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\$\begingroup\$ Recently I started reading a book about an introduction to electrical circuits. Currently, I am trying to learn the basic network topology needed to solve the exercises more efficiently. To understand where I am wrong I will describe the circuit you see below in topological terms: BRANCHES This circuit has 5 branches: 3 resistors. 1 Source of voltage. 1 Power source. NODES This circuit has 3 nodes: Node a where R1 and V1 are connected. Node b where R2, R3 and I1 are connected via cables. Node c where V1, R2, R3 and I1 are connected via cables. MESHES This circuit has 2 meshes: abca. mesh created between R3 and I1. So, if the above are correct, then according to the basic theorem of network topology: $$b=l+n-1 5 = 2 + 3 - 1 5 = 4 $$ which is obviously not correct. Where am I wrong?Simulate this circuit – Scheme created with CircuitLab 2 Shape taken by the network of interconnections of a circuit The topology of an electronic circuit is the shape taken by the network of interconnections of the circuit components. Specific values or different assessments of components are considered to be part of the same topology. Topology has nothing to do with the physical arrangement of the components of a circuit, nor with their position on a circuit diagram; similar to the mathematical concept of topology, it deals only with the connections between the components. There can be many physical layouts and circuit diagrams that all correspond to the same topology. Strictly speaking, replacing a component with a completely different type is always the same topology. In some contexts, however, these can be loosely described as different topologies. For example, exchanging inductors and capacitors in a low-pass filter results in a high-pass filter. These could be described as high-pass and low-pass topologies even if the network topology is identical. A more correct term for these object classes (i.e. a network where the component type is specified but not the absolute value) is network prototype. Electronic network topology is related to mathematical topology, especially for networks containing only two terminal devices, circuit topology can be seen as an application of graph theory. In a network analysis of such a circuit from a topological point of view, the network nodes are the vertices of graph theory and the network branches are the edges of graph theory. Standard graph theory can be extended to active components and multi-terminal devices such as integrated circuits. The graphs can also be used in the analysis of infinite networks. Circuit diagrams The circuit diagrams in this article follow the usual conventions of electronics;[1] the lines represent the conductors, the small filled circles represent conductor junctions, the small open circles represent the terminals for the connection with the outside world. In most cases impediments are represented by A practical circuit diagram would use specific symbols for resistors, inductors, capacitors etc., but the topology does not deal with the type of component in the network, so the general impedance symbol was used. The Graph Theory section of this article provides an alternative method of representing networks. Topology Names Many topology names refer to their appearance when drawn diagrammatically. Most circuits can be designed in various ways and as a result has a variety of names. For example, the three circuits shown in Figure 1.1 all look different but have identical topologies.[2] Figure 1.1. The topologies T, Y, and Star are all identical. This example also demonstrates a common convention of naming topologies according to a letter of the alphabet to which they have a resemblance. Letters of the Greek alphabet can also be used in this way, e.g. Ã© (pi) topology and Ã© (delta). Serial and parallel topologies For a network with two branches, only two topologies are possible: serial and parallel. Figure 1.2. Serial and parallel topologies with two branches Even for these simpler topologies, there are variations in the way the circuit can be presented. Figure 1.3. All these topologies are identical. Series topology is a generic name. The voltage divider or potential divider is used for circuits of this purpose. Section L is a common name for topology in filter design. For a network with three branches there are four possible topologies; Figure 1.4. Series and parallel topologies with three branches Note that the parallel series topology is another representation of the delta topology discussed below. You can continue to build serial and parallel topologies with an ever-increasing number of infinite branches. The number of unique topologies obtainable from n branches is 2n-1. The total number of unique topologies achievable with no more than n branches is 2n-1.[3] Topologies Y and Ã©Â¦ Figure 1.5. Y and Ã©Â¢ topologies Y and Ã¢¢ topologies are important topologies in linear network analysis, as they are the simplest three-terminal networks possible. For linear circuits a Y transform is available. This transformation is important because there are some networks that cannot be analysed in terms of series and parallel combinations. These networks often originate in three-phase power circuits as they are the two most common topologies for three-phase windings of motors or transformers. Figure 1.6An example of this is the network in Figure 1.6, which consists of a Y network connected parallel to a network Ã©Â¢. Let's say you want to calculate the impedance between two network nodes. In many networks, this can be done by applying the rules for the combination of serial or parallel impedances. This is however not possible in this case, where the Y-I-T transformation is in addition to the series and parallel rules.[4] Topology Y is also called star topology. However, the topology of stars can also refer to the more general case of many branches connected to the same node rather than just three. [5] See also: Star Transformation Simple Filter Topologies Main article: Electronic Filter Topology Figure 1.7 Common Balanced and Unbalanced Filter Topologies The topologies shown in Figure 1.7 are commonly used for filter and attenuator drawings. Section L is the topology identical to the potential topology of the divisor. Section T is topology identical to topology Y. Section II is the topology identical to the topology Î. All of these topologies can be seen as a short section of a scale topology. Longer sections would normally be described as scale topology. These types of circuits are commonly analysed and characterized by a two-port network. [6] Bridge topology Main article: Bridge Circuit Figure 1.8 Bridge topology is an important topology with many uses in both linear and non-linear applications, including, but not limited to, the bridge straightener, the Wheatstone bridge, and the lattice phase equalizer. There are several ways in which the bridge topology is rendered in circuit diagrams. The first rendering in figure 1.8 is the traditional representation of a bridge circuit. The second rendering clearly shows the equivalence between the bridge topology and a topology derived from serial and parallel combinations. The third rendering is more commonly known as reticular topology. It is not so obvious that this is topologically equivalent. You can see that this is really so by displaying the top left node moved to the right of the top right node. Figure 1.9 Bridge Circuit with Connection Output Load shown It is normal to call a network bridge topology only if it is used as a two-port network with the input and output ports, each consisting of a pair of diagonally opposite nodes. The topology of the box in Figure 1.7 can be seen to be identical to the topology of the bridge, but in the case of the filter the entrance and exit ports are each a couple of adjacent nodes. Sometimes the load component (or null indication) on the output port of the bridge will be included in the bridge topology as shown in Figure 1.9. [7] Bridged T and twin-T topologies Figure 1.10 Bridged T topology is derived from the bridge topology in a way explained in the Zobel Network article. There are many derived topologies also discussed in the same article. Figure 1.11 There is also a twin-T topology which has practical applications where it is desirable to have the input and output share a common terminal (ground). This may be, for example, because the input and output connections are made with coaxial topology. Connecting an input and output terminal together is not allowed with the normal bridge topology and for this reason Twin-T is used where a bridge otherwise used for balance measurement applications or null. The topology is also used in the twin-T oscillator as a sine wave generator. The lower part of figure 1.11 shows the twin-T redrawn topology to emphasisewith bridge topology.[8] Infinite topologies Scale topology can be extended without limits and is widely used in filter projects. There are many variants on the topology of scales, some of which are discussed in the articles on the topology of electronic filters and composite image filters. Figure 1.13. Anti-scale topology The balanced shape of the scale topology can be considered as the side graph of a prism of arbitrary order. The side of an antiprism forms a topology which, in this sense, is an anti-scale. Anti-scale topology is applied in voltage multiplier circuits, particularly in the Cockcroft-Walton generator. There is also a full-wave version of the Cockcroft-Walton generator which uses a double anti-scale topology.[9] Infinite topologies can also be formed by multiple cascading sections of some other simple topology, such as lattice or T-bridge sections. These infinite chains of lattice sections occur in teleanalysis. and in artificial simulation of transmission lines, but are rarely used as practical circuit construction.[10] Components with More than Two Terminals Circuits containing components with three or more terminals greatly increase the number of possible topologies. In contrast, the number of different circuits represented by a topology decreases and in many cases the circuit is easily recognizable by the topology even when specific components are not identified. Figure 1.14. Basic amplifier topology as a common bipolar transistor transistor amplifier Figure 1.15. Balanced amplifier like a long tail torque amplifier In the case of more complex circuits, the description can proceed by specifying a transfer function between the network ports rather than the component topology.[11] Graph Theory Graph theory is the branch of mathematics that deals with graphs. In network analysis, graphs are widely used to represent a network being analyzed. The graph of a network captures only some aspects of a network; those related to its connectivity, or, in other words, its topology. This can be a useful representation and generalization of a network since many network equations are invariant between networks with the same topology. This includes equations derived from Kirchhoff's laws and Tellegen's theorem.[12] History Graph theory has been used in the analysis of linear and passive networks almost from the time Kirchhoff's laws were formulated. Gustav Kirchhoff himself, in 1847, used graphs as an abstract representation of a network in his analysis of resistive circuits.[13] This approach was later generalized to RLC circuits, replacing resistances with impedances. In 1873 James Clerk Maxwell provided twice this analysis node analysis.[14][15] Maxwell is also responsible for the topological theorem according to which the determinant of the node-admittance matrix is equal to the sum of all the admittance products of the trees. In 1900 Henri PoincarÃÂ© introduced the idea of representing a for its incidence matrix,[16] thus founding the field of algebraic topology. In 1916, Oswald Veblen applied PoincarÃ© algebraic topology to Kirchhoff analysis.[17] Veblen was also responsible for introducing the spanning tree to help choose a compatible set of network variables. [18] Figure 2.1. Circuit diagram of a low-pass filter ladder network: a two-element network The complete cataloguing of network graphs as they apply to electrical circuits began with Percy MacMahon in 1891 (with a friendly engineer article in The Electrician in 1892) who limited his investigation to combining series and parallel actions. MacMahon called these charts yoke-chains.[note 1] Ronald M. Foster in 1932 classified charts by their nullity or rank and provided charts for all those with a small number of nodes. This work grew from an earlier survey by Foster while collaborating with George Campbell in 1920 on 4-door phone repeaters and producing 83,539 separate charts. [19] For a long time topology in the theory of electric circuits remained interested only in linear passive networks. The latest developments in semiconductor devices and circuits have required new topology tools to address them. Enomial increases in circuit complexity have led to the use of combinators in graph theory to improve the efficiency of computer computation. [18] Circuit diagrams and diagrams Figure 2.2. Graph of the stairway network shown in Figure 2.1 with a four-step staircase assumed. Grids are commonly classified according to the type of electrical components which make them up. In a circuit diagram these elements are specifically drawn, each with its own unique symbol. Resistive networks are monoelement-kind networks, which consist only of R-elements.Similarly, capacitive or inductive networks are one-element-type. RC, RL and LC circuits are simple two-element networks. The RLC circuit is the simplest three-element network. The LC ladder network commonly used for low-pass filters may have many elements, but it is another example of a two-element network. [20] On the contrary, topology concerns only the geometric relationship between the elements of a network, not with the type of elements themselves. The heart of a topological representation of a network is the network graph. Elements are represented as the edges of the graph. A border is drawn like a line, ending on points or small circles from which other edges (elements) can emanate. In circuit analysis, the edges of the graph are called branches. The points are called the vertices of the graph and represent the nodes of the network. Node and vertex are terms that can be used interchangeably when talking about network graphs. Figure 2.2 shows a representation of the circuit diagram in the 2.1.[21] Charts used in grid analysis are usually, in addition, both direct charts, to capture the direction of current flow and voltage, and labeled charts, to capture the uniqueness of branches and nodes. For For For a branch square chart would remain the same topological chart if two branches were exchanged, unless the branches are uniquely labelled. In direct graphs, the two nodes to which a branch connects are designated as the source node and the destination node. Typically, these will be indicated by an arrow drawn on the branch.[22] Incidence Main article: incidence matrix Incidence is one of the fundamental properties of a graph. An edge connected to a vertex is said to incident on that vertex. The incidence of a graph can be captured in matrix format with a matrix called the incidence matrix. In fact, the incidence matrix is an alternative mathematical representation of the graph that eliminates the need for any kind of drawing. The matrix rows correspond to the nodes and the matrix columns correspond to the branches. The matrix elements are zero, for no incidence, or one, for incidence between the node and the branch. Direction in oriented graphs is indicated by the element sign.[18][23] Equivalence Graphs are equivalent if one can be transformed into another by deformation. Deformation may include the operations of translating, rotating, and reflecting; bending and stretching branches; and crossing or knotting branches. Two equivalent deformation graphs are called congruent graphs.[24] In the field of electrical grids, there are two other transformations that are believed to produce equivalent graphs that do not produce congruent graphs. The first is the exchange of branches connected in series. This is the double exchange of parallel connected branches which can be achieved by deformation without the need for a particular rule. The second concerns graphs divided into two or more separate parts, i.e. a graph with two sets of nodes that have no ramifications affecting one node in each set. Two of these separate parts are considered a graph equivalent to one in which the parts are joined by combining a knot of each into a single knot. Similarly, a graph that can be split into two separate parts by dividing a node into two is considered equivalent.[25] Trees and Links Figure 2.3. A possible tree of the graph in Figure 2.2. Links are shown as dashed lines. A tree is a graph in which all nodes are connected, directly or indirectly, by branches, but without forming closed loops. Since there are no closed rings, there are no currents in a tree. When analyzing the network, we are interested in the extension of the trees, that is, the trees that connect every node in the network graph. In this article, "non-qualified shaft" means unless otherwise specified. A given network graph can contain several trees. Branches removed from a graph to form a tree are called links, the remaining branches in the tree are called twigs. For a graph with nodes, the of branches in each tree, t, must be; t = n â¢¢¢ 1 {\displaystyle t=n-1\ } An An AnThe relationship for the analysis of the circuits is; b = «' + t Â {\displaystyle b=\ell +t\ } where b is the number of branches in the chart and â'' is the number of links removed to form the tree.[26] Tie set and cutting set The purpose of the analysis of the circuits is to determine all currents and voltages of the filiation present in the network. These network variables are not all independent. The branching voltages are connected to the currents by the transfer function of the elements of which they are composed. A complete solution of the network can therefore be both in terms of current branching and voltage branching. Neither all branching currents are independent of each other. The minimum number of currents required for a complete solution is l. This is due to the fact that a tree has the removed rings and cannot be current in a tree. Since the remaining branches of the tree have zero current, they cannot be independent of the connecting currents. The branching currents chosen as a set of independent variables must be a set associated with the bonds of a tree: you cannot arbitrarily choose any branch l.[27] With regard to branching tensions, a complete solution of the network can be obtained with the branching voltages t. This is a consequence of the fact that the short circuit of all branches of a tree leads to zero tension everywhere. Connection tensions cannot therefore be independent of the tensions of the branches of the tree.[28] Figure 2.4. A figure 2.2 chart cut set derived from the figure 2.3 tree by cutting the branch 3. A common approach to analysis is to solve for cycle currents rather than branching currents. The branching currents are then found in terms of ring currents. Again, the set of cycle currents cannot be arbitrarily chosen. To ensure a set of independent variables, cycle currents must be those associated with a certain set of cycles. This set of cycles consists of those formed cycles by replacing a single ring of a given circuit chart tree to be analyzed. Since the replacement of a single ring in a tree forms exactly one ring, the number of ring currents so defined is equal to l. The term cycle in this context is not the same as the usual cycle term in graph theory. The set of branches forming a given cycle is called a set of bonds.[note 2] The set of network equations is formed by the equation of loop currents to the algebraic sum of the branching currents of the ties set.[29] You can choose a set of independent ring currents without reference to the trees and tie sets. A sufficient condition, but not necessary, for the choice of a set of ringsis to ensure that each selected ring includes at least one branch not previously included by already selected rings. A particularly simple choice is the one used in mesh analysis, where all loops are selected as mesh.[note 3] Mesh analysis can only be applied if you can map the graph to a plane or sphere without any of the branches crossing. These charts are: Planar graphs. The ability to map on a plane or a sphere is equivalent. Any finished graph mapped to a plane can be shrunk until it is mapped to a small region of a sphere. In contrast, a mesh of any graph mapped to a sphere can be stretched as long as the space inside it occupies almost the entire sphere. The whole graph thus occupies only a small region of the sphere. This is the same as in the first case, so the graph will also map to a plane.[30] There is an approach to choosing network variables with voltages that is analogous and dual to the loop current method. Here the tension associated with the pairs of nodes are the primary variables and the branch voltages are located in terms of them. Again, you must choose a particular tree of the graph to ensure the independence of all variables. Double the set of ties is the cutting set. A set of ties is formed allowing all links in the chart except one to be open circuit. A cut set is formed allowing all branches except one to be shorted. The cutting set consists of the branch of the shaft that has not been shorted and any of the connections that have not been shorted by the other branches of the shaft. A cut-out set of a graph produces two disjointed subgraphs, that is, it divides the graph into two parts, and is the minimum set of branches needed to do so. The set of lattice equations consists of the equation of the torque voltages of the nodes to the algebraic sum of the cut branch voltages.[31] Twice the special case of mesh analysis is nodal analysis.[32] Nullity and rank The nullity, N, of a graph with s separate parts and b branches is defined by: N = b Ã¢Â¢Â¢ n + s Ã¨ {\displaystyle N=b-n+s\ } The nullity of a graph represents the number of degrees of freedom of its set of network equations. For a planar graph, nullity is equal to the number of meshes in the graph.[33] The rank, R of a graph is defined by; R = n Ã¢Â¢ s Ã¨ {\displaystyle R=n-s\ } Rank plays the same role in node analysis as nullity in mesh analysis. That is, it provides the number of node tension equations needed. R + N = b is {\displaystyle R+N=b\ } Resolving Network Variables Once a set of geometrically independent variables is selected, the state of the network is expressed in terms of them. The result is a set of independent linear equations that must be solved simultaneously to find the values of the network variables. This set of equations can be expressed in a matrix format that leads to a matrix of parameters characteristic for the network. Parametric matrices take the form of an impedance matrix if the equations have been formed on the basis of cycle analysis, or an admission matrix if the equations have been formed on the basis of cycle analysis. based on node analysis.[35] These equations can be solved in many well-known ways. One method is the systematic elimination of variables.[36] Another method involves the use of determinants. This is known known known Cramer's rule and provides a direct expression for the unknown variable in terms of determinants. This is useful as it provides a compact expression for the solution. However, for something more than the trivial networks, you need more computation effort for this method when working manually. [37] Duality Two graphs are dual when the ratio between branches and pairs of nodes in one is the same as the ratio between branches and loops in the other. The double of a graph can be found entirely with a graphical method. [38] Double a graph is another graph. For a given tree in a graph, the complementary set of branches (that is, branches not in the tree) form a tree in the double graph. The set of current loop equations associated with the tie sets of the original chart and the shaft are identical to the set of tension node-pair equations associated with the cut sets of the dual chart. [39] The following table lists dual concepts in topology related to circuit theory. [40] Figure 2.5 The Double Graph of the Graph in Figure 2.2 Summary of the Two Concepts Current Voltage Tree Maze Branch Mesh Node Loop Node Couple Node Link Tree Branch Ties Set Cutting Short Circuit Open Circuit Parallel Connection Nullity Rank Series Double a tree is sometimes called a labyrinth [note 4] It consists of spaces connected by ties in the same way that the tree consists of nodes connected by branches of the tree. [41] Doubles cannot be formed for every graph. Duality requires each set of ties to have a double cut set in the double chart. This condition is satisfied if and only if the graph is mapable to a sphere without branches crossing. To see this, note that a set of ties you need to "tie off" a chart into two portions and its double, the cut set, you need to cut a chart into two portions. The graph of a finite network that does not map to a sphere will require an n-fold bull. A set of ties that goes through a hole in a bull will fail to tie the chart into two parts. As a result, the double chart will not be cut into two parts and will not contain the required cutting set. Therefore, only planar graphs have doubles. [42] Even Duals cannot be formed for networks containing reciprocal inductances since there is no corresponding capacitive element. Equivalent circuits can be developed that have duals, but the dual cannot be formed directly from a mutual inductance. [43] The node and mesh removal operations on a series of grid equations have a topological meaning that can help visualize what is happening. The elimination of a node voltage from a set of lattice equations corresponds topologically to the elimination of that node from the graph. For a node connected to three other nodes, this corresponds to the well Y-I transformation. The transformation can be extended to a greater number of connected nodes and is then known as the star-mesh transformation. [44] The inverse of this transformation is the Î-Y transformation, which analytically corresponds to the elimination of a network current topologically corresponds to the elimination of a mesh. However, removing a mesh stream whose mesh has branches in common with an arbitrary number of other meshes will generally not lead to a workable graph. This is because the graph of the transformation of the general star is a graph that does not map to a sphere (contains stellar polygons and thus multiple crosses). The double of such a graph cannot exist, but it is the graph required to represent a generalized elimination of the mesh.[44] Reciprocal coupling Figure 2.6. Dual tuning circuit often used to pair tuned amplifier stages. A, the graph of the double-adjustment circuit. B, an equivalent graph with the disjointed parts combined. In conventional circuit graphics, there is no way to explicitly represent reciprocal inductive couplings, as in a transformer, and such components may result in a disconnected graph with more than one separate part. For ease of analysis, a graph with multiple parts can be combined into a single graph by unifying a node for each part into a single node. This does not change the theoretical behavior of the circuit, so the analysis performed on it is still valid. However, if a circuit were made this way, it would make a practical difference, as it would destroy the isolation between the parts. An example could be a grounded transformer on both the primary and secondary sides. The transformer still functions as a transformer with the same voltage ratio, but can no longer be used as an insulation transformer.[45] Newer techniques in graph theory are able to treat active components, which are also problematic in conventional theory. These new techniques are also able to deal with reciprocal couplings.[46] Active Components There are two basic approaches available for dealing with reciprocal couplings and active components. In the first of these, Samuel Jefferson Mason introduced signal flow graphs in 1953. Signal flow charts are weighted and direct charts. He used them to analyze circuits containing reciprocal couplings and active networks. The weight of an oriented edge in these charts represents a gain, like that possessed by an amplifier. In general, signal flow graphs, unlike the regular oriented graphs described above, do not correspond to the topology of the physical arrangement of the components.[46] The second approach is to extend the classic method to include reciprocal couplings and active components. Various methods have been proposed for this purpose. In one of these two graphs are constructed, one representing the currents in the circuit and the other representing the voltages. Passive components will have identical branches in both trees, but the Active might not be. The method is based on identifying trees that cover both graphs. An alternative method to extend the classic one-graphic approach was proposed by Chen in 1965.[note 5] It is based on a rooted tree.[46] Hypergraphs Another way to extend classical graph theory to active components is through the use of hypergraphs. Some electronic components are not graphically represented. The transistor has three connection points, but a normal graphics branch can only connect to two nodes. Modern integrated circuits have many more connections than this. This problem can be solved by using hypergraphs instead of regular graphs.[48] Figure 2.7. An example of hypergraphy. Regular edges are shown in black, hyperedges in blue and tentacles in red. In a conventional representation the components are represented by edges, each of which connects to two nodes. In a hypergraph, the components are represented by hyperedges that can connect to an arbitrary number of nodes. Hyperboards have tentacles that connect the hyperboard to the knots. The graphic representation of a hyperedge can be a square (compared to the edge which is a line) and the representations of its tentacles are lines from the square to the connected nodes. In a direct hypergraphy, the tentacles bear labels determined by the hyperboard label. A conventional oriented graph can be thought of as a hypergraph with hyperedges each of which has two tentacles. These two tentacles are indicated as source and target and are usually indicated by an arrow. In a general hypergraphy with multiple tentacles, more complex labelling will be required.[49] Hypergraphs can be characterized by their incidence matrices. A regular graph containing only two terminal components will have exactly two non-zero elements in each row. Any incidence matrix with more than two non-zero values in each row is a representation of a hypergraph. The number of non-zero voices in a row is the rank of the corresponding branch, and the highest rank is the rank of the incidence matrix.[50] Non-homogeneous Variables Classical grid analysis develops a set of grid equations whose grid variables are homogeneous in both current (cycle analysis) and voltage (cycle analysis). knots). The set of lattice variables thus found is not necessarily the minimum necessary to form a set of independent equations. There may be a difference between the number of variables in a loop analysis and that of a node. In some cases the minimum possible number may be less than one of these two values if the requirement of homogeneity is attenuated and a combination of current and voltage variables is allowed. A finding of Kishi and Katajini in 1967[note 6] is that the absolute minimum number of variables needed to describe the behavior of the network is given by the maximum distance[note 7] between two forests extending[note 8] of the network plot.[46] Network Synthesis Graph theory can be applied to the synthesis of network. The summary of the network realizes the required network in one of the canonical forms. Examples of canonical forms are the realization of a guide point impedance by the network of canonical staircases of Cauer Cauer Foster's canonical form or Brune's realization of an imitation from his positive-real functions. Topologic methods, on the other hand, do not start from a canonical form. Rather, form is the result of mathematical representation. Some canonical forms require reciprocal inductances for their realization. An important goal of topological methods of network synthesis was to eliminate the need for these common inductions. A theorem to get out of topology is that a realization of a driving impedance without reciprocal couplings is minimal if and only if there are no all-inductor loops or all-capacitor. [51] The chart theory is at its most powerful in network synthesis when network elements can be represented by real numbers (networks of a type-element as resistive networks) or binary states (such as switching networks). [46] Infinite Networks Perhaps, the first network with an infinite graph to study was the network of scales used to represent the transmission lines developed, in its final form, by Oliver Heaviside in 1881. Certainly all the first studies of endless networks have been limited to periodic structures such as scales or grids with the same repeated elements more and more times. It was not until the end of the 20th century that the tools to analyze endless networks with arbitrary topology became available. [52] The infinite networks are largely only of theoretical interest and are the game of mathematicians. The infinite networks that are not bound by real world restrictions can have some very infisical properties. For example, Kirchhoff's laws may fail in some cases and infinite resistance scales can be defined that they have a driving point impedance that depends on infinite resolution. Another inphysical property of infinite theoretical networks is that, in general, they will disperse infinite power, unless they are placed constraints on them as well as the usual network laws such as the laws of Ohm and Kirchhoff. There are, however, some real-world applications. The example of the transmission line is one of a class of practical problems that can be shaped by infinitesimal elements (the distributed element model). Other examples are launching waves in a continuous medium, crushing field problems, and resistance measurement between points of a substrate or down a hole. [53] Transfinite networks further extend the idea of endless networks. A knot at the end of an infinite network can have another branch connected to it leading to another network. This new network can be infinite. Thus, topologies can be built which have pairs of nodes without path ended between them. Such networks of infinite networks are called transfinite networks. [54] Notes Yoke-chains. A terminology coined by Arthur Cayley. The Yokes are branches in parallel, the chains are branches in series.(MacMahon, 1891,a single branch can be considered a yoke or chain. ^ set of tie. the term draw was coined by ernst guillemin guilleminp.xv). Guillemin says the name was chosen because if the branches of the tie set had been reduced to zero, the chart would have been "attached" like a drawstring net (Guillemin, p.17). Guillemin was a leading figure in the development and teaching of linear net analysis (Wild) Lindgren, pp.154Â"159). A mesh is a ring that does not contain other rings. ^ Labyrinth. This term is another Guillemin coinage (Guillemin, p.xv). Named so because the spaces of a graph crossed by links have the shape of a puzzle maze. ^ Chen, Wai-Kai., "Topological analysis for active networks", IEEE Transactions on Circuit Theory, vol.13, iss.4, pp.438-439, December 1966. ^ A summary of this work was presented for the first time at; Kishi, Genya; Jitani, Yoji, "On Highly Distinct Trees", Fifth Annual Allerton Lecture on Circuit and Systems Theory, pp.635-643, 1967. See the Bibliography section for the full article published later in 1969. ^ The distance between trees is defined as the number of edges in one tree but not in the other. That is, it is the number of edges that need to be changed to transform one tree into another (Kishi and Kajitani, p.323). A forest of trees where each node of the graph is visited by one of the trees. See also Analysis of symbolic circuits Network topology References ^ Tooley, pp. 258Â"264 ^ Guillemin, pp.5Â"6 ^ MacMahon (1891), p.331 ^ Farago, pp.18Â"21Redifon, p.22 ^ Redifon, p.22 ^ Farago, pp.112Â"116 Rededifon, pp.45 Â"48 ^ Farago, pp.117, pp. 125Â"127 ^ Campbell, pp.5Â"6, Kind and Fesser, pp.29Â"30 ^ Campbell, pp.5Â"6, 20 ^ Farago, pp. 98Â"134 ^ Suresh, pp. pp.483Â"484, 530Â"532 ^ Kirchhoff, G. (1847) Â"On the resolution of equations in the study of the linear distribution of galvanic currentsÂ" (On the solution of the equations to which one is led during the investigation of the linear distribution of galvanic currents ^ James Clerk Maxwell, A Treatise on Electricity and Magnetism (Oxford, Inghilterra: Clarendon Press, 1873), vol. 1, Parte II, Â"Sistemi lineari di conduttori in generaleÂ", pp. 333Â"336. ^ Wataru Mayeda and Sundaram Seshu (November 1957) "Topological Formulas for Network Functions", University of Illinois Engineering Experiment Station Bulletin, No. 446, p. 5. ^ H. PoincarÃÂ© (1900) Â"Second complement Ã lÂAnalysis SitusÂ", Proceedings of the Mathematical Society of London, 32: 277Â"308. Available online at: Mocavo.com ^ Oswald Veblen, The Cambridge Colloquium 1916, (New York: American Mathematical Society, 1918-1922), vol. 5, pt. 2nd: Analysis Situs, Â"Matrices of orientationÂ", pagg. 25-27. Campbell, p.232 ^ Guillemin, p.5 ^ Guillemin, pp.5 Â"6Suresh, p.485 ^ Guillemin, p.5Minas, pp.213Â"214Suresh, p.485 ^ Suresh, pp.485, 487Â"489 ^ Foster, p.310 ^ Guillemin, p.6-7Fos Ter, p.6-7 p. 310 7Suresh, pag. 486 ^ Guillemin, pagg. 8Â» 9 ^ Guillemin, pagg. 9Â» 10 ^ Guillemin, pagg.10Â»17 ^ Guillemin, pagg.23Â»27Suresh p.514 ^ Guillemin, pagg.17Â»23 ^ Guillemin, p.43Suresh, p. 518, pp.523 Â«528 ^ Foster, pp.310 Â«311 ^ Foster, pp.312 Â«313 ^ Guillemin, pp.64Â»81 ^ Guillemin, pp.112Â»116 ^ Guillemin, pp.116Â»120 ^ Guillemin, p.44Suresh, pp.516 Â«517 ^ Guillemin, pp.49 Â«50Suresh, p.517 ^ Guillemin, p.517 ^ Guillemin, p.51Â»53 ^ Guillemin, p.535Suresh, p.517 ^ Guillemin, p.536 ^ a b Guillemin, pagg. ^ Samuel J. Mason (Settembre 1953) Â«Teoria del feedback Â«Alcune proprietÃ dei grafici di flusso del segnaleÂ», Atti dellâI.R.E., 41 (9) Â: 1144Â»1156. ^ Minas, p.2 ^ Minas, pp.213-214 ^ Skiena, p.382 ^ Cederbaum, p.67 ^ Brittain, p.39Zemanian, p.vii ^ Zemanian, pp.vii-ix, 17Â»18, 24Â»26 ^ Zemanian, p.x Bibliografia Brittain, James E., Lâintroduzione della bobina di carico: George A. Campbell and Michael I. PupinÂ», Technology and Culture, vol. 11, no. 1, pp. 36 Â«57, The Johns Hopkins University Press, gennaio 1970 doi:10.2307/3Â 102Â 809. Campbell, G. A., Â«Teoria fisica del filtro a onda elettricaÂ», Bell System Technical Journal, novembre 1922, vol. 1, n. 2, pp. 1Â»32. Cederbaum, I., Â«Alcune applicazioni della teoria dei grafi per analisi e sintesi di reteÂ», IEEE Transactions on Circuits and Systems, vol.31, iss.1, pp.Â 64Â»68, gennaio 1984. Farago, P.S., Unâintroduzione allâanalisi lineare della rete, The English Universities Press Ltd, 1961. Foster, Ronald M., Â«Geometrical circuits of Electrical networksÂ», Transactions of the American Institute of Electrical Engineers, vol.51, iss.2, pp. 309 Â«317, giugno 1932. Foster, Ronald M.; Campbell, George A., Â«Maximum output networks for phone substation and repeater circuitsÂ», Transactions of the American Institute of Electrical Engineers, vol.39, iss.1, pp.Â 230Â¢ 290, gennaio 1920. Guillemin, Ernst A., Introductory Circuit Theory, New York: John Wiley & Sons, 1953 OCLCÂ 535Â 111 Kind, Dieter; Feser, Kurt, tecniche di prova ad alta tensione, traduttore Y. Narayana Rao, Newnes, 2001 ISBNÂ 0-7506-5183-0. Kishi, Genya; Kajitani, Yoji, Â«Maximally distant trees and principal partition of a linear graphÂ», IEEE Transactions on Circuit Theory, vol.16, editoriale 3, pp. 323-330, agosto 1969. MacMahon, Percy A., Â«Yoke-catene e composizioni multipartite in connessione con le forme analitiche chiamate Â«AlberiÂ», Atti della London Mathematical Society, vol.22 (1891), pp.330Â»346 doi:10.1112/plms/s1-22.1.330. MacMahon, Percy A., Â«Combinazioni di resistenzeÂ», The Electrician, vol.28, pp.Â 601Â¢ 602, 8 aprile 1892.Ristampato in Matematica Applicata Discreta, vol.54, edizioni.Iss.2Â¢ Â«3, pp.Â 225Â¢ Â 228, 17 ottobre 1994 doi:10.1016/0166-218X (94) 90Â 024-8. Minas, M., Â«Creating semantic representations of diagramsÂ», Applications of Graph Transformations with Industrial Relevance: workshop internazionale, AGTIVEâ99, Kerkrade, Paesi Bassi, 1Â» settembre, 209-224, Springer, 2000 ISBN 3-540-67658-9. Redifon Radio Diary, 1970, William Collins Sons & Co, 1969. Skiena, Steven S., The Algorithm Design Manual, Springer, 2008, ISBN 1-84800-069-3. Suresh, Kumar K. S., "Introduction to network topology" chapter 11 in Electric Circuits and Networks, Pearson Education India, 2010 ISBN 81-317-5511-8. Tooley, Mike, BTEC First Engineering: Compulsory and selected optional units for BTEC Firsts in Engineering, Routledge, 2010 ISBN 1-85617-685-1. Wildes, Karl L.; Lindgren, Nilo A., "Analytics and synthesis of networks: Ernst A. Guillemin", A Century of Electrical Engineering and Computer Science at MIT, 1882–1982, pp. 154–159, MIT Press, 1985 0-262-231 Zemanian, Armen H., Infinite Electrical Networks, Cambridge University Press, 1991 ISBN 0-521-40153-4. (EN) (EN.wikipedia.org/w/index.php?title=Topology_(electrical_circuits)&oldid=1042734484)

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