Propulsion:

It is act of changing the motion of body (or) creating force leading to movement.

A word propellere derived from latin words.

Pro - after (or) forward

Pellere - drive

Propulsion System:

Source of mechanical power and converting into propulsive power.

Jet Propulsion:

Means of locomotion whereby a reaction force is imparted to a device by the momentum of ejected matter.

1. Rocket Propulsion:

Produce thrust by ejecting stored matter called propellant.

2. Duct Propulsion:

It is mostly utilize the surrounding medium as working fluid, together with some stored fuel.

# Rocket Propulsion Classification!

On basis source of Energy

1. Chemical Rockets
2. Solar Rockets
3. Nuclear Rockets
4. Electric Rockets

On basis of Propellent

1. Liquid Propellant Rocket
2. Solid Propellant Rocket
3. Hybrid Propellant Rocket

On basis of application

1. Booster Rocket
2. Sustainer Rocket
3. Retro Rocket
4. Weather (or) Sounding Rocket
5. Military Rockets.

On basis of types Vehicle

1. A/c Propulsion
2. Ram Jet Rockets (or) assisted take off
3. Space Rocket

On basis of number of Stage

1. Single Stage
2. Multi Stage

On basis of size & Range

1. Short range & small Rocket
2. long range & large Rocket

Definitions:

Total Impulse is the thrust force F (which can vary with time) integrated over the burning time t.

$$I_t = \int_0^t F\,dt$$

For constant thrust and negligible start & stop transients.

$$I_t = F t$$

$I_t$ is proportional to total energy released by all the propellant in the propulsion system.

Specific Impulse: ($I_s$)

It the total impulse per unit weight of propellant

$$I_s = \frac{\int_0^t F\,dt}{g_0 \int \dot{m}\,dt}$$

$\dot{m}$ Total mass flow rate of propellant

$g_0$ Standard acceleration due to gravity

The above equation gives the time averaged specific impulse value for any rocket propulsion system

For Constant thrust & Propellant flow, the average value of F & ṁ for short time intervals, taken consideration.

$$I_s = \frac{I_t}{m_p g_0} = \frac{I_t}{w}$$ unit is "second"

$$I_s = \frac{F}{\dot{m} g_0} = \frac{F}{\dot{w}}$$

Effective exhaust velocity: c

It is the average equivalent velocity at which propellant is ejected from the vehicle.

$$c = I_s g_0 = \frac{F}{\dot{m}}$$

Specific Propellant Consumption

It is the reciprocal of the specific impulse.

Mass Ratio: (MR)

It is defined to be the final mass $m_f$ (after rocket operation has consumed usable propellant) divided by $m_0$ (before rocket operation) of the vehicle or particular stage.

$$MR = m_f / m_0$$

MR can vary from 60% for some tactical missiles & less than 10% for some unmanned launch vehicle

$m_f$ - final mass

$m_0$ - initial mass

Propellant mass fraction

$$\zeta = m_p / m_o$$

$m_p$ - Propellant mass

It is a fraction of Propellant mass $m_p$ in an initial mass $m_o$.

Where

$m_o = m_f + m_p$

$$\zeta = \frac{(m_o - m_f)}{m_o}$$

$$\zeta = \frac{m_p}{(m_p + m_f)}$$

Impulse to weight ratio.

It is defined as the total impulse "$I_t$" divided by the initial or Propellant-loaded Vehicle Weight "$W_o$"

$$\frac{I_t}{W_o} = \frac{I_t}{(m_f + m_p) g_o}$$

Thrust to weight ratio:

It is defined as the ratio of thrust F to the initial or Propellant-loaded Vehicle Weight $W_o$

$$= \frac{F}{W_o} = \frac{F}{m_o g_o}$$