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AbstractSedra/Smith 7ed e-book Ask the publishers to restore access to 500,000+ books. THE OXFORD SERIES IN ELECTRICAL AND COMPUTER ENGINEERING A d e l S. S e d r a , Series Editor H EDITION A l l e n and H 10,448 3,099 44MB Read more Ask the publishers to restore access to 500,000+ books. Download & View Microelectronic Circuits 6th Edition Sedra Smith as PDF for free PART I Devices and Basic Circuits CHAPTER 1 Signals and Amplifiers 4 CHAPTER 2 Operational Amplifiers 52 CHAPTER 3 Semiconductors 124 CHAPTER 4 Diodes 164 CHAPTER 5 MOS Field-Effect Transistors (MOSFETs) CHAPTER 6 Bipolar Junction Transistors (BJTs) 350 230 P art I, Devices and Basic Circuits, includes the most fundamental and essential topics for the study of electronic circuits. At the same time, it constitutes a complete package for a first course on the subject. The heart of Part I is the study of the three basic semiconductor devices: the diode (Chapter 4); the MOS transistor (Chapter 5); and the bipolar transistor (Chapter 6). In each case, we study the device operation, its characteristic circuits is the processing of signals, an understanding is essential of signals, their characterization in the time and frequency domains, and their analog and digital representations. This is provided in Chapter 1, which also introduces the most common signal-processing function, amplification, and the characterization and types of amplifiers. Besides diodes and transistors, the basic electronic devices, the op amp is studied in Part I. Although not an electronic device in the most fundamental sense, the op amp is commercially available as an integrated circuit (IC) package and has well-defined terminal characteristics. Thus, despite the fact that the op amp's internal circuit is complex, typically incorporating 20 or more transistors, its almost-ideal terminal behavior makes it possible to treat the op amp as a circuit element and to use it in the design of powerful circuits, as we do in Chapter 2, without any knowledge of its internal construction. We should mention, however, that the study of op amps can be delayed to a later point, and Chapter 2 can be skipped with no loss of continuity. The foundation of this book, and of any electronics course, is the study of the two transistor types in use today: the MOS transistor in Chapter 5 and the bipolar transistor in Chapter 6. These two chapters have been written to be completely independent of one another and thus can be studied in either order as desired. Furthermore, the two chapters have the same structure, making it easier and faster to study the second device, as well as to draw comparisons between the two device types. After the study of Part I, the reader will be fully prepared to undertake the study of either integrated-circuit amplifiers in Part II or digital integrated circuits in Part III. 3 CHAPTER 1 Signals and Amplifiers Introduction 5 1.5 Circuit Models for Amplifiers 21 1.1 Signals 6 1.6 Frequency Response of Amplifiers 30 1.2 Frequency Spectrum of Signals 9 Summary 41 1.3 Analog and Digital Signals 11 Problems 42 1.4 Amplifiers 14 IN THIS CHAPTER YOU WILL LEARN 1. That electronic circuits process signals, and thus understanding electrical signals is essential to appreciating the material in this book. 2. The Thévenin and Norton representations of signal sources. 3. The representation of a signal as the sum of sine waves. 4. The analog and digital representations of a signal. 5. The most basic and pervasive signal-processing function: signal amplification, and correspondingly, the signal amplifier. 6. How amplifiers are characterized (modeled) as circuit building blocks independent of their internal circuitry. 7. How the frequency response of an amplifier is measured, and how it is calculated, especially in the simple but common case of a single-timeconstant (STC) type response. Introduction !"#$%&'(#)*$+,$*'-%$'++.$-%$/+0#12$#3#)*1+2-)%4$5$,-#30$*"5*$"5%$)+/#$*+$'#$.2+62$5%$!"#$%& '(#)$%*"#+7, -'#$%'(#)$%*"#+$ 1#,#1%$ *+$ *"#$ -2*#815*#09)-1)&-*$:;4$5$!"#$%/$%#'++%$7 ;2$*"-%$'++.$6#$%"533$%*&0>$#3#)*1+2-)$0#E-)#%$*"5*$)52$'#$&%#0$%-283>$:-2$*"#$0#%-82$+,$1"+&$ #$')', #"$#0")+=$ +1$ 5%$)+/?+2#2*%$ +,$ 52$ "*)?2$3)'11&#"$#0")$ 4567$)"-27$ F#$ %"533$ %*&0>$ *"# 0#%-82$520$5253>%-%$+,$-2*#1)+22#)*-+2%&+,$*"#%&#0$-)+/?3#D-*>520?#1,+1/$5$6-0#$E51-#*>$+,$,&2)*-+2%7$F#$%"533$53$+$3#512 5'+&*$5E5-35'3#$;#0-2%&'%#G*$)"5?*#1%$-2$*"#$0#%-82$520$5253>%-%$+,$5)*&53$5/?3-,-#1$)-1)&-*%7 5 6 Chapter 1 Signals and Amplifiers ;2$500-*-+2$*+$/+*-E5*-28$*"#$%*&0>$+,$#3#)*1+2-)%4$*"-%$)"5?*#1%$#1E#%$5%$5$'1-08#$'#*6##2 *"#$%*&0>$+,$3-2#51$)-1)&-*%520*"5*$+,$*"#$%&'(#)*$+,$*'-%$'++.H$*"#$0#%-82$520$5253>%-%$+, #3#)*1+2-)$)-1)&-*%7 1.1 Signals I-8253%$)+2*5-2$-2,+1/5*-+2$5'+&*$5$E51-#*>$+,$*'-28%$520$5)*-E-*-#%$-2$+&1$?">%-)53$6+1307 JD5/?3#%$5'+&20H$;2,+1/5*-+2$5'+&*$*"#$6#5*"#1$-%$)+2*5-2#0-2%-8253%$*"5*$1#?1#%#2*$*"# 5-1$*#/?#15*&1#4$?1#%%&1#4$6-20$%?##04$#*)7$!"#$E+-)#$+,$5*150-+522+&2)#1$!#50-28$*"#$2#6% -2*+$5$/-)1+?"+2#$?1#E-0#%$5*&%$+,$5$2&)3#51$1#5)*+14$-2%*1&/#2*%$51#$&%#0$*+$/#5%&1#5$/$3-1#3#E52*$?515/#*#1%4$#5)"$-2%*1&/#2*$?1+0&)-28$5$%-82537 !+$ #D*15)*$ 1#G&-1#0$ -2,+1/5*-+2$,1+/$ 5$ %#*$ +,$ %-8253%4$ *"#$ +'%#1E#1$:'#$ -*$ 5$ "&/52$ +1$ 5 /5)"-2#=$-2E51-5'3>$2#0%$*+$/$%#'++$*"#$%-8253%$-2$%+/#$?1#0#*#1/-2#0$/522#17$!"-%$+"2*3(/$%#'++"*2$-%$&%&533>$/+%*$)+2E#2-#2*3>$?#1,+1/#0$'>$#3#)*1+2-)$%>%*#/%7$K+1$*-%$*+$'#$?+%%-9 '3#4$"+6#E#14$*"#$%-8253$/&%*$,-1%*$'#$)+2E#1*#0$-2*+$52$#3#)*1-)53$%-82534$*"5*$-%4$5$E+3*58#$+1$5)&11#2*7$!"-%$?1+)#%%-%$5))+/?3-%"#0$'>$0#E-)#%$.2+62$5%$)$3*+10#'$+7,L$E51-#*>$+,$*152%9 0&)#1%$#D-%*4$#5)"$%&-*5'3#$,+1$+2#$+,$*"#$E51-+&%$,+1/%$+,$?">%-)53$%-8253%7$K+1$-2%*52)#4$*"# %+&20$65E#%$8#2#15*#0$'>$5$"&/52$)52$'#$)+2E#1*#0$-2*+$+3#)*1-)53$%-8253%$'>$&%-28$5$/-)1+9 ?"+2#4$6"-)"$-%$-2$#,,#)*$5$?1#%%&1#$*152%0&)#17$;*-$%$2+*$+&1$?&1?+%#$*"#1#$*+$%*&0>$*152%0&)#1%M15*"#14$6#$%"533$5%%&/#$*"5*$*"#$%-8253%$+,$-2*#1#%*$531#50>$#D-%*$-2