude
5. Hear the sound level at Speaker.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution followed (use blank sheet provided if space not sufficient)

……..…
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……..…
.....……..

XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 14.1 Observation Table

Sr. No.	Input Voltage Vin (volts)	Output Sound level (dB) or Output voltage on CRO(volts)
1		
2		
3		
4		
5		

XVI Results

1. Sound level(dB) = ……..……(for input = ……..V).

XVII Interpretation of Results (Give meaning of the above obtained results)

……..…
.....……..
……..…
.....……..

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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.....……..

XIX Practical Related Questions

1. Suggest Audio amplifier IC (mono and stereo).
2. State the Significance of wattage rating of Loudspeaker?

Space for Answers

XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. http://www.becbapatla.ac.in/ece/lab/EC%20261%20EC-1%20Lab%20Manual.pdf

XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Observations	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total :25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.15: Voltage Series Feedback Amplifier

I Practical Significance

As negative feedback is used for stability. This configuration most stable one and used in most discrete amplifier system. This practical will help to develop practical skill of the students to use appropriate feedback connection in the amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as feedback amplifier

V Practical Outcome

- Use transistor to built /test voltage series feedback amplifier parameters with and without feedback.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

When any increase in the output signal results into the input in such a way as to cause the decrease in the output signal, the amplifier is said to have negative feedback. The advantages of providing negative feedback are that the transfer gain of the amplifier with feedback can be stabilized against variations in the hybrid parameters of the transistor or the parameters of the other active devices used in the circuit. The most advantage of the negative feedback is that by proper use of this, there is significant improvement in the frequency response and in the linearity of the operation of the amplifier. This disadvantage of the negative feedback is that

the voltage gain is decreased. In Current-Series Feedback, the input impedance and the output impedance are increased. Noise and distortions are reduced considerably.

VIII Practical Circuit diagram

a. Sample

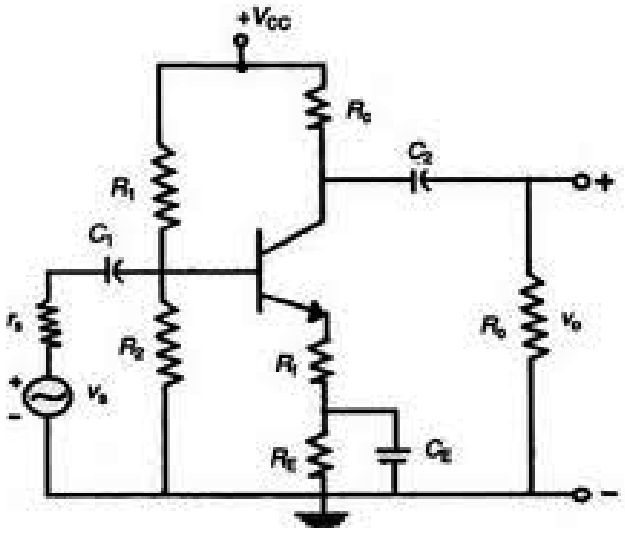

Figure 15.1: Voltage series feedback amplifier

Courtesy:https://www.tutorialspoint.com/amplifiers/class A_power_amplifier.htm

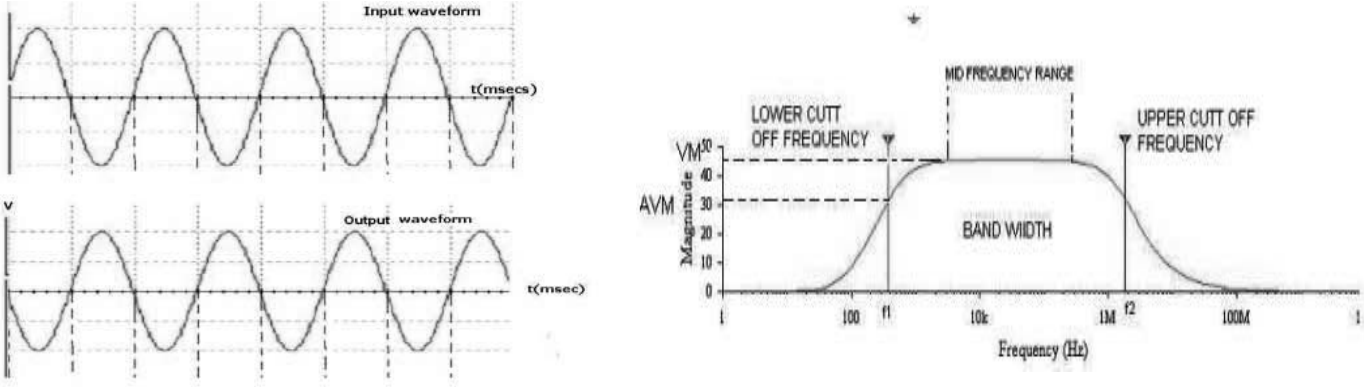

Figure 15.2: Input output waveforms and frequency response

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Signal Generator	(0-3)MHz	1 No.	
4.	Transistor	BC558 or CL100 or BD115	1 No.	
5.	Resistors	R_1=33kΩ,R_2=3.3Ω,Rc= 1.5kΩ R_E=330Ω R_L=1kΩ,	1 No.	
6.	Capacitors	C_1=10 µF C_2=10 µF C_E=10 µF	1 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Connect function generator output to CRO and observe input signal on CRO
3. Switch ON DC Power Supply, function generator and CRO
4. Keep the input voltage constant, vary the frequency from 10 Hz to 1M Hz in regular steps and note down the corresponding output voltage on CRO.
5. Remove the emitter bypass capacitor and repeat Step 4 and observe the effect of feedback on the gain of the amplifier.
6. Note down the value of output voltage for each frequency. The voltage gain in dB is calculated by using expression Av = 20log (V0 / Vi) dB
7. Plot frequency response on semi log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 15.1 Observation Table

Input Voltage in mV (To be kept Constant), Vi = ……

Sr. No.	Input Frequency (Hz)	Output Voltage, Vo (with feedback) (Volts)	Output Voltage, Vo (without feedback) (Volts)	Gain in dB (with feedback)	Gain in dB (without feedback)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Calculations:

i. Voltage Gain: Vo/Vi

ii. Bandwidth (with feedback) $(B.W)_F = F_H - F_L$

iii. Bandwidth (without feedback) $(B.W) = F_H - F_L$

XVI Results

1. Bandwidth (with feedback) $(B.W)_F$ =……..
2. Bandwidth (without feedback) (B.W) =……

XVII Interpretation of Results (Give meaning of the above obtained results)

……
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……
……

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. State the significance of value of bypass capacitor.
2. Compare Voltage series feedback and voltage shunt feedback.
3. Suggest the changes in circuit to form voltage shunt feedback amplifier
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. http://www.becbapatla.ac.in/ece/lab/EC%20261%20EC-1%20Lab%20Manual.pdf

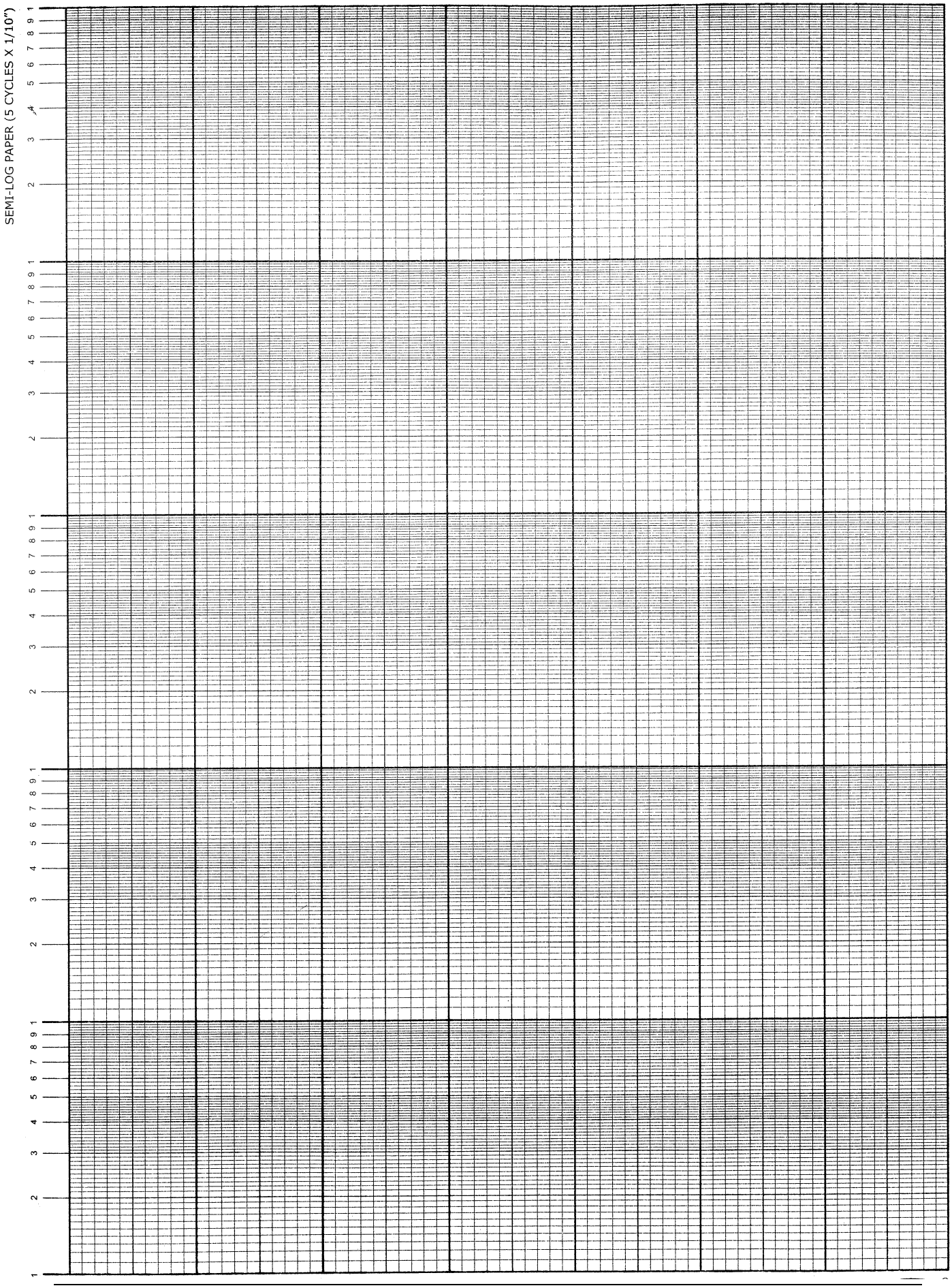
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of Gain and Bandwidth	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total:25 Marks		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


SEMI-LOG PAPER (5 CYCLES X 1/10")

Philips Semiconductors **Product specification**

PNP general purpose transistors BC556; BC557; BC558

FEATURES

- Low current (max. 100 mA)
- Low voltage (max. 65 V).

APPLICATIONS

- General purpose switching and amplification.

DESCRIPTION

PNP transistor in a TO-92; SOT54 plastic package. NPN complements: BC546, BC547 and BC548.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	collector

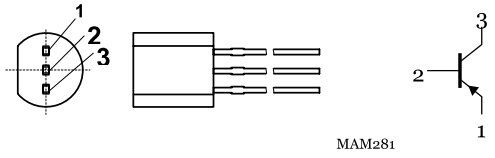


Fig.1 Simplified outline (TO-92; SOT54) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
VCBO	collector-base voltage	open emitter			
	BC556		–	−80	V
	BC557		–	−50	V
	BC558		–	−30	V
VCEO	collector-emitter voltage	open base			
	BC556		–	−65	V
	BC557		–	−45	V
	BC558		–	−30	V
ICM	peak collector current		–	−200	mA
Ptot	total power dissipation	$T_{amb} \leq 25$ °C	–	500	mW
hFE	DC current gain	$I_C = -2$ mA; $V_{CE} = -5$ V			

Practical No.16: Voltage Shunt Feedback Amplifier

I Practical Significance

Voltage shunt feedback connection decreases output resistance. It is one of important feature of amplifier. This practical will help the students to use appropriate feedback connection in the amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as feedback amplifier

V Practical Outcome

- Use transistor to built /test voltage shunt feedback amplifier parameters with and without feedback.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Negative feedback is that by proper use of this, there is significant improvement in the frequency response and in the linearity of the operation of the amplifier. This disadvantage of the negative feedback is that the voltage gain is decreased. Voltage shunt feedback, operates as a current-voltage controlled feedback system. In the voltage-shunt feedback configuration the signal fed back is in parallel with the input signal. The output voltage is sensed and the current is subtracted from the input current in shunt. As the output voltage is fed back as a

current to a current-driven input port, the shunt connections at both the input and output terminals reduce the input and output impedance. therefore the system works best as a transresistance system with the ideal input resistance, Rin being very small, and the ideal output resistance, Rout also being very small. It is also called as shunt shunt feedback.

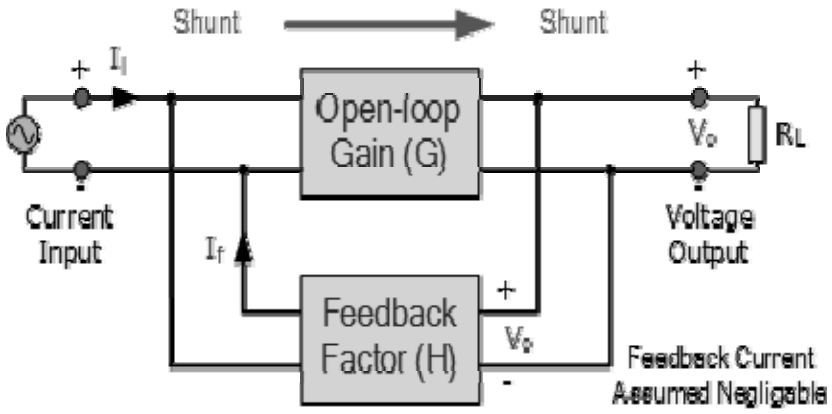


Figure 16.1: Block diagram of Voltage shunt feedback amplifier

Courtesy: *https://www.electronics-tutorials.ws/systems/feedback-systems.html*

VIII Practical Circuit diagram

a. Sample

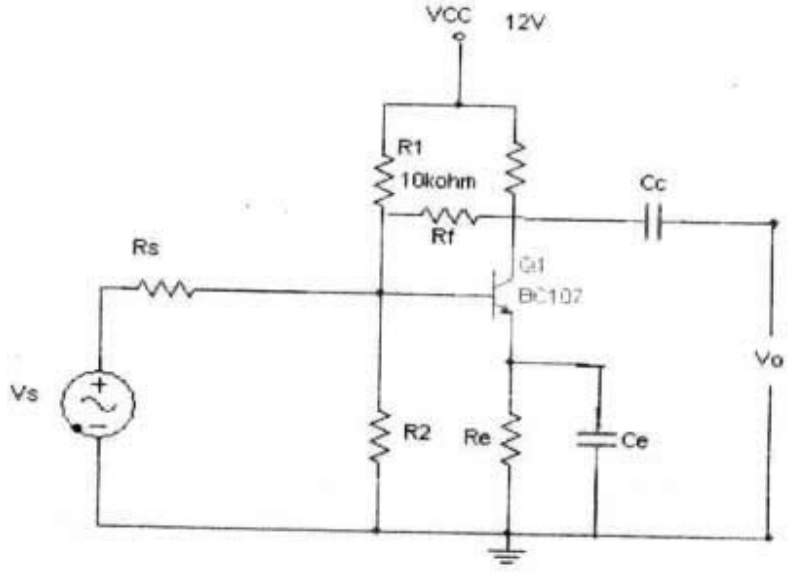


Figure 16.2: Circuit diagram of Voltage shunt feedback amplifier

Courtesy:*https://www.tutorialspoint.com/amplifiers/class A_power_amplifier.htm*

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3.	Signal Generator	(0-3)MHz	1 No.	
4.	Transistor	BC107 or CL100 or BC558 or BD115	1 No.	
5.	Resistors	R_1=33kΩ,R_2=3.3Ω,Rc=1.5kΩ R_E=330Ω ,Rf=10 kΩ, Rs=560 Ω	1 No. each	
6.	Capacitors	Cc= 10 µF C_E =10 µF	1 No.	
7.	Breadboard	5.5 CM X 17CM	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Connect function generator output to CRO and observe input signal on CRO
3. Switch ON DC Power Supply, function generator and CRO
4. Keep the input voltage constant, vary the frequency from 10 Hz to 1MHz in regular steps and note down the corresponding output voltage on CRO.
5. Remove the emitter bypass capacitor and repeat Step 4 and observe the effect of feedback on the gain of the amplifier.
6. Note down the value of output voltage for each frequency. The voltage gain in dB is calculated by using expression Av = 20log (V0 / Vi) dB
7. Plot frequency response on semi log paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 16.1 Observation Table

Input Voltage in mV (To be kept Constant), Vi = ...

Sr. No.	Input Frequency (Hz)	Output Voltage Vo in Volts (with feedback)	Output Voltage Vo in Volts (without feedback)	Gain in dB (with feedback)	Gain in dB (without feedback)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Calculations:

i Voltage Gain: Vo/Vi

ii. Bandwidth (with feedback) $(B.W)_F = F_H - F_L$

iii. Bandwidth (without feedback) $(B.W) = F_H - F_L$

XVI Results

1. Bandwidth (with feedback) $(B.W)_F$ =……..
2. Bandwidth (without feedback) (B.W) =……..

XVII Interpretation of Results (Give meaning of the above obtained results)

……
……
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……

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

……
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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. List the specifications of transistor used in circuit from datasheet.
2. State the effect of change in value of feedback resistance.
3. ……
4. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. https://www.electronics-tutorials.ws/systems/feedback-systems.html
2. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
3. Transistor Database User Guide, 2016
4. http://www.becbapatla.ac.in/ece/lab/EC%20261%20EC-1%20Lab%20Manual.pdf

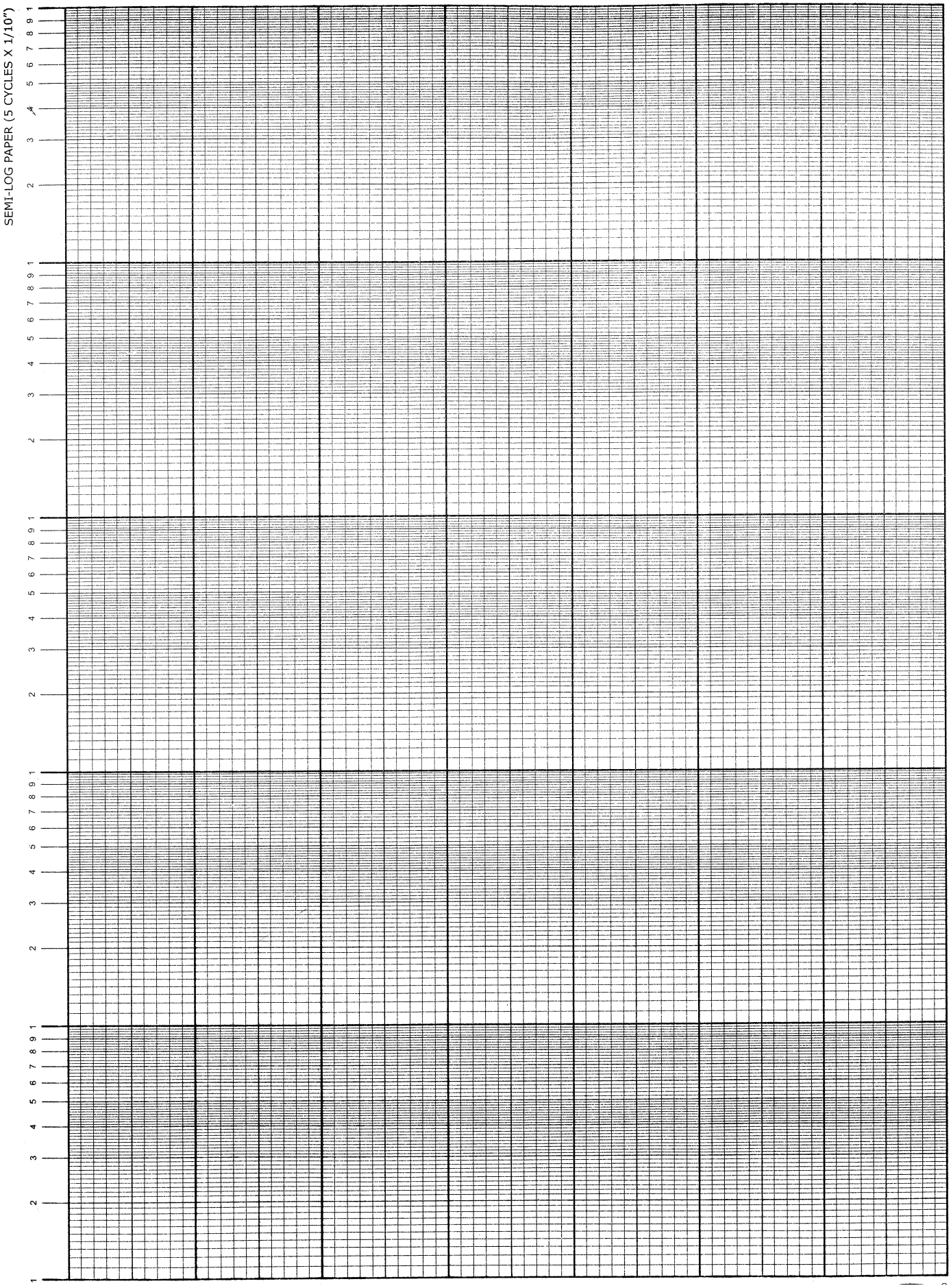
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of Gain and bandwidth	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


SEMI-LOG PAPER (5 CYCLES X 1/10")

Practical No.17 and 18: Positive and Negative Feedback. (PART-I and II)

I Practical Significance

Positive or regenerative feedback has the tendency of making an amplifier circuit unstable, so that it produces oscillations (AC). Negative or degenerative feedback has the tendency of making an amplifier circuit more stable, so that its output changes less for a given input signal than without feedback .This practical will help the students to develop skills to test the effect of positive and negative feedback on the given amplifier.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use discrete electronic devices and voltage regulators'***:

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as feedback amplifier.

V Practical Outcome

- Test the effect of positive and negative feedback on the given amplifier.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.
3. Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Feedback is the coupling of an amplifier's output to its input. Depending upon whether the feedback signal increases or decreases the input signal, there are two types of feedback in amplifier.

1. Positive or Regenerative feedback
2. Negative or Degenerative feedback.

Positive or Regenerative feedback: If the feedback signal is applied in phase with the input signal and thus increases output signal amplitude, then it is called positive feedback. It is also called regenerative or direct feedback.

a. It increases gain of amplifier
b. It produces excessive distortion
c. It is used in oscillators.

Negative or Degenerative feedback: If the feedback signal is applied out of phase with the input signal and thus decreases the output signal amplitude, so it is called negative feedback. Negative feedback

a. Reduces gain of the amplifier.
b. Improves the amplifier performance.
c. Used in the small and large signal amplifier circuits.

VIII Practical Circuit diagram

a. Sample

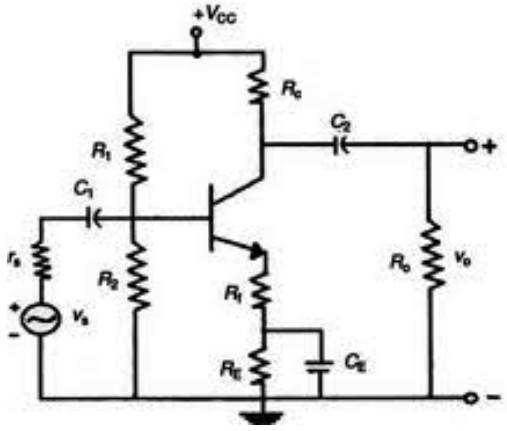


Figure 17.1 Negative feedback amplifier.(voltage series)

Courtesy : https://www.scribd.com/doc/119790927/Voltage-Series-Feedback-Amplifier

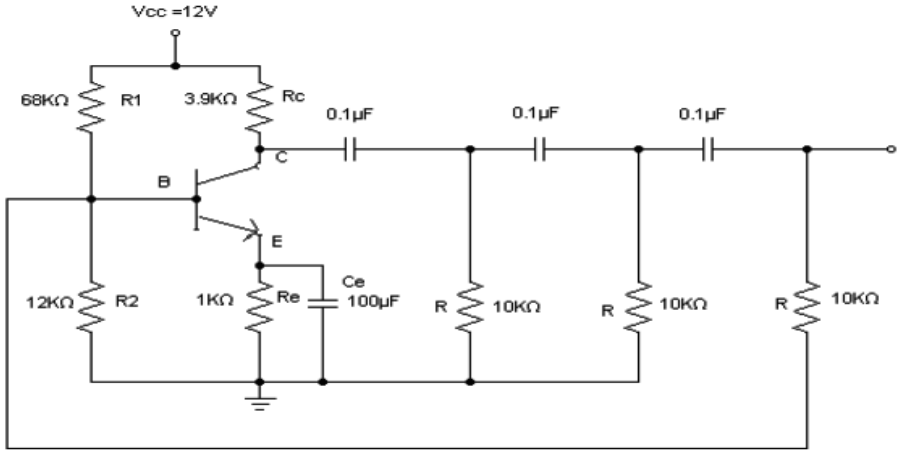


Figure 17.2 RC phase shift oscillator (positive feedback amplifier)

***Courtesy**: http://bhagwantuniversity.ac.in/wp-content/uploads/2016/01/ELECTRONICS-LAB-II-SEM-IV.pdf*

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remark
1	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3	Signal Generator	(0-3) MHz	1 No.	
4	Transistor	BC107,BC548	1 No.	
5	Resistors	For Figure 1 R_1=33kΩ, R_2=3.3KΩ,R_E=330Ω R_C=1.5KΩ R_L=1kΩ,	1 No.	
		For Figure 1 R_1=68kΩ, R_2=12kΩ,Rc=3.9kΩ R_E=1kΩ R=10kΩ,	03 No.	

6	Capacitors	For Figure 1 : C1=1μF, C_2=1μF,CE=10μF For Figure 2: C_E =100 μF , C= 0.1 μF	01 No. 03 No.	
7	Breadboard	5.5 CM X 17CM	2 No.	
8	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.

XI Procedure

1. Build circuit of negative feedback amplifier on breadboard as per Figure 1.
2. Select appropriate amplitude (10 mV to 20 mV) and frequency (10 KHz) of sine wave input signal on function generator.
3. Connect function generator output to CRO and observe input sine wave signal on CRO
4. Connect function generator at input terminals and CRO at output terminals of circuit.
5. Switch on DC Power Supply and Observe output waveform on CRO
6. Note down output voltage from CRO with and without bypass capacitor C_E.
7. Build circuit of positive feedback (RC phase shift oscillator) on breadboard as per Figure 2.
8. Connect DC Power Supply to the circuit and CRO at output terminals.
9. Switch ON power supply, Set V_{CC} = 12V.
10. Switch on CRO and Observe output on CRO.
11. Note down Output voltage from CRO.
12. Change the value of resistor R in RC network and observe the change in output.
13. Note down Output voltage from CRO.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations

Table No: 17.1 Observation Table (Negative feedback amplifier)

Sr. No	Input Voltage Vi	Output Voltage without feedback (Vo)	Output Voltage with feedback (Vo)	Gain without feedback (Av= Vo/Vi)	Gain with feedback (Av= Vo/Vi)
1					

Table No: 17. 2 Observation Table (Positive feedback amplifier)

Sr. No.	Input Voltage (Vi) (at base of transistor)			Output Voltage (Vo) (at the collector			Gain Av=Vo/Vi		
	RC N/W 1	RC N/W 2	RC N/W 3	RC N/W 1	RC N/W 2	RC N/W 3	RC N/W 1	RC N/W 2	RC N/W 3
1									
2									

Calculations:

1. Gain = Vo/Vi

XVI Results

1. Gain with Negative feedback =……..
2. Gain with positive feedback =……..……

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Write the difference between gain with and without negative feedback.
2. State the effect on output voltage with change in capacitor of RC network.
3. State the specifications of transistors used in circuit from datasheet.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. https://en.wikipedia.org/wiki/Negative-feedback_amplifier
3. https://www.electronics-tutorials.ws/systems/feedback-systems.html
4. https://en.wikipedia.org/wiki/Positive_feedback

XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculate gain with positive and negative feedback.	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.19: RC Phase Shift Oscillator.

I Practical Significance

It is a linear electronic circuit that produces a sine wave output. It consists of transistor with its output fed back to its input through a phase-shift network consisting of capacitors and resistors in a ladder network. It is used for generating signals over a wide frequency range. This practical will help the students to develop skills to build RC phase shift oscillator and measure the generated frequency using CRO.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as waveform generator

V Practical Outcome

- Build RC phase shift oscillator and measure the generated frequency using CRO.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.

VII Minimum Theoretical Background

An oscillator is an electronic circuit for used generating oscillations with a DC biasing supply .The frequency of the generated signal is decided by the circuit elements. An oscillator requires an amplifier, a frequency selective network and a positive feedback from the output to the input.

The Barkhausein's criterion for sustained oscillation is $A\beta = 1$ where A is the gain of the amplifier and β is the feedback factor (gain). A phase-shift oscillator is a linear electronic oscillator circuit that produces a sine wave output. RC-Phase shift Oscillator has a CE amplifier followed by three sections of RC phase shift feed-back Networks. The output of the

last stage is return to the input of the amplifier. The values of R and C are chosen such that the phase shift of each RC section is 60º.Thus The RC ladder network produces a total phase shift of 180º between its input and output voltage for the given frequency. Since CE Amplifier produces 180º phases shift. The total phase shift from the base of the transistor around the circuit and back to the base will be exactly 360º or 0º. This satisfies the Barkhausein's condition for sustaining oscillations and total loop gain of this circuit is greater than or equal to 1, this condition used to generate the sinusoidal oscillations.

VIII Circuit diagram

a. Sample

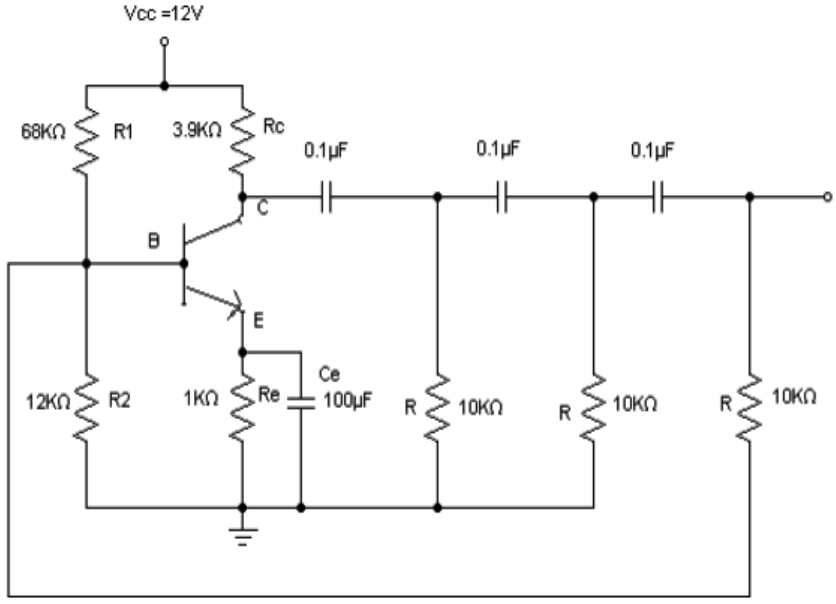

Figure 19.1: RC phase shift oscillator

Courtesy: *http://bhagwantuniversity.ac.in/wp-content/uploads/2016/01/ELECTRONICS-LAB-II-SEM-IV.pdf dt 22/01/2018*

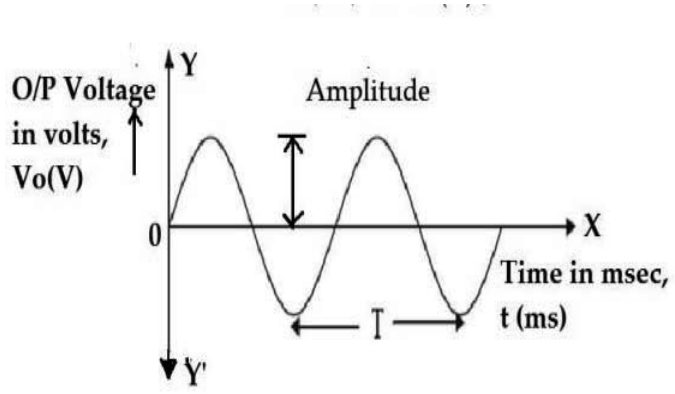

Figure 19.2: Model Wave forms

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument /Component	Specification	Quantity	Remark
1	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
3	Transistor	SL100 or BC547	1 No.	
4	Resistors	R_1=68kΩ,R_2=12kΩ,Rc=3.9kΩ R_E=1kΩ R=10kΩ,	1No.Each 3 No.	
5	Capacitors	C_E =100 μF C= 0.1 μF	1 No. 03 No.	
6	Breadboard	5.5 CM X 17CM	1 No.	
7	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of CRO before use.

XI Procedure

1) Build circuit on breadboard as per circuit diagram.
2) Connect DC Power Supply to the circuit and CRO at output terminals.
3) Switch on power supply , Set V_{CC} = 12V.Switch on CRO
4) Observe output on CRO.
5) Measure amplitude and time period from CRO.
6) Calculate frequency of oscillation by the formula f=1/T
7) Calculate theoretical frequency of oscillation by the given formula.
8) Plot the output waveform on graph paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 19.1 Observation Table

Keept Vcc = 12 volt

Sr. No.	Amplitude (V) of output signal (volts)	Time period (T) of output signal (msec.)

Calculations:

i. Practical frequency **(F)** $_{TH}$ =1/T

ii. Theoretical Frequency **(F)** $_{PR}$ = 1/(2πRC√6)

XVI Results

1. Theoretical frequency **(F)** $_{TH}$ =……..
2. Practical frequency **(F)** $_{PR}$ =……..

XVII Interpretation of Results (Give meaning of the above obtained results)

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.....
.....

XVIII Conclusions and recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. A RC phase shift oscillator generated 1.2 KHz frequency with C=0.016µf.then what should be the value of resistor used in RC network?
2. State the effect of change in biasing supply on output signal.
3. Find out threshold frequency of used transistor from data sheet
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Transistor Database User Guide, 2016
2. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
3. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
4. https://www.youtube.com/watch?v=GFh2YycDHIw
5. https://www.youtube.com/watch?v=xupn6VebQzg

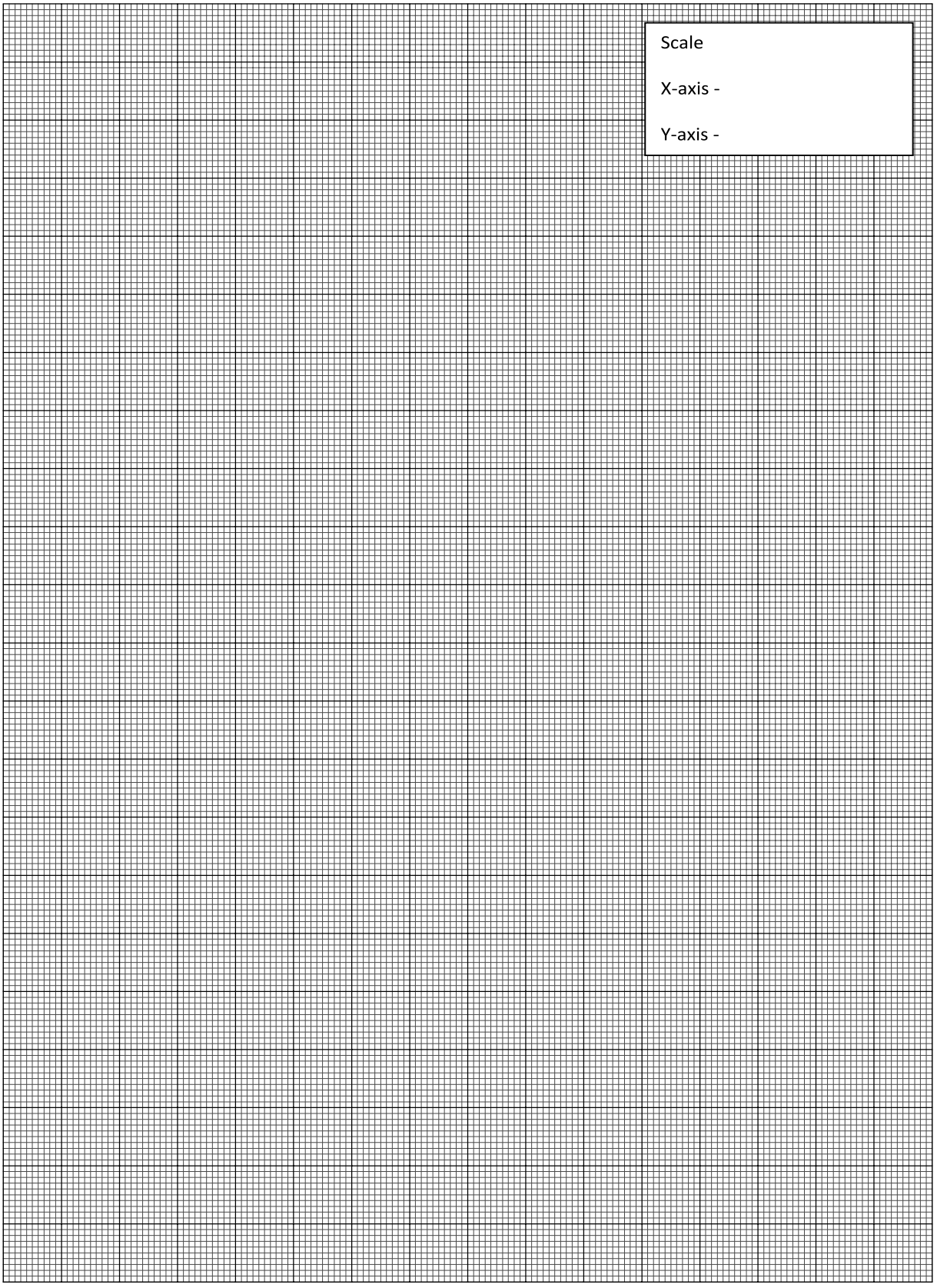
XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of theoretical and practical Frequency	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..……..
2. ……..…….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	


Scale
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Y-axis -

Practical No.20: Crystal Oscillator

I Practical Significance

It is a linear electronic circuit that produces a sine wave output. The use of crystal oscillator in military and aerospace is to establish an efficient modulation, for the navigation purpose, electronic warfare, in the guidance systems. This practical will help the students to develop skills to build crystal oscillator and measure the generated frequency using CRO.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronics components.
2. Test the selected electronic components.
3. Mount the electronic component on breadboard as per circuit diagram.

IV Relevant Course Outcome(s)

- Use BJT as waveform generator

V Practical Outcome

- Build Crystal oscillator and measure the generated frequency using CRO.

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Maintain tools and equipment.

VII Minimum Theoretical Background

Crystal oscillator gives most stable oscillations .It is widely used in microcontroller applications to provide clock signal .There are different types of piezoelectric resonators, but typically, quartz crystal is used in oscillators. Selecting crystals for a specific application will often be dependent on three factors: size (footprint area, height), performance (accuracy over temperature, lifetime) and cost (for example, higher performance and smaller package = higher price).Crystals are available with leads or without leads.

The quartz crystal oscillator circuit diagram consists of series resonance and parallel resonance, i.e., two resonant frequencies.

VIII Circuit diagram

a. Sample

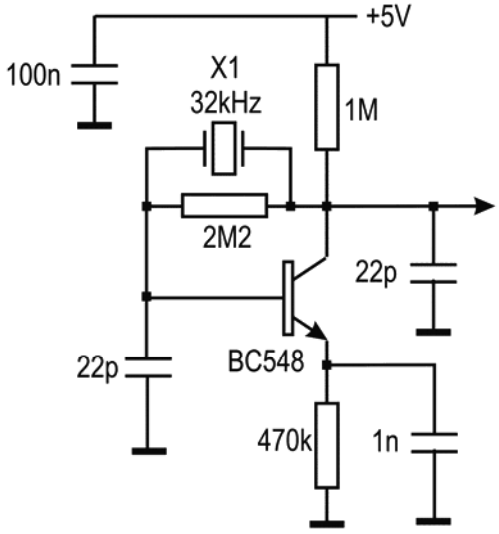

Figure 20.1 Crystal oscillator

***Courtesy**:https://www.google.co.in/search?q=crystal+oscillator+circuit+using+BJT+images&dcr=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjV25TnjenZAhUZTY8KHcYzCG0Q_AUICigB&biw=1024&bih=662#imgrc=kbI5c9s7EIpicM:*

b. Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument/component	Specification	Quantity	Remark
	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
1	Regulated DC Power Supply	0-30V, 2Amp SC protection Vcc=12 volt	1 No.	
2	Crystal	1MHz or equivalent	1 No.	
3	Transistor	BC548 or equivalent	1 No.	
4	Resistors	R_B=2.2MΩ,Rc=1MΩ R_E=470kΩ	1 No.	
5	Capacitors	22pf, 100nf,22pf ,1nf	1 No.	
6	Breadboard	5.5 CM X 17CM	1 No.	
7	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure proper settings of function generator and CRO before use.
4. Test the transistor before use.

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Connect DC Power Supply to the circuit and CRO at output terminals.
3. Switch ON power supply, Set V_{CC} = 12V.
4. Switch on CRO and Observe output on CRO.
5. Measure amplitude and time period from CRO.
6. Calculate frequency of oscillation by the formula f=1/T
7. Plot the output waveform on graph paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 20.1 Observation Table

Keep Vcc = 12 volt

Sr. No.	Amplitude (V) of output signal (volts)	Time period (T) of output signal (msec.)
1		

Calculations:

i. Practical frequency $(F)_{PR} = 1/T$

XVI Results

1 Theoretical frequency of Crystal $(F)_{TH}$= ……

2 Practical frequency $(F)_{PR}$ =……..

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Identify the crystal available on Microcontroller kit and state it frequency
2. State the characteristic of crystal oscillator.
3. From crystal datasheet state parameter values such as package number, resistance, capacitance, frequency, temperature tolerance.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Transistor Database User Guide, 2016
3. http://www.ti.com/lit/an/swra372c/swra372c.pdf
4. https://www.youtube.com/watch?v=_3YK-FHJ3zI.
5. http://www.sanfoundry.com/analog-circuits-questions-answers-crystall-oscillator-1/

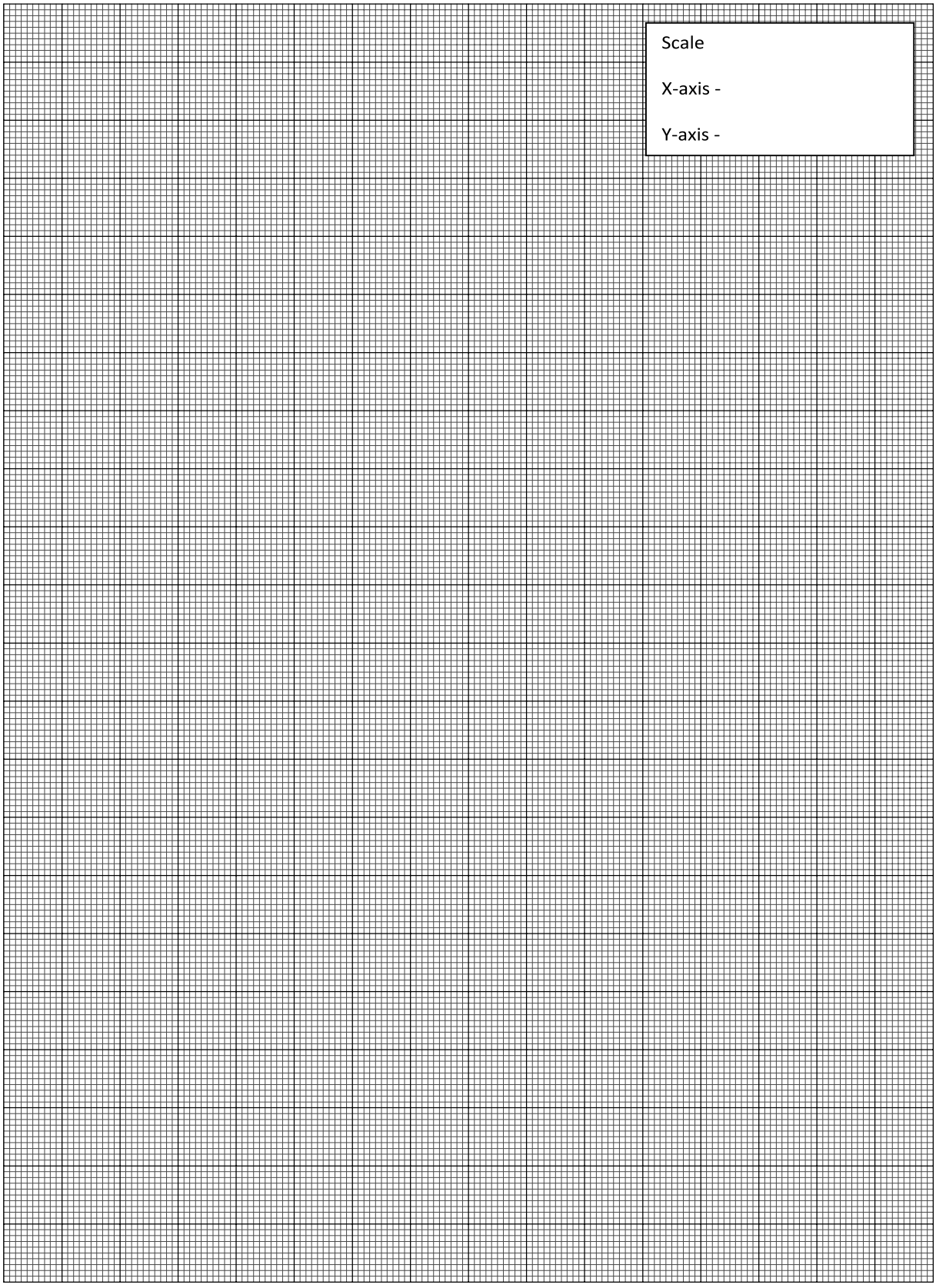
XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of Frequency	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
	Total	100 %

Names of Student Team Members

1. ……..
2. ……..….
3. ……
4. ……..…

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 21: Simulation of Hartley Oscillator

I Practical Significance

The Hartley oscillator is an electronic oscillator circuit in which the oscillation frequency is determined by the tuned circuit consisting of capacitors and inductors, i.e. an LC oscillator. This practical will help the students to develop skills to build Hartley oscillator using appropriate EDA tool.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations
- **EDA Tools Usage**: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive from software library
2. Simulate the relevant oscillator circuit.

IV Relevant Course Outcome(s)

- Use BJT as waveform generator.

V Practical Outcome

- Simulate Hartley oscillator using any relevant simulation software.(like spice, multisim, Lab view, LTspice, Octeva).

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

Hartley oscillator is inductively coupled; variable frequency oscillators where the oscillator may be a series or shunt fed. A Hartley oscillator is the advantage of having one tuning capacitor and one center tapped inductor. The transistor provides amplification along with inversion to amplify and correct the signal generated by the tank circuit. The mutual inductance between L1 and L2 provides the feedback of energy from collector-emitter circuit to the base-emitter circuit.

The frequency of oscillations in this circuit is

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{C(L_1 + L_2)}}$$

VIII Practical Circuit diagram :

a) Sample

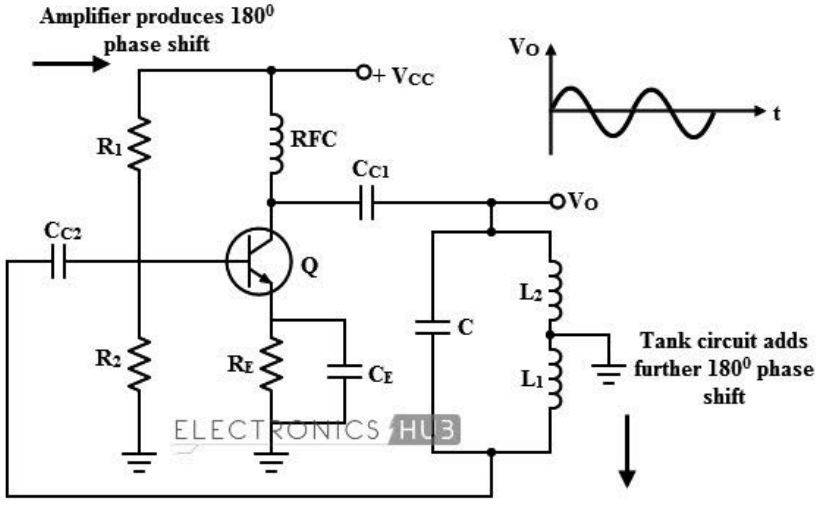


Figure 21.1 Circuit Diagram of Hartley Oscillator

Courtesy:*https://www.google.co.in/search?q=hartley+oscillator+images&tbm=isch&source=iu&ictx=1&fir=gPCajApSUlNDfM%253A%252CfGR2V1HVajww_2M%252C &usg=__IYRXWiMKj3v122vkkwiPTm6dlZk%3D&sa=X&ved=0ahUKEwiPgc_4 qNrZAhWMqo8 KHecs BK0Q9QEIKzAA#imgrc= UDozz Xoi6wrz3M:::.*

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

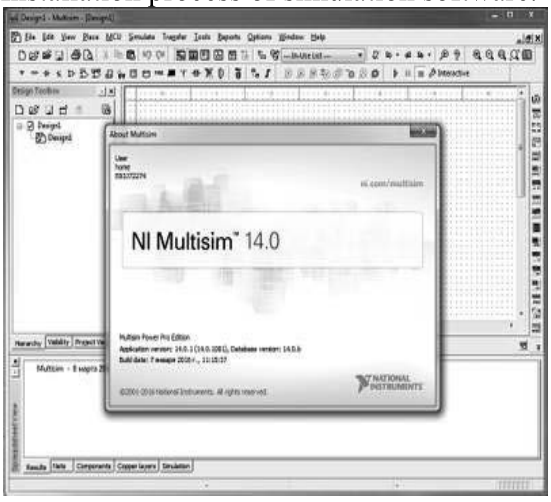
S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Computer with desired Configuration	Latest Processor	1 No.	
2.	Simulation software	LT Spice /Lab view/H Spice /P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1 No.	

X Precautions to be Followed

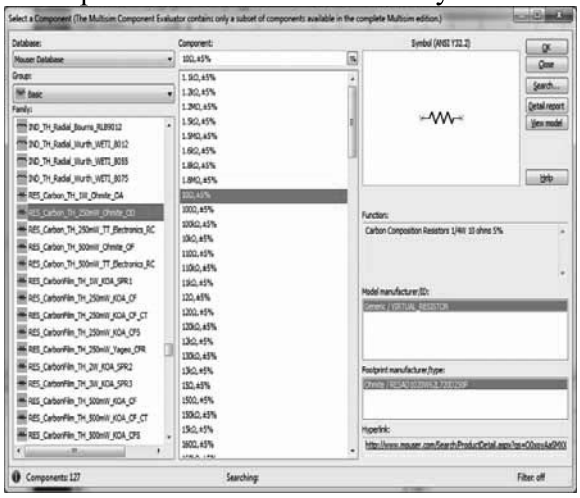
1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

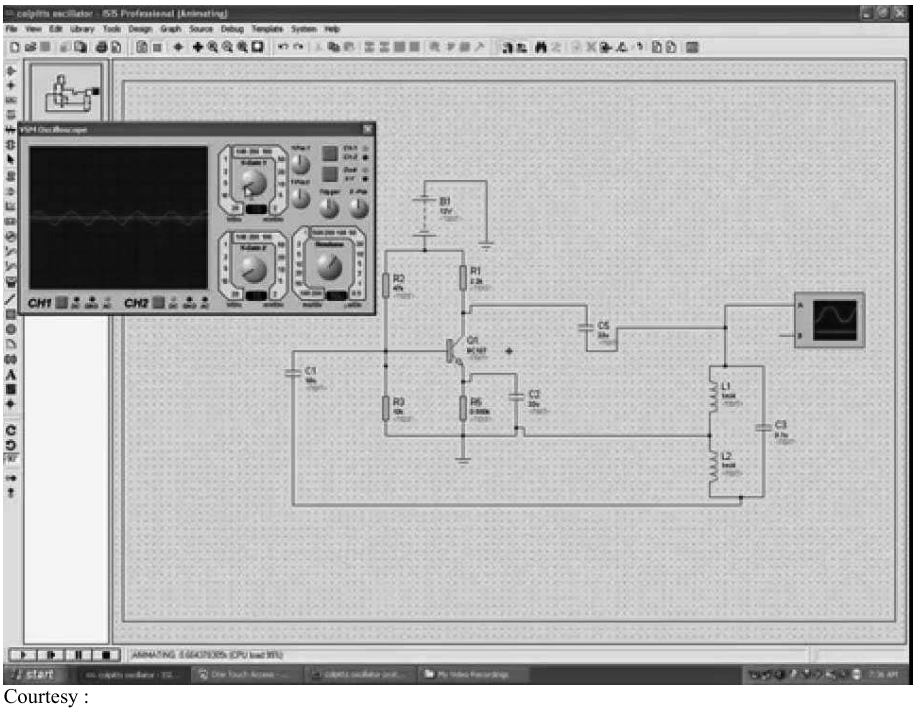
1. Perform step by step Installation process of simulation software.



2. Select relevant electronic components from software library.



3. Build the Hartley oscillator in simulation software as per diagram.



Courtesy :
https://www.google.co.in/search?dcr=0&biw=1024&bih=662&tbm=isch&sa=1&ei=r7unWrH2KoryvATw34z4DQ&q=simulation+of+hartley+oscillator+circuit&oq=simulation+of+hartley+oscillator+circuit&gs_l=psy-ab.3...3 730
07.383976.0.386229.0.0.0.0.0.0.0.0..0.0....0...1c.1.64.psy-ab..0.0.0....0.YhA- 3MFgx0A#imgrc=LCszHyK96CrUoM:

4. Simulate /run the circuit.
5. Observe output waveform on PC screen
6. Take printouts of circuit diagram and waveforms on A-4 Paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Actual Precaution (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 21.1 Observation Table

Amplitude of Waveform Vo = **---------**

Sr. No.	Time 'T'(sec)	Practical Frequency F=1/T (Hz)	Theoretical Frequency (Hz)	Remark
1.				

Calculations :

i. Practical Frequency: $F_{PR}=1/T$

ii. Theoretical Frequency F_{TH}:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{C(L_1 + L_2)}}$$

Results

1. Practical Frequency F_{PR} =……..
2. Theoretical Frequency F_{TH} =…..……
3. Amplitude of Output V_O=…..……

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions and recommendations (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. State the configuration of transistor used in Hartley oscillator circuit?
2. Suggest the changes required to simulate colpitts oscillator.
3. Which type of feedback is used in oscillator circuit?
4. If transistor is replaced by Op-Amp then draw the circuit of Hartley oscillator.
5. ……
6. ……

[Space for Answers]

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XIX References / Suggestions for further reading

1. Modern Oscillator circuit Encyclopedia,Graf, Rudolf F.
2. NI Multisim Lab Manual for Electricity and Electronics, Howard H. Gerrish, William E. Dugger Jr , Richard M. Roberts, Goodheart-Wilcox Publisher; ISBN :1590708830
3. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
4. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
5. https://www.youtube.com/watch?v=FQjQs0z5XUs

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of simulation software	10 %
2.	Building of circuit diagram	20 %
3.	Measuring values from PC Screen	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of theoretical and practical value of Frequency	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. ……...
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Paste here printouts of Output waveforms

Practical No. 22: Miller Sweep Generator

I Practical Significance

The transistor Miller time base generator circuit is the popular Miller integrator circuit that produces a sweep waveform. This is mostly used in horizontal deflection circuits for scanning purpose in CRT display. This practical will help the students to develop skills to build Miller's sweep generator circuit.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Test Transistor Resistor, and Capacitor.

IV Relevant Course Outcome(s)

- Use BJT as waveform generator.

V Practical Outcome

- Generate a waveform Using Miller's sweep generator and measure sweep time and retrace time.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

The Miller time base generator circuit consists of a switching device and a timing circuit. Transistor 1 acts as a switch and Transistor 2 acts as a CE configuration high gain amplifier. When Transistor 1 is ON, Transistor 2 is OFF. At this instance output voltage across capacitor is equal to V_{CC}. If a pulse of negative polarity is applied, then Transistor 1 is reverse biased and it is switched OFF. Transistor 2 then is switched ON. Since Transistor 2 conducts, output voltage begins to decrease towards zero. When the input pulse is removed the capacitor again begins to charge. Sweep time of miller sweep generator is given as :

Sweep Time Ts = C.Rc(β+1)

Where β = CE current gain of transistor 2

VIII Practical Circuit diagram :

a) Sample

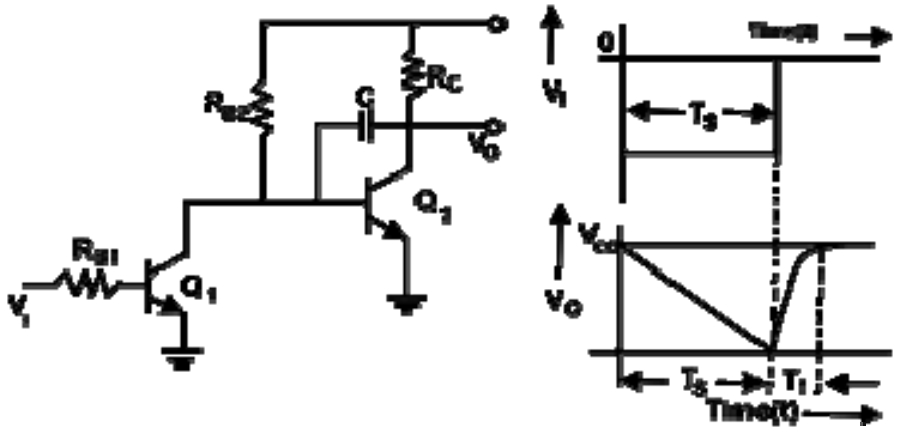
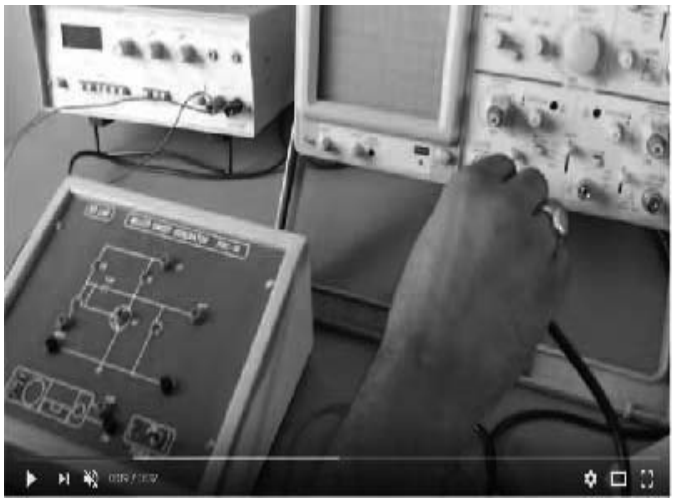


Figure 22.1 Miller Sweep generator

Courtesy:https://www.google.co.in/search?q=wAVEFORMS+OF+MILLER+SWEEP+GENERATOR&source=lnms&tbm=isch&sa=X&ved=0ahUKEw is2Lm2wtrZAhVEuY8KHXHjCskQ_AUICigB&biw=1600&bih=794#imgrc=nfBs9fbDXjZY8M*:*

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory



IX Resources Required

S. No.	Instrument/component	Specification	Quantity	Remark
1.	Cathode Ray Oscilloscope (Analog type)	20/30/100 MHz Frequency	1 No.	
2.	Function Generator	0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1 No.	
3.	Regulated DC Power Supply	0-30V, 2Amp SC protection	1 No.	
4.	Transistor 2	2N2222 or equivalent Transistor	1 No.	
5.	Transistor 1	BC 547 or equivalent Transistor	1 No.	
6.	Resistors	R_{B2}=100KΩ,R_{B1}=7KΩ,R_C=10KΩ,	1 No.	
7.	Capacitor	C=0.001μf	1 No.	
8.	Breadboard	5.5 cm X 17 cm	1 No.	
9.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper Connections are made to the equipment.
2. Ensure the power switch is in ‘off’ condition initially.
3. Ensure proper settings of function generator and CRO before use.
4. Test the transistor before use.

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Select appropriate square wave amplitude (1V to 10V) and appropriate frequency(1 KHz) on function.
3. Connect function generator output to CRO and observe input square wave signal on CRO.
4. Connect Function generator at input terminals of the circuit and connect CRO at output terminals of the circuit.
5. Switch on DC Power Supply. Set biasing supply Vcc as per transistor V_{CC}(max) Rating
6. Observe input and output waveforms on CRO
7. Set input square wave frequency from the range 1K Hz to 5KHz and write down Sweep Time and retrace time from CRO for that set input frequency and amplitude.
8. Calculate theoretical sweep time.
9. Plot input output waveforms on graph paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 22.1 Observation Table

Input Amplitude Vin = ---------- Input Frequency Fin =----------

Sr. No.	Practical Retrace Time 'Tr'(sec)	Practical Sweep Time 'Ts'(sec)
1.		

Calculations :

i. Theoretical Sweep Time :

$$Ts = C*Rc\ (\beta+1)$$

XVI Results

1. Practical Retrace Sweep Time =……..
2. Practical Sweep Time =……..
3. Theoretical Sweep Time =…..……

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Sketch the output waveform if in this circuit RC > T, where T= Total time duration of input square wave.
2. Sketch the output waveform if in this circuit RC < T, where T= Total time duration of input square wave
3. State the effect of threshold Frequency, Ft on this circuit performance.
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Signal and sweep generators by J. Richard Johnson.
2. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
3. https://www.youtube.com/watch?v=7hroDRsnYEA

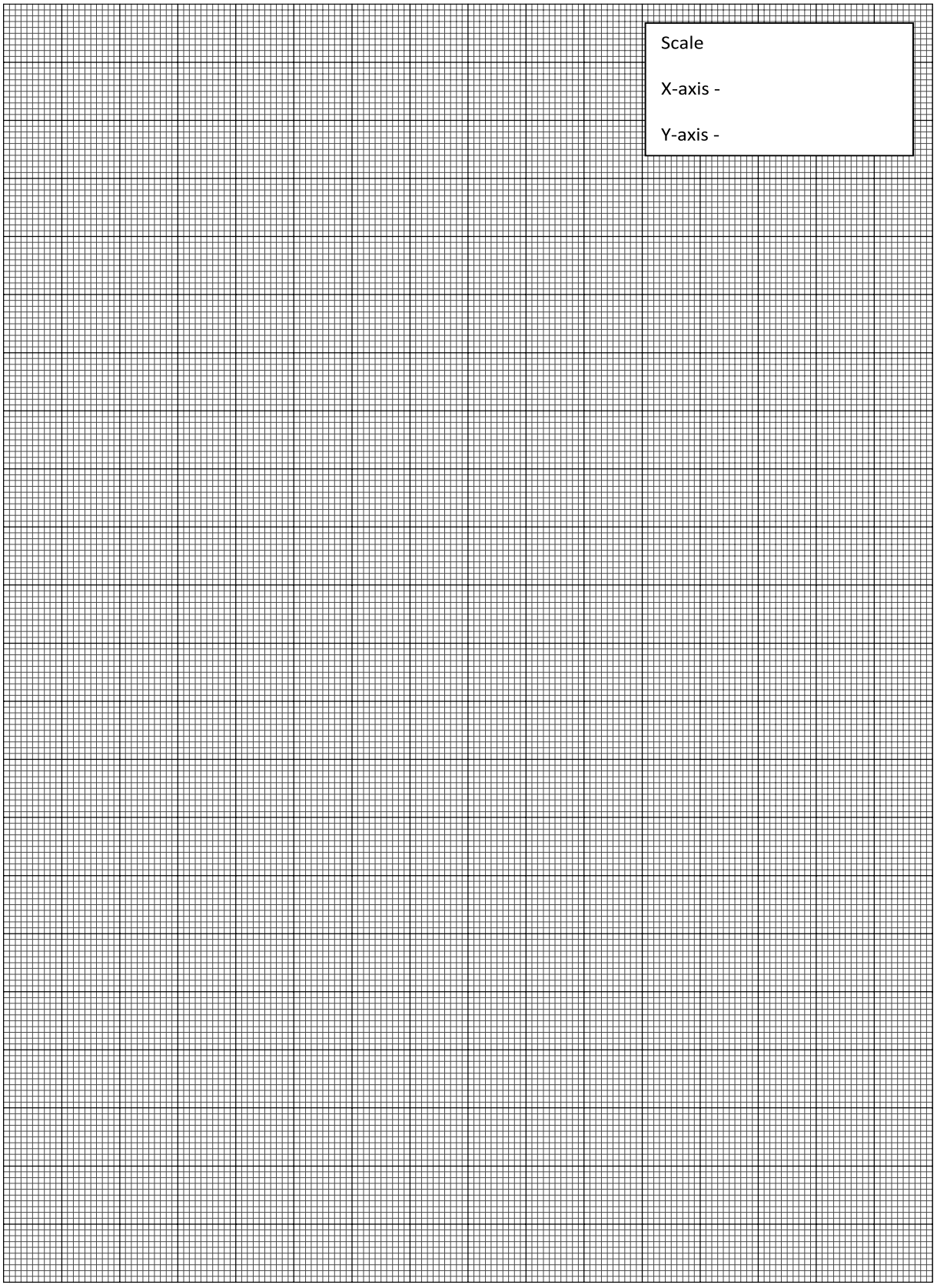
XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using CRO	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total :25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. ……...
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	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Y-axis -

Practical No. 23: Simulation of Dual Voltage Regulator

I Practical Significance

In the industry and home appliances three terminal regulators are used. They give fixed output voltages making them useful in a wide range of applications. Use of IC 78xx and 79xx will help students to acquire necessary practical skills related to regulators. This practical will help the students to apply relevant Electronics technologies and EDA tools with an understanding of the limitations.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations
- **EDA Tools Usage**: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant simulation software for simulating and testing of electronic circuit.
2. Select relevant electronic components i.e. active and passive from software library.
3. Build the electronic circuit in simulation software as per circuit diagram.

IV Relevant Course Outcome(s)

- Maintain IC voltage regulator and SMPS.

V Practical Outcome

- Simulate/test dual voltage regulator using IC 78XX and 79XX for the specified regulated output voltage.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

IC 78XX is positive series of regulators. For ICs within the 78xx family, the xx is replaced with two digits, indicating the output voltage for example; the 7805 has a 5-volt output, while the 7812 produces 12 volts. The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak

output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. Voltage Ranges are LM7805C 5V; LM7812C 12V ; LM7815C 15V.

The LM79XX series of 3-terminal regulators is available with fixed output voltages of 5V, 8V, 12V, and 15V. These devices need only one external component, i.e. compensation capacitor at the output. The LM79XX series is packaged in the TO-220 power package and is capable of supplying 1.5A of output current.

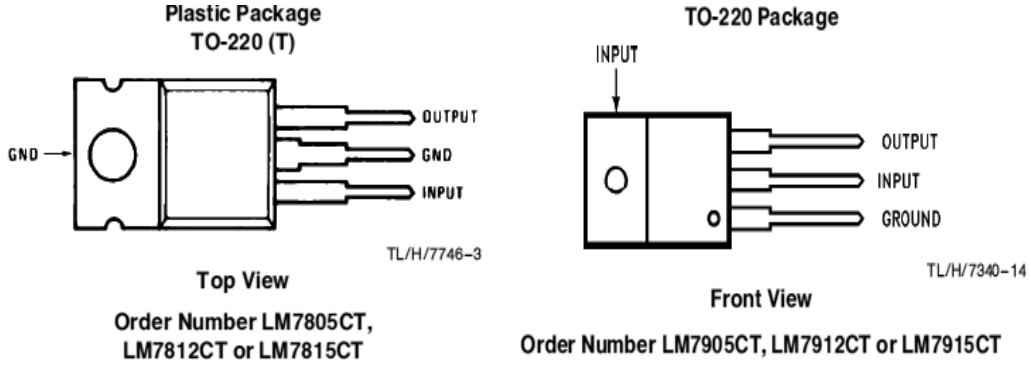


Figure 23.1 IC package

Practical Circuit diagram:

a) Sample

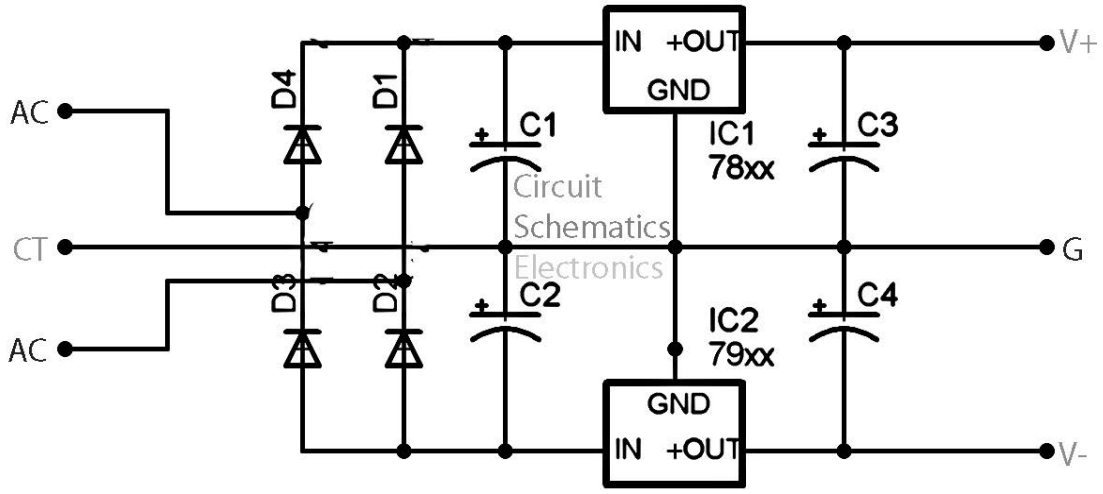


Figure 23.2 Dual Voltage Regulator

Courtesy: https://www.google.co.in/search?q=SIMULATION+OF+DUAL+VOLTAGE+REGULATOR(%2B/-)+USING+IC+78XX+and+ 79XX&source= lnms&tbm=isch&sa=X &ved=0ahUKEwikpvC-zdrZAhWIOI8KHQBYD-UQ_AUICigB&biw=1600&bih=794#imgrc=WPX7H4YONvYSEM:

b) Actual Circuit used in laboratory /Actual Experimental set up used in laboratory

VIII Resources Required

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Computer with advanced Configuration	Latest Processor	1 No.	
2.	Simulation software	LT Spice /Lab view/H Spice /P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1 No.	

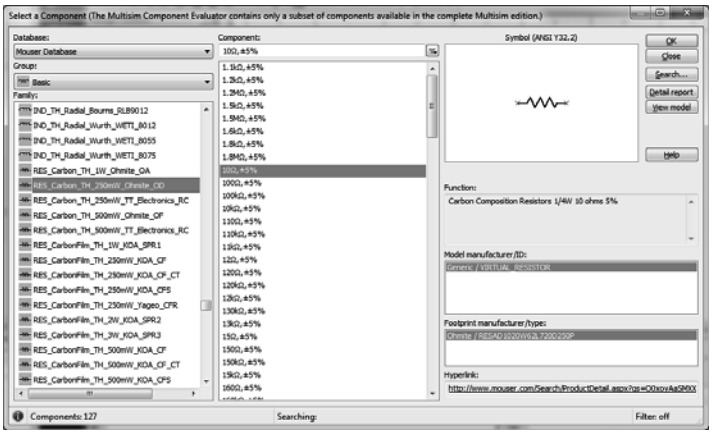
IX Precautions to be Followed

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

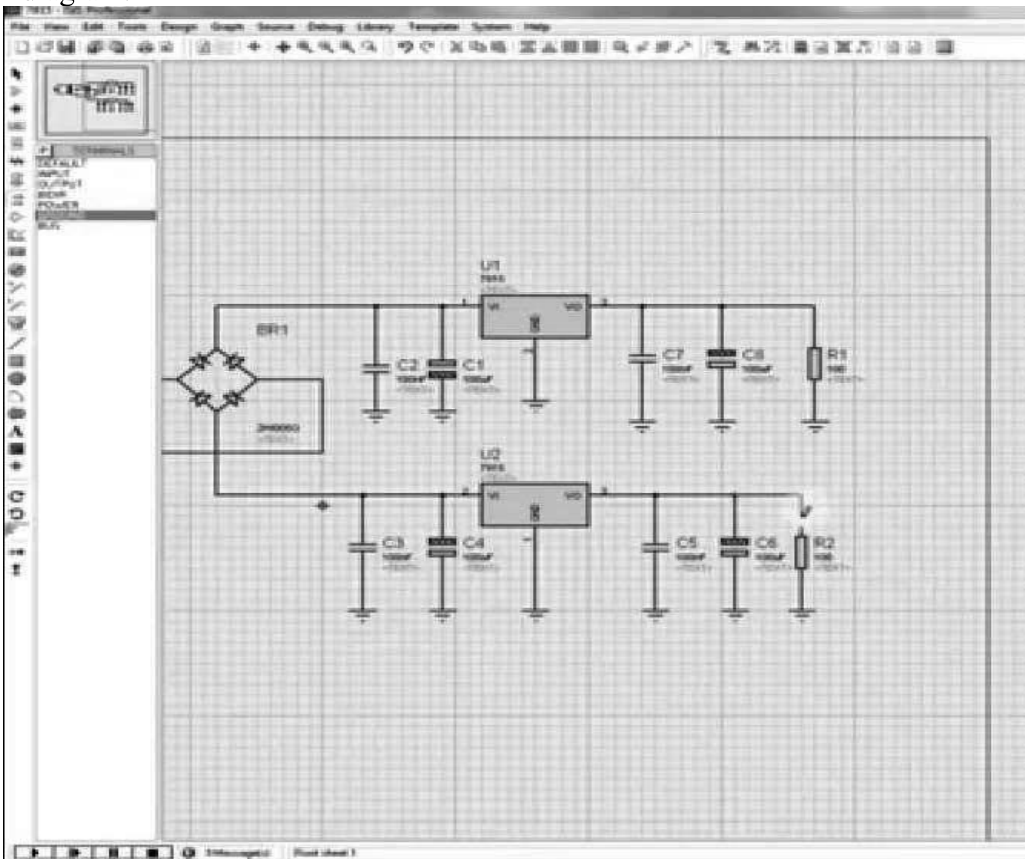
X Procedure

1. Perform step by step Installation process of simulation software.

2. Select relevant electronic components from software library.



3. Build the dual regulated power supply using IC 78XX & 97XX in simulation software as per diagram.



4. Simulate /run the circuit.
5. Note down the output voltages at different stages of dual power supply.
6. Take printouts of circuit diagram and waveforms on A-4 Paper

XI Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			

XII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIII Precautions Followed (use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 23.1 Observation Table

Sr. No.	IC Used	Output DC Voltage
1.	7805	
	7905	
2.	7812	
	7912	
3.	7815	
	7915	

XV Results

1. …….. ……..
2. …….. ……..
3. …….. ……..

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions and recommendation (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Measure output current using the simulation software for variable potentiometer.
2. Suggest the equivalent simulation software to build/simulate dual regulated power supply?
3. List out changes which are essential to simulate dual tracking power supply.
4. ……
5. ……

[Space for Answers]

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XIX References / Suggestions for further reading

1. NI Multisim Lab Manual for Electricity and Electronics, Howard H. Gerrish, William E. Dugger Jr , Richard M. Roberts, Goodheart-Wilcox Publisher; ISBN :1590708830
2. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
3. https://www.youtube.com/watch?v=mG9Jok1lTxU

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of simulation software	10 %
2.	Building of circuit diagram	20 %
3.	Measuring values from PC Screen	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Observations	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Output Waveforms	15 %
9.	Submitting the journal in time	05%
	Total	100 %

Names of Student Team Members

1. ……..
2. ……..…….
3. ……
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Paste here printouts of simulated circuit and waveforms

Practical No. 24: Dual Voltage Regulator

I Practical Significance

Three terminal voltage regulators i.e. 78xx and 79xx series ICs are most commonly used to build fixed voltage regulated power supply for various applications. 78xx and 79xx series ICs have built-in protection against a circuit drawing too much current. They have protection against overheating and short-circuits, making them robust in most applications. This practical will help the students to develop practical skills to build dual regulated power supply for appropriate output voltage.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Select relevant IC for appropriate output voltage and test the IC.

IV Relevant Course Outcome(s)

- Maintain IC voltage regulator and SMPS.

V Practical Outcome

- Build dual voltage regulator for the specified regulated output voltage.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

IC 78XX is series of positive voltage regulator and IC 79XX as a negative voltage regulator. Last two digits indicates the voltage value for example, the 7805 has a + 5-volt output, while the 7905 produces -5 volts. The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation.

The LM79XX series of 3-terminal regulators is available with fixed output voltages of 5V, 8V, 12V, and 15V. These devices need only one external component, i.e. compensation capacitor at the output. The LM79XX series is packaged in the TO-220 power package and is capable of supplying 1.5A of output current.

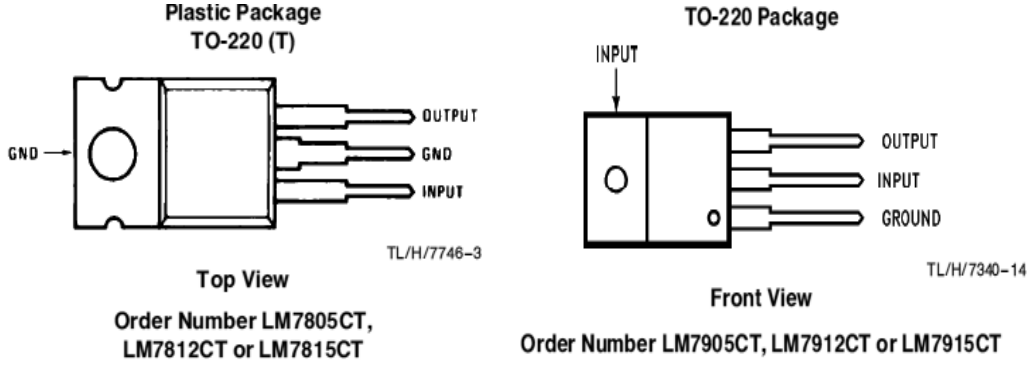

Figure 24.1 IC package

VIII Practical Circuit diagram :

a) Sample

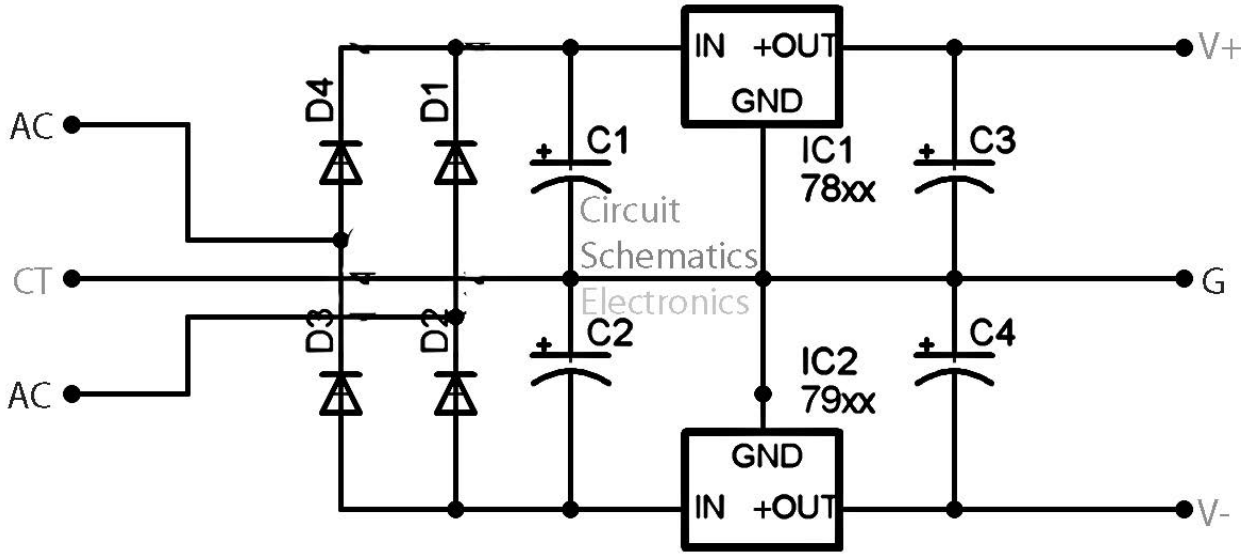

Figure 24.2 Dual Voltage Regulator

Courtesy: https://www.google.co.in/search?q=SIMULATION+OF+DUAL+VOLTAGE+REGULATOR(%2B/-)+USING+IC+78XX+and+79XX&source= lnms&tbm=isch&sa=X &ved=0ahUKEwikpvC-zdrZAhWIOI8KHQBYD-UQ_AUICigB&biw= 1600 &bih=794 #imgrc =WPX7H4YONvYSEM:

b) Actual Circuit used in laboratory /Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	IC 7805/ 7812/ 7815	Thermal, short circuit and safe area protection, High ripple rejection, 1.5A output current, 4% tolerance on preset output voltage	1 No.	
2.	IC 7905/ 7912/ 7915	Thermal, short circuit and safe area protection, High ripple rejection, 1.5A output current, 4% tolerance on preset output voltage	1 No.	
3.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1 No.	
4.	PN junction Diode	1N4007or any other equivalent	4 No.	
5.	Centre tapped Transformer	6-0-6 or 9-0-9 or12-0-12,	1 No.	
6.	Capacitors	1000µF, 100 µF,	1 No.	
7.	Breadboard	5.5 cm X 17 cm	1 No.	
8.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the polarity and appropriate range of multimeter

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. Apply unregulated voltage to the circuit.
3. Measure input voltage with Digital Multimeter
4. Measure output voltage with Digital Multimeter
5. Note down the output voltages at different stages of dual regulated power supply.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 24.1 Observation Table

Sr. No.	IC Used	Output DC Voltage
1.	7805	
2.	7905	

XVI Results

1. …….. ……..
2. …….. ……..

XVII Interpretation of Results (Give meaning of the above obtained results)

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.....

XVIII Conclusions and recommendation (Actions/decisions to be taken based on the interpretation of results).

.....
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XIX Practical Related Questions (Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. Sketch the circuit of dual regulated power supply using IC 78XX and 79XX that will give output equals to +/- 20V
2. Refer the datasheet state the performance parameters of IC 7812 and 7912.
3. Compare fixed and variable regulators?
4. ……
5. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Voltage regulator PCB for LM317 LM337 or 78xx 79xx IC by ebay.com
2. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
3. https://hw-server.com/voltage-regulators-stabilizers-78xx-and-79xx
4. https://www.youtube.com/watch?v=mG9Jok1lTxU

XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using DMM	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Observations	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Output waveforms	15 %
9.	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. ……..….
3. ……
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 25: Low Voltage Regulator Using IC 723

I Practical Significance

Voltage regulators are used to compensate for voltage fluctuations in main power as well as load current variation .Voltage regulators are used in industries as well as in domestic applications such as Air Conditioners, TV Receivers and Refrigerators in order to protect them from fluctuating input voltage. In this practical students will able to sketch line and load regulation characteristics of given IC 723.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Select relevant IC for appropriate output voltage and test the IC.

IV Relevant Course Outcome(s)

- Maintain IC voltage regulator and SMPS.

V Practical Outcome

- Build low voltage regulator using IC 723 for the given regulated output voltage. (2v-7v).

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

IC 723 voltage regulator is commonly used for series voltage regulator applications. It can be used as low and high voltage regulator. The output voltage can be set to any desired positive voltage between 2 volt to 37volt. It is available in both Dual-In-Line and Metal Can packages.

Features of 723 Voltage Regulator

- 150 mA output current without external pass transistor
- Output currents of 10A is possible by adding external transistors
- Input voltage ranges from 9.5 to 40V.
- Output voltage adjustable from 2V to 37V

- Can be used as either a linear or a switching regulator
- Reference voltage Vref = 6.8V to 7.5V.
- Line regulation = 0.5% Vo = 0.001%Vo.
- Load regulation 0.6% Vo = 0.003% Vo.
- Short circuit current limit Isc = 65mA at Rsc = 10Ω and Vo = 0.
- Quiescent current drain is 3.5mA, typically 1.3mA.

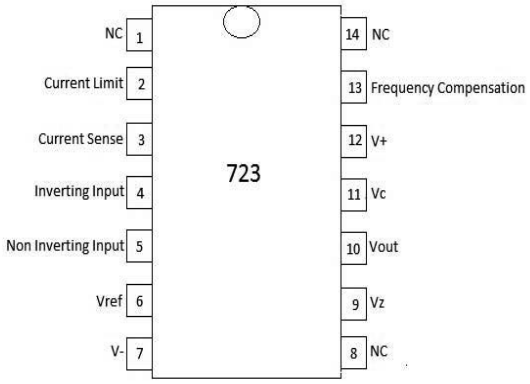

Figure 25.1: Pin configuration of IC LM723

Courtesy: https://electrosome.com/wp-content/uploads/2012/12/723-Voltage-Regulator-Pin-Diagram.jpg

Block diagram of IC 723.

Includes, voltage reference source, error amplifier, a series pass transistor and a current limit transistor all are included in 14 pin DIP package. It has temperature compensated 6.2 V Zener, which is biased with constant current source. A reference voltage amplifier generates the precise reference voltage in between 6.8 to 7.5 V.

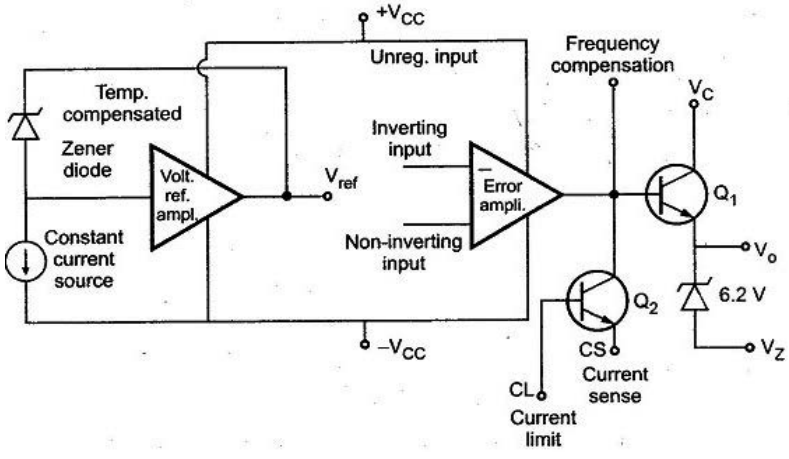

Figure 25.2: Block diagram of IC LM723

Courtesy: https://electrosome.com/wp-content/uploads/2012/12/723-Voltage-Regulator-Pin-Diagram.jpg

The output of error amplifier drives the series pass transistor Q1 to give output voltage. Transistor Q2 is connected internally to provide short circuit current limiting.

VIII Practical Circuit diagram :

a) Sample

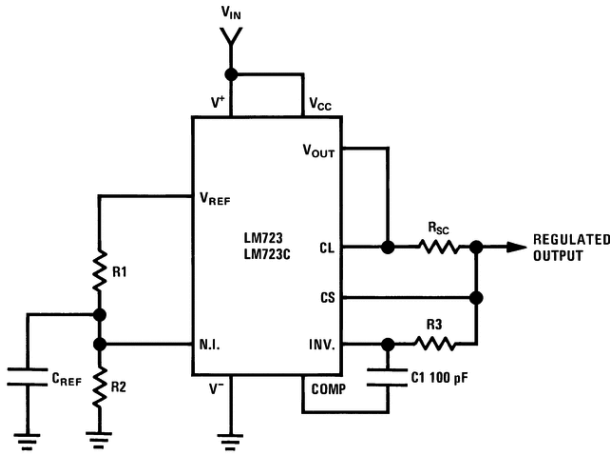

Figure 25.3: Circuit diagram of IC LM723

Courtesy:https://www.google.co.in/search?q=LOW+voltage+regulator+using+IC+723+circuit+diagram& source= lnms&tbm= isch&sa=X&ved=0ahUKEwiC0NHx4trZAhUG3o8KHb8CAJcQ_AUICigB&biw=1600&bih=794#imgrc=srxWkRGFxdkxcM:

b) Actual Circuit used in laboratory /Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1 No.	
2.	DC Power Supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current. Or output of rectifier –filter circuit	1 No.	
3.	Regulator IC	LM 723	1 No.	
4.	Resistor	1.2KΩ, 560Ω, 3.9 KΩ,15 KΩ ,0.15Ω/5W,10KΩ variable resistor	1 No. each	
5.	Capacitor	100 pF,100 Nf,	1 No.each	
6.	Breadboard	5.5 cm X 17 cm	1 No.	
7.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in ‘off’ condition initially.
3. Ensure the polarity and appropriate range of multimeter

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. To find out line regulation vary the input voltage in steps keeping load constant.
3. Measure the output voltage.
4. To find out Load regulation vary the load in steps keeping input voltage constant.
5. Measure Output voltage.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 25.1: Measurement of Vin and Vo for Line Regulation

R_L =…… (to be kept constant)

Sr. No.	Input Voltage (Vin)	Output Voltage (Vo)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 25.2: Measurement of I_L and Vo for Load Regulation

V_{in} =…… (to be kept constant)

Sr. No.	Load Current (I_L)in mA	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

i. Line Regulation = ΔVout/ΔVin

ii. Load Regulation =

$$\% \text{ Regulation} = \frac{V_{no\text{-}load} - V_{full\text{-}load}}{V_{full\text{-}load}} \times 100$$

Where

$V_{no\text{-}load}$ is the no-load voltage and

$V_{full\text{-}load}$ is the full-load voltage.

XVI Results

1. %Line Regulation =……..
2. %Load Regulation =…..……

XVII Interpretation of Results (Give meaning of the above obtained results)

.....

.....

.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions(Note :Teacher shall assign batch wise additional one or two questions related to practical)

1. State the difference between low voltage and high voltage regulator?
2. List out various protection circuits used in regulator
3. State the significance of lead temperature rating of IC 723
4. ……
5. ……

[Space for Answers]

XX References / Suggestions for further reading

1. Voltage Regulator Circuit Manual by Robert J. Traister ,Publisher : Academic Presss
2. http://www.ti.com/lit/ds/symlink/lm723.pdf
3. https://www.youtube.com/watch?v=veXShWaCliA
4. https://www.youtube.com/watch?v=tNqT7vCDswk
5. https://www.youtube.com/watch?v=mG9Jok1lTxU

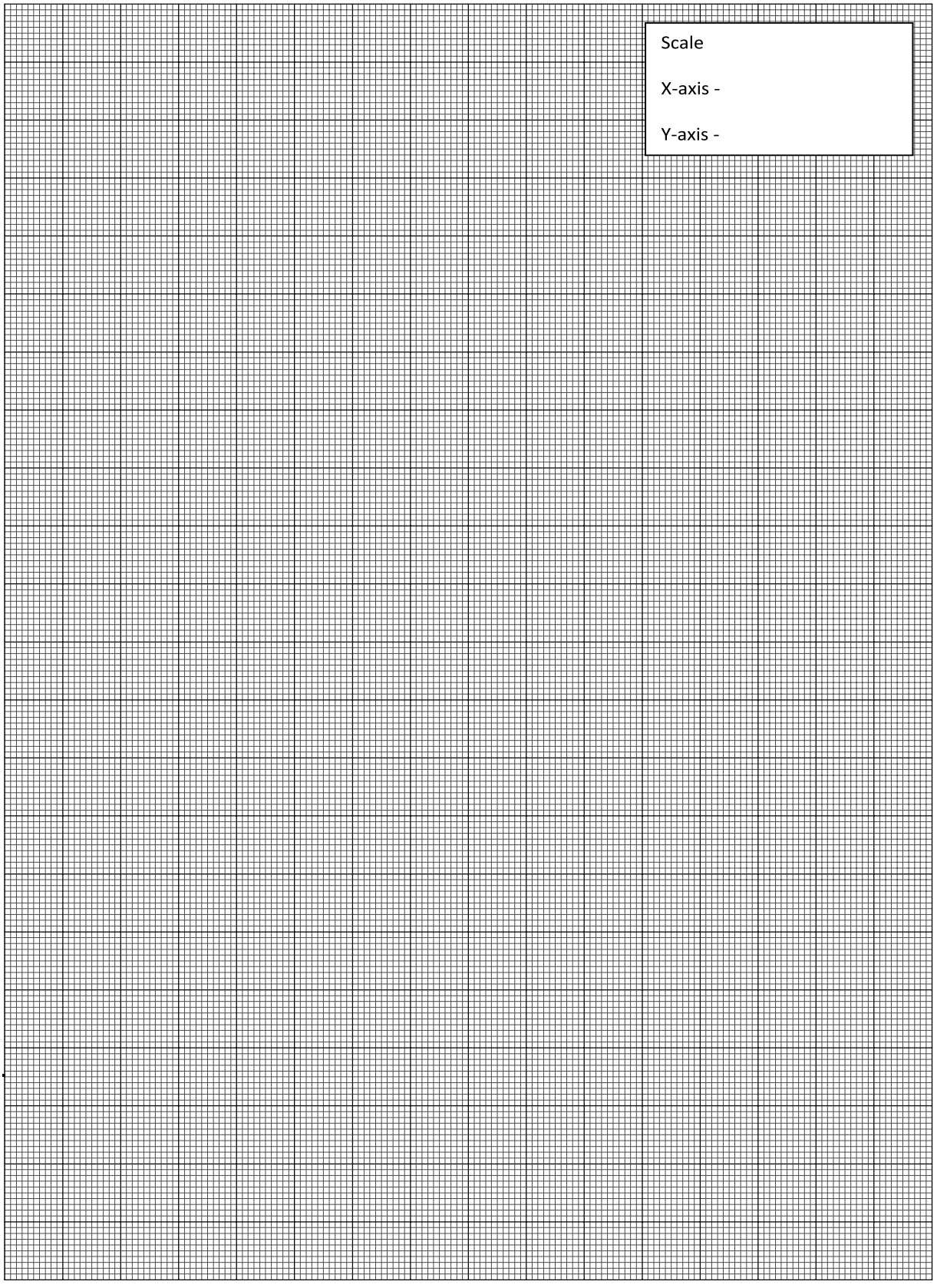
XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the components	10 %
2	Mounting of component	20 %
3	Measuring value using DMM	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculation of line and load regulation	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions, Graph	15 %
9	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. …….
2. ……..
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	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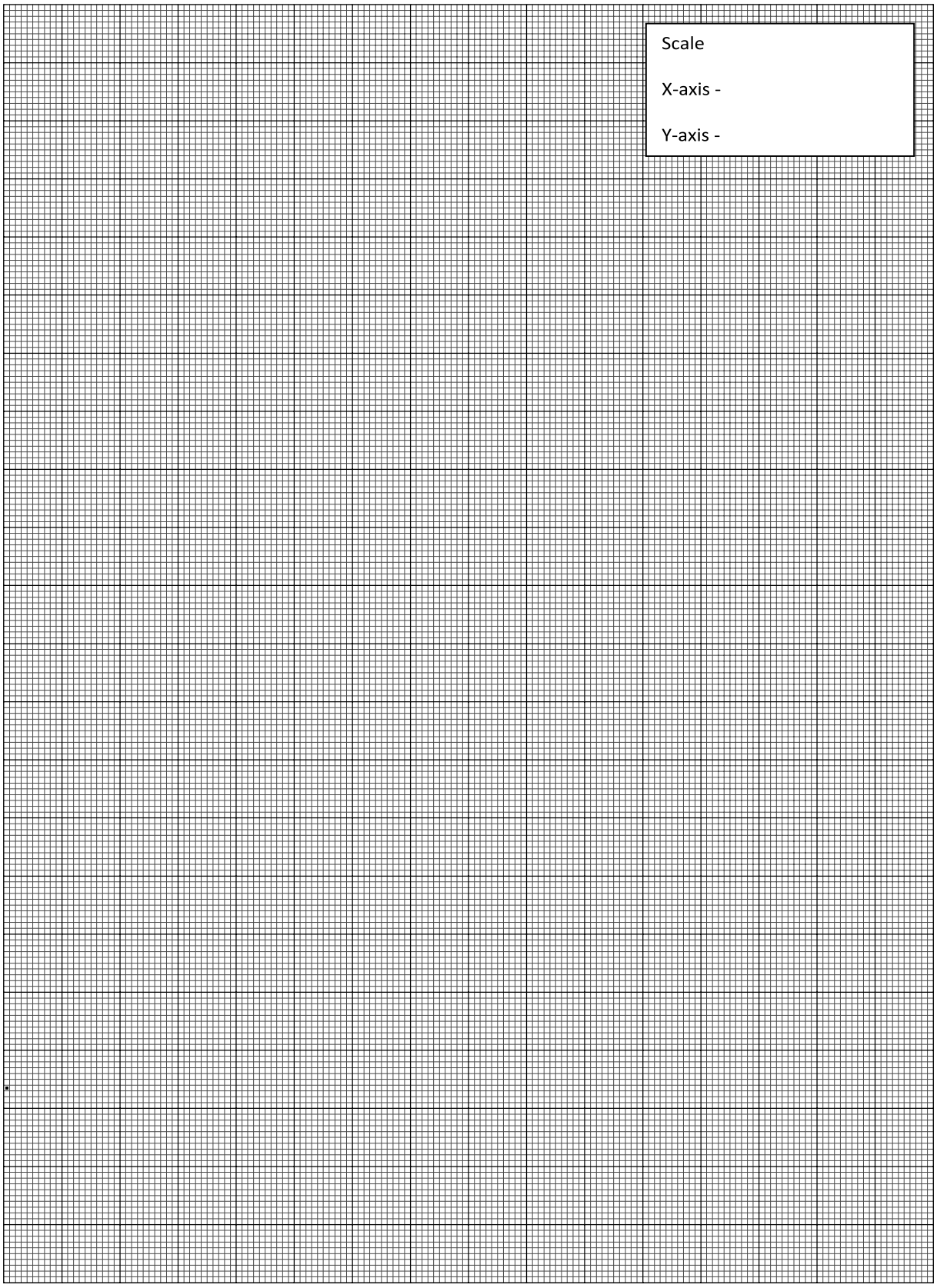
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SNVS310A –FEBRUARY 2005 –REVISED APRIL

LM723QML Voltage Regulator

Check for Samples: LM723QML

FEATURES

150 mA Output Current Without External Pass Transistor

- **Output Currents in Excess of 10A Possible by Adding External Transistors**
- **Input Voltage 40V Max**
- **Output Voltage Adjustable from 2V to 37V**
- **Can be Used as Either a Linear or a Switching Regulator**

Connection Diagram

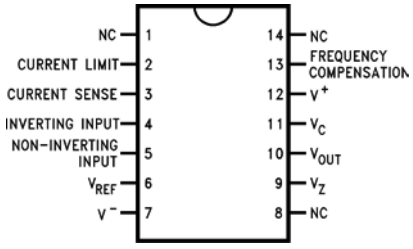

Figure 1. Dual-In-Line Package (Top View)
See Package J0014A

Pulse Voltage from V^+ to V^- (50 ms)			50V
Continuous Voltage from V^+ to V^-			40V
Input-Output Voltage Differential			40V
Maximum Amplifier Input Voltage	Either Input		8.5V
	Differential		5V
Current from V_Z			25 mA
Current from V_{REF}			15 mA
Internal Power Dissipation Metal Can(2)	Cavity DIP(2)		900 mW 800 mW
	LCCC (2)		900 mW
Operating Temperature Range			$-55°C \le T_A \le +125°C$
Maximum T_J			+150°C
Storage Temperature Range			$-65°C \le T_A \le +150°C$
Lead Temperature (Soldering, 4 sec. max.)			300°C
Thermal Resistance	θ_{JA}	CDIP (Still Air)	100°C/W
		CDIP (500LF/ Min Air flow)	61°C/W
		Metal Can (Still Air)	156°C/W
		Metal Can (500LF/ Min Air flow)	89°C/W
		LCCC (Still Air)	96°C/W
		LCCC (500LF/ Min Air flow)	70°C/W
	θ_{JC}	CDIP	22°C/W
		Metal Can	37°C/W
		LCCC	27°C/W
ESD Tolerance(3)			500V

Practical No. 26: High Voltage Regulator Using IC 723

I Practical Significance

The LM723/LM723C is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain and provision is made for either linear or fold-back current limiting. The LM723/LM723C is also useful in a wide range of Regulator other applications such as a shunt regulator, a current regulator or a temperature control. This practical will help the students to develop practical skills to build high voltage regulator using IC 723.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Select relevant IC for appropriate output voltage and test the IC.

IV Relevant Course Outcome(s)

- Maintain IC voltage regulator and SMPS.

V Practical Outcome

- Build high voltage regulator using IC 723 for the given regulated output voltage. (7V - 37V).

VI Relevant Affective domain related Outcome(s)

1. Follow safe practices.
2. Demonstrate working as a leader/a team member
3. Maintain tools and equipments

VII Minimum Theoretical Background

The 723 voltage regulator is commonly used for series voltage regulator applications. It can be used as both positive and negative voltage regulator. LM723 IC can also be used as a temperature controller, current regulator or shunt regulator and it is available in both Dual-In-Line and Metal Can packages.

Features of 723 Voltage Regulator:-

- 150 mA output current without external pass transistor
- Output currents in excess of 10A possible by adding external transistors

- Input voltage ranges from 9.5 to 40V.
- Output voltage adjustable from 2V to 37V
- Can be used as either a linear or a switching regulator
- Reference voltage Vref = 6.8V to 7.5V.
- Line regulation = 0.5% Vo = 0.001%Vo.
- Load regulation 0.6% Vo = 0.003% Vo.
- Short circuit current limit Isc = 65mA at Rsc = 10Ω and Vo = 0.
- Quiescent current drain is 3.5mA, typically 1.3mA.

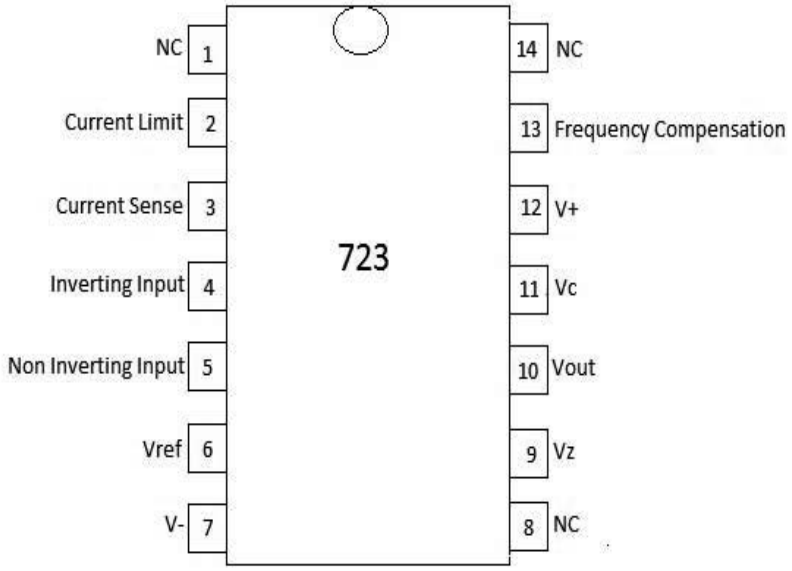

Figure 26.1: Pin configuration of IC LM723

Courtesy: https://electrosome.com/wp-content/uploads/2012/12/723-Voltage-Regulator-Pin-Diagram.jpg

Block diagram of IC 723.

Includes, voltage reference source, error amplifier, a series pass transistor and a current limit transistor all are included in 14 pin DIP package. It has temperature compensated 6.2 V Zener, which is biased with constant current source. A reference voltage amplifier generates the precise reference voltage in between 6.8 to 7.5 V. The output of error amplifier drives the series pass transistor Q1 to give output voltage. Transistor Q2 is connected internally to provide short circuit current limiting.

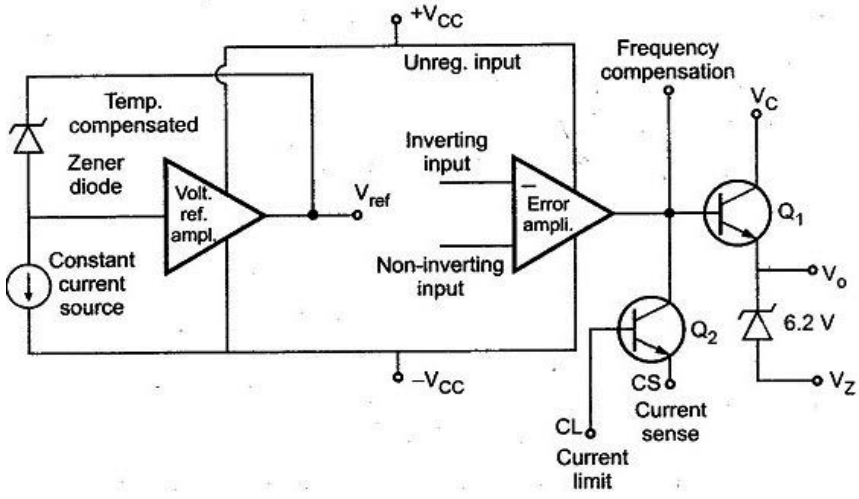

Figure 26.2: Block diagram of IC LM723

Courtesy: https://electrosome.com/wp-content/uploads/2012/12/723-Voltage-Regulator-Pin-Diagram.jpg

VIII Practical Circuit diagram :

a) Sample

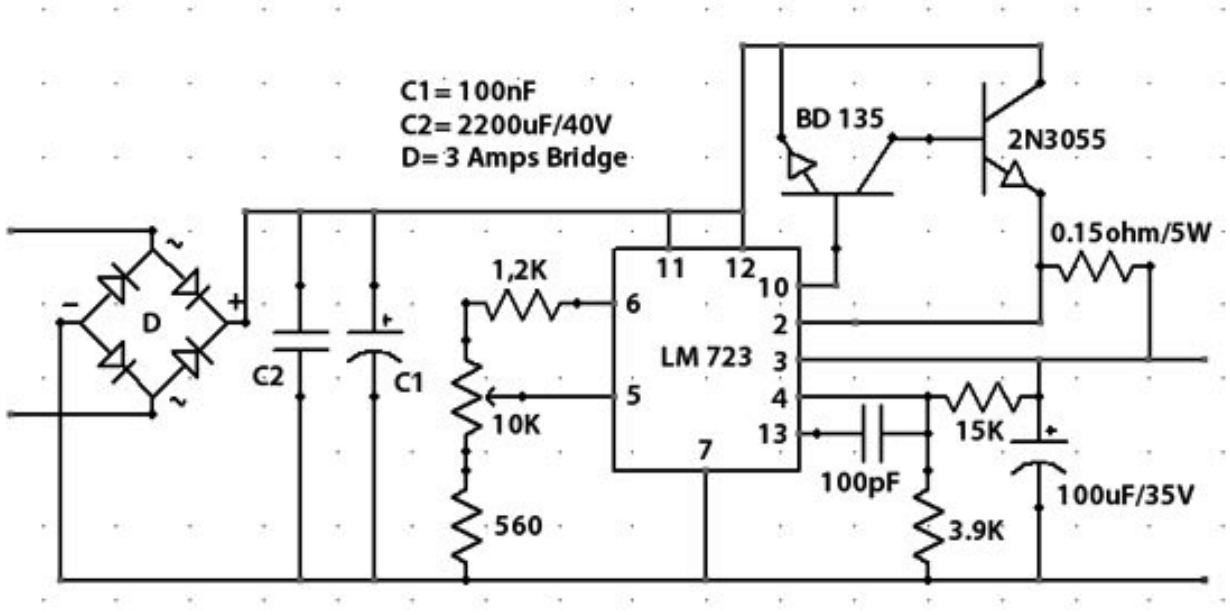

Figure 26.3: Circuit diagram of IC LM723

Courtesy: https://in.images.search.yahoo.com/yhs/search;_ylt=A0geK9yeu6Ba31oAKPnnHqx.?p=high+voltage+regulator+using+ic+723+circuit+diagram&fr=yhs-pty-pty_extension&fr2=piv-web&hspart=pty&hs imp=yhs-pty_extension&type=#id=19&iurl= http%3A%2F%2F www .eleccircuit .com %2Fwp-content %2Fuploads%2F2008%2F11%2F0-30-volts-25a-variable-power-supply-using-lm723.jpg&action=click:

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1 No.	
2.	DC Power Supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current. Or rectifier – filter output	1 No.	
3.	Regulator IC	LM 723	1 No.	
4.	Resistor	1.2KΩ, 560Ω, 3.9 KΩ,10 KΩ ,0.15Ω/5W,10KΩ variable resistor	1 No each	
5.	Capacitor	100 pF,100 Nf,100 µF,2200 µF.	1 No each	
6.	Breadboard	5.5 cm X 17 cm	1 No.	
7.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the polarity and appropriate range of multimeter

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. To find out line regulation vary the input voltage in steps keeping load constant.
3. Measure the output voltage.
4. To find out Load regulation vary the load in steps keeping input voltage constant.
5. Measure Output voltage.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			
6.			
7.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 26.1: Measurement of Vin and Vo for Line Regulation

R_L =.....(to be kept constant)

Sr. No.	Input Voltage (Vin) in Volts	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 26.2: Measurement of I_L and Vo for Load Regulation

Vin =……(to be kept constant)

Sr. No.	Load Current (I_L) in mA	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

i. Line Regulation =ΔVout/ΔVin

ii. Load Regulation =

$$\% \text{ Regulation} = \frac{V_{no\text{-}load} - V_{full\text{-}load}}{V_{full\text{-}load}} \times 100$$

Where

$V_{no\text{-}load}$ is the no-load voltage and

$V_{full\text{-}load}$ is the full-load voltage.

XVI Results

1. %Line Regulation =……..
2. %Load Regulation =…..……

XVII Interpretation of Results (Give meaning of the above obtained results)

.....

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

.....

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XIX Practical Related Questions(Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. State the output voltage ranges for low voltage and high voltage regulator?
2. List the IC used as variable voltage regulator and fixed regulators
3. State equivalent IC's for adjustable voltage regulation.
4. Draw the metal can package of IC 723.
5. ……
6. ……

[Space for Answers]

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XX References / Suggestions for further reading

1. Voltage Regulator Circuit Manual by Robert J. Traister ,Publisher : Academic Presss
2. http://www.ti.com/lit/ds/symlink/lm723.pdf
3. https://www.youtube.com/watch?v=veXShWaCliA
4. https://www.youtube.com/watch?v=tNqT7vCDswk
5. https://www.youtube.com/watch?v=mG9Jok1lTxU

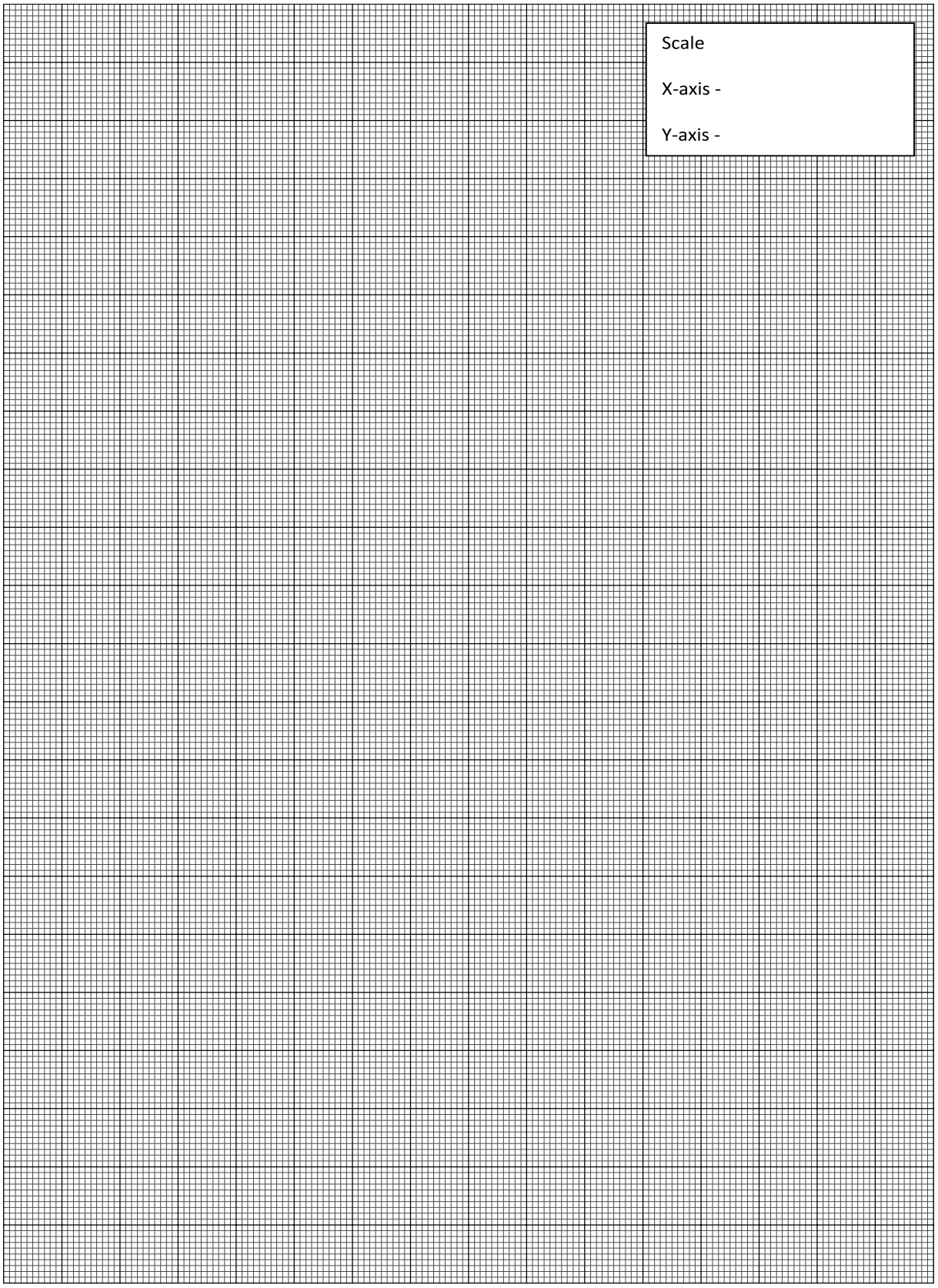
XXI Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using DMM	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of line and load regulation	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions, Graph	15 %
9.	Submitting the journal in time	05%
Total: 25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. ……..…….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	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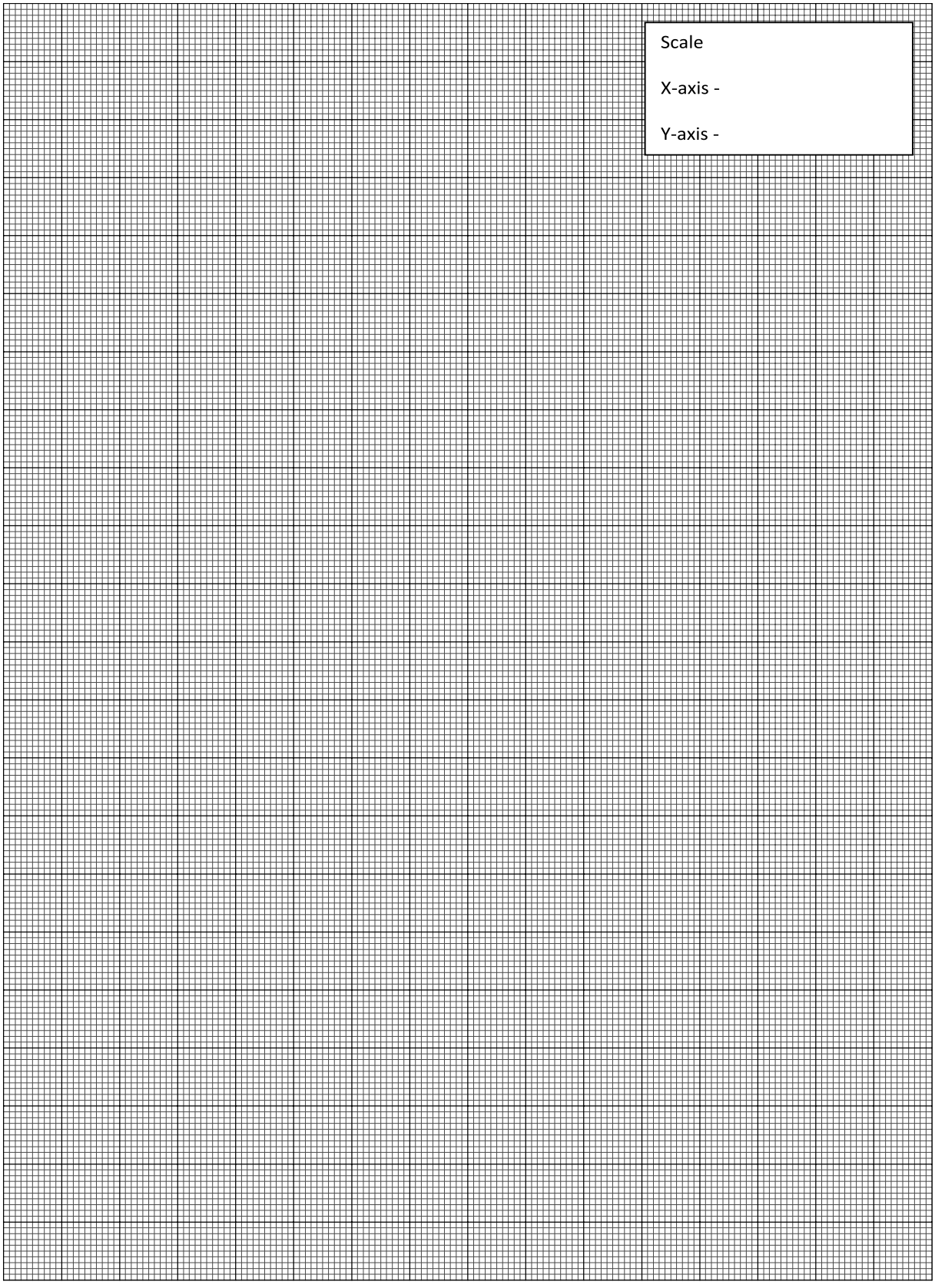
Y-axis -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Y-axis -

Practical No. 27: Voltage Regulator Using IC LM 317

I Practical Significance

The LM317 is an adjustable 3-terminal positive voltage regulator capable of supplying different DC voltage outputs other than the fixed voltage power supply of +5 or +12 volts, or as a variable output voltage from a few volts up to some maximum value all with currents of about 1.5 amperes. Voltage regulator using IC 317 is used in various applications such as battery chargers, post regulation for switching supplies, constant-current regulator, Microprocessor supplies, Automotive LED Lighting. This practical will help the students to develop the practical skills to build the voltage regulator using IC LM317.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Use discrete electronic devices and voltage regulators***':

1. Select relevant electronic components i.e. active and passive
2. Select relevant IC for appropriate output voltage using datasheets and test the IC.

IV Relevant Course Outcome(s)

- Maintain IC voltage regulator and SMPS.

V Practical Outcome

- Test the performance parameters of voltage regulator using IC LM 317.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member
- Maintain tools and equipments

VII Minimum Theoretical Background

Voltage regulation can be defined as maintaining constant voltage or maintaining the voltage level of a system within acceptable limits over a wide range of load conditions and thus, voltage regulators are used for voltage regulation. For linear voltage regulation, occasionally adjustable LM317 voltage regulators are used wherein non-standard voltage is intended.

Features of LM 317 Voltage Regulator

- It is capable of providing excess current of 1.5A, hence it is conceptually considered as operational amplifier with an output voltage ranging from 1.2V to 37V
- The LM317 voltage regulator circuit internally consists of thermal overload protection and short circuit current limiting constant with temperature.
- It is available in two packages as 3-Lead Transistor Package and surface mount D2PAK-3.
- Stocking of many fixed voltages can be eliminated.

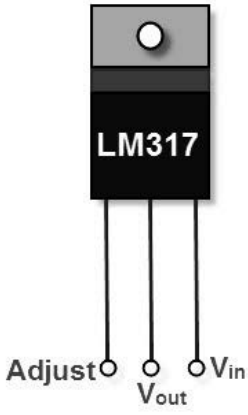

Figure 27.1: Pin configuration of IC LM317

Courtesy: https://www.elprocus.com/wp-content/uploads/2014/09/lm3171.jpg

VIII Practical Circuit diagram :

a) Sample

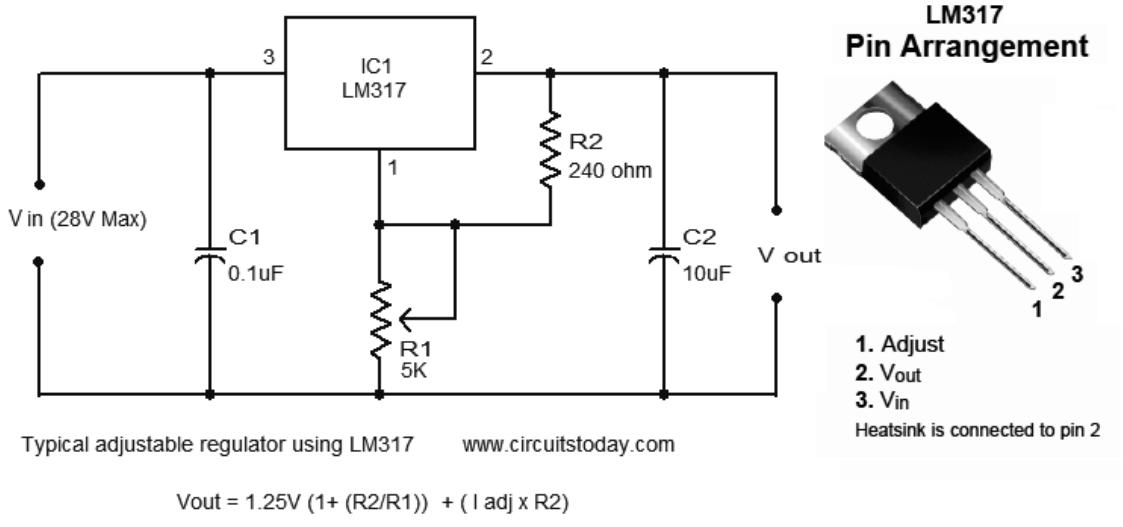

Figure 27.2: Circuit diagram of IC LM317

Courtesy: http://www.circuitstoday.com/wp-content/uploads/2011/04/LM317-typical-adjustable-regulator-ckt.png:

b) Actual Circuit used in laboratory / Actual Experimental set up used in laboratory

IX Resources Required

S. No.	Instrument/Component	Specification	Quantity	Remark
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	1	
2.	DC power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1	
3.	Regulator IC	LM 317	1 No.	
4.	Resistor	240Ω, 5 KΩ Potentiometer ,	1 No.	
5.	Capacitor	10μF,0.1 μF.	1 No.	
6.	Breadboard	5.5 cm X 17 cm	1 No.	
7.	Connecting wires	Single strand Teflon coating (0.6 mm diameter)	As per requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the polarity and appropriate range of multimeter

XI Procedure

1. Build circuit on breadboard as per circuit diagram.
2. To find out line regulations vary the input voltage in steps keeping load constant.
3. Measure the output voltage.
4. To find out Load regulations vary the load in steps keeping input voltage constant.
5. Measure Output voltage.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

.....

.....

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.....

XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 27.1: Measurement of V_{in} and Vo for Line Regulation

R_L =…… (to be kept constant)

Sr. No.	Input Voltage (Vin) in Volts	Output Voltage (Vo) in Volts
1		
2		
3		
4		

Sr. No.	Input Voltage (Vin) in Volts	Output Voltage (Vo) in Volts
5		
6		
7		
8		
9		
10		

Table 27.2: Measurement of I_L and Vo for Load Regulation

V_{in} =…… (to be kept constant)

Sr. No.	Load Current (I_L) in mA	Output Voltage (Vo) in Volts
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Calculations:

i. Line Regulation =ΔVout/ΔVin

ii. Load Regulation =

$$\% \text{ Regulation} = \frac{V_{no\text{-}load} - V_{full\text{-}load}}{V_{full\text{-}load}} \times 100$$

Where

$V_{no\text{-}load}$ is the no-load voltage and

$V_{full\text{-}load}$ is the full-load voltage.

XVI Results

1. %Line Regulation =……..

2. %Load Regulation =…..……

XVII Interpretation of Results (Give meaning of the above obtained results)

.....
.....
.....

XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions(Note : Teacher shall assign batch wise additional one or two questions related to practical)

1. State the difference between IC LM 723 and LM 317?
2. State the parameters of IC LM 317 with help of datasheet.
3. State applications of IC LM 317
4. ……
5. …….

[Space for Answers]

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XX References / Suggestions for further reading

1. Voltage regulator PCB for LM317 LM337 or 78xx 79xx IC by ebay.com
2. https://in.video.search.yahoo.com/search/video?p=theory+of+voltage+regulator+using+ic +3 17&fr=yhs-invalid#id=4&vid=73e4797a4388858318b5b485ce837715&action=view
3. https://www.electronics-tutorials.ws/blog/variable-voltage-power-supply.html
4. https://www.youtube.com/watch?v=veXShWaCliA
5. https://www.youtube.com/watch?v=tNqT7vCDswk
6. https://www.youtube.com/watch?v=mG9Jok1lTxU

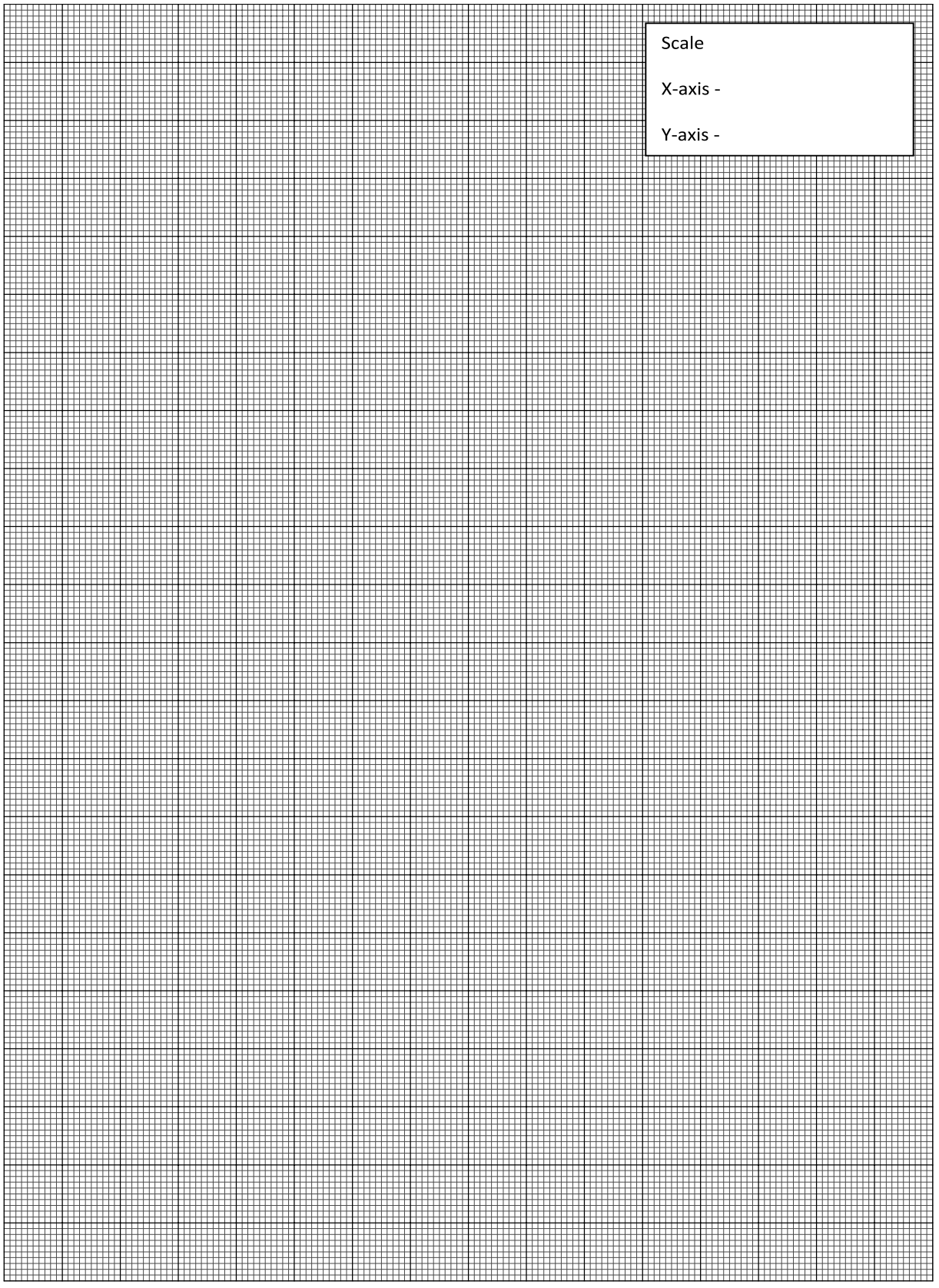
XXI Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Mounting of component	20 %
3.	Measuring value using DMM	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Calculation of line and load regulation	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions. Graph	15 %
9.	Submitting the journal in time	05%
Total :25 Marks		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	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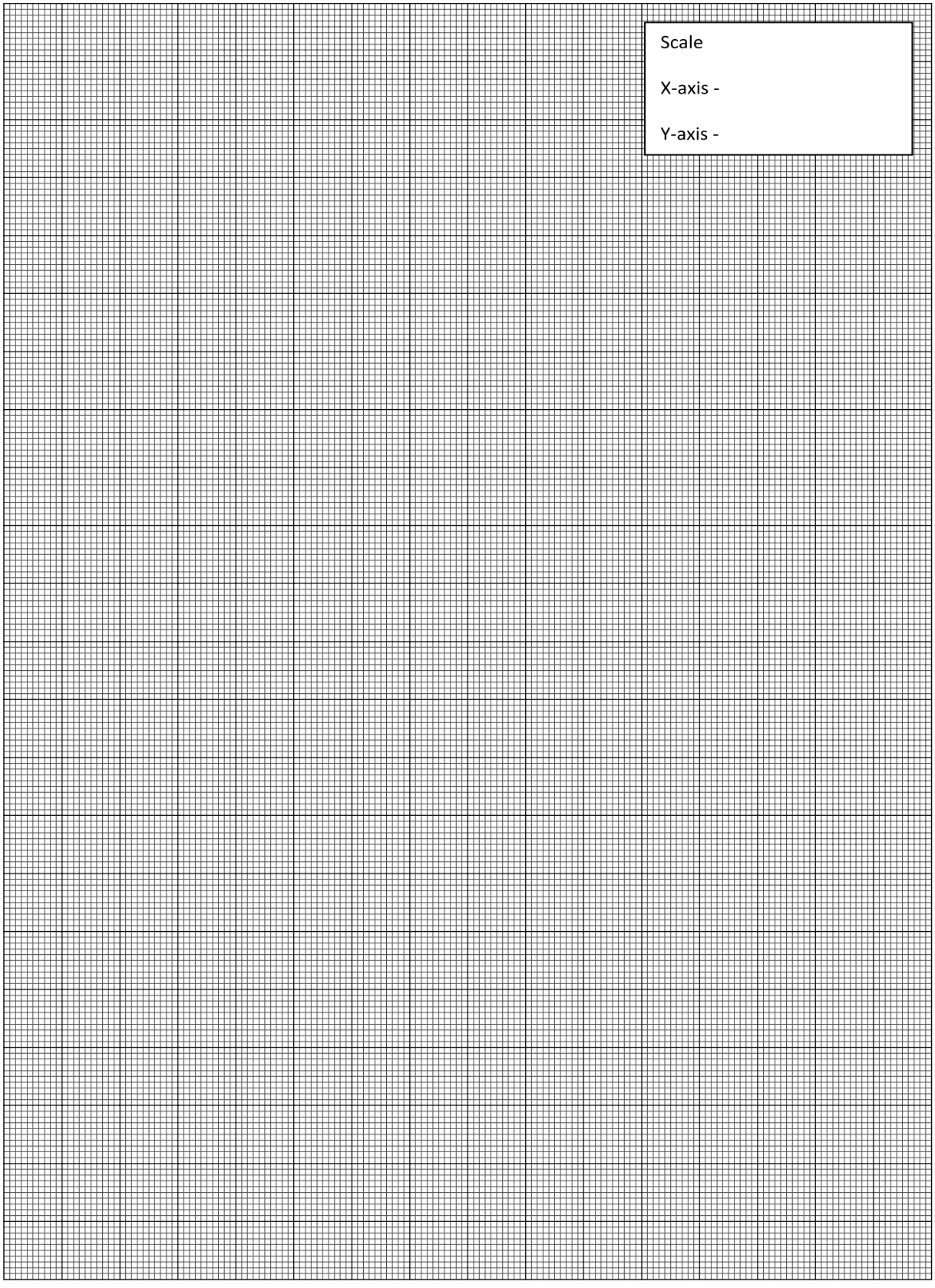
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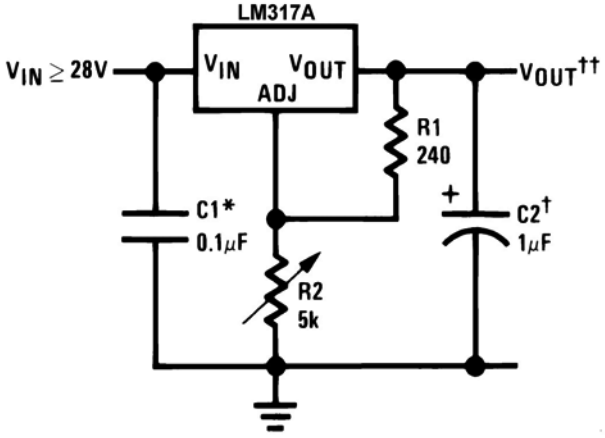
LM317A 1% Accurate Three-Terminal Adjustable Regulator

1 Features

- Typical 0.005%/V Line Regulation
- 1% Output Voltage Tolerance
- 1.5-A Output Current
- Adjustable Output Down to 1.25 V
- Current Limit Constant with Temperature
- 80-dB Ripple Rejection

2 Applications

- Battery Chargers
- Post Regulation for Switching Supplies
- Constant-Current Regulator
- Microprocessor Supplies
- Automotive LED Lighting



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First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
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1	Applied Multimedia Techniques	22024
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18	Digital Techniques & Microprocessor	22323
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23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
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1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
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10	Electric Motors And Transformers	22418
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12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
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10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
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18	Mass Transfer Operation	17648
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24	Industrial Drives	17667
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28	Intensive Care Equipment	17672
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1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

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1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

HEAD OFFICE

Secretary,
Maharashtra State Board of Technical Education
49, Kherwadi, Bandra (East), Mumbai - 400 051
Maharashtra (INDIA)
Tel: (022)26471255 (5 -lines)
Fax: 022 - 26473980
Email: -secretary@msbte.com
Web -www.msbte.org.in

REGIONAL OFFICES:

MUMBAI

Deputy Secretary (T),
Mumbai Sub-region,
2nd Floor, Govt. Polytechnic Building,
49, Kherwadi, Bandra (East)
Mumbai - 400 051
Phone: 022-26473253 / 54
Fax: 022-26478795
Email: rbtemumbai@msbte.com

PUNE

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
412-E, Bahirat Patil Chowk,
Shivaji Nagar, Pune
Phone: 020-25656994 / 25660319
Fax: 020-25656994
Email: rbtepn@msbte.com

NAGPUR

Deputy Secretary (T),
M.S. Board of Technical Education
Regional Office,
Mangalwari Bazar, Sadar, Nagpur - 440 001
Phone: 0712-2564836 / 2562223
Fax: 0712-2560350
Email: rbteng@msbte.com

AURANGABAD

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
Osmanpura, Aurangabad -431 001.
Phone: 0240-2334025 / 2331273
Fax: 0240-2349669
Email: rbteau@msbte.com