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CHAPTER 1 BASIC ELECTRONIC STUDY BIPOLO TRIPOLO AND QUADRIPOLO OBJECTIVE: Demonstration of the relationships between voltage and current of chips variables between a bipole, tripole and quadripole. Include concepts related to linearits. Illustrates the theory of volt-amp characteristics, symbols, mathematical and circuit models. 1 INTRODUCTION TO THE 1.1. For this bipole, we can express the following instantaneous values: Figure 1.1 - Representation of a birúd. VAB (t) = VA (t) - VB (t), (1.1) and pAB(t) = VAB(t)iA(t), (1.2), in which VAB(t) represents the total instantaneous voltage between the bipole A and B terminuses; Va(t) indicates the voltage on-kulysi in Terminal A; Vb(t) indicates the total voltage on terminal B; iA(t) represents the total current entering terminal A and exiting terminal B; pAB (t) means the momentary power developed between terminals A and B; Oats represents the complex impedance between terminals A and B If pAB(t) • 0 W, the bipole acts as a supplier (or generator). CHAPTER 1-2: STUDY BIPOLO TRIPOLO AND QUADRIPOLO 1.1 COMPONENTS CC AND DC VOLTAGE AND CURRENT At this stage we discriminate between the CC (continuous component, or medium component) and the alternating component (alternating component) components voltage and current, marking. VAB(t) and iA(t) can normally be expressed as a function of components CC and AC, as follows: VAB (t) = VAB + Vab(t) (1.3) iA(t) = (1.4) and = AI + ia(t). in which: VAB is the continuous component, CC or vab mean(t); usually represented by vcc or vmedia; vab(t) represents the current voltage of the alternating component (AC, VAB(t); usually represents VCA(t); AI is the continuous component, CC or average AI(t); represented by the ICC or Media; ia(t) represents the current current of the AC(s), usually iCA(t). By omitting poles A and B, voltage marks and current can be rewritten as follows: V(t) = VCC + VCA(t) or V(t) = Vmedia + VCA(t), Vmedia ⎕ VCC (1.5) i(t) = Imedia + iCA(t), Imedia ⎕ ICC . (1.6) and i(t) = ICC + iCA(t) or 1.1. We have observed that the graphical sum of VCC and VCA(t) corresponds to the form of V(t). The forms V(t) and VCA(t) can be displayed on the oscilloscope screen using one of the input channels. The scale of the channel CC is displayed in the form of V(t). On the AC scale, the form of the VCA(t) is displayed. NELSON JOSÉ CAMELO - DEE-UFMA 1-3 NELSON JOSÉ CAMELO - DEE-UFMA Placing the V(t) signal on the two channels of the oscilloscope; selection: cc scale of the first channel and second file; By activating the inversion button on the second channel and the amount button on the two channels, we get the VCC magnitude trace on the oscilloscope screen. In section 1.3, we present mathematical models of average voltage, average current and average power. In section 1.4, we discriminated against dc and dc power components. To do this, we reviewed the concept of average in general in Figure 1.2. 1.2 - Distinguishing the CC and AC components of the total voltage V(t). 1.2 AVERAGE ELENTE VALUES AND CONSTANT VARIABLES Consider xi ⊞ {X1, X2, X3, ... , XN / i = 1, 2, 3, ..., N}. So, N x 1 N i Xmean = ○ = ○ xi N N i ◼1 i ◼1 (1.7) In this case, x is a separate variable. Consider x as a continuous variable over time, i.e. x, as a function of t or x(t), as a function of ⊞[0, T]. So Xmean = T 0 x(t) 1 T ◼ x(t)dt . T T T 0 (1.8) BASIC ELECTRONICS 1-4 1. So equivalence has a biunivocal compliance: ○ - (N, N • T, xi), x(t), i • t and [i = 1, 2, 3, ..., N] • ⊞[0, T]. 1.3 MEDIUM VOLTAGE AND POWER EXPRESSIONS We can write from the general definition of Xmedia voltage v(t), current i(t) and power p (t), corresponding mean voltage (Vmedia), medium current (Average) and average power (Pmedia), as follows : 1 T v(t)dt , T -0 Vmedia = Average = (1,9) 1 T i (t)dt and T ,0 Pmedia = (1.10) 1 T p(t)dt . T tt (1.11) 1.4 CC AND POWER CA Return to 1.1 (1.2). Omitting the indication of poles A and B, as referred to in 1.1 (1.12) Now v(t) and i(t), Eq. (1.5) and (1.6), results: p(t) = [VCC + V CA(t)][ICC + i CA(t)] and Pmedia = = = (1,13) 1 T 1 T 1 T p(t = v(t)i (t)dt = ([VCC ◈ vCA (t)][I CC ◈ iCA (t)]}dt . T 0 T 0 T 1 T 1 T 1 T VCC I CCdt + VCC { iCA (t)dt }+ ICC { NELSON JOSÉ CAMELO - DEE-UFMA 0 }+ ICC{ 0 }+ 1 T vCA (t)iCA (t)dt T t t (0 }+ 1 T vCA (t)dt T t t (1 1.14) 1-5 NELSON JOSÉ CAMELO - DEE-UFMA Pmediamedia = VCCICC + 1 T vCA (t)iCA (t) dt = PCC + PCA, T 0 PCC = VCCICC and PCA = 1 T vCA (t)iCA(t) dt. T tt (1.15) (point 1.16) We observed that the PCA is permanent because it comes from a specific integral. That's why we can't mistake Pmedia for the PCC. The PCC is only a fraction of pmedia. So it is obvious that both continuous and alternating components, current and voltage result in average performance, Eq. (1.15) 1.5 and 'E|t0'), energy changes over time [0, t]. So dE(t) ◼ p(t) or dE(t) = p(t)dt ⊗ dt t a p(t)dt, energy change calculated from 0 to t or t ∫0 dE(t) = 0 T0 = - -E | T0 = (T 0 t t) p(t)dt 0 or, p(t)dt or (1,17) (1,18) (1,19) (1,19) (1,20) 1 T p(t)dtT = (Pmedia)T or T ≥0 (1,21) •E |0n T = (Pmedia)nT, n = 1, 2, 3, ... and (1.22)E |0n T =n-E | T0 . (1.23) SOLUTION 1.1: min 'E |100 = 0 100 ≥0 600dt = (600 W)100 min = 6 kWh. (1.24) BASIC ELECTRONICS 1-6 CHAPTER 1: STUDY ON BIPOLO TRIPOLO AND QUADRIPOLO EXAMPLE 1.2: If the average power of a bull is 400 W, what is the energy change over 100 periods? The period is 1/60 s. SOLUTION: 'E |0n T = (Pmedia)nT = (600 W)(100) (1/60 s) = 6 kWh. (1.25) SOLUTION 1.3: •E |0n T = n-E | T0 = 100 (360 Ws) = 10 kWh, n = 100 (1.26) 1.6 EFFECT VOLTAGE AND CURRENT VALUES Calculate the mean power distributed in resistance resistance R, which is subject to voltage v(t). So, from EQ. (1.11 and (1.12): Pmedia = 1 T 1 T v(t) v (v (t) dt] or (p (t))) (i (t ( ) t dt dt = = = = = = [T 0 R T t , 0 T 0 R (1,27) Pmedia = 1 T 1 T 1 T 1 T 1 T 1 T p(t) dt = v(t)i (t)dt = ri (t)i (t)dt = R[t 2 (t)dt]. 0 0 0 T T T T T 0 (1.28) If in set (1,27) 1 T 2 v (t)dt = Vef2 ◼ VRMS, then, Vef = VRMS = 0 T 1 T 2 v (t)dt . T ≥0 (1.29) If set in (1.28): 1 T 2 i (t)dt = i ef2 ◼ I 2RMS , then Ief = IRMS = 0 T 1 T 2 i (t)dt T ≥0 (1.30) Logo, the mean power supplied by the resistance R by voltage v(t) or i(t) current is given by the following data: NELSON JOSÉ CAMELO - DEE-UFMA 1-7 NELSON JOSÉ CAMELO - DEE-UFMA 1 1 T 2 V2 [v (t)dt] = ef , or R T 0 R T 1 Pmedia = R[i 2 (t)dt] = R I ef2, T 0 in which: Pmedia = Vef (1.31) (1.32) - called vrms voltage or effective value v(t) - is called voltage or RMS (Root Means Square) second-degree version of v(t). Both markings are equivalent, so they have the same meaning. This means that if the value v(t) is replaced by a continuous voltage, it would result in the same power in an R resistance over the same period as shown in 1.3. In these two circuits, the R is the same. Let Pmedium-1 be the current supplied to the resistance R by source v(t) in circuit 1; and the Pmedia-2, supplied by the Vef source from the Vef source to the same R resistance in circuit 2. So if Pmedia-1 = Pmedia-2, Vef is the actual value of v(t). The same can be said for ief or IRMS for i(t). It is important to note that this is the equivalence of energies. Figure 1.3 - v(t) and its actual value, equivalence of Vef; and i(t) and its actual value, between Ief. 1.7 EFFECTIVE PERFORMANCE WITH RESISTANT LOAD MULTIPLIED FROM MEMBER TO LIMB, EQ. (31) and (32) are: ☂ Vef2 ◼ 2 2 2 (Pmedia) = • ☂♀ RIef ◼ = ☂♀ Vef ◼) ☂♀ Ief ◼/ = ♀ R • 2 ☂♀Vef Ief ◼) ◼ ☂♀Vef Ief ◼☂ ♀Vef Ief ◼. (1.33) Eq. (1.33): Pmedia = Vef Ief = PRMS = Pef. (1.34. (34) is also referred to as RMS performance, effective, or active. 100% vef as a product, as shown by Eq. (1.34), only if the load is resistant, which means current in phase with voltage, as well as 1-8 (1.35). In other cases, the parameter called the power factor is displayed, as shown in Eq. (1.41. 1.41.1. effective power and peak power in the resistance load The case of Figure 1.3 is taken into account, in which: v(t) = Vpsen('t) and i(t) = Ipsen('t). (1.35) Entry with v(t) in Eq. (1.29) is: 1 T 2 v (t)dt = T -0 Vef = VRMS = VP 1 T 2 1 T 2 V (t)dt ◼ [V sen(wt)] dt ◼ p t 0 T 0 2 (1,36) Entry i(t) na (1.1.36) 30) is: Ief = IRMS = IP 1 T 2 1 T 2 i (t)dt ◼ [I sen(wt)] dt ◼ p t 0 T 0 2 (1,37) Connections (1,36) and (1,37) show that in this case sinus flow, a peak below 2 square root determines the corresponding effective value. The following shall be replaced by the following: Combination of Eq (1.34), (1.36) and (1.37) R resistance: PRMS = Vef Ief = VP I P •I P - ◼ P ◼ P ◼ 50%PP 2 2 (1.38) Eq. (38): PP = VP I P (1,39) Eq. (1.39) is called peak performance. The percentage displayed in Eq. (38) the PRMS is equal to 50% PP, only valid in this case if the load is resistant, leading to the current phase of voltage, Eq. (1.35), and stress is considered a sinus. Be it the case when the load is not resistant and, as a result, the current is relative to the voltage, as shown by Eq. (1.40): NELSON JOSÉ CAMELO - DEE-UFMA 1-9 NELSON JOSÉ CAMELO - DEE-UFMA v(t) = Vpsen('t) and i(t) = Ipsen(-t+➶). Enter (1,40) by typing (1,11): Pmedia = 1 T p(t)dt = T 0 1 T (1,40) ∫ V sen('t)IP sen('t + ➶) = T 0 P VP IP cos(➶) √2 √ √2 = Vef Ief fc. (1.41) (1.41), fc = cos(➶) is hereinafter referred to as the performance factor. 1.8 EFFECTIVE DC AND DC VOLTAGE AND CURRENT COMPONENTS AS 1.1. Now we will show you how these components enter the formation of effective values. To do this, we have introduced Eq. (1.5) on Eq. (1.29) and we develop as follows: Vef2 = 1 T 2 1 T v (t)dt [VCC ◈ vCA (t)]2 dt = 0 0 T T = 1 T 2 1 T 2 1 T VCCdt + 2VCDT vCAdt ≥ + * vCA (t)dt t 0 0 T 0 T (1.42) = = 2 VCC 2 VCC + 0 + 1 T 2 vCAdt = T 0 Vef2 ◼CA , From the ratio (1.42) we noticed that: Vef2 ◼CA = 1 T 2 1 T 2 1 T 2 T 2 VCAdt ⊗ Vef-CA=√ vCA dt and VCC VCCdt ⊗ VCC = √ VCC dt = ≥ t t t t 0 (1,43) We concluded that in Eq. (1.42):(a) Vef-CA represents only the actual value of the component of v(t), i.e. vCA(t); (b) the constant, in which case the actual value of the VCC is the value of the vcc itself. Also, considering the relationship, Eq. (1.42), with its second degree, you can conclude that: Vef = 2 VCC ◈ Vef2 ◼ CA . (1.44) Using the same procedure but eq. (1.6) and (1.30) may also be inferred that for currents: Ief = 2 I CC ◈ I ef2 ◼CA , (1.45) with Ief-CA, which represents only the actual value of the component of iCA(t), i.e. iCA(t). BASIC ELECTRONICS 1-10 1 (1.44) and (45) shall be associated with the relationship between hypotension and the pythagorastrapation of the square triangle, as shown in Figure 4.4 - Relationship between CC, AC components and actual voltage and current value. 1.44. 1.9 Typical electrotechnical waveforms are as 1.5. In addition to the figure, the information 1.1 and 1.2 are to be used. Sine, triangular, and square waveforms are characteristic or primary electrical engineering. Each function-producing device shall contain at least these three waveforms. From them, other waveforms can be easily generated using analog processor circuits. NELSON JOSÉ CAMELO - DEE-UFMA 1-11 NELSON JOSÉ CAMELO - DEE-UFMA 1.1. Vefmedia Vp 0V Vef-CA Vp 2 2 Vp 0V Vp 0V 3 3 Vp 2 2 2 Vp 2 2 vp 2 2 V + VP 2 V + VP0 2 VP1 − VP0 2 √(P1) +( ) 2√2 ◼ Vp1 ◈ VP 0 2 (VP1 − VP0 2√2) 1.10 TRUE EFFECT AND EFFECT VALUE MEASUREMENT In multimeters we have two scales for measuring voltage. One only cc values, and another just authentication. On the CC scale, we measured the mean voltage. On the authentication scale, only the actual value of the authentication component is measured. Then 1-12 ◈ ◈. (1.46) Some multimeters have true RMS function. Even these multimeters, like all, are measured separately for CC and alternating and alternating color components. The difference is that the TRUE RMS multimeter measures the effective value more accurately, even the 1.5. 1.11 SYSTEMS OR LINEAR CIRCUITS Systems can be classified in many ways, depending on the models assigned to them. Thus, it can be framed as: analog, digital, stationary, discreet, linear and non-linear, to name a few. In this text, we would like to discuss only the categories of systems or circuits, linear and non-linear 1.11.1 Properties of linear systems Consider a system or electrical circuit f, Figure 1.6, which answers an excitation E(t) s(t) by S(t) = f(E(t)). Figure 1.6 - Block diagram of the electrical circuit f. If: E(t) = E1(t), f(E1(t)) = S1(t), E(t) = E2(t), f(E2(t)) = S2(t), E(t) = E1(t) + E 2 for 2(t), f(E1(t)+ E2(t)) = f(E1(t)) + f(E2(t)) = S1(t) + S2(t), we say that the system corresponds to the property of aditivity. If: E(t) = En(t) f(En(t)) = Sn(t) and E(t) = kEn(t) f(kEn(t)) = kf(En(t)) = kSn(t) in which k equals any fair value and n=(1, 2, 3, ...); we say that the system corresponds to the property of homogeneity. Any system that meets these two properties at once is said to be linear. If a circuit is not linear, it is non-linear, and vice versa. In this linear or non-linear classification, we do not take into account the initial conditions of the system. In the block of Figure 1.6, the general variables E(t) and S(t), i.e. any electrical quantity, are the most common voltage and current of NELSON JOSÉ CAMELO - DEE-UFMA 1-13 NELSON JOSÉ CAMELO - DEE-UFMA. This block can represent a system, circuit or simply a bipole, such as a resistance. Figure 1.6a - Illustration of the aditivity property. Figure 1.6b - Illustration of the homogeneity property. 1.11.2 SUPERPOSITION PRINCIPLE Take into account the electrical system or circuit represented by block f, Figure 1.7, which reacts to S(t) by simultaneous excitation of X(t) and Y(t) by S(t) = f(X(t),Y(t)). Figure 1.7 - Block illustration of a linear system. Let X(t) and Y(t) inputs be: If X(t)= k1X1(t) + k2X2(t) and Y(t)= m1X1(t) + m2X2(t) The response of the system should be S(t) by: S(t) = f(X(t),Y(t)) = f((k1X1(t) + k2X2(t)), (m1Y1(t) + m2Y2(t)) = k1f(X1(t)) + + m1f(Y1(t)) + m2f(Y2(t)) This response sums up two properties of linearity, making this two-input system linear. In illustrations 1.8a and 1.8b, each input X(t) and Y(t) are presented separately. The two terms summarize the principle of superposition, which is set out in 1.9. BASIC ELECTRONICS 1-1. 1.8b. Figure 2 - Illustration of the linearity properties of Y(t). Figure 1.9 - Illustration of the principle of superposition. 1.11.3 LINEAR CIRCUIT FEATURE The graph of the relationship between the S and E signals is called a transmission characteristic, distinguished by the units of the quantities represented by these variables in the pair of axes. For example, typical V-A (Volt-Ampère), characteristic C-V (Coulomb-Volt), characteristic V-V (Volt-Volt), etc. Then we will prove that it corresponds to the properties of additivity and homogeneity. (a) (b) function 1.11 (b) V-A. v(t) = f(i(t)= Ri(t), then: f(i1) = Ri1(t) NELSON JOSÉ CAMELO - DEE-UFMA 1-15 NELSON JOSÉ CAMELO - DEE-UFMA f (i Ri2(t) f(i1 + i2) = R(i1 + i2) = Ri1(t) + Ri2(t) = f(i1) + f(i2), corresponds to the i2 property of entry; f()i) = R(i) = (Ri) = (f)[i). The following shall be replaced by the following: For this circuit, skipping the independent variable, t, you can write the following connections: Figure 1.12 - Linear RC circuit. di dv i = f(v) and i + CR dt = C dt . Let v = k1 v1 + k 2 v2 be inferred as follows: C d(k1 v1 +k2 v2) dt = C d(k1 v1) dt +C d(k2 v2) dt = k1 C d(v1) dt + k2C d(v2) dt ⊗ f(k1v1+k2v2) = f(k1v1)+f(k2v2) = k1f(v1) +k2f(v2) Therefore, the circuit corresponds to the two properties of linearity. 1.11.4. NON-LINEAR CIRCUIT CHARACTERISTICS Imagine a device whose V-A characteristic is represented by the mathematician v. model v i = f(v) = (e━vT -1) and another i = f(v) = IDSS (1 − V)2 . We clearly noticed P that the first function is exponential and that the second function is second-degree. Then we prove that none of them correspond to the property of homogeneity. It is sufficient that one of the properties of linearity is not met, so we say that the device under analysis is not linear. For the first device: (v f(v) = Van (e━VT − 1) ≠ (v) = Is) (e━VT − 1); For the second device: (v f(v) = IDSS (1 − V)2 ≠ (v) = IDSS, (1 − V)2; P P Both devices do not correspond to the homogeneity property and are therefore not linear. BASIC ELECTRONICS 1-16 1. About BIPOLO TRIPOLO AND QUADRIPOLO Here are some examples of nonlinear devices with V-A characteristics, including a nonlinear circuit consisting of incandescent power supply from an AC voltage source. (b) designates an amplifier with a constant profit between E1 and E2; with a saturated seat (limited) to the left of E1 and to the right of E2; (c) inverter designates a logical port; (d) filament lamp operating alternating voltage. 1.11.5 SIDE-BY-SIDE WITH LES. If this does not occur throughout the domain, we will check the principle of output derivation relative to the input. Let S be the output and E is the input to S=f(E). If dS/dE=CTE (positive value constant, negative or zero) in each subrange of E, the circuit is linear in this subrange. If it's not linear, it can be linear components. However, if the circuit is linear only in a subdomain, it is said to be linear in part; if it's linear for some subdomans, we say linear components. S and E are decommt into the components of CC and AC: S = SCC + sCA, and consequently E = ECC + eCA. In each subdomain where the circuit is linear, you can create a new pair of axes with one point (SCC, ECC) for sCA and eCA variables. Then, in this subdomain, sCA = f(eCA) corresponds to the properties of aditivity and homogeneity. Linearization with a graphical characteristic means dividing them into regions and bringing them closer with straight-line segments. The best part linearization is performed by incremental line segments. It's not always practical, it's desirable. In 1.13 e, B and C. We visually noticed that the straight section of Figure 1.13(a) between A and B is closer to the curved points than in Figure 12.13 b. For Figure (b), the straight-line section between B and C, which can be tracked by two points, is closer to the spherical line than for the string B to C. Another type of linearization is tangential, which is the type of linearization 14. In this type of linearization, called tangential linearization, only one curve point is used as a reference for each approximation. (a) (d) (b) (c) (e) 13(a) (f) (b) 1.14. BASIC ELECTRONICS 1-1. conditions, i.e. constant current and voltage, ICC and VCC. The point defined by these coordinates is the resting action point, Q. Then Q = (Icc, VCC). At this point, static resistance or RCC is determined as follows: R CC = VCC (1.47) ICC 1.15 . (b) static resistance to point Q The practical meaning of the RCC is that at the operating point Q the device can be replaced by RCC resistance without changing the values of terminal variables, ICC and VCC. 1.11.7 MEDIUM CA RESISTANCE We assume a bipole with a characteristic V-A displayed in Figure 1.16. 1.16 - a) Static operating point; b) dynamic operating region 1 to 2. NELSON JOSÉ CAMELO - DEE-UFMA 1-19 NELSON JOSÉ CAMELO - DEE-UFMA This warp region has infinite points, each with different slopes. Therefore, a variety of related resistance. To associate resistance to curvature segments, we approach it with a straight-line segment, as shown in Figure 1.17(a). Figure 1.17 - a) Linearisation of the curvature segment from q1 to q2; (b) extrapolation from linearisation to current i = 0 A and v = VC0. From point 1.17. CI2 −IC1 to point (q a q) 1 2 (1,47) The straight-line segment shown in Figure 1.17(b) is mathematically represented by: v = VC0 + rmedia i v vc1 to VC2. (1.48) The practical meaning of rmedia is that 1.17 (1.48) is the equivalent of figure 1.18. 1.18 — The linear compound bipole is equivalent to the one in 1.16a. 1.11.8 DYNAMIC AC RESISTANCE The same bipole is assumed to have a v-A property as set out in 1.16. Now associate a resistance to the curved segment by approaching it with a straight-line segment, as shown in Figure 1.19(a). BASIC ELECTRONICS 1-20.b) extrapolation from linearization to current i = 0 A and v = VC0. 1.19a is replaced by the following: di at function point Q (1,49) The following shall be incorporated in item 1.1b: (1.50) The report that nonlinear bipole, Figure 1.19a, can be replaced by the compound bipole described by Eq. (1.50) In the case of the information referred to in 1.20(1)(a) and (2), the following shall be If we know the function i = f(v) only calculates the derivative point Q. No graph. Figure 1.20 – The bipole linear compound is approximately the same as the one in 1.19a. NOTES for medium and dynamic Authentication and Authentication and Water Resistance: (a) Save the concept of dynamic resistance for rd incremental linearization segments, i.e. around the resting point. (b) For wide linearization segments, the concept indicated by medium dynamic resistance, rmed or sometimes rf is associated. In this case, we are not concerned about extreme intersections, but about a more practical approach to the curved region under consideration. Nor does the related segment necessarily have to pass through two points, such as on the right, between A and B, such as nelson josé camelo - DEE-UFMA 1-21 NELSON JOSÉ CAMELO - DEE-UFMA 1.13b, which takes into account the curvature region on a straight stretch coinciding with the axis of variable v. This is more justified as the vertical size of (i) in point (i) is negligible. NOTES FOR LINEARIZATION IN THE FACE OF COMPONENTS: The average resistance of point-to-point linearisation may be the same as the dynamics (which could be achieved by the tangent of the operating point) in the 1.21. In the diagram on the right, we observed that in linearization of a small segment, point by point or tangent, the average Alternating Resistance is close to dynamics, i.e. ✐ rd. In general, if dynamic operation is introduced by small signals, we work with dynamic resistance, rd, especially if it can be achieved by calculating the derivative of the characteristic function of the device at point Q of the operating region. In this case, the analysis of the circuit is called a small signal analysis. Figure 1.21 - Point-to-point and tangent linearization. 1.12 CIRCUIT MODELS BIPOLO Has simple and composite bipoles. Composite bipole is an open circuit consisting of simple elements in series or parallel. Example of simple bipole: a resistance; capacitor, etc. Take a bipole circuit represented by 1.22 poles p1 and p2, respectively. We represent the possible difference between the poles simply v1. Therefore, v1 = (vP1-vP2). i1 represents the current entering the pole p1 and exiting at p2. v1 and i1 voltage and input current. These are the terminal variables for bipole. Figure 1.22 - Representation of bipole in blocks with p1 and p2 poles. To do this bipolo we can write two functions, establishing connections between terminal variables i1 and v1: BASIC ELECTRONICS 1-22 CHAPTER 1: STUDY BIPOLO TRIPOLO AND QUADRIPOLO i1 = f(v1,ix) = Gv1 + βix (1.51) v1 = g(i1, vx) = Ri1 + vx (1.52) and G and R, the parameters conductivity (unit S - Siemens) and resistance (unit Ω - ohm), respectively. β and ' dimension parameters. Any of these functions describe the relationship between the current and voltage of bipolar terminals. The following shall be replaced by the following: Figure 1.24. 1.23 - Circuit model i1 = f(v1,ix) and can be called norton equivalent circuit. Figure 1.24 - Circuit model v1 = g(i1,vx) and can be called the equivalent Circuit Thèvenin. Article 3(2) shall β replaced by the following: The same shall apply to the products 1.24. On the other hand, if we call βix iNo (Norton current), the bipole configuration of Figure 23 assumes the representation of the equivalent Norton circuit. If ix represents the current on any node pair, another element, or circuit block, the branch to the right of G represents a current-controlled current source. In this case, we say that the bipole of Figure 1.23 is a circuit model for a real power source controlled by a current with an output resistance of 1/G. Similarly, if called vx vTh, the bipole configuration in Figure 1.24 assumes a representation of the equivalent circuit of Thèvenin (vTh- voltage Thèvenin). If vx represents voltage at any node of another element or circuit block, the branch in the r nelson josé camelo - DEE-UFMA 1-23 NELSON JOSÉ CAMELO - DEE-UFMA series represents the voltage-controlled voltage source. In this case, we say that the 1.24. Other possible bird models are 1.22 ix) = G1v1 + Gxvx (54) v1 = g(i1, vx) = R1i1 + Rxix (55) v1 = g(i1,vx) = R1i1 + vx (56) Relationships (from 1,53 (1,6) may assume other formats if G and R are replaced by inductive or cashiticances. These functions correspond to the mathematical models of bipole, which represent the real sources of current and voltage controlled by voltage and current. Thus, the vx voltage and current ix therefore represent the variables associated with another pair of terminals on one circuit or another bipole. This idea leads to the study of a quadripole of terminal variables, i1, v1, i2 and v2. 1.13 QUADRIPOLE AND TRIPOLO CIRCUIT MODELS Take a four-pole circuit, which is used by 1.25. v1 and i1 as terminal variables for poles p1 and p2. v2 and i2 are terminal variables for poles p3 and p4. v1 = (vP1- vP2); v2 = (vP3- vP4). It should be noted that the associated current and voltage directions were chosen for each pair of poles. Poles p1 and p2 the front door. The p3 and p4 pole pairs are called output ports. Figure 1.25 - Representation of a rectangular pole (poles p1, p2, p3 and p4). The input variable v1 and the output variable i2 can be written as independent of the following functions quadripole: v1 = g(i1, v2) = R1i1 + •v2 (1,57) i2 = g(i1,v2) = βi1 + G2v2 (1,58) Parameter definitions, R1, G2, • and β: BASIC ELECTRONICS 1-24 CHAPTER 1: STUDY BIPOLO TRIPOLO AND QUADRIPOLO v1 R1 = : short-circuit input impedance at the output; [R1] = Ω; i1 v =0 V 2 v = v1 | 2: Reverse voltage transmission ratio in open circuit at inlet; i1 =0 A [-]= dimensional; β = i2 | 1: DC transmission ratio in short circuit output; v2 =0 V [β] = dimension; i G2 = v1 | 2 i1 =0 A : open circuit exit driving at the entrance; [G2] = S. The following is replaced by the following: Then we rewrite the functions (1,57) and (1,58) in their traditional form: v1 = g(i1, v2) = h11i11+ h12v2 (1,59) i2 = g(i1,v2) = h21i11+ h22v2 (1,60) in which: h11 = R1 = v1 | i1 v =0 V 2 i h21 = β = i2 | 1 Ω-dimensional v2 =0 V v h12 = - v1 | 2 adimidimension i1 =0 A i h22 = G2 = v1 | 2 in S i1 =0 A Independent variables h11-h22 are called hybrid parameters because they are expressed in different units. From this fact, we take the initials of the hybrid word to represent the parameters h. The hybrid parameters can be expressed by partial detroi ∂ ∂ ∂ ∂- 2 1 ∂v Ω h12 = ∂v1 dimens h22 = ∂v1 dimensional 2 ∂I 2 S we can derive a tripole circuit from a rectangular column for joint reference to entry and exit, in 1.27, the following shall be replaced by the following: Figure 1.27 - Tripole circuit for hybrid parameters. You can choose from other pairs of independent variables and new rectangular models. Rectangular circuit 1.26 is t-N shaped (Thèvenin-Norton). From this we can generate three equivalent settings: T-T, N-N and N-T, the task is left to the reader. 1.14 BIPOLO VOLT-AMP FEATURES The following diagrams show the volt-amp (V-A) characteristics of voltage and power sources. v = Vo ∀ i (a) (b) 1.28(b) circuit symbol. Mathematical model: v = Vo + Ri-Im - i - In a) b) 1.29. b) circuit model. BASIC ELECTRONICS 1-26 ∀.b. circuit symbol. Mathematical model: i = Io + v/R Vm - v - Vn a) b) 1.31 b) circuit model. Mathematical model: i = βIx + v/R For Vm Vn (a) (b) 1.32 (b) circuit model. Mathematical model: v = βVx + iR The Im - i • Circuit model (a) (b) 1.33 (b). NELSON JOSÉ CAMELO – DEE-UFMA 1-27 NELSON JOSÉ CAMELO – DEE-UFMA Tripole or four-pole input and output characteristics are similar to those of 1.28-1.33. ■ 1.15 SUMMARY1 In this unit, we provide a complete picture of all the funds needed to develop the following units. Basic electronic devices, diodes and transistors are non-linear in nature. The engineer's considerable effort is to operate electronic devices in regions that can be considered linear on the basis of their characteristics. Circuits made with linear devices are also linear. Linear circuit analysis is simpler because it results in systems of linear equations. To do this, you need to know how to use techniques for linearization, modeling and analysis of circuits of diodes and transistors, basic elements of electronics. The modeling is done bipolo, tripole and quadripole, as seen in this chapter in general. For electrical characteristics, usually V-A, we can write mathematical and circuit models. The concepts of linearity are essential in the field of electronics and electrical engineering in general. 1.15 REFERENCE CONSULTED ON ELECTRONIC DEVICES AND CIRCUIT THEORY; Robert L. Boylestad and Louis Nashelsky; Pearson Prentice Hall, 8. BASIC CIRCUIT THEORY; Charles A. Desoer and Ernest S. Kuh; McGraw-Hill, 1969. Basic electrical circuits; Charles K. Alexander and Matthew N. O. Sadiku. 1 In order to improve this work, we ask readers to point to possible errors and suggestions for improvements and other discussions. BASIC BASIC ELECTRONICS