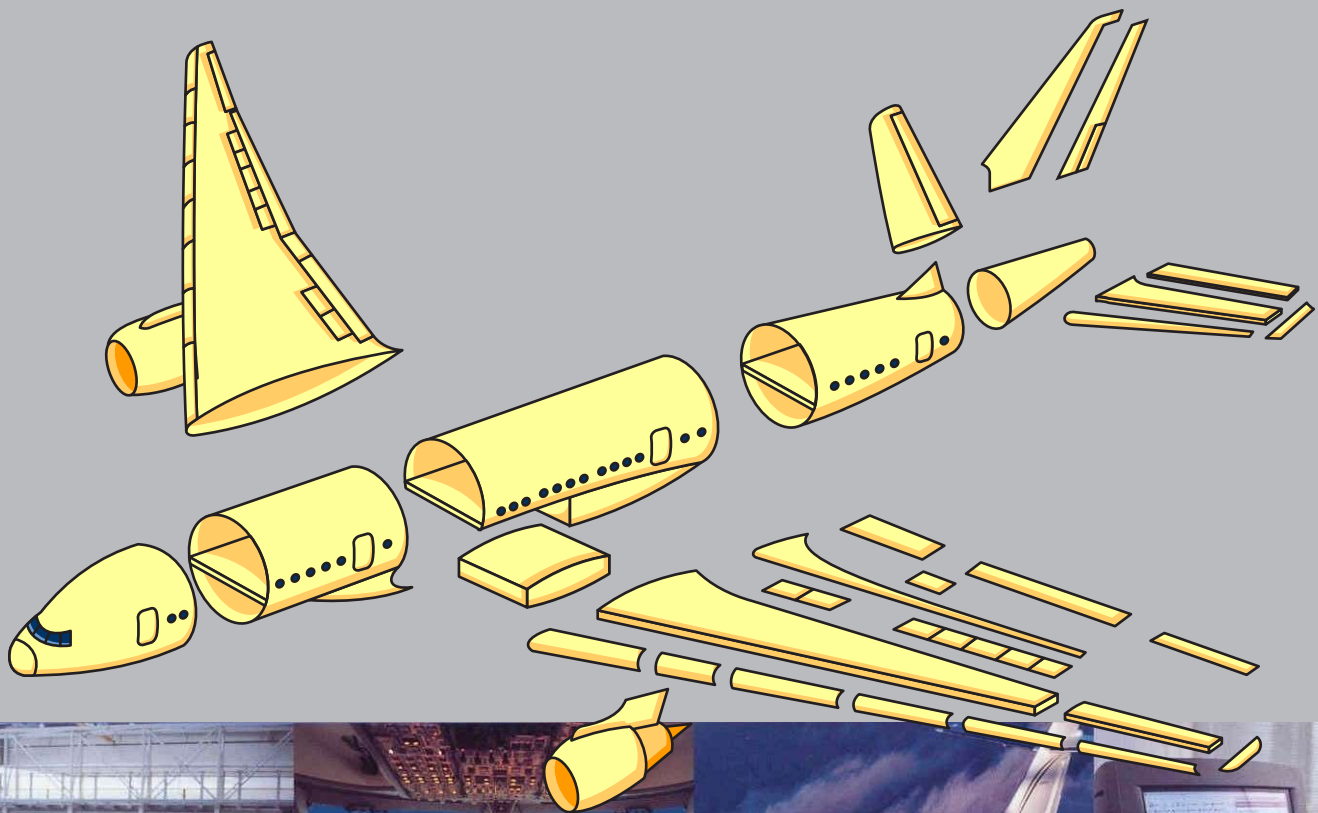


# IR Part-66 Aircraft Maintenance Licence Distance Learning Modules



Sample Booklet

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## Introduction

We hope you will enjoy this booklet, which has been produced to give you a taste of our new and innovative EASA IR Part-66 Training Notes, which follow the module syllabi.

On the following pages you will be able to view extracts from Modules 1 to 5, as a sample of the modules available as printed books. The style we have adopted for the printed notes is clear and uncluttered with a simple colour palette for both text and illustrations. Each module has been broken down into bite size chunks supported with self-assessment questions to test yourself and monitor your progress.

We have produced these notes so that they can be used individually or in a conventional classroom or, with their optional CD-Rom, as an interactive distance/e-learning package. They meet all the requirements of EASA IR Part-66 and as such, are recognised by all countries that belong to EASA or are running comparable programmes.

Research has show that people learn in different ways. We believe that with the options we provide you can study in a way that suits you, which will help you meet your own goals and aspirations.

## International Centre for Aerospace Training (ICAT) An EASA IR Part-147 Organisation

The content for the modules has been authored and tested at the International Centre for Aerospace Training, an IR Part-147 organisation. The tutors at this centre have many years experience in all areas of aircraft maintenance. This provides excellent support for self-study notes, and students can sit exams at the centre where the notes were produced. The CAA has approved the Part-66 notes to support ICAT's Part-147.

At the heart of ICAT is the recognised model of excellent education and training which supports an industry. The Centre is also constantly developing a range of courses for professionals to continue building upon their existing skills. Consequently the ICAT has a wide range of students all with varying requirements learning simultaneously on one of the full-time, part-time or flexible learning courses created for their needs.

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## More Information

More information on this unique learning opportunity with IR Part-66 modules and ICAT can be found on our website at [www.part66.co.uk](http://www.part66.co.uk), which also contains information for engineers and an online ordering system. Alternatively contact us using the information on the inside cover of this booklet.



## An extract from Module 1 - Mathematics

### Fractions

A fraction is part of a whole, where the whole can be anything we define.

A fraction consists of two parts, the numerator (top) and the denominator (bottom).

The bottom tells us how many equal parts the whole has been divided into and the top tells us how many of these equal parts are taken.

### Example

Consider the fraction  $\frac{3}{4}$

The whole has been divided into 4 equal parts and three of those parts have been shaded.

So the shaded parts represents  $\frac{3}{4}$  of the whole.

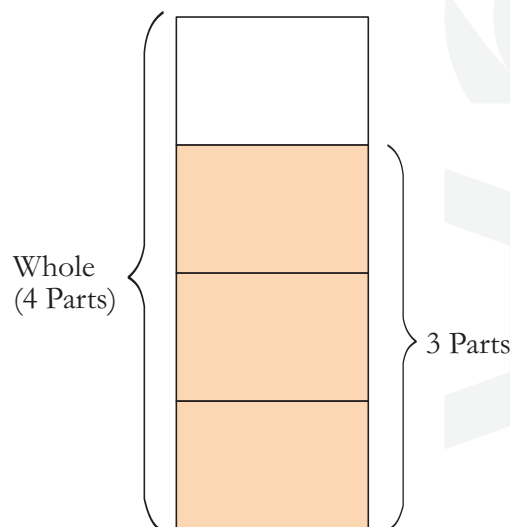


Figure 1.1 –  $\frac{3}{4}$  of a Whole

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## Types of Fractions

### Proper Fraction

In this type the top of the fraction is less than the bottom.

$\frac{3}{4}$ ,  $\frac{2}{5}$ ,  $\frac{1}{8}$ ,  $\frac{17}{20}$  are all examples of *proper fractions*.

### Improper Fraction

In this type, the top of the fraction is more than the bottom.

$\frac{5}{2}$ ,  $\frac{6}{5}$ ,  $\frac{12}{4}$ ,  $\frac{18}{11}$  are all examples of *improper fractions*.

These types of fractions are also called *top-heavy* fractions.

### Mixed Number

In this type you have the sum of an *integer* (whole number) and a proper fraction.

$$3 + \frac{3}{4} = 3\frac{3}{4}$$

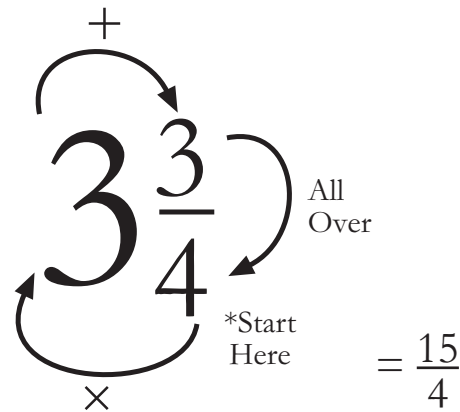
$1\frac{2}{3}$  and  $5\frac{7}{8}$  are further examples of *mixed number fractions*.

Mixed number fractions can be changed into improper fractions and vice versa. For example,

$$5\frac{2}{3} = \frac{(3 \times 5) + 2}{3} = \frac{17}{3}$$
$$4\frac{2}{5} = \frac{(5 \times 4) + 2}{5} = \frac{22}{5}$$

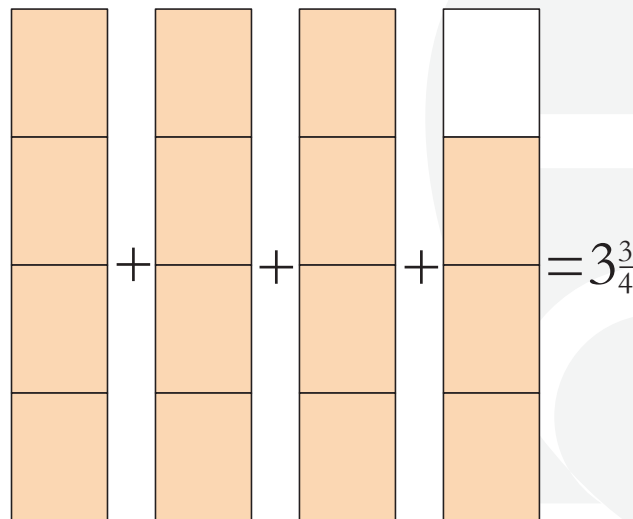
If you find this difficult, the following diagram might help.

**Example 1** Change  $3\frac{3}{4}$  into an improper fraction



**Figure 1.2 – How to Change  $3\frac{3}{4}$  into an Improper Fraction**

Another method is to consider what  $3\frac{3}{4}$  would look like in diagrammatic form as shown on the next page.



**Figure 1.3 –  $3\frac{3}{4}$  in a Diagrammatic Form**

The shaded part is equal to  $3\frac{3}{4}$  but this also equals fifteen quarters  $= \frac{15}{4}$

In the reverse way  $\frac{15}{4} = 3\frac{3}{4}$  ( $15 \div 4 = 3$  remainder 3)

## Equivalent Fractions

If we consider three equal ‘wholes’ and divide one of them into two equal parts, one into four equal parts and one into eight equal parts.

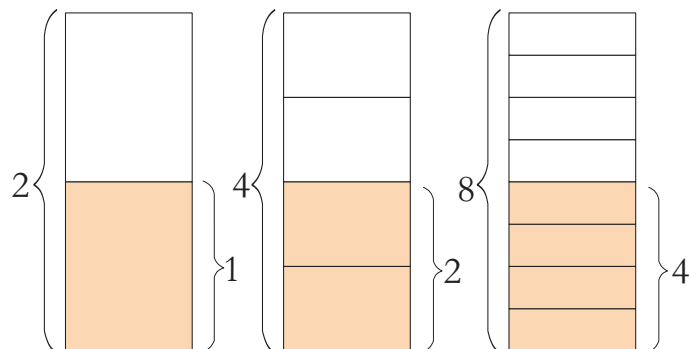


Figure 1.4 – Equivalent Fractions

If the same portion of the whole is shaded in each one, then the shaded parts must be equal.

For example,  $\frac{1}{2} = \frac{2}{4} = \frac{4}{8}$

These are called Equivalent Fractions. Their values are the same!

$$\frac{1}{2} = 1 \div 2 = 0.5 \quad \frac{2}{4} = 2 \div 4 = 0.5 \quad \frac{4}{8} = 4 \div 8 = 0.5$$

This leads to the very important conclusion that the value of a fraction remains the same as long as the top and bottom of it are multiplied by the same number.

$$\frac{1 \times 2}{2 \times 2} = \frac{2}{4}, \quad \frac{2 \times 2}{4 \times 2} = \frac{4}{8}$$

The reverse of this is also true (i.e. the value of a fraction remains the same if the top and bottom of it are divided by the same number). This is called cancelling down.

$$\frac{20 \div 2}{30 \div 2} = \frac{10}{15}, \quad \frac{10 \div 5}{15 \div 5} = \frac{2}{3}$$

In the above case the fraction  $\frac{2}{3}$  is said to be in its lowest terms because there is now no number that will divide exactly into the top and bottom of it.



## An extract from Module 2 - Physics

### Centre of Gravity (C of G or CG)

We have already discussed the concept of a centre of mass where we consider all the gravitational forces acting on a body pass through it. This point, is called the object's *Centre of Gravity (C of G or CG)*. This concept was used in calculations for determining the centre of gravity position of a simple system of distributed forces acting on a beam and on an aircraft. Before we move on to discuss CG in more detail, we need to define some of the terms we use.

### Gravity

Gravity is the name given to the force of attraction that exists between any two masses. Newton's Law of Gravitation states that:

*'The force of gravity is proportional to the product of the two masses, M1 and M2, and a gravitational constant (G) all divided by the square of the distance between them.'*

As a formula, this becomes:

$$F = \frac{G(M1 \times M2)}{d^2}$$

The force is almost negligible between two small bodies but when one of the bodies is as large as the Earth, its effect on a smaller body like the moon is appreciable. The distance between the two masses is always measured from their centres and this presents a problem in establishing a global figure for the force of gravity on the Earth, as it is not a perfect sphere.

The distance 'd' will vary with longitude, lowest at the Poles and highest at the equator. These variations are small but to establish a figure for global use the acceleration due to gravity at 9.81m/s<sup>2</sup>, experienced in NW Europe, has been adopted as the average.

The gravitational force on a body situated on the Earth's surface will be directly proportional to the mass of that body and the acceleration due to gravity and can be calculated by:

$$F = \text{Mass} \times \text{Acceleration}$$

Where the mass is in kilograms (kg) and acceleration is taken as 9.81 m/s<sup>2</sup>.

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## Centre of Gravity of a Body

The mass of a body must, of necessity, occupy a volume that is distributed according to the body's shape. The force due to gravity must also be distributed among all the particles that make up the body, each having its own discrete value. However, it is easier to think of this distribution of forces as a resultant single force that acts vertically downwards through a point considered to be the body's centre of mass. In practical terms, if a body were supported on a knife-edge, positioned at its C of G, there would be no moments causing rotation and the body would be in equilibrium.

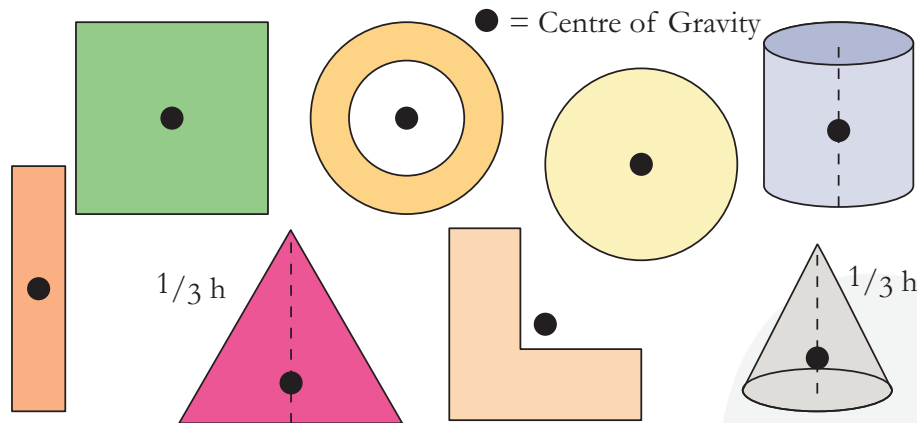


Figure 2.1 – Examples of C of G Position

Of course, if the supported body tilts, the C of G may move out of alignment with the support and a turning moment would then exist. A body's stability would depend on where the C of G was located in the body. If it were low then the turning moment created would be lower than if the C of G were placed at a higher position.

The C of G position may be located inside a body or outside it. An annular ring would have its C of G, for example, in space in the centre as would a hollow sphere or ball. *Whereas an L shaped plate would have its C of G outside the material.*

## Stable, Unstable and Neutral Equilibrium

A body is said to be in **Stable Equilibrium** when, if slightly displaced from its position, the forces acting upon it tend to cause it to return to that position. A body is said to have **Unstable Equilibrium** when, if slightly displaced from its position the forces acting upon it cause it move further away from that position.

A body is said to possess **Neutral Equilibrium** when, if slightly displaced from its position, the body tends to remain in the displaced position with no tendency to return to its original position; or displace further away from its new position.

These conditions are illustrated in figure 2.2.

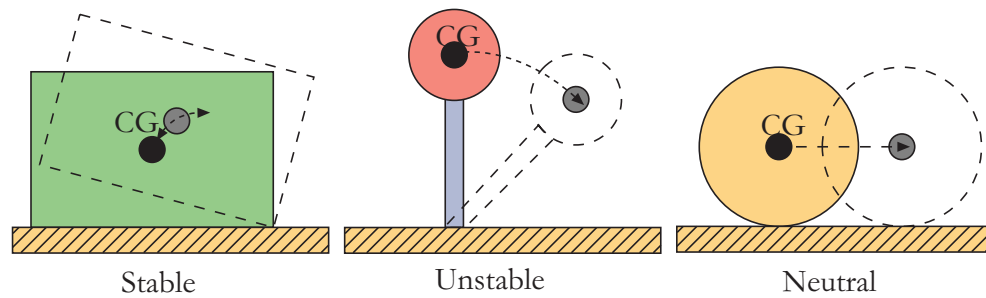


Figure 2.2 – Bodies in various forms of Equilibrium

### Centre of Gravity of an Unevenly Loaded Beam

If a beam is described being uniform, it means that its cross section and density are even throughout its length and that its C of G position is exactly at its centre. If other forces act on the beam, however, the C of G position could move as a result of where the force is placed and what moment arm it generates.

Let us take an example of a uniform beam 4m long having a mass of 50kg that supports three masses, 20kg, 10kg and 5kg respectively. As shown in figure 2.3, the masses' are distributed at 1m, 1.5m and 3m respectively from the left end of the beam, designated as reference datum A. The beam is resting on a flat smooth surface and the task is to locate the position of its C of G so that it can be lifted safely.

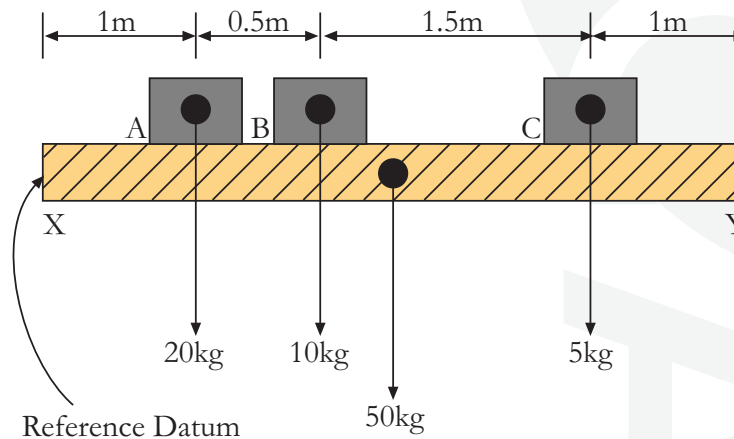


Figure 2.3 – Unevenly Loaded Beam

The beam is too heavy to lift by hand and so its balance point, (C of G), cannot be found by experimentation. Now using the reference datum at A, we need only deal with clockwise moments as tabulated

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Item	Mass (kg)	Moment Arm (Metres)	Moment kg Metres (kgm)
Beam	50	2	100
Mass A	20	1	20
Mass B	10	1.5	15
Mass C	5	3	15
Total Mass	85	Total Moment	150

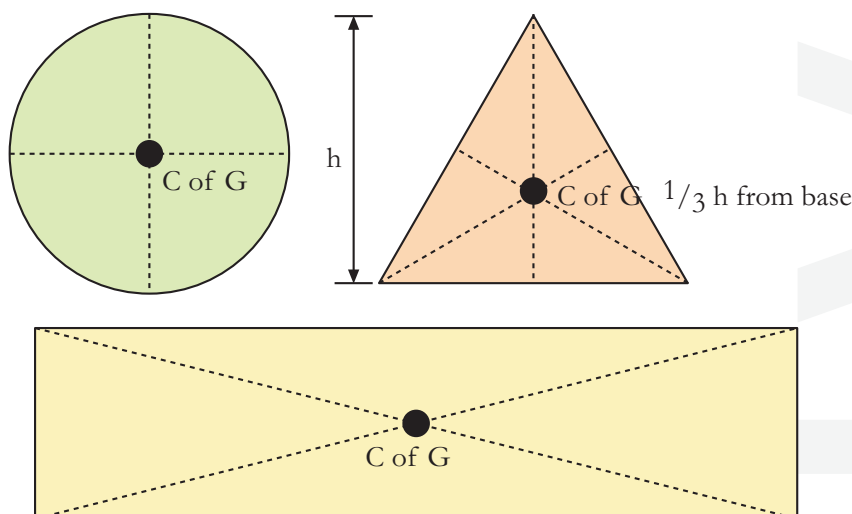
**Table 2.1 – Masses on an Evenly Loaded Beam**

$$\begin{aligned}
 \text{Centre of Gravity Position} &= \frac{\text{Total Moment}}{\text{Total Weight}} \\
 &= \frac{150}{85} \\
 &= 1.76 \text{ from datum A}
 \end{aligned}$$

**Note:** This calculation was completed with using Mass in kg; the same answer would be obtained if Newtons had been used. Try it for yourself and see!

### C of G of Symmetrically Shaped Uniform Flat Plates

When looking at symmetrically shaped objects, it is possible to determine the body's C of G diagrammatically. Figure 2.4 shows some typical shapes with their respective C of G positions shown.



**Figure 2.4 – C of G of various symmetrically shaped objects**

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## An extract from Module 3 – Electrical Fundamentals

### The Simple Generator

The simplest generator is an ac generator and basic generating principles are more easily explained by looking at this type first; the dc generator will then be discussed later. A simple generator, figure 3.1, consists of a wire loop positioned so that it can rotate in a stationary magnetic field and as it does will produce an induced emf in the loop. Sliding contacts, usually called **brushes**, connect the loop to an external circuit load in order to **pick up** or use the induced emf.

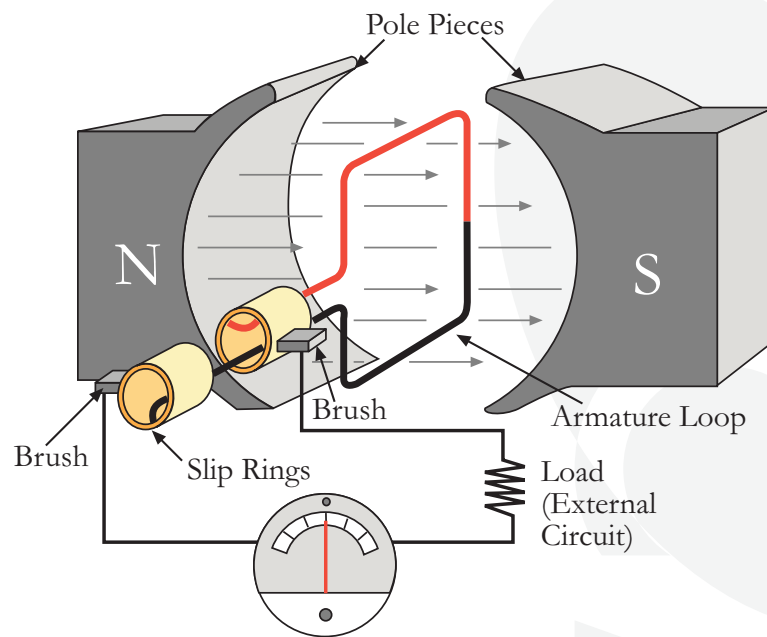


Figure 3.1 - The simple ac generator

In figure 3.1 the pole pieces provide the magnetic field and are shaped and positioned as illustrated to concentrate the magnetic field as close as possible to the wire loop. The rotating wire is called the **Armature** and its ends are connected to rings, more correctly called **Slip Rings**, which rotate with the armature. Brushes, usually made of carbon, ride against the slip rings and have wires attached to them that connect to the external load. Any generated voltage appears across these brushes; this is demonstrated graphically in figure 3.2 below.

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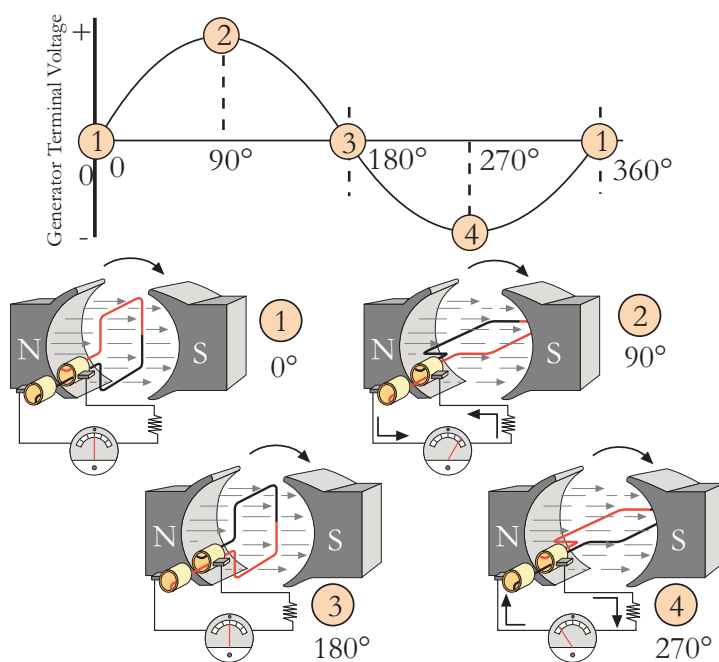


Figure 3.2 – Voltage Generation

The simple generator illustrated in figure 3.2 above, produces a voltage as the armature loop rotates in a clockwise direction. For the purposes of this explanation, the initial or starting point is shown with the loop vertical, i.e. at position ①, called the 0° position. As illustrated in figure 3.2, at 0° the armature loop is perpendicular to the magnetic field and the loop's red and black conductors are moving parallel to the magnetic field.

At this point, indeed at any time the conductors are moving parallel to the magnetic field, they do not cut any lines of flux, so no emf is induced and the meter at position ① indicates zero. This position is called the **Neutral Plane**. As the armature loop now rotates from position ① to ②, i.e. 0° to 90°, the conductors cut through more and more lines of flux, at a continually increasing angle. At 90°, they are cutting through maximum flux lines and at a maximum angle. This results in the induced emf going from zero to maximum between 0° and 90°.

Note that from 0° to 90°, the **red** conductor cuts **down** through the field and at the same time the **black** conductor cuts **up** through the field. This means that the induced emfs in the conductors are **series-adding** and the resultant voltage across the brushes, i.e. the terminal voltage, is the sum of the two induced voltages and the meter at position ② reads maximum value.

As the armature loop continues rotating from 90° to 180°, position ③, the conductors that were cutting through a maximum of flux lines at position ② now cut through fewer lines and they are again moving parallel to the magnetic field at position ③, no longer cutting through any flux lines. As the armature continues the rotation from 90° to 180°, the induced voltage decreases to zero in the same way that it increased during the rotation from 0° to 90° and the meter reads zero again.

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As the armature has rotated from  $0^\circ$  to  $180^\circ$ , the conductors have been moving through the magnetic field in the same direction and so the polarity of the induced voltage has remained the same, illustrated by points A to C on the graph in figure 3.2. As the loop rotates beyond  $180^\circ$  through  $270^\circ$ , position ④, and back to the initial starting point, position ①, the direction of the conductors' cutting reverses through the magnetic field. Now the **red** conductor cuts **up** through the field while the **black** conductor cuts **down** through the field and as a result, the polarity of the induced voltage reverses, as shown in figure 3.2. The terminal voltage will be the same as it was from ① to ③, except that the polarity is reversed as shown by the meter deflection at position ④. The voltage output waveform for a complete revolution of the loop is shown on the graph in figure 3.2.

## The Simple DC Generator

With the DC generator, we need to look at a single-loop generator again, but this time with each terminal connected to a section of a two-segment metal ring. The two segments are insulated from each other, forming a **Commutator** that replaces the slip rings of the ac generator. The commutator **mechanically** reverses the armature loop connections to the external circuit and this occurs at the same time that the armature loop voltage reverses. Through this process, known as **commutation**, the commutator changes the generated ac voltage to a pulsating dc voltage as shown in the graph of figure 3.3 below.

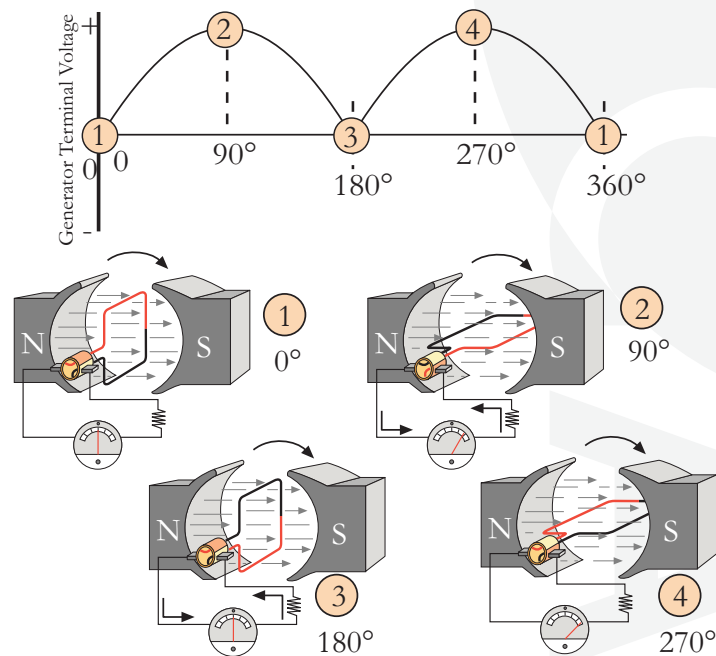


Figure 3.3 – Results of using a Commutator

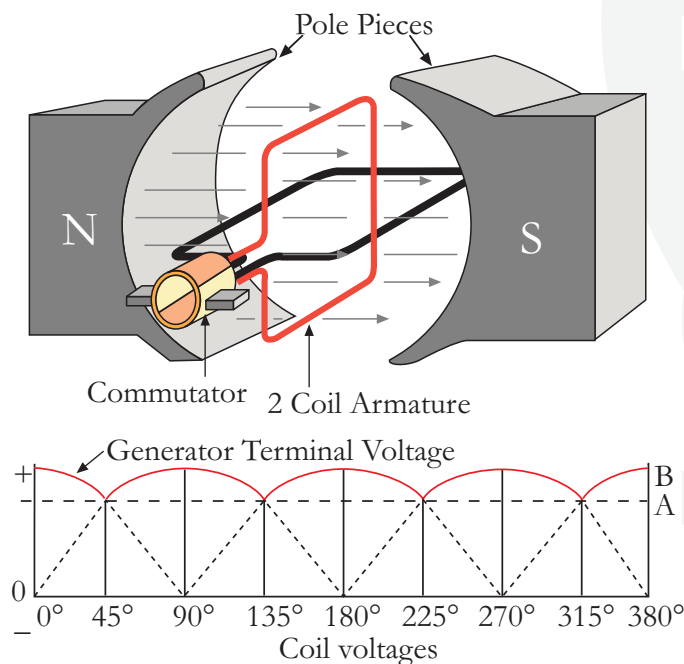
When the armature loop rotates clockwise from ① to ②, a voltage is induced in the armature loop that causes a current in a direction that deflects the meter to the right. Current flows through loop, out of the negative brush, through

the meter and the load, and back through the positive brush to the loop. Voltage reaches its maximum value at ② on the graph and the generated voltage and the current fall to zero at ③. At this instant, each brush makes contact with both segments of the commutator and as the armature loop continues to rotate to position ④, a voltage is again induced in the loop, but is the opposite polarity. The voltages induced in the two sides of the coil at ④ are in the reverse direction to that shown at ②.

In this case, the current is flowing from the *black* side to the *red* side in position ② and from the *red* side to the *black* side at ④. However, because the segments of the commutator have rotated with the loop and are contacted by opposite brushes, the direction of current flow through the brushes and the meter remains the same as at ②.

The voltage developed across the brushes is now pulsating and unidirectional, i.e. in one direction only and varies twice during each revolution between zero and maximum; this variation is called *Ripple*.

Obviously, for most applications, a pulsating voltage is inappropriate. Therefore, in practical generators, more armature loops, i.e. coils, and more commutator segments are used to produce an output voltage waveform with less ripple. The effects of additional coils may be illustrated by adding a second coil to the armature, figure 3.4.



**Figure 3.4 – Effect of an additional coil**

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# An extract from Module 4 – Electronic Fundamentals

## Integrated Circuits

Up to now, the various semiconductors, resistors, capacitors, etc we have discussed have been considered as separately packaged elements called *Discrete Components*. In this section, we will be looking at some of the more complex devices that contain complete circuits packaged as a single component. These devices are called *Integrated Circuits (ICs)* and the broad term used to describe the use of these devices to miniaturise electronic equipment is called *Microelectronics*.

An *Integrated Circuit (IC)* is a device that integrates both active and passive components of a complete electronic circuit in a single chip, i.e. a tiny slice or wafer of semiconductor crystal or insulator.

Integrated circuits (ICs) have almost eliminated the use of individual electronic components as the building blocks of electronic circuits. Instead, tiny chips have been developed whose function is not that of a single part, but of dozens of transistors, resistors, capacitors and other electronic elements, all interconnected to perform the task of a complex circuit. These chips are frequently mounted on a printed circuit board that plugs into an electronic unit.

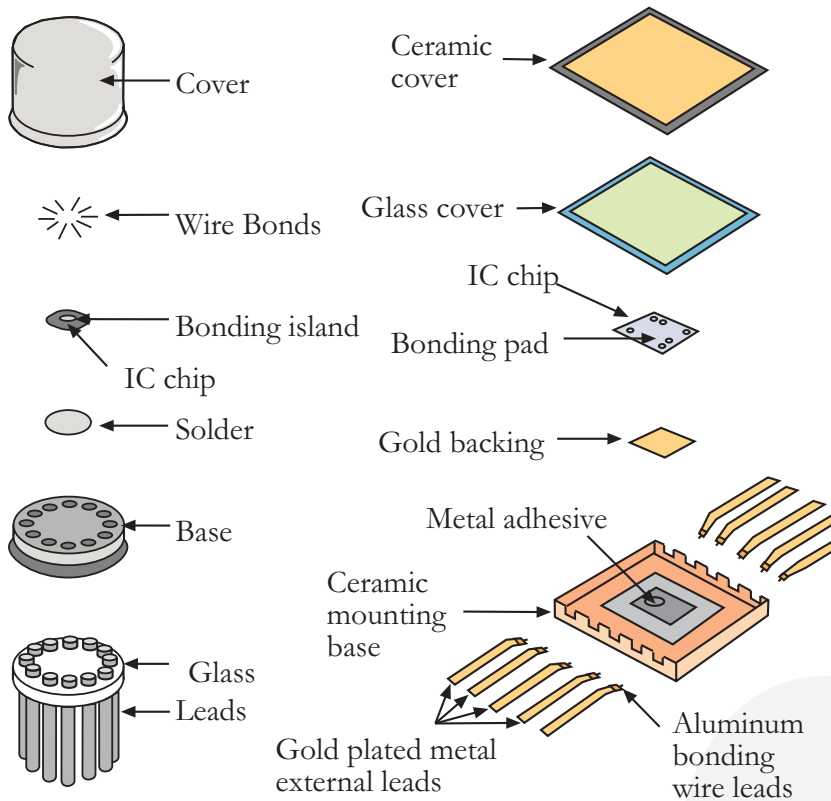
Integrated circuits have several advantages over conventional wired circuits of discrete components, which include:

- A drastic reduction in size and weight
- A large increase in reliability
- Lower cost
- Possible improvement in circuit performance

However, integrated circuits are composed of parts so closely associated with one another that repair IC repair is almost impossible. In the majority of cases, if an IC fails, the entire circuit is replaced as a single component.

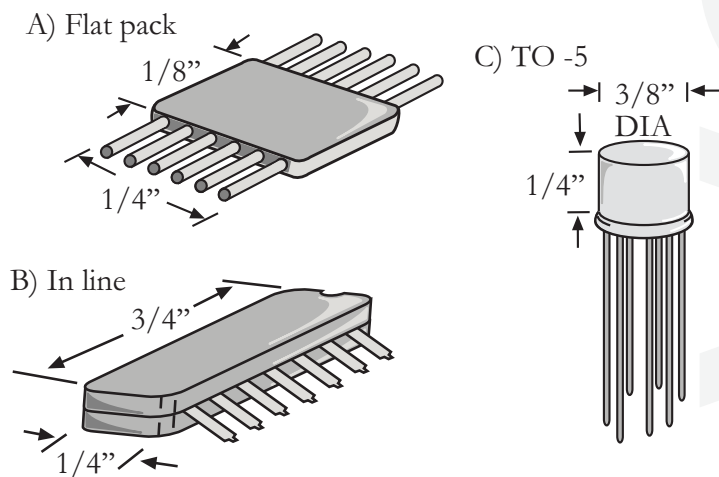
Integrated circuits are being used in an ever-increasing variety of applications. Small size and weight and high reliability make them ideally suited for use in airborne equipment, missile systems, computers, spacecraft and portable equipment. They are often easily recognised because of the unusual packages that contain the integrated circuit. Two (2) typical packaging arrangements are shown in figure 4.1.

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**Figure 4.1 – A Typical IC Packaging Sequence**

These tiny packages protect and help dissipate heat generated in the device. These packages may contain one or several stages, often having several hundred components. Some of the most common package styles are shown in figure 4.2.



**Figure 4.2 – Common IC Package Styles**

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## Operational Amplifiers

An *Operational Amplifiers*, commonly shortened to *Op-Amp*, are very high-gain dc amplifiers designed to be used with other circuit components to perform computing functions, e.g. addition, subtraction, transfer operations, such as filtering and operations associated with analogue measurements. An operational amplifier's gain is determined by the amount of feedback fed to its input, which also acts as a stabilising function.

Op-Amps can perform many functions and these will depend on they operate in a linear or non-linear range. Linear operation is where the output is directly proportional to the input and is usually used for analogue applications; while non-linear operation is where the output is not directly proportional to the input and is usually used for digital applications.

Today many devices use operational amplifiers and the reason for this widespread use is that they are very versatile and efficient devices. As an integrated circuit it has become an inexpensive and readily available '*building block*' for many devices. In fact, an operational amplifier in integrated circuit form is no more expensive than a good transistor. Table 4.1 shows some of their uses.

Operating Range	Circuit Function
Linear	Inverter, non-inverting, Oscillator, Differentiator, Integrator, Summing functions, Voltage Follower, Precision Rectification, Logarithmic functions, Filters
Non-Linear	Comparator, Multi-vibrator

Table 4.1 – Operational Amplifier Applications

Operational amplifiers have been in use for some time and were originally developed for analogue computers and used to perform mathematical functions. They were not used in other devices very much because they were expensive and more complicated than other circuits.

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## Characteristics of an Operational Amplifier

The schematic symbols for an operational amplifier are shown in figures 4.3 below.

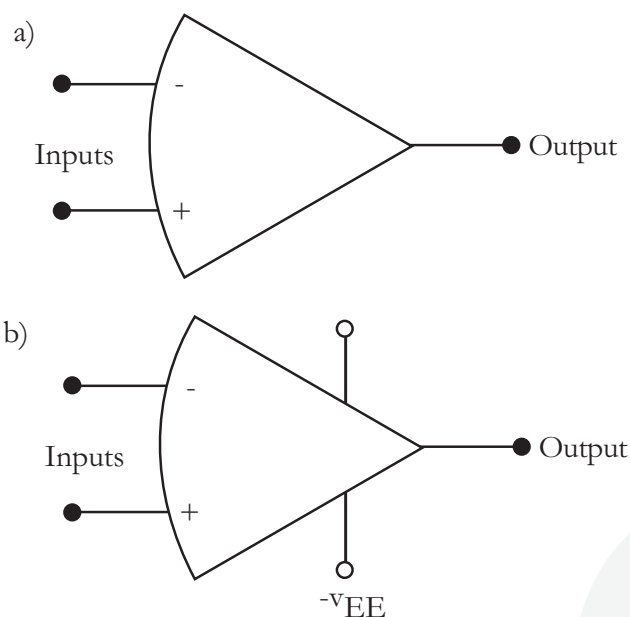


Figure 4.3 – Schematic Symbols of an Operational Amplifier

The symbol shown in figure 4.3 (a) is for a simple Op-Amp, while that in (b) is for a dual Op-Amp that may be used as a summing amplifier or integrator.

An Op-amp's negative input is called the *inverting* input while the positive input is *non-inverting* input. In figure 4.3, as you might expect then, if a positive signal is applied to the inverting input with the non-inverting input grounded, the polarity of the output signal will be *opposite* that of the input and naturally, if a positive signal is applied to the non-inverting input with the inverting input grounded, then the output signal's polarity will be the *same* as that of the input. However, if the same signal is applied to both inputs, the two (2) amplified outputs will be 180° anti-phase and cancel each other out. Therefore, in this case if two (2) different signals are applied at the inputs, the amplifier will only respond to *differences* between the two and so acts as a *Differential Amplifier*.

The most common op-amp circuit configuration uses two components, an input and feedback. As you would expect, when the feedback component is between the op-amp output and inverting input, it is *negative feedback* and when it is between the output and non-inverting input it is *positive feedback*.

## An extract from Module 5 – Digital Techniques/Electronic Instrument Displays

### The Analogue Flight Deck

Figure 5.1 shows the typical layout of an analogue or '*classic*' Boeing 747. In the vast majority of civilian aircraft, the pilot sits in the left-hand seat, the co-pilot in the right and the flight engineer at a station positioned behind the co-pilot's seat. The flight engineer's seat can usually move on tracks so that they can face forwards during take-off and landing to take control of the engine levers.

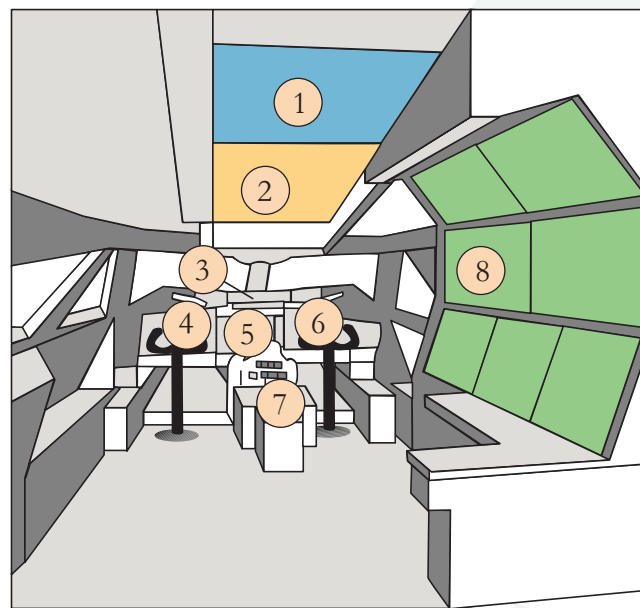


Figure 5.1 – A typical Boeing 747 Analogue Flight Deck

The pilots' main instrument panel consists of the flight instruments on the left, ④, with a similar panel layout for the co-pilot on the right, ⑥. The pilots' central panel ⑤, holds the main engine instruments, the standby instruments and the central master warning panel. Autopilot switching and some radio selectors are mounted on the glare shield, ③, and a standby compass sits at the top of the central window post. There is usually additional switching beneath each pilot's panel to allow cross transfer of information.

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The pilot's overhead panels are shown at ① and ②. ① contains the circuit breakers for the whole of the aircraft, whilst ② contains the engine control switches and fire handles, anti-icing switching, light switches, etc and other ancillary equipment. The pilot's central console, ⑦, holds the control units for the navigation and communication systems, weather radar controls and the control surface trim switches.

Forward of the centre console, mounted on a pedestal, are the engine thrust levers, manual trim control, speed brake control, and flap selector. To avoid inadvertent operation of the wrong control, each selector, lever and control knob is a different shape. In addition, some also have to be moved out of a definite detent for extra safety, but these are usually control levers that move flight critical components such as the flap lever.

The flight engineer's station, ⑧, at first glance, appears a mass of instruments and switches. However, these are laid out in a regular way, covering the many systems onboard an aircraft as well as the engine monitoring and control. Typically the upper flight engineer's panel is laid out with the *Auxiliary Power Unit (APU)* controls and electrical power switching and indicating systems to the left; oxygen, air conditioning, pneumatics and pressurisation controls in the centre; and hydraulics, fire protection and numerous warning lights to the right. The lower panel holds *secondary* engine instruments, the fuel system control and transfer and additional ancillary equipment displays, e.g. humidifier control, engine vibration, etc.

The circuit breakers, protecting all the aircraft systems, are located above the pilots on the flight deck roof ① and to the right of the flight engineer's station ⑧.

This type of aircraft requires a *minimum* of three crew; two pilots and one flight engineer. On extended routes, however, it is quite common for an extra pilot to fly with the aircraft to relieve crewmembers during these long flights. However, national and international law requires the crew that handled the aircraft on take-off must be the same crew that lands it.

## The Digital Flight Deck

This type of cockpit has revolutionised the flight deck of modern aircraft and was designed by Boeing in co-operation with 365 pilots from 29 different airlines, resulting in an aircraft cockpit that reduces the stress levels experienced by the flight crew. Figure 5.2 shows a typical layout of a digital EFIS equipped Boeing 747-400.

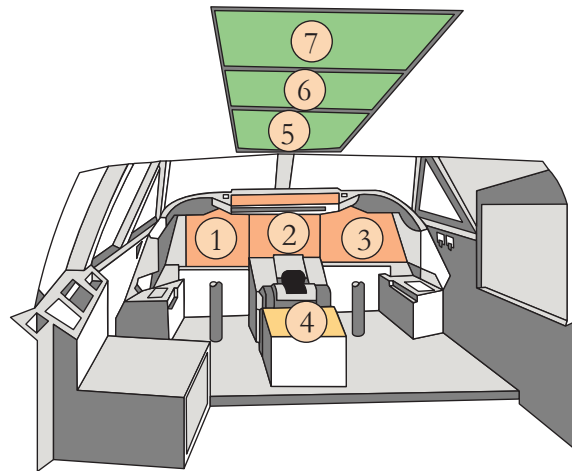


Figure 5.2 – Boeing 747-400 Flight Deck

As with the analogue flight deck, the Pilot sits in the left-hand seat, the First Officer in the right but with this aircraft there is no flight engineer's station. However, most of these flight decks also have two observer seats to accommodate the extra pilots needed for particularly long flights.

With this installation, all the mechanical instruments, excluding the small standby altimeter, standby air speed indicator and standby artificial horizon, have been replaced by six (6), eight by eight inch, i.e. 20 × 20 cm, **Cathode Ray Tubes (CRTs)**, mounted across panels ①, ② and ③.

These display computer generated pictures of the aircraft's primary flight data, (attitude, navigation information and system information). All the CRTs are identical and interchangeable and can operate in any of the six positions. All previous information, usually found in an analogue cockpit, **and more**, is still available but is presented on pages selected by the flight crew on the appropriate CRT.

However, it is still a legal requirement that the basic 'I' information is permanently displayed to the flight crew, and the two outboard tubes on each side of the cockpit are usually used for this purpose, figure 5.3.

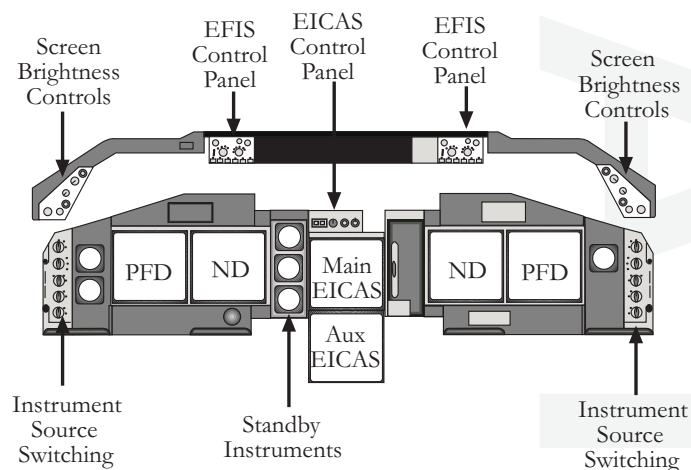


Figure 5.3 – Boeing 747-400 Flight Deck Panels

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As shown, there are some additional mechanical standby instruments on these panels with instrument source selector switches. The centre panel, ②, has two displays dedicated to the *Engine Indication and Crew Alerting System (EICAS)*. The upper screen usually displays primary engine data and any fault or emergency warnings, while the bottom displays secondary data, systems' status and, when selected, system synoptic displays, as in figure 5.3 above.

The introduction of these CRT displays has reduced the number of dials and switches on the Boeing 747-400 by two-thirds. Instrument displays alone have reduced from 132 - 13 and the main checklist from 187 - 61 entries. Modern digital techniques mean several operations are now fully automatic and the flight crew are only informed of a system's function if a problem occurs. Even then, non-critical faults are not necessarily displayed immediately and are sometimes stored for later display.

With the absence of a flight engineer, the digital, two-crew cockpit must have all controls and switches within reach of the pilot and first officer. Most radio and navigation controls are placed in the centre aisle stand, ④, while the overhead panels, ⑤, ⑥ and ⑦, replace the old flight engineer's station and has all of the major system control.

The flight crew does not routinely monitor these panels in flight, as the systems concerned are normally set before departure and function automatically throughout a flight. If a problem with one of the systems does occur, all necessary information automatically displays on the EICAS displays.

## Latest Developments

As shown in the previous figure 5.4, on aircraft like the Boeing 747-400 there are still some instruments that are analogue, e.g. standby instruments. On the latest aircraft, e.g. *Boeing 777, Airbus A320*, even these instruments have now been replaced with electronic displays, as illustrated in the following photograph of a Boeing 777 cockpit.



Figure 5.4 – Boeing 777 Cockpit



# Revision

## Questions

### Mathematics

- 1. The top half of a fraction is called the:**
  - a. Numerator
  - b. Denominator
  - c. Integer
  
- 2. To change a mixed number fraction to an improper fraction which operation is performed first?**
  - a. Add integer to numerator
  - b. Divide by denominator
  - c. Multiply Integer by denominator

### Physics

- 1. The centre of gravity of a square is at the:**
  - a. Bottom
  - b. Top
  - c. Centre
  
- 2. What is the formula used to calculate the gravitational force of a body?**
  - a. Mass  $\times$  Acceleration
  - b. Mass + Acceleration
  - c. Mass  $\div$  Acceleration

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## **Electrical Fundamentals**

- 1. What is the name of the sliding contacts that connect the loop to the external circuit?**
  - a. Armature
  - b. Brushes
  - c. Slip Rings
  
- 2. In a simple DC Generator at what degree of rotation will the terminal voltage be positive?**
  - a. At  $90^\circ$
  - b. At  $180^\circ$  and  $270^\circ$
  - c. At  $90^\circ$  and  $270^\circ$

## **Electronic Fundamentals**

- 1. What type of components do Integrated Circuits integrate?**
  - a. Positive
  - b. Negative
  - c. Both Positive and Negative
  
- 2. On an Operational Amplifier, which input is called the 'inverting' input?**
  - a. Positive
  - b. Negative
  - c. Either

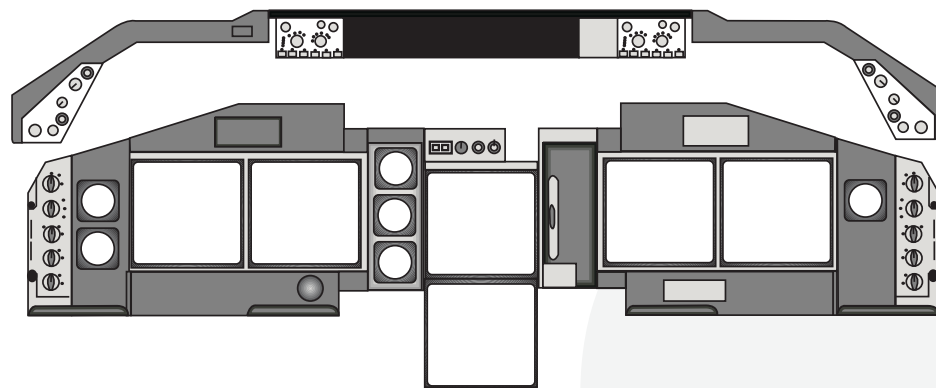
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## Digital Techniques/Electronic Instrument Displays

1. What type of components do Integrated Circuits integrate?

- a. Left-hand
- b. Right-hand
- c. Either

2. Where in the following diagram are the displays located?



Co-pilots  
PFD

Auxiliary  
EICAS

Primary  
EICAS

Pilots  
ND

Pilots  
PFD

Co-pilots  
ND

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# Revision

## Answers

### Mathematics

1. A
2. C

### Physics

1. C
2. A

### Electrical Fundamentals

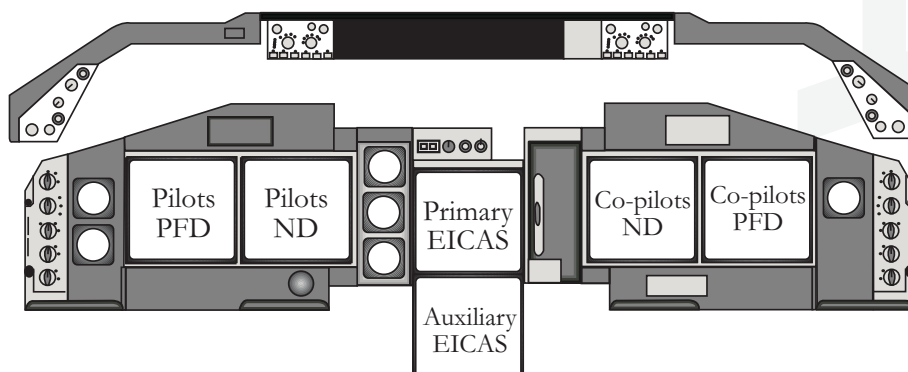
1. B
2. C

### Electronic Fundamentals

1. C
2. B

### Digital Techniques/Electronic Instrument Displays

1. A
- 2.



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