**NOTES:**

## SECTION 3 : PREFIXES, METRIC UNITS, UNIT CONVERSION

Large and small numbers written in standard form are often expressed in terms of a **PREFIX** corresponding to a power of ten. Thus:

$$6000 = 6 \times 10^3 = 6 \text{ kilo} = 6\text{k}$$

In this example 'kilo' or just 'k' stands for a multiplier of 1000 or the power 3 in $10^3$. Usually the prefix comes before a unit of measurement so

1000 metres = 1 kilometre or

1000 m = 1 km.

Sometimes the underlying number will not be in standard form and we could see, for example, 25 km = 25000 m

We have the following common prefixes which should be memorised:

| Prefix | Letter | Power | Multiplier | Example |
|---|---|---|---|---|
| Giga | G | 9 | 1000000000 | 6.5 GByte = 6,500,000,000 Byte |
| Mega | M | 6 | 1000000 | 4.7 MΩ = 4,700,000 Ω |
| kilo | k | 3 | 1000 | 3.2 kHz = 3,200 Hz |
| milli | m | -3 | 0.001 | 2.7 mm = 0.0027 m |
| micro | µ | -6 | 0.000001 | 1 µH = 0.000001 H |
| nano | n | -9 | 0.000000001 | 10 ns = 0.00000001 s |
| pico | p | -12 | 0.000000000001 | 9 pF = 0.000000000009 F |



Note that upper case are used for Giga (G) and Mega (M). The units shown in the examples are units that you will come across during your studies; do not worry if you do not know what they represent at this stage.

Metric units are widely used although Imperial or American units are still very widely within the aerospace industry. The standard metric units are as follows and should be memorised.

| Quantity | Basic Unit | Symbol | | Common Units |
|---|---|---|---|---|
| length | metre | m | ft | foot |
| mass | gram | g | lb | pound |
| time | second | s | s | second |
| temperature | degrees Celsius | °C | ºF | degree Fahrenheit |

## SECTION 4 : USE OF THE BINARY NUMBER SYSTEM

The binary number system is used in computers and other digital systems.

In digital systems numbers are represented by electrical quantities. It is possible to use other quantities to represent numbers, eg. Hydraulic pressure, however, in computers it is always electrical quantities and invariably voltage which is used.

If the decimal system were used in computers, the circuits would have to be able to distinguish between 10 different levels of voltage corresponding to the number 0 to 9. This is very difficult to achieve with any reliable degree of accuracy. Hence only two levels are used, often 0 volts and 5 volts, representing ‘0’ and ‘1’ – the binary system, allowing for calculation and switching within the system to be carried out extremely fast and accurately.

| $2^3$ | $2^2$ | $2^1$ | $2^0$ | |
|---|---|---|---|---|
| **8** | **4** | **2** | **1** | **Decimal Value** |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |
| 1 | 0 | 1 | 0 | 10 |
| 1 | 0 | 1 | 1 | 11 |
| 1 | 1 | 0 | 0 | 12 |
| 1 | 1 | 0 | 1 | 13 |
| 1 | 1 | 1 | 0 | 14 |
| 1 | 1 | 1 | 1 | 15 |



Example: $4+2=6$ can be calculated as $100_2 + 10_2 = 110_2$

and $15 \times 8 = 120$ can be calculated as $1111_2 \times 1000_2 = 1111000_2$

For example, consider power measurements. If we were dealing with powers between 1µW and 10kW (W stands for watt the unit of power measurement) then we have a range of 0.000001 W to 10000 W. This is usually expressed as from

$$10\log(0.000001)\ \text{dBW to } 10\log(10000)\text{W dBW or}$$

$$-60 \text{ to } 40 \text{ dBW}$$

You will learn about dBs (**DECIBELS**) later. For the moment you should be aware that it is a logarithmic measure of a ratio of powers. It is 10 times the logarithm of the ratio of the power to be measured over 1 W.

Also, with sound, the brain interprets the level in a logarithmic way. So, for example, if the sound level increases a hundredfold then the brain perceives this a doubling in level. Thus a logarithmic scale, expressed in decibels, is a natural scale to use for sound measurement.

| | |
|---|---|
| **NOTE:** | That this is consistent with the previous paragraph since sound level is a power measurement. |

$$y = kx \text{ (directly proportional)}$$

$$y = k/x \text{ (inversely proportional)}$$

$$y = 3x^2 + \log(x)$$

**NOTE**: The use of k as a constant. Where we have a number of variables of a general nature we use the letters u, v, w, x, y, z. Where we have a number of constants of a general nature we use the letters k, l, m, n.

When we are talking about specific variables or constants we usually use letters which clearly indicate the quantity concerned. So we have

t representing time

v representing voltage

h representing height

etc.



Certain natural constants are given Greek letters. So we have $\pi$ representing the ratio of the circumference of a circle to its diameter (value 3.14159265358979…). This appears in the formula for the area of a circle:

$$A = \pi r^2$$

where r is the radius. Here A is a function of r.

**NOTE:** We can have functions of more than one variable but these are not dealt with in this course.