Low frequency response of bjt amplifier pdf

• For this analysis it is considered a BJT bias configuration of the voltage divider with load.• For such a voltage bias network, the CS, CC and CE capacitors will determine the low frequency response. CS:• At medium or high frequencies, the condenser reaction will be small enough to allow a short – the circuit approximations for the element.• The voltage will then be connected to Vs byVi |mid = VsRi / (Ri+Rs)• A f = FLS, Vi = 70.7% of its average band value.• The voltage applied to the input of the active device can be calculated using the voltage divider rule: Vi = RiVs / (Ri+ Rs – jXCs)Effect of CC:• Since the coupling condenser is normally connected between the output of the active device and the applied load, the RC configuration that determines the low cut frequency due to CC appears as in the figure below. • Ro = Rc|| ro EC Effect:• The effect of the EC onis better described in quantity remembering that the gain for thewithout bypassing the emitter resistor is given by:AV = - RC / (re + RE)• The maximum gain is obviously available in which RE is 0W.• At low frequencies, with the CE bypass capacitor in its equivalent "open circuit", all RE appears in the gain equation above, resulting in minimal gain.• While the frequency increases, the reactivity of the CE condenser will decrease, reducing the parallel impedance of RE and CE until the RE resistor is effectivelyshorted out of CE.• The result is a maximum gain or midband determined by AV = - RC / re.• Input and output coupling capacitors, emitter bypass capacitor will only affect low frequency response.• At the frequency level of the media band, the short circuit equivalents for these capacitors can be inserted.• Although each will affect the gain in a similar frequency range, the highest low frequency cutoff determined by each of the threewill have the biggest impact. Problem:Determining the lower cut freq. for the networkusing the following parameters: C = 10μF, CE = 20μF, Cc = 1μFRs = 1kΩ, R1= 40kΩ, R2 = 10kΩ,RE = 2kΩ, RC = 4kΩ, RL = 2.2kΩ,β = 100, ro = ∞Ω, Vcc = 20V• Solution:a. In order to determine the king for the dc conditions, we check whether bRE > 10R2Here, bRE = 200kW, 10R2 = 100kW. The condition is satisfied. Thus approximate analysis can be carried out to find IE and then re.VB = R2VCC / (R1+R2) = 4VVE = VB – 0.7 = 3.3VIE = 3.3V / 2kW = 1.65mAre = 26mV / 1.65mA = 15.76 WMid band gain:AV = Vo / Vi = -RC|RL / re = - 90• Input impedanceZi = R1 Cutting frequency due to the input coupling capacitor (fLs)fLs = 1/ [2p(Rs +Ri)CC1 = 6.86Hz.fLc = 1 / [2p(RC + RL) CC= 1 / [6.28 (4kW + 2.2kW)1uF]= 25.68 HzEffect of CE:R¢R2|R2|R2 In this case, fLe is the lower cutting frequency.• In the high frequency region, the capacitive elements of importance arebetween terminals) internal capacity to the active device and wiring capacity between network cables.• The large network capacitors that controlled the low frequency response area replaced by their equivalent short circuit due to their very low reactivity level.• For inverting amplifiers, the input and output capacity has increased from a level of capacity sensitive to interelectrode capacity between the input and output terminals of the device and the amplifier gain. Exterior 1. Basic concepts 2. Decibel 3. Low frequency amplifier response 4. High Frequency Amplifier Response 5.. Total Amplifier Response 6. GOALS multistage amplifier frequency response -- Explain how the circuit capacity affects the frequency response of an amplifier -- Use the decibel (dB) to express the amplifier gain -- Analyse the low frequency response of an amplifier-- Analyze the high frequency response of an amplifier -- Analyze an amplifier for total total-- Analyze multi-stage amplifiers for frequency response -- Measure frequency response of a TERMINOLOGY amplifier -- Decibel -- Medium-range detection -- Critical frequency -- Roll-off -- Decade -- Bode Plot -- Bandwidth INTRODUCTION In previous sections on amplifiers, the effects of input frequency on the operation of an amplifier due to capacitive elements in the circuit were neglected to focus on other concepts. The coupling and bypass capacitors were considered ideal shorts and the internal transistors' capabilities were considered as ideal openings. This treatment is valid when the frequency is in a midrange of the amplifier. As you know, capacitive responsiveness decreases with increasing frequency and vice versa. When the frequency is low enough, the coupling and bypass capacitors can no longer be considered as short because their reactslarge enough to have a significant effect. Also, when the frequency is quite high, the internal capabilities of transistor transistordo not be considered as opening because their reacts become small enough to have a significant effect on the operation of the amplifier. A complete picture of an amplifier's response should take into account the complete frequency range on which the amplifier can operate. In this section, you will study the frequency effects on the amplifier gain and phase change. The cover applies to both BJT and FET amplifiers, and a mix of both are included to illustrate the concepts. 1. NETHERLANDS In amplifiers, the coupling and bypass capacitors seem to be short ac at the frequency of the average band. At low frequencies, the capacitive reactivity of these capacitors affects the gain and change of signal phase, so they must be taken into account. Frequency response of an amplifier is change of gain or change of phase on a certain range of signal frequenciesObjectives: -- Explain how the circuit's capabilities affect the frequency response of an amplifier -- Define the frequency response -- Discutereof coupling capacitors -- Recall the formula for capacitive reactivity -- Discuss the effect of bypass capacitors -- Describe the effect of internal transistor capabilities -- Identify the internal capacity in BJTs and JFETs -- Explain Miller's theorem -- Calculate the input and output capabilities Miller Effect of coupling capacitors Richiamo from basic circuit theory that XC = 1/(2 f). This formula shows that capacitive responsiveness varies inversely with frequency. At lower frequencies the reactivity is greater, and decreases as the frequency increases. For example, the audio frequencies below 10 capacitively coupled amplifiers, such as those in FIG. 1 have a voltage gain lower than they have at higher frequencies. The reason is that at lower frequencies more voltage than the signal has dropped through C1 and C3 because their reacts are higher. This voltage drop of the signal abovelower reduces voltage gain. In addition, a phase change is introduced bycapacitors because C1 forms a lead circuit with the Amplifier Rin and C3 forms a lead circuit with RL in series with RC or RD. Let's remember that a lead circuit is an RC circuit in which the output voltage through R leads the input voltage in phase. FIG. 1--BJT and FET amplifiers capacitively coupled. Bypass capacitors Effect At lower frequencies, the bypass capacitor reaction, C2 in FIG. 1, becomes significant and the emitter (or FET source terminal) is no longer on ac ground. The XC2 capacitive reactivity in parallel with RE (or RS) creates an impedance that reduces the gain. This is illustrated in FIG. 2. FIG. 2 - Nonzero reactivity of the bypass capacitor in parallel with RE creates an emitter impedance, (Ze), which reduces the voltage gain. Effect of transistor internal capabilities At high frequencies, coupling and bypass capacitors become effective short ac and do not affect the responseAmplifier. transistor internal joint capacity, however, makein play, reducing the gain of an amplifier and introducing phase change as the signal frequency increases. Fig. 3 shows the internal joint capabilities for both a bipolar junction transistor and a jfet. in the case of bjt, cbe is the basic-emitter and cbc joint ability is the basic-collector joint ability. in the case of the jfet, cgs is the ability between gate and source and cgd is the ability between gate and drain. fig. capacity of 3-internal transistors. 4-AC equivalent circuit for a bjt amplifier showing effects of internal capacity cbe and Cbc.(a) effect of cbe, in which vb is reduced by the voltage division action of rs and xcbe; (b) cbc effect, where part of vout (vfb) returns through cbc to the base and reduces the input signal because it is about 180° off phase with vin. data sheets often refer to the bjt cbc capacity as the ocita ability, often designated cob. cbe capacity is often designatedinput inputCib. Data sheets for FETs normally specify input capacity Ciss and Crss inverse transfer capacity. From these, Cgs and Cgd can be calculated, as you will see in sect. 4. At lower frequencies, the internal capacities have a very high reactivity due to their low capacity value (usually only some picofarads) and low frequency value. At this point, they seem open and have no effect on the performance of the transistor. While the frequency rises, the internal capacitive reacts descend, and at some point they begin to have a significant effect on the gain of the transistors. When the reaction of Cbe (or Cgs) becomes quite small, a significant amount of the signal voltage is lost due to a division effect of the resistance of the signal source and reaction of Cbe, as illustrated in FIG. 4(a.) When the reaction of Cbc (or Cgd) becomes small enough, a significant amount ofof the output signal is fed again from the phase with the input (negative responses,) effectivelythe age gain volt. This is illustrated in FIG. 4 b). Miller's theorem is used to simplify the analysis of invertent amplifiers at high frequencies where the internal transistors are important. The Cbc capacity in BJTs (Cgd in FETs) between the entrance (base or gate) and the exit (collector or exhaust) is shown in FIG. 5 a) in general form. Av is the absolute voltage gain of the inverting amplifier at midrange frequencies, and C represents Cbc or Cgd. FIG. 5-General case of Miller input and output capabilities. C represents Cbc or Cgd. Miller's theorem states that C appears effectively as an entry-level capacity, as shown in FIG. 5(b), which can be expressed as follows: EQN. 1 Cin(Miller) = C(Av + 1) This formula shows that Cbc (or Cgd) has a much greater impact on the input capacity than its real value. For example, if Cbc = 6 pF and the amplifier gain is 50, then Cin (Miller) = 306 pF.6 shows how this effective inputappears in the actual circuit equivalent ac in parallel with Cbe (or Cgs). FIG. 6 - Amplifier ac equivalent circuits showing internal capacity and effective Miller capacity. Miller's theorem also states that C appears effectively as an output capacity on the ground, as shown in FIG. 5(b), which can be expressed as follows: EQN. 2 This formula indicates that if the voltage gain is 10 or greater, Cout (Miller) is approximately equal to Cbc or Cgd because (Av = 1) Av is approximately equal to 1. FIG. 6 also shows how this effective output capacity appears in the ac equivalent circuit for BJT and FET. 2. DECIBEL The decibel is a logarithmic gain measurement unit and is commonly used to express the amplifier response. Objectives: -- Use decibel (dB) to express the amplifier gain -- Express the power gain and the voltage gain in dB -- Discuss reference 0 dB -- Define the midrange gaindefine and discuss critical frequency -- discuss the power measurement in dbm -- identifycapacity in BJT and JFET -- Explain Miller's theorem -- Calculate Miller input and output capabilities The use of decibels to express gain was introduced in section 6. The decibel unit is important in amplifier measurements. The basis of the decibel unit comes from the logarithmic response of the human ear to the intensity of the sound. The decibel is a logarithmic measure of the ratio of one power to another or voltage to another. The increase in power is expressed in decibels (dB) from the following formula: EQN. 3: Ap(dB) = 10 Ap log where Ap is the actual gain of power, Pout Pin. The voltage gain is expressed in decibels by the following formula: EQN. 4: Av (dB) = 20 logs Av If Av is greater than 1, the dB gain is positive. If Av is less than 1, the dB gain is negative and is usually called attenuation. You can use the LOG button on the computer when working with these formulas. FYI, factor 20 in EQN. 4 is because the power isto square tension. Technically, theshould be applied only when tensions are measured in the same impedance. This is the case for many communication systems, such as television or microwave systems. 0 dB Reference Often it is convenient in amplifiers assign a certain gain value as reference 0 dB. This does not mean that the actual voltage gain is 1 (which is 0 dB); means that the reference gain, no matter what its real value is, is used as a reference with which to compare other gain values and is therefore assigned a value 0 dB. Many amplifiers display a maximum gain on a certain frequency range and a reduced gain at lower frequencies and higher than this range. The maximum gain occurs for the frequency range between the higher and lower critical frequencies and is called the midrange gain, which is assigned a value 0 dB. Any gain value below the midrange can be reported to 0 dB andas negative dB value. For example, if the midrange voltage gain of a certain amplifier is 100 and andgain at a certain frequency below the average is 50, so this reduced voltage gain can be expressed as 20 logs (50>100) = 20 logs (0.5) -=6 db. this indicates that it is 6 db under reference 0 db. the interruption of the ocita voltage for a constant input voltage is always a reduction of 6 db in the gain. correspondingly, a doubling of the ocita voltage is always an increase of 6 db in the gain. fig. 7 illustrates a normalized gain curve against frequency showing different db points. the normalized term means that the voltage gain of midrange is assigned a value of 1 or 0 db. fig. 7---Normalized voltage gain compared to frequency curve. table 1 shows how to double or block voltage gains results in decibel values. notice in the table that each time the voltage gain is doubled, the decibel value increases by 6 db, and whenever the gain is interrupted, the db valueof 6 dB. Critical frequency A critical frequency (also known as cutting frequency or angle frequency) is a frequency at which the outputdrops to a half of its midrange value. This corresponds to a 3 dB reduction in power gain, as expressed in dB by the following formula: Ap(dB) = 10 logs (0.5) -=3dB TABLE 1 decibel values corresponding to the doubling and halving of the voltage gain. Moreover, at critical frequencies the voltage gain is 70.7% of its midrange value and is ex pressed in dB as Av(dB) = 20 log (0.707) = -3dB FYI----- The dBmV unit is used in some applications such as cable TV where the reference level is 1 mV, which corresponds to 0 dB. Just as the dBm is used to indicate the actual power, the dBmV unit is used to indicate the actual voltage. TABLE 2 Power in dBm. Power measurement in dBm The dBm is a unit to measure the reference power levels at 1 mW. Positive dBm values represent power levels above 1 mW and negative dBm values represent power levels below 1Since the decibel (dB) can be used to represent only the power ratios, not the actual power, the dBm provides a convenient way to express real realocita of an amplifier or other device. every 3 dbm increase corresponds to a doubling of power, and a 3 dbm de fold corresponds to a half of power. to state that an amplifier has a 3 db power gain only indicates that the ocite power is twice the input power and nothing about the actual ocita power. to indicate the actual ocita power, the dbm can be used. For example, 3 dbm is equivalent to 2 mw because 2 mw is double of reference 1 mw. 6 dbm is equivalent to 4 mw, and so on. Similarly, -3d bm is the same as 0.5 mw. Table 2 shows different power values in terms of dbm. 3. LOW-FREQUENCY applifier responses voltage gain and phase shift of capacitively coupled amplifiers are affected when the signal frequency is lower than a critical value. at low frequencies, the reaction of the coupling capacitors becomes significant, resulting in reduction of theof tension and an increase in phase change. The frequency responses of both BJT and FET amplifiers are discussed. Coupled.-- Analyze the low frequency response of an amplifier -- Analyze a BJT amplifier -- Calculate the medium-range voltage gain Identifying the parts of the amplifier that affect the low frequency response -- Identifying and analyzing the input circuit of the BJT amplifier analysis RC -- Calculate the lower critical frequency and roll-off gain Sketch at Bode plot - phase Define decade ectaof an amplifier -- Illustrate the answer with Bode diagrams -- Calculate the lower critical frequency Determining the BJT phase change Amplifiers A typical condensed common-emitter-condensed amplifier is shown in FIG. 8. Supposing the coupling and bypass capacitors are the ideal shorts to the frequency of the midrange signal, you can determine the voltage gain of midrange using EQN. 5, where Rc=Rc|RL . EQN. 5 If an oscillating resistor is used, it appears in series with and the equation becomes r'e (RE1) FIG. 8 A BJT amplifier with capacity. The BJT amplifier in FIG. 8 has three high-pass RC circuits that affect its gain as the frequency is reduced below the midrange. These are shown in the ac circuit equivalent to low frequency in FIG. 9. Unlike the ac equivalent circuit used in the previous sections, which represented the midrange response (XC = 0 ohm), the circuitlow frequency maintains coupling and bypass capacitors because XC is not small enough to neglect when the signal frequency islow. FIG. 9 - The low frequency equivalent circuit of the amplifier in FIG. 8 consists of three high-pass RC circuits. A RC circuit consists of the C1 input coupling capacitor and the input resistance of the amplifier. The second RC circuit consists of the output coupling capacitor C3, the resistance that looks at the manifold and the load resistance. The third RC circuit that affects the low frequency response is formed by the broadcaster-bypass C2 capacitor and the resistance that looks at the emitter. The RC input circuit The RC input circuit for the BJT amplifier in FIG. 8 is formed by C1 and the resistance to the input of the amplifier and is shown in FIG. 10. (Input resistance was discussed in section 6.) While signal frequency decreases, XC1 increases. This causes less tension through the input resistance of the amplifier at the base because more voltage has fallenC1 and because of this, the overall voltage gain of the amplifier is reduced. Basic voltage for RC RC inputin FIG. 10 (neglecting the internal resistance of the source signal input) can be indicated as (Rout) FIG. 10 input RC circuit consisting of the input coupling capacitor and the input resistance of the amplifier. As mentioned above, a critical point occurs in the amplifier response when the output voltage is 70.7% of its midrange value. This condition occurs in the input RC circuit when XC1=Rin Lower critical frequency The condition in which the gain is down 3 dB is logically called the -3 dB point of the amplifier response; the total gain is 3 dB less than the midrange frequencies due to attenuation (guadagna less than 1) of the input RC circuit. The frequency, fcl, to which this condition occurs is called lower critical frequency (also known as lower cutoff frequency, lower angle frequency, or lower breakage frequency) and can beas follows: EQN. 6 If the input source resistance is taken into account, EQN. 6 becomes [...]As you have seen, the input RC circuit reduces the overall voltage gain of a 3 dB amplifier when the frequency is reduced to the critical fc value. The rate of decrease in voltage gain with frequency is called roll-off. For each ten-time frequency reduction under fc, there is a 20 dB reduction in voltage gain. Consider a frequency that is a tenth of critical frequency (f = 0.1fc). From XC1=Rin to fc, then XC1=10Rin to 0.1fc due to the reverse relationship of XC1 and f. The attenuation of the input RC circuit is, therefore, [...] The attenuation dB is [...] The Bode Plot A ten-time change in frequency is called a decade. Thus, for the input RC circuit, attenuation is reduced by 20 dB for each decade that the frequency decreases under critical frequency. This causes the overall voltage gain of20 dB per decade. A dB voltage gain plot respecton semi-log graph paper (Logarithmic horizontal axis scale and linear vertical axis scale) is called a Bode chart. In FIG appears a generalized Bode plot for an input RC circuit. 12. The ideal response curve is shown in blue. Note that it is flat (0 dB) until critical frequency, at which point the gain drops to -20 dB/decennium as shown. Above fc are the frequencies of midrange. The actual response curve is shown in red. Note that it gradually decreases beginning in midrange and is down to -3dB at critical frequency. Often, the ideal response is used to simplify the analysis of the amplifier. As mentioned earlier, the critical frequency at which the curve "breaks" in a -20 dB / fall cascade is sometimes called the lower break frequency. FIG. 12---Bode plot. (Blue is ideal; red is real.) Sometimes, the voltage gain roll-off of an amplifier is expressed in dB/octave rather than dB/decade.corresponds to a doubling or frequency suspension. For example, an increasefrom 100 hz to 200 hz is an eighth. Similarly, a decrease in frequency from 100 khz to 50 khz is also an octave. a rate of -20 dB/decennium is approximately equivalent to -6 dB/octave, a rate of -40 dB/decennium is approximately equivalent to -12 dB/octave, and so on. ------- from story hendrik wade bode pronounced Boh-dee (1905-1982) was born in madison, wisconsin. he graduated in B.A. in 1924, at the age of 19, from the ohio state university and his degree in M.A. in 1926, both in mathematics. he was hired by Bell Labs and completed his PhD in Physics in 1935. in 1938 he developed his now known greatness and its phase plot. his work on automatic control systems introduced innovative methods for the study of system stability. ------ phase shift in the input rc circuit in addition to reducing the voltage gain, the input rc circuit also causes a growing phase change through an amplifier, while the frequencyAt midrange frequencies, the phase passes through the input RC circuitabout zero because capacitive responsiveness, XC1, is about 0 ohm. At lower frequencies, the highest values of XC1 cause a change of phase to be introduced, and the age of the RC circuit output volt leads the input voltage. As you learned in ac circuit theory, the phase angle in an input RC circuit is expressed as: Eqn 7 A continuation of this analysis will show that the phase transition through the input RC circuit approaches as the frequency approaches zero. Figure 13 shows a plot of the phase angle compared to the frequency. The result is that the voltage at the base of the transistor brings the input signal voltage to the lower stage than the average, as shown in Figure 14. FIG. 13---Phase angle compared to the frequency for the input RC circuit. FIG. 14... The input RC circuit causes the basic voltage to lead the input voltage below the average of a quantity equal to the phase angle of theTheta. The RC output circuit The second high-pass RC circuit in the BJT amplifier of Figure 8 is formed by the coupling from the couplingC3, the resistance that looks at the collector, and the resistance to the RL1 load as shown in Figure 15(a.) In determining output resistance, looking at the collector, the transistor is treated as an ideal current source (with infinite internal resistance,) and the upper end of RC is actually on ac ground, as shown in Figure 15(b.) Therefore, the sale of the left-hand circuit of the capacitor C3 produces a voltage source equivalent to the voltage of the collector and a resistance of the series equal to RC, as shown in Figure 15(c. The lower critical frequency of this RC output circuit is Equation 8 FIG. 15--Development of the RC output circuit at low frequency equivalent. The effect of the output RC circuit on the voltage gain of the amplifier is similar to that of the input RC circuit. While the signal frequency decreases, XC3 increases. This causes less tension through load resistance, because morefell through c3. signal voltage is reduced by a factor of 0.77 when the frequency isto the lower critical value, fcl, for the circuit. This corresponds to a 3 dB reduction in voltage gain. Phase turn in the RC output circuit The phase angle of the RC output circuit is EQN. 9 theta = 0 degr. for midrange frequencies and approaches 90 deg while the frequency approaches zero (XC3 approaches infinite). At the critical frequency fc, the phase shift is 45 deg. Bypass RC Circuit The third RC circuit that affects the low frequency gain of the BJT amplifier in FIG. 8 includes the bypass capacitor C2. As shown in FIG 17(a) for midrange frequencies, it is assumed that XC2 = 0 ohm, effectively shortening the emitter to the ground so that the gain of the amplifier is Rc>r' and, as you already know. As the frequency is reduced, XC2 increases and no longer provides a sufficiently low reaction to effectively position the ac-ground emitter, as shown in part (b). Since impedance from emitter to ground increases, thedecreases. In this case, King in the formula Av = Rc>(r'e Rc>(r'eRe), is replaced by an impedance constituted by RE in parallel with XC2. FIG. 17 - At low frequencies, XC2 in parallel with RE creates an impedance that reduces the voltage gain. FIG. 18 Development of the bypass circuit RC equivalent. The RC bypass circuit is formed by C2 and the resistance that looks at the emitter, Rin(emitter), as shown in FIG. 18(a). The resistance that looks at the emitter is derived as follows. First, Thevenin's theorem is applied by looking from the transistor base to the Vin input source, as shown in FIG. 18(b). This involves an equivalent resistance (Rth) and an equivalent voltage source (Vth(1)) in series with the base, as shown in FIG. 18(c). The resistance within the emitter is determined by the abbreviated equivalent input source, as shown in FIG. 18(d), and is expressed as follows: EQN. 10 Looking from the capacitor is in parallel with RE, as shown in FIG. 18(e). Selling again, we getequivalent RC circuit shown in FIG. 18(f). The lowestfrequency for this RC equivalent bypass circuit is C2, r'e + Rth>Beta_ac 1 EQN. 11 FET A D-MOSFET amplifier with capacitive coupling on the input and output is shown in FIG. 20. As you have learned in Section 9, the midrange voltage gain of a zero biased amplifier is Av(mid) = gm R. This is the gain at quite high frequencies so that capacitive reactations are about zero. FIG. 20 D-MOSFET amplifier in zero form. The FIG. 20 amplifier has only two high-pass RC circuits that influence its low-frequency response. A RC circuit is formed by the input coupling capacitor C1 and the input resistance. The other circuit consists of the output coupling capacitor C2 and the output resistance that looks in the discharge. FIG. 21... RC input circuit. The RC input circuit The RC input circuit for the FET amplifier in FIG. 20 is shown in FIG. 21. As inof the BJT amplifier, the input coupling capacitor reaction increases while the frequency decreases. Whenre, the gain is down 3 db below its average band value. the lowest critical frequency is the entry resistance is where Rin(gate) is determined by data sheet information as for practical work, the value of is so great that it can be ignored, as will be illustrated in ex. 7. the gain rolls under fc to 20 dB/decennium, as shown above. the phase angle of the rc circuit of low frequency input is Rin(gate) eqn. 12 eqn. 13 the rc circuit of ocita the second rc circuit that affects the low frequency response of the fet amplifier in fig. 20 is formed by a condenser of coupling c2 and the ocita resistance that looks in the discharge, as shown in Fig. 23(a). the load resistor, rl, is included. as in the case of bjt, the fet is treated as a current source, and the upper end of the rd is actually ac ground, as shown in Fig. 23(b). thevenin equivalent of the circuit to the left of c is shown in23(c). The lower critical frequency for this RC circuit is EQN 14 FIG. 23 Development of thelow frequency output RC circuit. The effect of the output RC circuit on the voltage gain of the amplifier under the midrange is similar to that of the input RC circuit. The circuit with the highest critical frequency dominates because it is what first causes the gain to roll out as the frequency drops under its midrange values. The phase angle of the low frequency output RC circuit is: EQN. 15 Again, at the critical frequency, the phase angle is 45° and approaches 90° while the frequency approaches zero. However, from the critical frequency, the phase angle 45° decreases and becomes very small as the frequency goes higher. Total low frequency response of an amplifier Now that we have individually examined the high-volume RC circuits that influence a BJT or FET voltage gain at low frequencies, let's take a look at the combined effect of the three RC circuits in a BJT amplifier. Eachhas a critical frequency determined by the values r and c. critical criticismof the three RC circuits are not necessarily all the same. If one of the RC circuits has a critical frequency (breaks) higher than the other two, then it is the dominant RC circuit. The dominant circuit determines the frequency in which the total voltage gain of the amplifier begins to descend to -20 dB/decennium. The other circuits cause an additional -20 dB/decade roll-off under the respective critical frequencies (break). To get a better picture of what happens at low frequencies, refer to the Bode plot in FIG. 25, which shows the ideal overlapping answers for the three RC circuits (green lines) of a BJT amplifier. In this example, each RC circuit has a different critical frequency. The input RC circuit is dominant (higher fc) in this case, and the RC bypass circuit has the lowest fc. The ideal overall answer is indicated as a blue line. That's what happens. Since the frequency is reduced by midrange, the first "break point" isto the critical frequency of the RC RC inputfcl(input), and the gain begins to fall this constant roll-off speed continues until the critical frequency of the rc ocita circuit, fcl(output), is reached. at this point of break, the rc ocita circuit adds another -20 dB/decennium to make a total roll-off of -40 dB/decennium. this constant -40 dB/decade roll-off continues until the critical frequency of the bypass rc circuit, fcl(bypass), is reached. the bypass rc circuit adds another dB/decent to this breaking point, making the roll-off gain to -60 dB/decennium. fig. 25 composite bode plot of a bjt amplifier response for three low frequency rc circuits with different critical frequencies. the total answer is shown by the blue curve. fig. 26 composite bode plot of an amplifier response where all rc circuits have the same fcl. (blue is ideal; red is real.) if all rc circuits have the same critical frequency, the response curve has a break-up pointfcl value, and the voltage gain rolls out to -60 dB/decent under that value, as well asfrom the ideal curve (blue) to FIG. 26. Actually, the medium-range voltage gain does not extend to the dominant critical frequency, but it is actually to -9dB under the voltage gain at midrange at that point (-3 dB for each RC circuit), as shown by the red curve. FYI---SPICE was one of the first computer programs that could simulate electronic circuits. Its origins can be traced to a program called CANCER (Computer Analysis of Nonlinear Circuits, Excluded Radiations) at the University of California. It was developed as a computer aid for the design of integrated circuits in the 1960s. SPICE is an acronym for the simulation program with integrated circuit emphasis. Over the years, SPICE has been reviewed many times, but it is still the underlying software for many of today's simulations. Frequency response computer simulation As you have seen in the previous example, the calculation morecriticism is involved and every critical frequency contributes to the general response. The ideal answerin EX. 9 is an excellent first approximation, but when more accuracy is required, a computer simulation is used. The computer takes into account all parameters for the particular device, including effects such as internal capabilities that are usually ignored in manual calculations, and can calculate in detail the interactions that occur when there are multiple breakpoints like in EX. 9. Multisim is based on SPICE models that can show the frequency response of the circuits on the Bode plotter. As mentioned above, the Bode plotter is not a real tool. It performs the same function as a tool called spectrum analyzer, which can also track the frequency response of a circuit. EX. 10 illustrates the application of computer analysis to the circuit in the previous example. Other 2 > Similar articles

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