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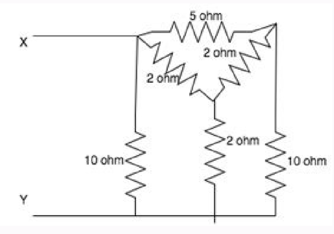

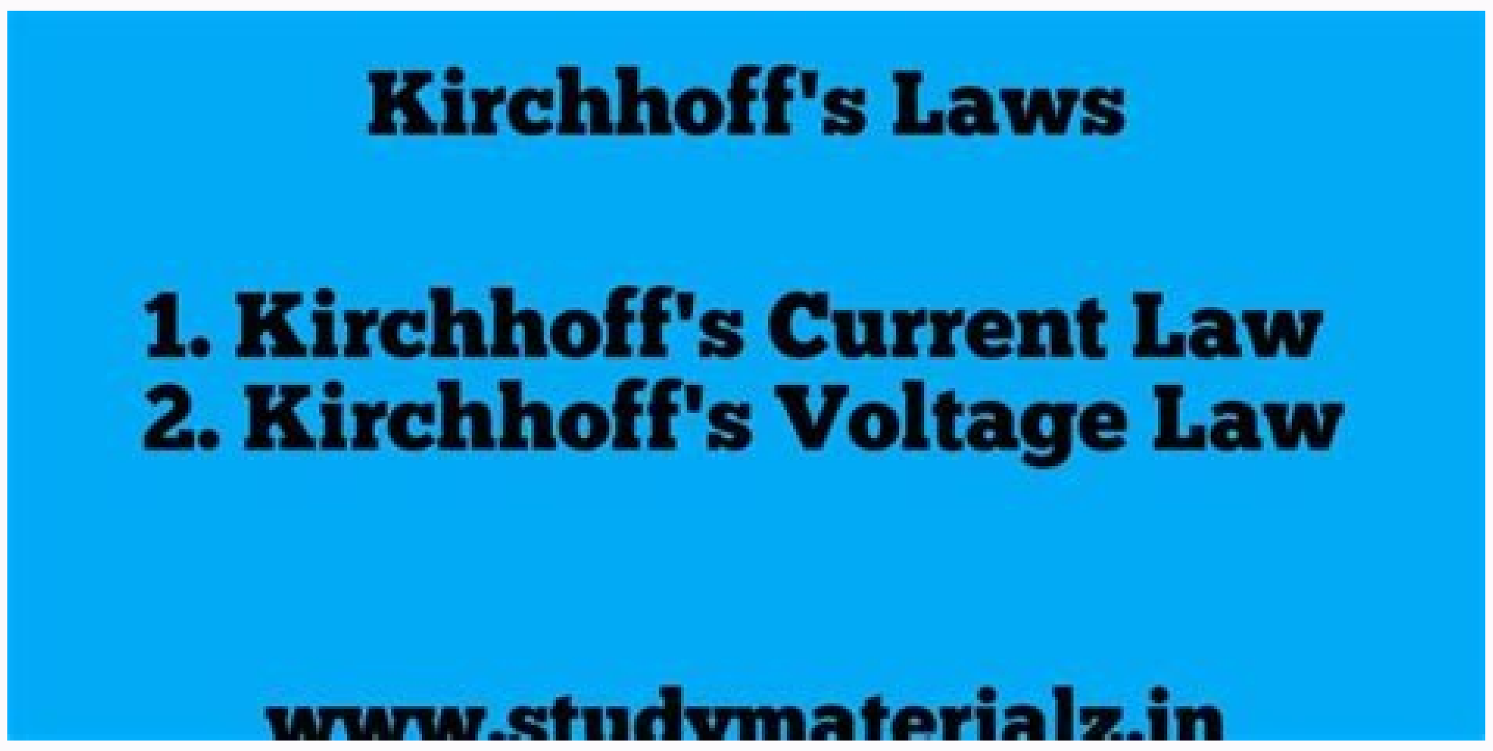

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View Solution Exercises: V1=8V, V2=-4V, V4=14V. For the following figure The node equation can be written as To use KCL to analyze a circuit, Write KCL equations for the currents Use Ohm's law to write currents in terms of bode voltages (one equation for each resistor) Solve to find values of node voltage and current Example: Find the current through a 20Ω resistance, and current through a 40Ω resistance Write KCL at node x Write in the circuit using Ohm's Law Apply last two equation into KCL at node x The current through a 20Ω resistance The current through a 40Ω resistance Kirchhoff's Voltage Law (KVL): The algebraic sum of all voltage around the closed loop must be always zero. Therefore, current in mesh ABC = i1 Current in Mesh CA = i2 Then current in Mesh CDA = i1 – i2 Now, Apply KVL on Mesh ABC, 20V are acting in clockwise direction. then: I1 + (–I2) + (–I3) + (–I4) + I5 = 0 OR I1 + I5 – I2 – I3 – I4 = 0 OR I1 + I5 = I2 + I3 + I4 = 0 i.e. Incoming or Entering Currents = Leaving or Outgoing Currents Or ΣI Entering = ΣI Leaving For instance, 8A is coming towards a point and 5A plus 3A are leaving that point in fig 1.b, therefore, 8A = 5A + 3A 8A = 8A. Find V3 and V5 in the following circuit Find Vx and Vy in the following circuit Find Vx , Vy and Vz in the following circuit Find the KCL node equations at nodes A,B,C, and D If I1=4A , I2 =5A, and I3 =3A, then using KCL find I4 and, I5 in the following circuit Answers: V3 =12V and V5=-2V Vx =12V and Vy=9V Vx =35V, Vy=5V, and Vz=15V At node A: At node B: At node C: At node D: I4=2A and I5=1A If we got the final value as positive it means, the supposed direction of the current was correct. Both AC and DC circuits can be solved and simplified by using these simple laws which are known as Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL). Also note that KCL is derived from the charge continuity equation in electromagnetism while KVL is derived from Maxwell – Faraday equation for static magnetic field (the derivative of B with respect to time is 0). Consider the incoming or entering currents as "Positive (+) towards point "A" while the leaving or outgoing currents from point "A" is "Negative (-)". The voltage drop occurs in the supposed direction of current is known as Positive voltage drop while the other one is negative voltage drop. (note: the arrows are signifying the positive position of the box and the negative is at the end of the box) Loop 1 Loop 2 Loop3 Example 5: Find V1, V2, V3,and V4 (note: the arrows are signifying the positive position of the box and the negative is at the end of the box) Loop 1 Loop 2 Loop 3 Loop 4 Practice Problems: (Click image to view solution) Problem 1: Find V1 in the following circuit. This law is also known as Point Law or Current law. Same like the case of election current and conventional current. In case of negative values, the current of the direction is reversed as compared to the supposed one then. Find the current through each resistor. If you're behind a web filter, please make sure that the domains *.kastatic.org and *.kasandbox.org are unblocked. N is the number of elements in the loop A common assignment: if the positive (+) side of the voltage is encountered first, assign a positive "+"sign to the voltage across the element. A common assignment: if the current is entering the node, assign a negative "-"sign and if the current is leaving the node, assign a positive "+" sign. In other words, in any closed loop (which is also known as Mesh), the algebraic sum of the EMF applied is equal to the algebraic sum of the voltage drops in the elements. Current through each independent loop is carried by applying KVL (each loop) and current in any element of a circuit by counting all the current (Applicable in Loop Current Method). Or the algebraic sum of the currents entering a node equals the algebraic sum of the currents leaving it. N is the number of branches. If you're seeing this message, it means we're having trouble loading external resources on our website. In any electrical network, the algebraic sum of incoming currents to a point and outgoing currents from that point is Zero. Solution: Assume currents to flow in directions indicated by arrows. The deriving current by the battery in clockwise direction is taken as Positive (+). The overall equation for the above circuit is: E1 – E2 = i1R1 + i2R2 – i3R3 – i4R4 If we go in the supposed direction of the current as shown in the fig, then the product of the IR is taken as positive otherwise negative. Apply KCL on Junctions C and A. Suppose some conductors are meeting at a point "A" as shown in fig 1.a. In some conductors, currents are incoming to the point "A" while in other conductors, Currents are leaving or outgoing from point "A". Or the entering currents to a point are equal to the leaving currents of that point. i1 = 72 ÷ 38 = 1.895 Amperes = Current in 10 Ohms resistor Substituting this value in (1), we get: 10 (1.895) + 4i2 = 20 4i2 = 20 – 18.95 i2 = 0.263 Amperes = Current in 4 Ohms Resistors. The imaginary direction of current is also shown in the fig. Kirchhoff's Laws are useful in understanding the transfer of energy through an electric circuit. ΣIR= ΣE Explanation of KVL: A closed circuit is shown in fig which contains two connections of batteries E1 and E2. The voltage drop in this closed circuit depends on the product of Voltage and Current. View Solution Problem 4: Find I1,I2, I3in the following circuit View Solution Problem 5: Find the resistor R value in the following circuit. The deriving current by the battery in anticlockwise direction is taken as Positive (-). The Voltage Drop in a loop due to current in anticlockwise direction is considered as Negative (-) Voltage Drop. Solve to find values of the currents and then voltages. In the above fig, I1R1 and I2R2 are positive voltage drops and I3R3 and I4R4 are negative V.D. If we go around the closed circuit (or each mesh), and multiply the resistance of the conductor and the flowing current in it, then the sum of the IR is equal to the sum of the applied EMF sources connected to the circuit. KVL equations for voltages Using Ohm's Law Substituting into KVL equation Example 3: Find v1 and v2 in the following circuit (note: the arrows are signifying the positive position of the box and the negative is at the end of the box) Loop 1 Loop 2 Example 4: Find V1, V2, and V3. Current through each branch is carried by applying KCL (each junction) KVL in each loop of a circuit (Applicable in Loop Current Method). Kirchhoff's second law is also known as Voltage Law or Mesh law. Demonstrating Kirchhoff's Current Law (KCL) Kirchhoff's Voltage Law (KVL): The Kirchhoff's second law or KVL stated that; In any closed path (or circuit) in a network, the algebraic sum of the IR product is equal to the EMF in that path. where vn is the nth voltage. Also used in Nodal and Mesh analysis to find the values of current and voltage. E1 drives the current in such a direction which is supposed to be positive while E2 interferes in the direction of current (i.e. it is in the opposite direction of the supposed direction of current) hence, it is taken as negative. These laws can be applied on any circuit* (See the limitation of Kirchhoff's Laws at the end of the article), but useful to find the unknown values in complex circuits and networks. Good to Know: Direction of the Current: It is very important to determine the direction of current whenever solving circuits via Kirchhoff's laws. If the negative (-) side of the voltage is encountered first, assign a negative "-"sign to the voltage across the element. Now, i1 – i2= 1.895 – 0.263 = 1.632 Amperes Applications of Kirchhoff's Laws Kirchhoff's laws can be used to determine the values of unknown values like current and Voltage as well as the direction of the flowing values of these quintets in the circuit. In other words, the sum of the currents flowing towards a point is equal to the sum of those flowing away from it. Circuit Analysis by Kirchhoff's Laws Solved Example on KCL and KVL (Kirchhoff's Laws) Example: Resistors of R1= 10Ω, R2 = 4Ω and R3 = 8Ω are connected up to two batteries (of negligible resistance) as shown. Once you select the custom direction of the current, you will have to apply and maintain the same direction for the overall circuit until the final solution of the circuit. Examples: Example 2: Find the current i and voltage v over the each resistor. View Solution Problem 3: Find V1,V2, and V3 in the following circuit. The overall sum of E.M.F's of the batteries is indicated by E1-E2. Equating the sum of IR products, we get; 10i1 + 4i2 = 20 … (1) In mesh ACD, 12 volts are acting in clockwise direction, then: 8(i1 – i2) – 4i2 = 12 8i1 – 8i2 – 4i2 = 12 8i1 – 12i2 = 12 … (2) Multiplying equation (1) by 3; 30i1 + 12i2 = 60 Solving for i1 30i1 + 12i2 = 60 8i1 – 12i2 = 12 ___________ 38i1 = 72 The above equation can be also simplified by Elimination or Cramer's Rule. A German Physicist "Robert Kirchhoff" introduced two important electrical laws in 1847 by which, we can easily find the equivalent resistance of a complex network and flowing currents in different conductors. Good To Know: These rules of thumbs must be taken into account while simplifying and analyzing electric circuits by Kirchhoff's Laws: The Voltage Drop in a loop due to current in clockwise direction is considered as Positive (+) Voltage Drop. View Solution Problem 2: Find V0 in the following circuit. Kirchhoff's Current Law (KCL): According to KCL: At any moment, the algebraic sum of flowing currents through a point (or junction) in a network is Zero (0) or in any electrical network, the algebraic sum of the currents meeting at a point (or junction) is Zero (0). For the following figure To use KVL to analyze a circuit, Write KVL equations for voltages Use Ohm's law to write voltages in terms of resistances and currents. Kirchhoff's Current Law (KCL) Kirchhoff's Voltage Law (KVL) The algebraic sum of all currents entering a node must always be zero where in is the nth current. The direction of current can be assumed through clockwise or anticlockwise direction.

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