Contents

2 – BODMAS

What does it mean?

This is a memory device used to ensure we enter values into a sum, or calculator, in the right order.

Wherever we have an equation, such as the Real Power equation:

$P = \sqrt{3}\ V_L\ I_L\ Cos\Phi$ Watts (W)

We have to be careful. We can make a real mess of this, as one student of mine did. He was calculating P, and calculated $\sqrt{(3\ V_L\ I_L\ Cos\Phi)}$ because he forgot to put the brackets in the right place: $P = \sqrt{(3)}\ V_L\ I_L\ Cos\Phi$.

Whenever we have equations with powers, division, multiplication, brackets, addition or subtraction mixed together, we MUST follow the **BODMAS** order:

Brackets
Operations (p**O**wers etc.)
Divide
Multiply
Add
Subtract

In fact, all calculators will attempt to put any sum that you put into them into the **BODMAS** order.

Lets take a look at some examples.

Example: If we take the formulae for the Capacitive Reactance (Xc) of a Capacitor

$$X_C = \frac{1}{2\pi f C}\ \text{Ohms}$$

We will let frequency f = 50 Hz and
Capacitance C = 250 µF

BODMAS

Now if we just input the figures into our calculator as follows:

1 / 2 x Π X 50 x 250 EXP $^{-6}$ = 0.001989 which is the wrong answer.

4 – Algebra

Algebra is where we use letters called 'variables' to represent the quantity being measured (the measurand), and numbers are called 'constants' Any letter or symbol can be used as a variable. In the example below, the letter V is used to represent voltage. The value of V will depend upon whatever values the variables I (current) and R (resistance) are given. Variables will change their value depending upon the values given to the other variables in a formulae. This is why they are called variables.

A 'constant' however is just that a constant, it never changes and a constant can have any value you can possibly imagine.

Take for example the number 5. This could represent 5 volts, or 5 apples, or 5 pounds. But and the big but about constants is that we are then referring to EXACTLY 5 volts, or 5 apples or 5 pounds, and not 4.999 or 5.111 etc.

Constants do not have to be exact numbers. The value 4.999 and 5.111 above are both constants also, but these constants contain decimal numbers after the decimal point.

When a number i.e. a constant is only a whole number, i.e. there is no numbers before or after the decimal point we call these whole numbers 'integers' An integer can be a positive or negative number or even the value zero, but it must be a whole number to be called an integer.

You may already know about ohms law and the power laws. These use P, V, I and R as variables to represent power, voltage, current and resistance respectively.

So, we could write V = IR and voltage = current times resistance.

IMPORTANT NOTE:
When writing algebraic equations such as V = IR what we really mean is V = I x R
But we usually do not show the multiplication sign ' x ' so whenever you see two or more variables adjacent (next) to each other, this means they are multiplied together. Sometimes you may see a period ' . ' between variables, this is also used to indicate the variables are multiplied together. You may be thinking "why not just use a multiplication sign wherever it is required" I would agree, but then I didn't make up the rules. ☺

Let's take a look at some variables, and see a few examples, the following examples do not represent any engineering formulae, but are included just to give you some understanding of how variables can be presented.

Example 1:
If a + b = c when a = 5 and b = 6 calculate the value of c

Answer:
We have to put the numbers into the variables in the equation, so we have:

5 + 6 = 11 So c = 11 That was easy, let's take a look at another example

Example 2:
If ab = c when a = 5 and b = 6 calculate the value of c

Answer:
Again we put the numbers into the variables, but remember what we have just learnt, when variables are shown adjacent to each other it means they are multiplied together. So we have:

5 x 6 = 30 So c = 30 "Hey" I hope you are saying, "I'm getting the hang of this"

5 - Transposition

Rearranging formulae (or transposing / transposition of formulae) is the process of changing a formula to solve it for a particular variable. We thought it best to summarise the transposition rules as a separate section, so that you can quickly check you understand each method without having to go through the whole chapter. However if you are not very confident with transposition there are some great example on the following pages.

For example, the power law states that if a current I flows with a voltage of V then the power P developed is:

$$P = VI$$

However, we can rearrange this formula to solve for I and so arrive at the alternative formula:

$$\frac{P}{V} = I$$

V has moved to the other side of the equals sign, and changed from multiplication to division. In the English language we read from the left to right, so in mathematics we usually re-write formulae to read left to right, as shown:

$$I = \frac{P}{V}$$

5.2 - Addition and Subtraction Method

We can use the operations of subtraction and addition to change formulae.
Example: Make $R1$ the subject of the formula:

$$Zs = R1 + R2$$

We can solve all transposition problems 'Mathematically' or 'Spatially' we have enclosed both types for you. You can choose which ever method you prefer best.

Mathematical Method	Spatial Method
$$Zs = R1 + R2$$ **To solve this for R1 we need simply take away R2 from both sides such that** $$Zs - R2 = R1 + R2 - R2$$ **hence the R2's cancel out on the R.H.S** $$Zs - R2 = R1 + \cancel{R2} - \cancel{R2}$$ **Leaving** $$Zs - R2 = R1$$ **Re-writing so the object of the equation R1 is on the left hand side we have:** $$R1 = Zs - R2$$ **And we have solved the equation for R1**	$$Zs = R1 + R2$$ **R2 moves to the other side of the equals sign and changes from a POSITIVE number to a NEGATIVE number as shown** $$Zs = R1 + R2$$ **Leaving** $$Zs - R2 = R1$$ **Re-writing so the object of the equation R1 is on the left hand side we have:** $$R1 = Zs - R2$$ **And we have solved the equation for R1**

6 - SI units

The SI (System International) system is the most widely used of all measurement systems, although other systems are used.

For example, the SI standard for temperature is the Kelvin, but we most often use Celsius or Fahrenheit, both of which can be derived from Kelvin. The many units of time: minute, hour and day are regularly used. Electrical energy is usually measured in kilowatt hours instead of the 'correct' measure of kilojoules. To make matters worse, most electrical equipment is rated in watts (such as light bulbs), where they should be rated in watt-hours or even joules!

The main thing is that these are the base units for all quantities and just about every other quantity can be derived or converted from one of the base units.

Name	Symbol	Measurement
Ampere	A	Electric current (not water current)
Candela	cd	Luminous Intensity
Kelvin	K	Temperature
Kilogram	kg	Mass (not weight!)
Metre	m	Physical linear length
Mole	mol	Amount of substance
Second	s	Time

For example, frequency (Hertz) is derived from the second and is: $f = \frac{1}{t}$

Exam style question 5: Example, from level 2 paper #3, question 76: The SI unit for power is

a) volt
b) watt
c) ohm
d) amp

The answer, of course is 'B'. Can you name what the other units are used for?

Yes, of course they are Voltage, Power, Resistance and Electric current in that order.
The full list of derived units and base is in the formula section.

7 - Calculator Use

You should have been advised to buy a decent calculator, so why can't you use that free one you got from a magazine? Well, the calculations you may encounter will include sine, powers, roots, exponential functions, engineering powers etc, which cheap calculators often cannot handle. 'My calculator can do Poisson distribution, I don't need another calculator!' Really, go on then show me how to use it! Are you really confident in the use of your calculator, or are their areas you are not sure about?

7.1 - Engineering Powers

As an example, let's look at this typical exam style question.

Exam style question 6, taken from Level 2 paper 1 , question 1.

Two parallel plates of dimension 30mm by 20mm are oppositely charged to a value of 50mC. Calculate the charge density of the electric field.

a) $0.12C/m^2$
b) $83.3C/m^2$
c) $0.003C/m^2$
d) $3000C/m^2$

We need to use the formulae $D = \frac{Q}{A}$ to solve this question

Where:
D = Charge Density in coulombs / m^2
Q = Charge in coulombs
A = Area in m^2
Note: Charge Density is sometimes referred to as Flux Density

Area A = 30 mm x 20 mm = 600 mm^2

Now we need to convert 600 mm^2 to Area base units, which is the $metre^2$
Which becomes 600 mm^2 x 10^{-6} m^2
OR 0.03 m x 0.02 m = 0.0006 m^2

Note: If you don't know why we must multiply by 10^{-6} to convert mm^2 to m^2 see page 89

Putting the values into the formulae gives

$$D = \frac{50mC}{600Exp^{-6}} = \frac{50Exp^{-3}}{600Exp^{-6}} = 83.3C/m^2$$

So the answer is b)

8 - Trigonometry

Example: Level 3 paper 5, question 91: Exam style question 17:

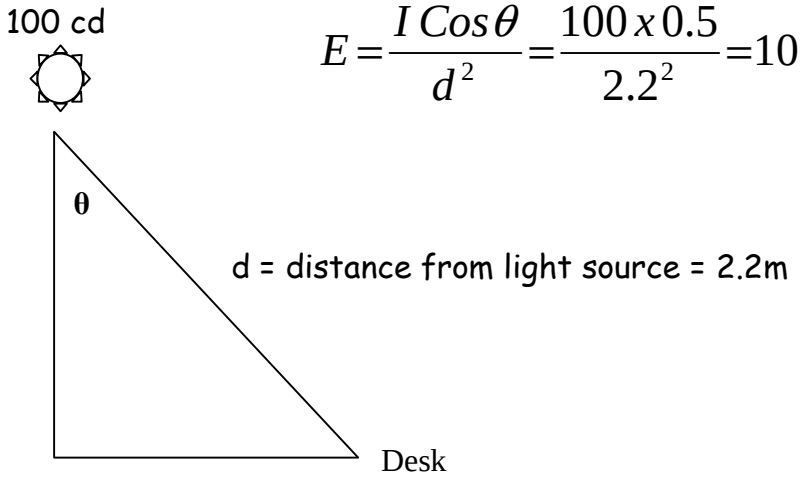
A light source of luminous intensity of 100cd is positioned to one side of a work surface, giving an effective angle of 60° and distance of 2.2m, what is the Illuminance at the surface:

a) 41.32 lux
b) 10.33 lux
c) 22.72 lux
a) 17.89 lux

To start with we are given the angle θ which is 60^0
We are given the distance d = 2.2m
We are given I (luminous intensity 100cd)

We need to calculate the cosine of 60° Cosθ = Cos 60° = 0.5

So all we need to do is put the values in the formulae below.



$$E = \frac{I\,Cos\theta}{d^2} = \frac{100\,x\,0.5}{2.2^2} = 10.33\,\text{Lx}$$

So 'B' is the correct answer.

10 - Remembering Formulae

Whilst this is not really a mathematical skill, remembering all the formula that you may need in the various GOLA exams is a major feat in itself. If anyone ever tells you that because you are doing a 2330, those on a National Certificate course are cleverer, remind them you have to memorise **ALL** your equations. I bet they can't do that!

Throughout this book we have used actual formulae found on the 2330.

In Appendix 1, we have listed all the major formulae needed.

The main thing with memory aids is finding one that works for you. The following are those that we and our students use to remember formulae. However, you may remember them as a picture (such as the Ohms Law triangle), by rote (constantly writing it down or repeating it aloud or in your head 100 times), a funny phrase, such as 'Fat Bill's Nuts'. Some equations are more easily remembered as they are in alphabetic order and of course you can learn by practicing with questions similar to those found on the exam.

Over the years as a lecturer, we have developed various memory aids (called mnemonics – pronounced new-monics) for some of the formula. Some equations, like Ohms Law (V=IR) and the Power Law (P=VI) MUST be learnt as they are the fundamental building blocks. Quite often, the only way to learn a formula or equation is to repeatedly say or write down the equation.

CIVIL. What's this? This is a memory aid for circuits with Capacitors (C) and Inductors (L) that relates the Voltage (V) and Current (I). If the capacitive reactance is larger (or if there is only a capacitor in the circuit), then we read from the 'C', giving: CIV. Breaking this down gives us: in a Capacitive circuit (C), then I (Current) comes before V (Voltage). If I comes before V, then it leads it, so in a Capacitive circuit, current leads the voltage. Another way of saying this is that the voltage lags the current.

If the inductive reactance is larger (or if there is only an inductor in the circuit), then we read from the 'L', giving: VIL. Breaking this down gives us: V (Voltage) comes before I (Current) in an Inductive circuit (L). If V comes before I, then it leads it, so in an Inductive circuit, voltage leads the current. Another way of saying this is that the current lags the voltage.

Some equations do lend themselves to memory aids.

Practice makes perfect

Finally, it's all down to practice. So practice the included exercises with the aim of getting 100%, as questions like these will be asked on the on-line examinations. There is a reported bank of 1,000 questions for the 2330, so we urge you to keep checking our site for papers relating to your studies and update yourself with our papers. Feedback from our customers indicates that many of our questions are very similar to the exam questions.

A note on revision. Hopefully I am teaching my grandmother to suck eggs here and you have probably been told this from day one by your lecturer or training provider: Revision starts from day one.

Your teacher cannot see into your mind and cannot use a crystal ball to 100% check you understand everything. It is up to YOU to ensure that YOU understand the topic covered each week and if you don't, ask if it can be explained a different way.

'But I'm thick, I don't get it!'. I'm sorry, you can't be a sparky if you're thick and that sort of negative attitude WILL mean YOU fail. In my experience, the difference between a 'thick' person and a clever one is UNDERSTANDING. Admittedly, there are a few individuals who understand something straight away. Irritating isn't it? However, and I speak from personal experience here, anybody who repeatedly goes over their work WILL learn it and will eventually UNDERSTAND it. It may take you 2, 10 or 100 readings before you 'get it'. But if you don't read over the stuff at least ONCE more, you won't LEARN.

Learning = Understanding.

So, don't wait until the week before the exam, as you will have a mountain of work to go back over and this will probably put you off immediately. If you've re-read these notes a few times, you should be able to skim through to REMIND yourself and not to re-learn it all over again! The same goes for your class notes. Don't put them to one side until the next class. Review them at least once before the next class, that way you can go into class and say 'I reviewed my notes and don't get it, can you help'. It's amazing how much help you will get from lecturers who see someone actually re-reads their notes and has the guts to admit they don't get it.

Believe me, it does take a lot of guts to admit you don't get it, because people are scared to admit this. Once you admit it, you're over the first hurdle and asking questions in the future becomes a lot easier.

Finally, if it's getting close to the exam and you've tried and tried and are still stuck, you can turn to us for help. Our website offers FREE e-mail help to our online customers. We have extended this service to customers who buy our books.

2330maths@britanniatraining.net

Just email us at the above address and we will try to get back to you within 24 hours. All we ask is that you provide the full question (with answers if you have them) you are stuck on and we will advise. Can't say fairer than that. What other book do you know of where you can correspond with the author(s) and obtain advice to anything within the book you don't understand?

Finally if you have any suggestions to offer, maybe something you feel would be useful to include in the book that we are not presently covering, or a new memory aid, or a better way to work something out. Then tell us, if we like your idea we will include it in the next revision of this book and add your name (if you wish) to our list of credits.

Check out our dedicated maths page:

http://www.britanniatraining.net/pages/2330_maths_page.htm

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