Boolean algebra worksheet pdf

Issue 1 Don't just sit there! Build something!! Learning to analyze digital circuits requires a lot of study and practice. Typically, students practice by working through a variety of sampling problems and checking their responses against those provided by a textbook or instructor. While this is good, there is a much better way. You'll learn a lot more by actually building and analyzing real circuits, allowing your test equipment to provide answers rather than a book or another person. To successfully build an exercise chart, follow these steps: Draw a diagram for the digital circuit that will be analyzed. Carefully build this pattern on a board or other comfortable environment. Check the accuracy of the chain design by following each wire to each point of the connection, and checking these items one by one on the chart. Analyze the diagram by determining all the states of output logic for these entry conditions. Carefully measure these logical states to check the accuracy of the analysis. If there are any errors, carefully check the design of your chain with a diagram, and then carefully analyze the scheme and measure. Always make sure that power voltage levels are within the specification for the logical circuits that you plan to use. If TTL, the power source should be a 5-volt adjustable stock, adjusted to a value as close to 5.0 volt DC as possible. One way to save time and reduce the likelihood of an error is to start with a very simple diagram and gradually add components to increase its complexity after each analysis, rather than build a completely new scheme for each practical problem. Another method of saving time is to reuse the same components in different schematic configurations. So you don't have to measure the value of any component more than once. Identify the answer Let the electrons themselves give you answers to their own practice problems! Notes: It was my experience that students require a lot of practice with scheme analysis to become experienced. To this end, teachers usually provide their students with many practical problems to work with and provide answers for students to test their work against. While this approach makes students possessing the theory of schemes, it is not able to fully educate them. Students need more than just mathematical practice. They also need real, practical schemes for the construction and use of test equipment. So, I suggest the following alternative approach: students should build their own practical problems with real components, and try to predict different logical states. Thus, the digital theory comes to life, and students acquire practical knowledge that they will not receive by simply solving Bulean equations or simplifying maps Another reason to follow this method of practice is to teach students a scientific method: process process testing the hypothesis (in this case, logical state forecasts) by conducting a real experiment. Students will also develop real troubleshooting skills as they sometimes make mistakes of the construction scheme. Take a few minutes of time with your class to consider some of the rules for building circuits before they start. Discuss these issues with your students in the same socratic way, usually you discuss the issues of the sheet rather than just telling them what they should and shouldn't do. I never cease to be surprised at how poorly students understand the instructions when presented in a typical lecture (instructor monologue) format! I highly recommend the CMOS Logic Scheme for Home Experiments, where students may not have access to 5-volt regulated power. The modern CMOS scheme is much more robust in terms of static discharge than the first CMOS schemes, so the fears of students harming these devices without having a proper laboratory set up at home are largely unfounded. Note to those instructors who may complain about the wasted time it takes for students to build real circuits, rather than just mathematical analysis of theoretical circuits: What is the purpose of students taking your course? If your students will work with real schemes, then they should learn from real circuits whenever possible. If your goal is to educate theoretical physicists, then stick to abstract analysis by all means! But most of us are planning for our students to do something in the real world with the education we give them. In addition, having students build their own practice challenges teaches them how to perform primary research, thereby empowering them to continue their electric/electronic education autonomously. In most sciences, realistic experiments are much more complex and expensive than customizing electrical circuits. Professors of nuclear physics, biology, geology and chemistry would simply like their students to apply advanced mathematics to real experiments that pose no security risk and cost less than a textbook. They can't, but you can. Use the convenience inherent in your science, and get these students your practicing your math on a lot of real circuits! Question 2 Identify each of these logical gates by name, and complete your respective truth tables: Identify the Answer Notes: In order to introduce students to the standard types of logical gates, I would give them a practice with identification and truth tables every day. Students should able to recognize these types of logical gates at a glance, otherwise they will find it difficult to analyze the diagrams that use them. Issue 3 Identify each of these relay logic functions by name (AND, OR, NOR, etc.) and fill the fill Truth Tables: Identify Answer Notes: In order to familiarize students with the standard contact configurations of the switch, I would like to give them the practice of identifying and truth tables every day. Students should be able to recognize these ladders of the logic of substitutes at first sight, otherwise they will have difficulty analyzing the more complex relay schemes that use them. Issue 4 The next set of mathematical expressions is the full set of time tables for the Boolean numbers: $0 × 0-$0-$0 - x $$1, x 0$$$1, at first nothing unusual in this expressions table seems to be something the same as multiplication, understood in our usual, everyday number system. However, it is unusual that these four statements make up the whole set of rules for multiplying Boolean! Explain how this can be the case in that there are no statements saying 1 ×2 and 2 or 2 ×3 and 6. Where are all the other numbers except 0 and 1? Identify the answer to Boolean quantities can have only one of two possible values: either 0 or 1. There is no such thing as 2 - or any other digits other than 0 or 1, for that matter - in the boolean number set! Notes: Some students with backgrounds in computers may ask if Boolean is just as binary. The answer to this very good question is no. The binary system is simply a numbering system for expressing real numbers, while Boolean is a completely different system of numbers (for example, integer numbers are too irrational numbers, for example). You can count arbitrarily high in binary, but you can only count as high as 1 in Boolean. Question 5 Bulean algebra is a strange kind of mathematics. For example, the full set of rules for adding Boolean is this: $$0'0'0$$$0'1'1$$1'0'1$$$1'1'$, assuming the student saw this for the first time, and was quite puzzled by this. What would you say to him or her as an explanation? How in the world can 1 and 1 and 1, not 2? And why aren't there more rules for Boolean Facebook? Where is the rule for 1 and 2 or 2 x 2? Identify the answer to Boolean quantities can have only one of two possible values: either 0 or 1. There is no such thing as 2 in the boolean number set. Notes: Bulean algebra is a strange mathematician, indeed. However, once students understand the limited amount of boolean quantity, the justification for boolean rules of arithmetic makes sense. 1 and 1 should equal 1, because there is no such thing as 2 in the world Of Boolean, and the answer certainly can not be 0. Issue 6 Rule Review for Boolean addition, 0 and 1 values seem to resemble a table of truth very common logical gate. What type of gate is this, and what does it say about the relationship between addition to Boolean and logical schemes? Rules for boolean addition: $0 x x 0 $$$$$$$$$1$$$$$$$1$$1 $1 1 $1 $$$1 $$$1 $$0 resembles a truth table for a gate or logic scheme, suggesting that adding Boolean can symbolize the logical function of OR. Notes: Students should be able to easily link the fundamental operations of Boolean with logical schemes. If they see a connection between the weird rules of Buli arithmetic and something they are already familiar with (i.e. tables of truth), then the association is much easier. Issue 7 Rule Review for Boolean Multiplication, values 0 and 1, seem to resemble a table of truth of very common logical gates. What type of gate is it, and what does it say about the relationship between Boolean multiplication and logic schemes? Rules for multiplying Boolean: $$0 x 0'0$$$$0 x 1 $$$$$1, x 0$$$$$1, x $1$$ Show Response This boolean response set resembles a table of truth for the chain and logical gate, suggesting that Boolean's multiplication can symbolize a logical and logical function. Notes: Students should be able to easily link the fundamental operations of Boolean with logical schemes. If they see a connection between the weird rules of Buli arithmetic and something they are already familiar with (i.e. tables of truth), then the association is much easier. Issue 8 What is the Boolean Room Supplement? How do we present the Boolean variable addition, and what function of chain logic acts as an add-on? Revealing the answer to the Boolean supplement is the opposite value of a given number. This is represented by either overbars or prime signs next to the variable (i.e. The supplement can be written as either ((reline) or A) qlt; Notes: Students should be able to easily associate The fundamental operations of Boolean with logical schemes. : adding, multiplying and inversion. Each of these operations has the equivalent of a logical gate function and an equivalent configuration of the relay scheme. Draw appropriate diagrams of the logic of gates and ladders for each: Reveal the answer notes: These three equivalences will be vital for students to master as they learn the combined logic schemes and complex logic relay schemes! Issue 10 Write the Boolean expression for each of these logical gates, showing how the exit (I) algebraically refers to input signals (A and B): Identify the answer Notes: In order to familiarize students with Boolean algebra and how it relates to the logic of gate schemes, I would like to give them daily practice with questions such as this. Students should be able to recognize these types of logical gates at first sight, and be able to associate the proper expression of Boolean with one, otherwise they will have difficulty analyzing logical circuits later. Issue 11 Write the Boolean expression for each of these relay logic schemes, showing how the output (I) algebraically refers to input signals (A and B): Identify the answer Notes: In order to familiarize students with Boolean algebra and how it relates to relay logic schemes, I would like to give them daily practice with questions such as this. Students should be able to figure out how each of these ladder logic chains works, and also be able to associate the proper expression of Boolean with each one, otherwise they will have difficulty analyzing the more complex relay circuits later. Issue 12 Transforming the next logic of the chain gate into the expression Boolean, writing Boolean sub-expression next to each gate exit on the chart: Show the answer Notes: The process of converting the gate scheme into Boolean expression is really quite simple if you continue the gate gate. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 13 Transforming the next logic of the chain gate into the Expression of Boolean, writing Boolean sub-expression next to each gate exit on the chart: Show answer Notes: The process of converting the gate scheme into Boolean expression is really quite simple if you continue the gate gate. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 14 Converting the following chain gate logic into a Boolean expression, writing Boolean sub-expression next to each gate exit on the chart: Show answer Notes: The process of converting the gate scheme into Boolean expression is really quite simple if you continue the gate gate. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 15 Conversion of the next relay logic chain into a Boolean expression, writing Boolean sub-expression next to each reel of relay and lamp on the chart: Identify the answer notes: The process of converting relay logic schemes into Boolean expressions is not as easy as it is converting gate schemes into Boolean expressions, but it is manageable. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 16 Transforming the next relay logic chain into a Boolean expression, writing Boolean sub-expressions next to each reel of relay and lamp on the chart: Show Answer Notes: The process of converting relay logic schemes into boolean expressions is not as easy as it is converting gate schemes into Boolean expressions, but it is manageable. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 17 next relay relay scheme in the expression Boolean, writing Boolean sub-expression next to each reel relay and lamp on the chart: Show answer Notes: The process of converting relay logical schemes into Boolean expressions is not as easy as it is converting gate schemes into Boolean expressions, but it is manageable. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 18 Automotive Engineer wants to develop a logical scheme that prohibits the engine in the car from starting unless the driver presses the clutch pedal when turning the ignition switch into the starting position. The purpose of this feature will be to prevent the car from moving forward during the start if ever the transmission is accidentally left in gear. Suppose we indicate the state of the ignition switch position start with the Boolean S variable (1 - start; 0 - start or off), and the position of the clutch pedal with the boulened variable C (1 clutch pedal suppressed; 0 - clutch pedal in a normal, unpressed position). Write the Boolean expression for starter solenoid status, given the status of the starting switch (S) and clutch (C). Then draw a logical gate diagram to implement this Boolean feature. Reveal the answer to boolean expression: Logic Gate Chain: Notes: It is not a very complex function for expression or implementation, the meaning of this question is mainly to introduce students to the practical use of logical gates and boulean algebra. Issue 19 The engineer hands you a piece of paper with the following Boolean expression on it, and tells you to build a gate scheme to perform this function: $$A Reveal Response Notes: The process of converting Boolean expressions into logical gate schemes is not as easy as converting a gate scheme into a Boolean expression, but it's manageable. Do your students share any methods or tricks they use to write expressions with the rest of the class. Issue 20 Critical electronic system receives dc powered by three power sources, each of which is powered by a diode, so if one power source develops an internal short circuit, it will not overload the other: The only problem with this system is that we have no signs of problems unless only one or two meals come off the end. Since the diode power route system from any available power (ies) to the critical system, the system does not see a power break if one or even two of the power stop the voltage output. It would be nice if we had some kind of alarm installed to alert technicians to a problem with any of the power sources, long before the critical system was at risk of losing power completely. The engineer decides that the relay can be installed on the every food, nutrition, to diodes. Contacts from these relays can be connected to some signaling device (flashing light, bell, etc.) to alert attendants to any problem: Part 1: Draw a diagram of the stairs of the relay contact supply warning lamp, so that the lamp energizes if any one or more power sources loses the output stress. Write the appropriate Boolean expression for this chain using the letters A, B and C to represent the state of the CR1, CR2 and CR3 relay reels respectively. Part 2: The solution for Part 1 worked, but unfortunately it generated nuisance anxiety when the technician powered any of the supplies down for regular maintenance. The engineer decides that two out of three failed alarms will be enough to warn of trouble, while allowing for regular maintenance without creating unnecessary alarms. Draw a diagram of the power contact relay ladder warning lamp, so that the lamp is energized if any two or more power sources lose the voltage of the exit. The Boolean expression for this is (reline) (about superline) Part 3: The guide to this object has changed its mind about the safety of the alarm system with two of the three. They want the alarm to be energized if any of the power supplies fails. However, they also understand that the troubles of anxiety generated during regular maintenance are unacceptable as well. After asking the maintenance staff to come up with a solution, one of the technicians suggests inserting a maintenance switch that will turn off the alarm during maintenance periods, allowing any of the power sources to be turned off without causing any inconvenience of the alarm. Change the part 1 solution alarm scheme to enable such a switch and, accordingly, change the Boolean expression for the new scheme (call the M service switch). Part 4: During one maintenance cycle, the technician accidentally left the bypass alarm switch (M) activated after it was done. The system has been working with power outages for several weeks. When the management discovered this, they were furious. Their next suggestion was to have a bypass switch change the conditions for the alarm, so that activating this M switch would turn the system from one of three failed alarms into two of the three-failed alarms. Thus, any of the power systems can be decommissioned for routine maintenance, but the alarm will not be fully activated. The system would still be signaling if two power supplies were to fail. The simplified Boolean expression for this rather complex feature is ovline («overline») (Draw a ladder diagram for the alarm chain based on this expression. Part 4 Solution: The next question: how many contacts on each repeater (and on the M service switch) are needed to implement any of these alarm functions? Call question: can you see how we could reduce the number of relay contacts required in the Solution 2 scheme, but still achieve the same logic functionality (albeit with a different Boolean expression)? Notes: Honestly, I had fun writing scripts for different parts of the problem. The evolution of this alarm system is typical of the organization. Someone comes up with an idea, but it doesn't meet all the needs of someone else, so they enter their own suggestions, and so on and so forth. Introducing scenarios like this not only prepare students for real work politics, but also emphasize the need what if? Thinking: Check out the proposed solution before implementing it, so avoid unnecessary problems. Issue 21 Implementation of the following Expression of Boolean in the form of digital chain logic: $$'overline (overline) B$$ Form chain by making the necessary connections between the pins of these integrated circuits on the solderboard: The Show Response Scheme shows not the only possible solution to the problem: Notes: First: Students remember to include power connections for each IC? This is a very common mistake! In order to successfully develop a solution to this problem, of course, students need to explore the pinouts of each integrated chain. If most students simply submit the answer shown to them in the sheet, call them during the discussion to submit alternative solutions. Also, ask them this question: Should we connect unused inputs to either the ground or the VCC, or is it permissible to leave the entrances floating? Students should not just give an answer to this question, but be able to support their answer (s) with reasoning based on building this type of logic chain. Issue 22 Complete the Truth Tables for These Two Boolean Expressions: $$Output - OverlineA'B$A B Output 0 0 1 1 1 $$Output A overlineA$A B Output 0 0 1 1 1 1 1 1 1 Reveal response $$Output overlineA'B$A B Exit 0 0 0 0 1 1 1 0 0 1 1 1 $$Output A overline A B$$ Exit 0 0 0 0 1 1 0 1 0 1 1 1 1 1 1 1 1 1 Notes A: Ask your students to explain exactly how they figured out the state output to fill in the gaps in the truth tables, for different input combinations. Ask them to also compare and contrast this process in order to find out the table of truth for this particular chain of gate logic. Issue 23 Complete the Truth Tables for these two Boolean expressions: $$Output overflow line (A) overlineB'CAA B C Output 0 0 0 0 0 1 0 1 0 1 0 1 1 0 0 1 1 1 1 1 1 1 1 0 1 $$Output BA (BPC) Pereliming)$B C Exit 0 0 0 0 0 1 0 1 0 1 1 1 1 1 1 0 0 1 0 1 0 1 1 1 1 Show Response Overline 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 1 1 1 1 1 1 1 0 0 1 0 0 0 $Output 0 $ A B C Exit 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 1 0 0 0 0 1 0 1 1 1 1 0 1 1 Notes: Ask your students to explain exactly how they found out the State Exit to fill the gaps in the truth tables, For different input combinations. Ask them to also compare and contrast this process in order to find out the table of truth for this particular chain of gate logic. This is especially educational if you ask your students to suggest methods for quickly determining the truth of the table states, based on certain features of the Boolean expression. For example, there is a way how we can say the first four Exit States in the Truth Table (reading from top to bottom) will be 0 without connecting values in expressions B and C. Discuss with your students how we can look at the expression, seeing as a multiplier for the amount in brackets, and immediately conclude that half of the truth of the output table will be 0. Issue 24 Like the real number algebra, Boolean algebra is subject to the laws of mitigation, association and distribution. These laws allow us to create different logical schemes that perform the same function of logic. For each of the equivalent circuit pairs shown, write the corresponding Boolean Act next to it: Note: three short, parallel lines represent a quivalent to in mathematics. Identify answer In order, top to bottom: $$AB - BA$$$(AB)C (B)C (BC)$$$$$$($$C - AC-BC$$ $$A'B - B'A$$$$(A'C)B Association and Distribution Laws of Bulaic Algebra are identical to the relevant laws in the real number algebra. This shouldn't be a difficult concept for your students to understand. The real advantage of working through these examples is to link the gates and relay logical circuits with the words Boolean, and to see that the Boulean algebra is nothing more than a symbolic means of presenting electrical discrete states (in/off) circuits. Due to the otherwise abstract mathematical concept of something tangible, students build a much better understanding of concepts. Issue 25 As well as real-number algebra, Boolean algebra is subject to certain rules that can be applied in the task of simplifying (reducing) expressions. Being able to algebraically reduce Boolean expressions, it allows us to build equivalent logic schemes using fewer components. For each of the equivalent circuit pairs shown, write the corresponding Boolean rule next to it: Please note that the three short parallel lines are the equivalent in mathematics. Identify the answer For top to bottom, from left to right: $$A-A - A$$$AA - A$$$$$A$0 - A$$A $$A $$-oelin $$$$$A x x 0 x $0 $$A x $1 $$A $A A$$ $$A»overline »A»B'A'B$$ Примечания: Большинство из этих правил Boolean идентичны их соответствующим законам в алгебре реального числа. Это не должно быть трудным понятия для ваших студентов, чтобы понять. Некоторые из них, однако, уникальны для булейской алгебры, не имея аналогов в алгебре реального числа. Эти уникальные правила вызывают у студентов больше всего неприятностей! Важным преимуществом работы над этими примерами является связывать ворота и реле логических схем с выражений Boolean, и видеть, что булеанская алгебра является не более чем символическим средством представления электрических дискретных состояний (в/выключив) схем. В связи с в противном случае абстрактные математические концепции что-то материальное, студенты строят гораздо лучшее понимание концепций. Вопрос 26 Здесь показаны шесть правил булейской алгебры (это не единственные правила, конечно). $$A+\overline{A} = 1$$ $$A+A = A$$ $$A+1 = 1$$ $$AA = A$$ $$A+AB = A$$ $$A+ \overline{A}B = A+B$$ Determine which rule (or rules) are being used in the following Boolean reductions: $$\overline{DF}+\overline{DFC}=\overline{DF}$$ $$1+G = 1$$ $$B+AB = B$$ $$\overline{FE}+\overline{FE}=\overline{FE}$$ $$XYZ+\overline{XYZ}=1$$ $$GQ+Q = Q$$ $$\overline{H} \ \overline{H}=\overline{H}$$ $$\overline{CD} + \overline{CD}=\overline{CD}$$ $$EF(EF) = EF$$ $$CD+\overline{C}=\overline{C}+D$$ $$LNM+ML = LM$$ $$A\overline{G}F\overline{C}+F\overline{C}\ \overline{G}=F\overline{C}\ \overline{G}$$ $$\overline{M}+1=1$$ $$\overline{BC}+BC=1$$ $$ABC+CAB = BCA$$ $$S+STV\overline{Q}=S$$ $$\overline{DE}(R+1)=\overline{DE}$$ $$\overline{RS}\ \overline{SR}=\overline{RS}$$ $$ABC\overline{D}+D=D+ABC$$ $$AC\overline{B}+CAD\overline{B}=A\overline{B}C$$ $$A+T+\overline{W}+\overline{A}+X=1$$ $$X\overline{YZ}+\overline{X}=\overline{X}+\overline{YZ}$$ $$\ \overline{GFH} \ \overline{HGF}=\overline{FHG}$$ $$C\overline{AB}+AB=AB+C$$ Reveal answer $$\overline{DF}+\overline{DFC}=\overline{DF} \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+AB=A$$ $$1+G=1 \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+1=1$$ $$B+AB=B \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+AB=A$$ $$\overline{FE}+\overline{FE}=\overline{FE} \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+A=A$$ $$XYZ+\overline{XYZ}=1 \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+\overline{A}=1$$ $$GQ+Q=Q \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+AB=A$$ $$\overline{H} \ \overline{H} =\overline{H} \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: AA=A$$ $$\overline{CD} + \overline{CD}=\overline{CD} \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+A=A$$ $$EF(EF)=EF \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: AA=A$$ $$CD+\overline{C}=\overline{C}+D \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+\overline{A}B=A+B$$ $$LNM+MK=LM \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+AB=A$$ $$A\overline{G}F\overline{C}+F\overline{C}\ \overline{G}=F\overline{C} \ \overline{G} \ \ \ \ \ \ \ \ \ \ \ \ \ Rule : A+AB=A$$ $$\overline{M}+1=1 \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: A+1=1$$ $$\overline{BC}+BC=1 \ \ \ \ \ \ \ \ \ \ \ \ \ Rule: $$ABC+CAB=BCA \ \ \ \ \ \ \ Rule: ASA '$$$SSTV'overline (DES) - . . . . A$$$$ABC, $AC D'D-ABC Overflow Line (B'$A C) : A-Owrdline (A-O-A-A)1, A $X . . . . He was a - he said that I . . . . Overline (FH $C G) Rule: A'overline (A'B'A'B$$ Notes: Pretty often (and quite depressingly), I meet students who seem to have the hardest time dealing with algebraic rules in their general form to specific cases of reduction. to master, because it is fundamentally a matter of abstraction: jumping from letter expressions to similar expressions, applying templates from general rules to specific instances. Such questions help students develop this ability of abstraction. Let the students explain how they made the connection between the Boolean rules and this abbreviation. Often, it helps to get a student to explain this process to another student because they are better than you to put it in terms struggling students can understand. Issue 27 Here are the eight rules of the Bulei algebra (these are not the only rules, of course). $$A»1$$$ $$A й A$$ $$A 1 $ $$AA $ $$A $$A (БЗК) - АБЗКА$$ $$A-АБ - A$$ $$A-overline Булеан упрощение: $$AB'B (Би-Оуплайн $AB $AB) БЗБ-Ouслайн (КЗК) overline -B'C$$ $$ABB'B'overline-C'$$ $$AB'B'C$$ $$B'C$$ Показать ответ $$ АБЗБ (Би-Оверлайн $AB $Rule) Ку-оулилайн (B'C$$ $$Rule: -) , A.A. - A$$$AB $Rule $Rule $AB: $A'B$$$AB»B'C$$ $$B $Rule: , Я встречаю студентов, которые, кажется, самое трудное время, касающиеся алгебраических правил в их общей форме конкретных случаях сокращения. For example, a student who cannot say that rule A and AB A refers to the expression R r, or worse B and AB. This skill takes time and hard work to because it's fundamentally a matter of abstraction: jumping from letter expressions into similar expressions, applying patterns from general rules to specific instances. Such questions help students develop this ability of abstraction. Let the students explain how they made the connection between the Boolean rules and this abbreviation. Often, it helps to get a student to explain this process to another student because they are better than you to put it in terms struggling students can understand. Issue 28 Student makes a mistake somewhere in the process of simplifying the following expression Boolean: $$AB - A/B) $$AB - AB - C$$AB and C$$ Identify where the error was made, and what should be the correct sequence of steps to simplify the original expression. Identify the answer Error was made in the second stage (distribution). The correct sequence of steps is this: $$AB - A (B) $$AB $$$$$$$$AB $$$A (B and C)$ Notes: An interesting way to sharpen students' understanding of algebraic techniques is to have them consider someone else's wrong job and find a mistake (s). Ultimately, algebraic abbreviation is actually just an exercise in pattern recognition. Anything you can do to help your students recognize the right models will help them become better at using algebra. Issue 29 Factoring is a powerful method of simplification in Boolean algebra, just as in real-life algebra. Show how you can use factoring to simplify the following Boolean expressions: $$A $C $XY Line - XY' - XYW$$ $$-overline-D-EF - AB - Overline - 0 - ABC$Reveal Response You'll need to show your work (including all factoring) in your responses! $$C x CD - C$$$$$Aoverline -B'C - A'over $XY line $$'overline-D'EF - AB - overlineD'E - 0 - ABC - AB'overline-DE'$ Notes: For some reason, many of my students (who enter my course are weak in algebra skills) usually seem to have a lot of problems with factoring, whether it's bulia algebra or the usual algebra. This is unfortunate because factoring is a powerful analytical tool. The trick, if there is such a thing, is to recognize common variables in different product terms, and determine which ones should be taken into account to reduce expression most effectively. Like all complex things, factoring takes time and practice to learn. There are no shortcuts, really. Issue 30 Here are the nine rules of the Bulei algebra (these are not the only rules, of course). $$A -oolineline - $1$$A $A $A $A $AA $0$$A (B - C) - AB - AC$$$A - AB - AB - A$$$$$A OverlineA'B - A'B$$ Determine what rule is used at each stage of the next Boolean simplification: $$-overline $$-overline-C-F - AF - Offline (OF) - C$$ $C $$C F - AF, Overline (B'F$$ $C F(1) $$C - F (1)$$$$C$$$$ - F$$ Identify answer to questions $$-overline-C-F (A'overline)-B'C $$$Rule: - A (B- C) - AB, AC$$-overline-C'F - AF, Overline (B'F) - C$$$Rule: B - A $$$C $$C - F - AF, overline B'F$$$Factoring$$$$C $$Rule $C $C $Rule $C: For example, student, student, for example, student, who can't say that rule A AB a applies to R R R , or worse B AB. This skill takes time and hard work to master, because it is fundamentally a matter of abstraction: jumping from letter expressions to similar expressions, applying templates from general rules to specific instances. Such questions help students develop this ability of abstraction. Let the students explain how they made the connection between the Boolean rules and this abbreviation. Often, it helps to get a student to explain this process to another student because they are better than you to put it in terms struggling students can understand. Issue 31 Two very important simplification rules in the Bulia algebra are as follows: Rule 1: (A and AB) Rule 2: (A'overline)A'B) Not only are these two rules confusingly similar, but many students find it difficult to successfully apply to situations where boolean uses different variables (letters) such as here: $$'overline-R'ST'overline-R'$$$ Here, this is the first rule that applies (A - AB) rather than the second rule ((A'A'overline)) Giving simplification: $$overline-$$$ Try to apply these two rules to the following Boolean expression, determining which rule is directly applied, or if none of the rules apply directly: $$FGH - G$$$$-overline-C'C'$ $$FGH $RS ABC$$$$overlineABCC$$$$-overlineR'V'overline overline XY$$$$$$-overline J (overline) KM overline JK$$$-overline EHFOverline E$$$ Show response $$FGH KF Line overflow line KSF (Rule) $RS $2)$$$$,OVLINE (ABPC) (Rule, $$$$,$,$, About $-overline (R'V'overline) Rule (E'F) - (Rule 1)$$ Notes: Many students find the replacement of the Galilee variables (the transition from A and B canonical rules to various variables of real terms where the rules must be applied) are very mysterious and difficult. Such problems give them the practice of learning how to identify rule patterns, despite similarities or differences in the actual variables (letters) used. Question 32 Use The Boolean Algebra to simplify the following expression, and then draw a logical gate scheme for a simplified expression: $$A (B and AB) and AC$$ Reveal Answer Notes: Your students explain the entire process they used in answering this question: simplifying expression using Boolean algebra techniques, and developing a scheme from the boolean summary. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Question 33 Use the Boolean algebra to simplify the following expression, and then draw a logical gate diagram for a simplified expression: $$(A'B)(Overline-A'overline)/$$$Reveal Answer Challenge question: identify a specific type of logical gate that will perform this Boolean function using only one gate. Notes: Your students explain the whole process they used to answer this question: simplifying expression using Boolean algebra techniques, and developing a gate diagram from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Issue 34 Use bulean algebra to simplify the following expression, and then draw a logical gate diagram for a simplified expression: $overline A (about superline) answer to this question: simplifying expression using Boolean algebra techniques, and developing a gate scheme from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Question 35 Use The Boolean Algebra to simplify the following logic gate scheme: Identify the answer notes: Your students explain the entire process they used in simplifying the chain of gates: developing the Expression of Boolean, simplifying this expression using Boolean algebra techniques, and then developing a new gate scheme from the simplified expression boolean. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Question 36 Use The Boolean algebra to simplify the following logic gate scheme: Open the answer Notes: Your students explain the whole process they used in simplifying the gate scheme: developing the Boolean expression, simplifying that expression using Boolean algebra techniques, and then developing a new gate scheme from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Question 37 Use The Boolean Algebra to simplify the following logic gate scheme: Identify the answer notes: Your students explain the entire process they used in simplifying the chain of gates: developing the Boolean expression, simplifying that expression using Boolean algebra techniques, and then developing a new gate scheme from the simplified Boolean expression. By having your students share their thoughts With the whole class, you will increase the level of learning by part of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Issue 38 Use Boolean algebra to simplify the following relay scheme (ladder logic): Open the notes to the answers: Explain to your students the whole process they used to simplify the relay scheme: developing the Boolean expression, simplifying this expression using Boolean algebra techniques, and then developing a new relay scheme from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Question 39 Use The Boolean algebra to simplify the following relay scheme (ladder logic): Identify the answer Notes: Your students explain the entire process they used in simplifying the relay scheme: developing the Boolean expression, simplifying this expression using Boolean algebra techniques, and then developing a new relay scheme from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Question 40 Use the Boolean algebra to simplify the following relay scheme (ladder logic): Identify the answer Notes: Your students explain the entire process they used in simplifying the relay scheme: developing the Boolean expression, simplifying this expression using Boolean algebra techniques, and then developing a new relay scheme from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students will get the best when presenting their decisions about how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. question 41 Use The Boolean algebra to simplify the following relay scheme (ladder logic): Identify the answer Notes: Your students explain the entire process they used in simplifying the relay scheme: developing the Boolean expression, simplifying this expression using Boolean algebra techniques, and then developing a new relay scheme from the simplified Boolean expression. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Issue 42 Full Truth tables for the following gate, and write the expression Boolean for each gate: The results should be obvious once the truth tables are complete. Does the general principle work here? Do you think we would like to get similar results with negative OR and NAND gates? Explain. Identify the answer Negative-And Gate: (Ovline) (Ovline) NOR Gate: (Ovline) Notes: Just a preview of the DeMorgan Theorem here! Issue 43 Often we find extended supplement bars in the expression Boolean. A simple example is shown here, where a long bar extends over the Boolean expression (A and B): $$'overline -A'B'$$ In this particular case, the expression represents the functionality of the NOR gate. Many times in the manipulation of boolean expressions, it is good to be able to know how to eliminate such long bars. We can't just get rid of the bar, though. There are specific rules for breaking long bars in small bars in boolean expressions. What other type of logical gate has the same functionality (the same table of truth) as the NOR gate, and what is its equivalent expression Boolean? The answer to this question will demonstrate what rules (s) we should follow when we break the long add-on bar in the boolean expression. Another example that we could use to teach how to break bars in boolean algebra is that of the nand gate: $$'overline-AB'$$ What other type of logical gate has the same functionality (same table of truth) as the NAND gate, and what is its equivalent expression Boolean? The answer to this question will also demonstrate what rule (s) we should follow when we break long bar addition in the expression Boolean. Identify the answer Negative-And gates have the same functionality, as NOR Gate, and their equivalent expression Boolean as such: $$'overline-A' Overline B'$ Negative or Gate have the same functionality as the NAND gate, and their equivalent expression Boolean as such: $$'overline-A' Students, seeing that these equivalent gate pairs have the same functionality, should be able to distinguish the general pattern (i.e. the rule) for breaking long bars. Question 44 What is the DeMorgan theorem? DeMorgan's revealing response is the rule for Boolean expression, stating how long supplement bars should be broken down into short bars. I will let you explore the terms of this rule, and explain how to apply it to the Boolean expression. Notes: There are many suitable links for students to be able to learn DeMorgan's Theorem from. Let them do the research on their own! Your job is to clear up any misunderstandings after they have done their job. Issue 45 Use DeMorgan theoreum, as well as any other applicable boolean algebra rules to simplify the following expression, so there are no more additions to bars stretching over a few variables: $$'overline'overline-overline-OVERline-AC'$Show answer Simplified expression: $$ABC$$ Notes: Your students demonstrate exactly what they did (step by step) to simplify this expression. Issue 46 Use TheoMorgan theorem, as well as any other applicable boolean algebra rules, to simplify the following expression, so there are no more add-on bars stretching over a few variables: $$'overline'overline'Y'$$Show the answer is a simplified expression: $$'overline, sharing your strategies for problem solving with the entire class. Issue 47 Use the DeMorgan theorem, as well as any other applicable Boolean algebra rules, to simplify the following expression so that there are no more add-on bars extending over a few variables: $$overline-overline-J'JL'$$ Show Answer Simplified Expression: (Expression always equals 1) Notes: Your students demonstrate exactly what they did (step by step) to simplify this expression. Ask your students to determine what a non-variable solution means for such a scheme in a practical sense. What would they suspect if they tried to simplify the digital scheme and got such a result? Question 48 Use Algebra Boolean to simplify the following logic gate scheme: Identify the answer Notes: Have yours explain the whole process they used in simplifying the chain of gates: developing the Boolean expression, simplifying that expression using Boolean algebra techniques, and then developing a new gate scheme from the simplified Expression of Boolean. By having your students share their thought processes with the entire class, you will increase the level of learning into parts of the presenter and the viewer alike. Students presenting their solutions will get a better understanding of how it works, because the act of submission helps consolidate what they already know. Students, looking through the presentation, dare the technique of the other person (not just the technique of the instructor), which will allow them to see examples of how to make these processes cast in a few different terms. Issue 49 Write the Expression Boolean for this relay of chain logic, and then reduce this expression to its simplest form, using any applicable laws and theorems of Boolean. Finally, draw a new relay diagram based on boolean's simplistic expression, which performs exactly the same logical function. Identify the answer Original expression Boolean: (overflow line)AB-C) Reduced scheme (no repeaters are required!): Notes: Ask your students to explain what the benefits might be using a simplified relay scheme rather than the original (more complex) relay scheme shown in the question. What is the significance of the study of Boolean algebra? This is what Boolean algebra is really for: reducing the complexity of logical schemes. It is too easy for students to lose sight of this fact by studying all the abstract rules and laws of the Bouhle algebra. Remember that when teaching bulia algebra, you should be training students to perform manipulations of electronic circuits, not just equations. Issue 50 Write the Boolean expression for this TTL logical gate scheme, and then reduce that expression to its simplest form using any applicable Galilee laws and theorems. Finally, draw a new gate chain diagram based on boolean's simplistic expression, which performs exactly the same logical function. Show the answer Original expression Boolean: (A'overline)overline (AB)C) Reduced Gate Scheme: Call Question: implement this reduced scheme using the only remaining gate between the two integrated circuits shown on the original board. Notes: Ask your students to explain what the benefits might be in using a simplified gate chain rather than the original (more complex) gate chain shown in question. What is the significance of the study of Boolean algebra? This is what Boolean algebra is really for: reducing the complexity of logical schemes. It is too easy for students to lose sight of this fact by studying all the abstract rules and laws of the Bouhle algebra. Remember that in teaching boolean algebra, you must be training students to perform diagrams, not just equations. Question 51 Student makes a mistake somewhere in the process of simplifying the expression Boolean ((overflow line) Identify what the error is: $$-overline-over $X line Answer to the question: $$(X'overline)$X $or) , try this exercise: draw an equivalent gate diagram for each of the expressions written in the student's work. In the wrong step, there will be an obvious abrupt change in the configuration of the scheme - a change that clearly cannot be correct. However, if all the steps are correct, the changes put in the equivalent gate schemes should make sense, culminating in the final (simplified) scheme. Notes: An important aspect of long bars is for students to recognize that they function as grouping symbols. By applying DeMorgan's theorem to breaking into these bars, students often make the mistake of ignoring the grouping implied in the original bars. I strongly recommend that you take your class through the exercise offered in response, for those who do not understand the nature of the error. Have students draw an equivalent diagram of each expression on the board in front of class so everyone can see, and then allow them to observe the dramatic changes that are being said in the place where the error was made. If students understand what the DeMorgan theorem means for individual gates (Neg-AND to NOR, Neg-OR to NAND, etc.), the gate diagrams clearly show them that something went wrong on this step. For comparison, do the same step-by-step translation of the proper Boolean simplification into the gate diagrams. Transitions between charts will make a lot more sense, and students should be able to get a diagram of a view on why supplement bars function as grouping symbols. Issue 52 Write the Boolean expression for this TTL logical gate scheme, and then reduce this expression to its simplest form using any applicable Galilee laws and theorems. Finally, draw a new gate chain diagram based on boolean's simplistic expression, which performs exactly the same logical function. Identify the answer Original expression Boolean: (Overline) Reduced Gate Scheme: Notes: Simplifying Boolean for this particular problem is difficult. Remind students that supplement bars act as group symbols, and that brackets should be used when in doubt to maintain the grouping after breaking bars with DeMorgan's Theorem. , boolean expression for this the chain is easier compared to the original scheme, but the scheme itself has improved significantly? This question highlights an important lesson about bulia algebra and the simplification of logic in general: simply because the mathematical expression is simpler does not necessarily mean that the physical embodiment of the expression will be simpler than the original! Question 53 Suppose you need an inverter gate in a logical scheme, but none of them were available. You have a spare (unused) NAND gate in one of the integrated circuits. Show how you connect the NAND gate to function as an inverter. Use boolean algebra to show what your solution really is. Identify the answer to the above solution: Overline (OVERLINE) The next question: Are there other ways to use the NAND gate as an inverter? The method shown above is not the only valid solution! Notes: The method shown in the response is not only the only valid solution, but may even be the worst! Your students should be able to explore or invent alternative inverter compounds, so by asking them to present their alternatives, ask the class as a whole to decide which solution is best. Ask them to consider electrical options such as spread delay times and fan out. Question 54 Suppose you need an inverter gate in a logical scheme, but none of them were available. You do, however, have a spare (unused) NOR gate in one of the integrated circuits. Show how you connect the NOR gate to function as an inverter. Use boolean algebra to show what your solution really is. Identify the answer to the above solution: Overline: There are other ways to use the NOR gate as an inverter? The method shown above is not the only valid solution! Notes: The method shown in the response is not only the only valid solution, but may even be the worst! Your students should be able to explore or invent alternative inverter compounds, so by asking them to present their alternatives, ask the class as a whole to decide which solution is best. Ask them to consider electrical options such as spread delay times and fan out. Issue 55 The equivalence between the NAND gate and the negative gate is something of an easy-to-test study of the respective truth tables of these two gates, and is often the starting point for studying the DeMorgan theorem: A lesser-known fact is how the equivalence between NAND and negative gates can be converted to express equivalence between the other two types of gate shown here : Another example is shown here: Explain how the first equivalence (between NAND and negative gate) was converted into two equivalences, both in terms of gate symbols and their respective Boolean expressions. In other words, explain how we can get the last two examples of the example first example. Identify the answer It is very similar to algebraic manipulation of the equation: doing the same for both sides of the equation to come up with a new equation that is more useful to us. I'll let you figure out the details of how it's done. Notes: This question is a precursor to students creating combined gate schemes using only nand or NOR gates. Issue 56 Suppose we wanted to have an E Gate for some logical purposes, but there was no and gate at hand. Instead, we only had a NOR gate in our collection of pieces. Draw a diagram in which several NOR gates are connected to each other to form the AND gate. Reveal the answer I'll let you figure this one on your own! The issue of 57 NAND and NOR gates both have an interesting property of versatility. That is, you can create any logic function at all using only a few gates of any type. The key to this is the DeMorgan theorem, because it shows us how the right inversion can transform between the two main types of logical gate (from AND to OR, and visa-versa). Using this principle, transform the following gate chain scheme into a scheme built exclusively from the NAND gate (without simplifying Boolean, please). Then do the same with nothing but the NOR gate: Show the answer Using nothing but the NAND gate: Using nothing but the NOR gate: Notes: Gate versatility is not the only esoteric properties of the logical gate. There are (or at least were) whole logic systems, composed of nothing but one of these types of gates! I once worked with a guy who supported gas turbine control systems for crude oil pumping stations. He told me that he had seen one manufacturer's turbine control system, where discrete logic was nothing more than the NAND gates, and another manufacturer's system, where logic was nothing more than the NOR gates. Needless to say, this was a bit of a challenge for him to switch between the systems of the two manufacturers, as it was natural for him to get used to one of the gate types after doing troubleshooting work on any type of system. Issue 58 Exclusive-OR Gate has the following expression Boolean: $$A Reveal Answer Notes: An interesting feature of this chain is the last three NAND gates: two NAND gates feeding into the third NAND gate equivalent to two and a gate feeding into the gate or, thanks to DeMorgan's Theorem! Issue 59 The automaker needs a logical scheme to accomplish a specific task in its new line of cars. These cars will be equipped with a headlight left on the alarm that sounds anytime these two conditions will be met: headlights and ignitions turn off. Draw a schematic scheme of the logical gate scheme, which will be this alarm system built completely out of the outside NAND Gate. Identify the answer the next question: suppose that the alarm requires more current than the final GATE NAND can source. Add the transistor buffer stage to the logical gate diagram to bring the extra current to the alarm. Call question: Explain how the next NOR gate scheme performs exactly the same logical function with fewer components: Notes: This question is really good to ask your students how they came to a decision. It's easy enough to just look at this answer and repeat it, but of course the purpose of this question is to make students think how they could develop such a scheme entirely on their own. Question 60 Draw a diagram for the logic of the gate chain, using nothing but two NOR input gates that simulates the operation of this relay chain: Reveal the answer to the subsequent question: pay attention to how nor gates are used as inverters in this chain. Compare this to the following (alternative) method: are there any obvious benefits that you see in any of the methods? Notes: In my first technical job, I worked as a CNC technician in a small machine, maintaining computer-controlled machines such as mills and machines. A very neat project that I had to work on was the transformation of the 1970s American machine into modern Japanese computer control. A lot of logic is that the old machine was implemented using a relay, and we replaced the cabinets full of relays with solid logic in Japanese computer management. In fact, solid state logic was a programmable logical controller or PLC function inside a Japanese control computer, rather than a discrete semiconductor logical gate. However, we could well replace the relay with a hard wired gate. The purpose of this question, if you haven't guessed it, is to introduce students to the concept of replacing electromechanical repeaters with semiconductor logical gates, especially identical logical gates, such as the NOR gates, which are universal. Issue 61 is the ladder logic diagram shown here for the fire alarm system, where activating any alarm switch opens up this (usually closed) switch contact and an alarm sounds: Write the Boolean expression for this relay scheme, then simplify this expression with the DeMorgan theorem and draw a new relay scheme, implementing a simplified expression. Identify the answer To the original expression of the scheme: $$'overline-overline-A' $A (on superline) In other words, which scheme will give the safest result in the event of a switch failure or wiring? Notes: Here students see that, although the two schemes are functionally identical (at least according to appropriately they may not behave exactly the same in adverse conditions (i.e. faulty switches or wiring). This is a very important thing for them to see because it emphasizes the practical need to go beyond the immediate design criteria (Boolean function) and consider other parameters (failure mode). Issue 62 Of the Distribution Act in buli algebra is identical to the law of distribution in the normal algebra: $$A (B reverse distribution) seems to be a more complex process for many students to master: $$AB, and then describe what the process entails. $$CD - AD - BD - D (C - A) $$X overline-X'$$$$$J JK - J(1) $$AB - ABCD - B - B(A - ACD - CD - 1)$$ You have to look for variables common to each product term. The next question is: if they are implemented using digital logic gates, which of these two expressions will require fewer components? $$A (B and C)$$$$$AB and AC$$ Notes: Factoring does seem like a more difficult pattern recognition skill than mastering, the latter being self-evident for many students. The purpose of this issue is to get students to recognize and formulate a factoring-related pattern matching process. Once students have a working explanation of how to factor in (especially if articulated in their own words), they will be better equipped to do so when needed. Issue 63 Simplify this gate chain logic that uses nothing but the NAND gate to perform a certain logic function: Show Answer Notes: This question is an example of how NAND gates can be used to build different types of logical functions. In fact, with enough NAND gates, any logical function can be built. That's why nand gates are said to be universal. Issue 64 Simplify this gate chain logic that uses nothing but the NOR gate to perform a certain logic function: Identify the answer notes: This question is an example of how NOR gates can be used to build different types of logical functions. In fact, with enough NOR gates, any logical function can be built. That's why the NOR gates are said to be universal. The question 65 Sum-of-Products (SOP) expressions can be implemented by a combination of AND and OR gates as such: Use the DeMorgan theorem to prove that this NAND gate chain performs exactly the same function: Show the answer I will leave the proof to you! Notes: is a very practical application of the DeMorgan theorem. Being able to use all NAND gates to implement the SOP function is a bonus for using separate AND and OR packages (one IC instead of two in this particular case). Issue 66 Write the expression Boolean for this gate chain logic and then reduce this expression to its simplest form using any applicable Laws and Theorem of Boolean. Finally, draw a new gate chain diagram based on boolean's simplistic expression, which performs exactly the same logical function. Identify the answer Original expression Boolean: (Offline) (overline)) Reduced Gate Scheme: Notes: This particular diagram is an example of how a combined logic function can be implemented using nothing but a NAND gate. Issue 67 Write the expression Boolean for this gate chain logic and then reduce this expression to its simplest form using any applicable Boolean laws and theorems. Finally, draw a new gate chain diagram based on boolean's simplistic expression, which performs exactly the same logical function. Identify the answer Original expression Boolean: ((Pereline) overline-overline (AB-C)) Reduced Gate Scheme: Notes: This particular diagram is an example of how the combined logic function can be implemented using nothing but a NAND gate. Gate. boolean algebra worksheet with answers pdf. boolean algebra worksheet with answers. boolean algebra worksheet pdf. boolean algebra worksheet with answers class 12. math 125 worksheet 10 boolean algebra. boolean algebra simplification worksheet. boolean algebra laws worksheet

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