

## Lab 2: Op Amp Circuits

U.C. Davis Physics 116A

### INTRODUCTION

This lab introduces the operational amplifier or "op amp". The circuit is already constructed for you on a single IC (integrated circuit) and in this lab we will use the IC in several of its most popular configurations. For an introduction to op amps, see section 2.4 in *Bodvrow*.

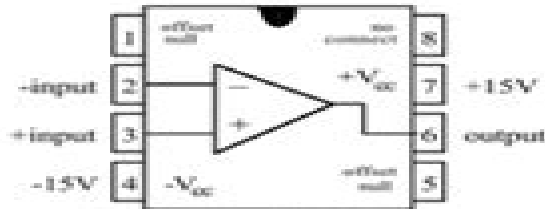


Figure 1: Pinout for the 741 op-amp.

### 1. INVERTING AMPLIFIER

The pinout diagram for the LM741 op amp IC is shown in figure 1. Use this to construct the inverting op amp circuit shown in figure 2.



Figure 2: The inverting amplifier.

At first, use  $R_1 = 1\text{k}\Omega$  and  $R_2 = 33\text{k}\Omega$ . Derive the gain formula  $A_v = -R_2/R_1$  and experimentally verify the gain for a 100Hz sine wave. Also calculate and measure the gain with  $R_2 = 10\text{k}\Omega$  and  $R_2 = 100\text{k}\Omega$ . For your lab report, give your derivation and compare the 2 calculated and measured gains. Why is this called an inverting amp?

### 2. NONINVERTING AMPLIFIER

Construct the noninverting amplifier shown in figure 3 with  $R_1 = 1\text{k}\Omega$  and  $R_2 = 33\text{k}\Omega$ . For your report, derive and experimentally verify the gain relation

$$A_v = \frac{R_1 + R_2}{R_1}$$



Figure 3: The noninverting amplifier.

### 3. CURRENT-TO-VOLTAGE CONVERTER

An op amp can be used to produce a voltage proportional to a given current. Construct the circuit in figure 4.



Figure 4: Current source with current-to-voltage converter.

Verify that  $V_{out} = -I_{in}R_2$  for this circuit. (That is, do the following for several voltage settings on the variable power supply: Measure the supply voltage and from this calculate  $I_{in}$ . Use the formula to calculate a theoretical  $V_{out}$  and compare this to a measured  $V_{out}$ . Include these measured values and calculations in your report along with a brief discussion of the agreement between theory and measurement.)

# Op Amp Lab Manual

**L. K. Maheshwari, M. M. S. Anand**



## Op Amp Lab Manual:

**Laboratory Manual for Introductory Electronics Experiments** L. K. Maheshwari, M. M. S. Anand, 1979 **Lab Manual to Accompany Op-Amps and Linear Integrated Circuits** Ramakant A. Gayakwad, 1999-08-01 This lab manual accompanies Gayakwad's Op Amps and Linear Integrated Circuits **Instructor's solutions manual with transparency masters (includes lab manual results) to accompany Op-amps and linear integrated circuits, fourth edition, Ramakant A. Gayakwad** Ramakant A. Gayakwad, 2000 **Laboratory Manual for Electronic Devices and Circuits** David A. Bell, 2001 This lab manual accompanies Electronic Devices and Circuits 4e Lab Manual to Accompany Op-amps and Linear Integrated Circuits, Fourth Edition Ramakant A. Gayakwad, 2000 Lab Manual for Electronics Martin Feldman, 2001-11 The emphasis is first on understanding the characteristics of basic circuits including resistors capacitors diodes and bipolar and field effect transistors The readers then use this understanding to construct more complex circuits such as power supplies differential amplifiers tuned circuit amplifiers a transistor curve tracer and a digital voltmeter In addition readers are exposed to special topics of current interest such as the propagation and detection of signals through fiber optics the use of Van der Pauw patterns for precise linewidth measurements and high gain amplifiers based on active loads **KEY TOPICS** Chapter topics include Thevenin's Theorem Resistive Voltage Division Silicon Diodes Resistor Capacitor Circuits Half Wave Rectifiers DC Power Supplies Diode Applications Bipolar Transistors Field Effect Transistors Characterization of Op Amp Circuits Transistor Curve Tracer Introduction to PSPICE and AC Voltage Dividers Characterization and Design of Emitter and Source Followers Characterization and Design of an AC Variable Gain Amplifier Design of Test Circuits for BJT's and FET's and Design of FET Ring Oscillators Design and Characterization of Emitter Coupled Transistor Pairs Tuned Amplifier and Oscillator Design of AM Radio Frequency Transmitter and Receiver Design of Oscillators Using Op Amps Current Mirrors and Active Loads Sheet Resistance Design of Analog Fiber Optic Transmission System Digital Voltmeter **Laboratory Manual for Operational Amplifiers and Linear ICs, Second Edition** David A. Bell, 1997 This Laboratory Manual accompanies the second edition of Operational Amplifiers and Linear ICs *Simulations for Operational Amplifiers Using Electronics Workbench* James L. Antonakos, 1998 Appropriate as a supplement to op amp and devices courses where Electronics Workbench is used This hands on electronics lab manual presents a variety of computer based simulations of electronic circuitry analog and digital within an easy to learn and use virtual environment using Electronics Workbench Operational Amplifiers and Linear Integrated Circuits James Fiore, 2016-02-04 This is the companion laboratory manual to accompany the third edition of Operational Amplifiers Linear Integrated Circuits Twenty two separate experiments are available Topics include the differential amplifier the comparator inverting and non inverting amplifiers slew rate gain bandwidth product operational transconductance amplifier DC offset precision rectifiers transfer function generation linear regulation integration differentiation oscillators active filters and more Each exercise includes a

summary of the relevant theory a parts list and equipment inventory Most exercises can be completed using just a dual output DC power supply digital multimeter AC waveform generator and a digital oscilloscope This is the print version of the on line OER     *Lab Manual Troubleshooting and Design to Accompany Digital Systems* Frank J. Ambrosio,1997

**LABORATORY EXPERIMENTS AND PSPICE SIMULATIONS IN ANALOG ELECTRONICS** MAHESHWARI, L. K.,ANAND, M. M. S.,2006-01-01 This laboratory manual for students of Electronics Electrical Instrumentation Communication and Computer engineering disciplines has been prepared in the form of a standalone text offering the necessary theory and circuit diagrams with each experiment Procedures for setting up the circuits and measuring and evaluating their performance are designed to support the material of the authors book Analog Electronics also published by PHI Learning There are twenty five experiments The experiments cover the basic transistor circuits the linear op amp circuits the active filters the non linear op amp circuits the signal generators the voltage regulators the power amplifiers the high frequency amplifiers and the data converters In addition to the hands on experiments using traditional test equipment and components this manual describes the simulation of circuits using PSPICE as well For PSPICE simulation any available standard SPICE software may be used including the latest version OrCAD V10 Demo software This feature allows the instructor to adopt a single laboratory manual for both types of experiments     **Simulations for Operational Amplifiers Using MicroSim PSpice** James L. Antonakos,1998 This hands on electronics lab manual presents a variety of computer based simulations of electronic circuiting within an easy to learn and use virtual environment using PSpice Features a Hands on approach even with no lab equipment that directs readers toward proper analysis technique and use of virtual instruments Provides a troubleshooting section in each lab Includes labs for The Buffer and Voltage Current Converters The Non Inverting Amplifier The Inverting Amplifier Mixers Difference Amplifiers The OpAmp as a Comparator Active Low Pass Filters Active High Pass Filters Active Bandpass Filters Notch Filters Oscillator Circuits The Peak Detector The Digital to Analog Converter The Integrator and Differentiator The Log and Anti Log Amplifiers The Analog Thermometer The Voltage Regulated Power Supply and The OpAmp Function Generator Provides ready to use lab circuits on a disk For those interested in operational amplifiers and PSpice     **Op-Amp Circuits Manual** R. M. Marston,2013-10-22 Op amp Circuits Manual Including OTA circuits discusses the operating principles and applications of operational amplifier op amp circuits The book is comprised of 10 chapters that present practical circuits diagrams and tables The text first deals with the standard op amp of the 741 type Next the book covers the special types of op amp such as the Norton amplifier the operational transconductance amplifier OTA and the LM 10 op amp reference IC The book will be of great use to design engineers and technicians Undergraduate students of electronics related degree will also find this book interesting     **Lab Manual** Buchla,1999-01 *Electronics World* ,1967 Some issues Aug 1943 Apr 1954 are called Radio electronic engineering ed called in 1943 Radionics ed which include a separately paged section Radio electronic engineering varies v 1 no 2 v 22 no 7 issued

separately Aug 1954 May 1955      **Foundations of Electronics** Russell L. Meade, 1999 Learn electronics fundamentals for both DC and AC circuits from Ohms Law through series and parallel resonant circuits This highly acclaimed introduction to the world of electronics technology has been carefully updated to better provide technicians with a foundation in modern electronics needed to launch a career or pursue more advanced study Real world color codes and strategic highlighting are integrated with ample color charts photos schematics and diagrams for a solid understanding of circuit behavior that equips readers to progress to more complex topics with ease This edition features all new automated calculations for the formulas in the book on the accompanying CD as well as new information on admittance susceptance and more      Advances in Control Education 1991 G.F. Franklin, M.J. Rabins, N.A. Kheir, 2014-05-23 This volume is the published proceedings of selected papers from the IFAC Symposium Boston Massachusetts 24-25 June 1991 where a forum was provided for the discussion of the latest advances and techniques in the education of control and systems engineers Emerging technologies in this field neural networks fuzzy logic and symbolic computation are incorporated in the papers Containing 35 papers these proceedings provide a valuable reference source for anyone lecturing in this area with many practical applications included

**Electronic Design**, 1969      *Experiments in Analog and Digital Electronics* Thomas E. Brewer, 2004-07-09

*Fundamentals of Analog Circuits* Thomas L. Floyd, David Buchla, 1999 Fundamentals of Analog Circuits offers comprehensive coverage of a wide relevant array of topics It integrates theory practical circuits and troubleshooting concepts keeping mathematical details to a minimum Delving more deeply into coverage of linear integrated circuits than discrete device circuits the text guides readers through a system of pedagogical tools that both reinforces and challenges their understanding Opens coverage with a five chapter introduction to discrete devices that include diodes and transistor circuits plus other topics often omitted in beginning devices texts such as RF amplifiers transmission lines transformer coupled amplifiers direct coupled amplifiers and power amplifiers Discusses the operational amplifier with separate chapters on active filters and oscillators Explores current topics of importance including instrumentation amplifiers isolation amplifiers operational transconductance amplifiers OTA phase locked loops A/D and D/A converters transducers and more Indicates current by meters not arrows allowing for easy integration into the curriculum of schools using either conventional current flow or electron flow Features

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