UNIT 5 - AERODYNAMIC FORCES

WEIGHT

Newton's equation of weight states that the gravitational forces between to objects depend on the mass of those objects and the inverse of the square of the distance between them:

$$F = G\,\frac{m_1 \cdot m_2}{d^2}$$

Where *G* is the gravitational force on earth (9.8 m/s^2), m_1 and m_2 the two masses (in kg) and *d* is the distance, (in metres). This can be re-written as

$$W = m \cdot G$$

Weight is a vector quantity meaning it has both magnitude and direction. For an aircraft, we can consider this force the sum of the mass of the aircraft itself, plus the fuel and traffic load or payload (passengers, baggage and weight) which acts through a single point called the center of gravity or CG.

THRUST TO WEIGHT RATIO

For example, the T/W ratio of an Airbus A320 can be calculated as follows:

Conditions:

Sea level (ISA) static thrust at full power, (2 x CFM56-5A engines) 111.2 kN x 2 engines = 222.4 kN, with a Maximum Takeoff Weight (MTOW) of 73 500 kg and force of gravity at 9.8 m/s^2:

$$\frac{T}{W} = \frac{222\,400\ \text{N}}{(73\,500\ \text{kg})\ (9.8\ \text{m/s}^2)} = 0.3087$$

Aircraft have a thrust to weight ratio that is less than 1, this is due to the lift to drag ratio being greater than one. In essence, less thrust or power is required to lift the aircraft off the ground than its weight. Rockets and military jets have T/W ratios greater than 1 due to the required thrust for manoeuvring or liftoff in case of rockets.