DEPARTMENT OF AEROSPACE ENGINEERING

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Year & Branch	:	**II AEROSPACE**	Semester	:	**IV**
Course	:	**23ASB201 - Aerospace Propulsion**			

UNIT VI - FUNDAMENTALS OF ROCKET PROPULSION

History and Basic Configurations of Rockets

This timeline looks at some of the historical aspects of rockets – taking science and technology to new heights.

1232 – Chinese fire arrows

The first true rocket is invented by the Chinese. Fire arrows are used against the Mongol invaders.

1591 – First multi-staged rocket

German fireworks maker Johann Schmidlap invents the two-stage rocket to reach higher altitudes. A large skyrocket (first stage) carries a smaller rocket (second stage).

1687 – Newton's laws of motion published

Sir Isaac Newton published his book Principia, which contains his three laws of motion and lays the scientific foundations for modern rocketry.

1792 and 1799 – Rocket revival

Indian rockets used against the British caught the attention of Colonel William Congreve. Rockets are subsequently designed for military use by the British military.

1844 – Spin stabilisation invented

Jet vents are designed on an angle, making the rocket spin, much like a bullet, making them more stable and accurate.

1898 – Space exploration proposed

Russian schoolteacher Konstantin Tsiokovsky puts forward the idea of using rockets for space exploration. He suggests liquid propellants would gain greater range.

1926 – Successful liquid-propellant rocket

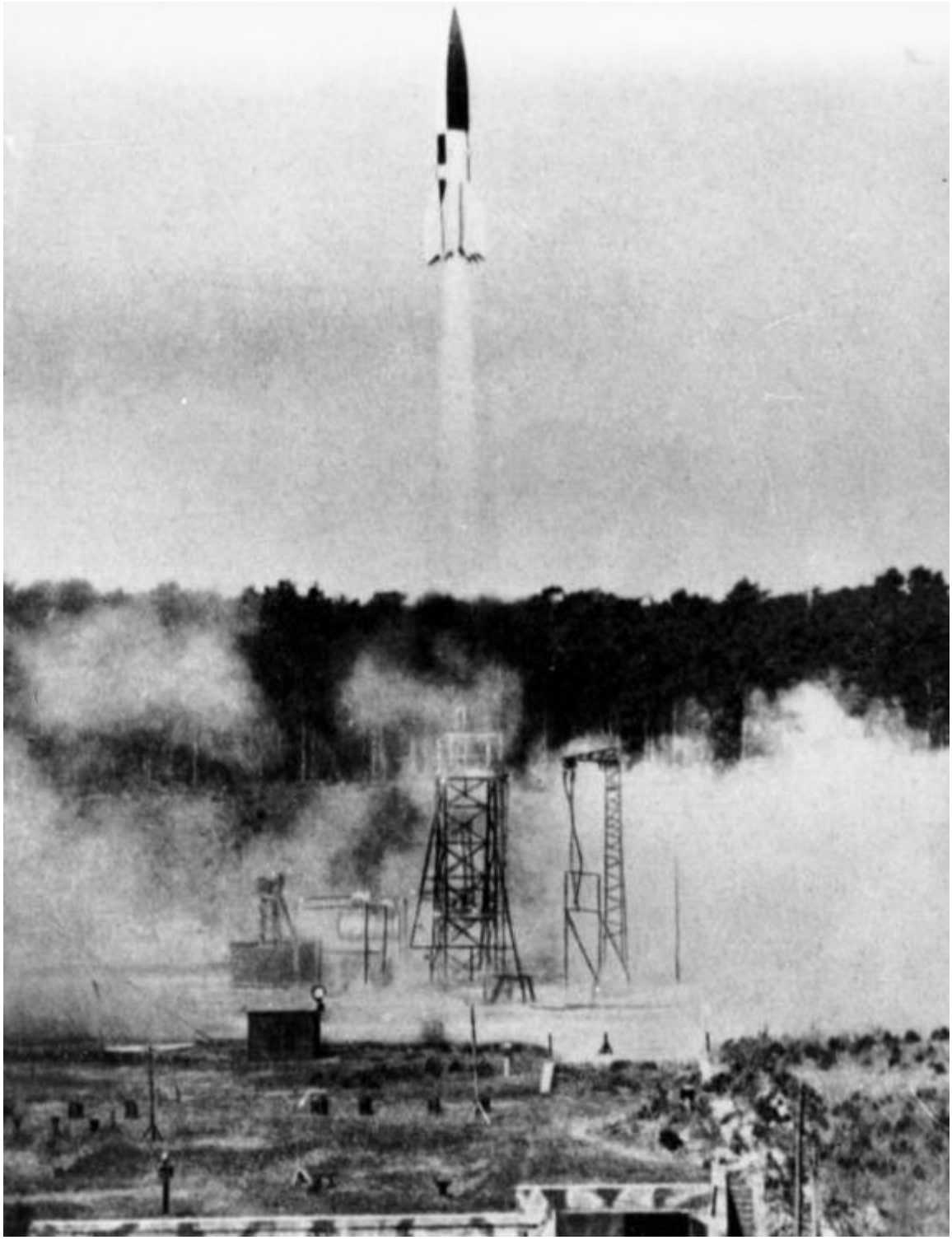
In March 1926 American Robert H Goddard flew a rocket powered by liquid oxygen and gasoline. Goddard goes on to build bigger rockets and higher rockets.

1929 – First manned rocket flight

Fritz von Opel became the first person to fly a rocket-propelled plane in Germany – the Opel RAK.1.

1942 – V-2 rockets

Ballistic missiles are developed by German engineers led by Wernher Von Braun during the Second World War. They burn a mixture of oxygen and alcohol at a rate of 1 ton every 7 seconds. This is the first rocket capable of reaching space.



1946 – First atmospheric testing

With the help of captured German rocket engineers, the United States began using V-2 rockets as sounding rockets to make measurements of the atmosphere at high altitudes. Little was known of the atmosphere before this.

1950s – Intercontinental ballistic missiles

A variety of medium and long-range missiles are developed and became the starting point of the US space program. Missiles like Redstone, Atlas and Titan would eventually launch astronauts into space.

4 October 1957 – First satellite – Sputnik 1

The Soviet Union launches the first Earth-orbiting artificial satellite. This marks the first significant success of the space race between the world's two superpowers.

January 1958 – First American satellite launches

Jet Propulsion Laboratories launch Explorer 1, America's first satellite. New Zealander Sir William Pickering is the director of JPL.

October 1958 – NASA founded

The United States formally organizes its space program and calls it the National Aeronautics and Space Administration.

January 1959 – Russian Luna 1 probe to the Moon

The successful launch of Luna 1 by the Russians, which sees the rocket fly past the moon.

February 1959 – The first weather satellite launched

The Vanguard 2 satellite is used by scientists to forecast the weather.

April 1961 – First man to orbit Earth

Russian Yuri Gagarin becomes the first man to orbit Earth.

February 1962 – First American to orbit Earth

John Glenn orbits the earth in a capsule packed with so much equipment there is sitting room only.

July 1962 – Mariner probes to Venus

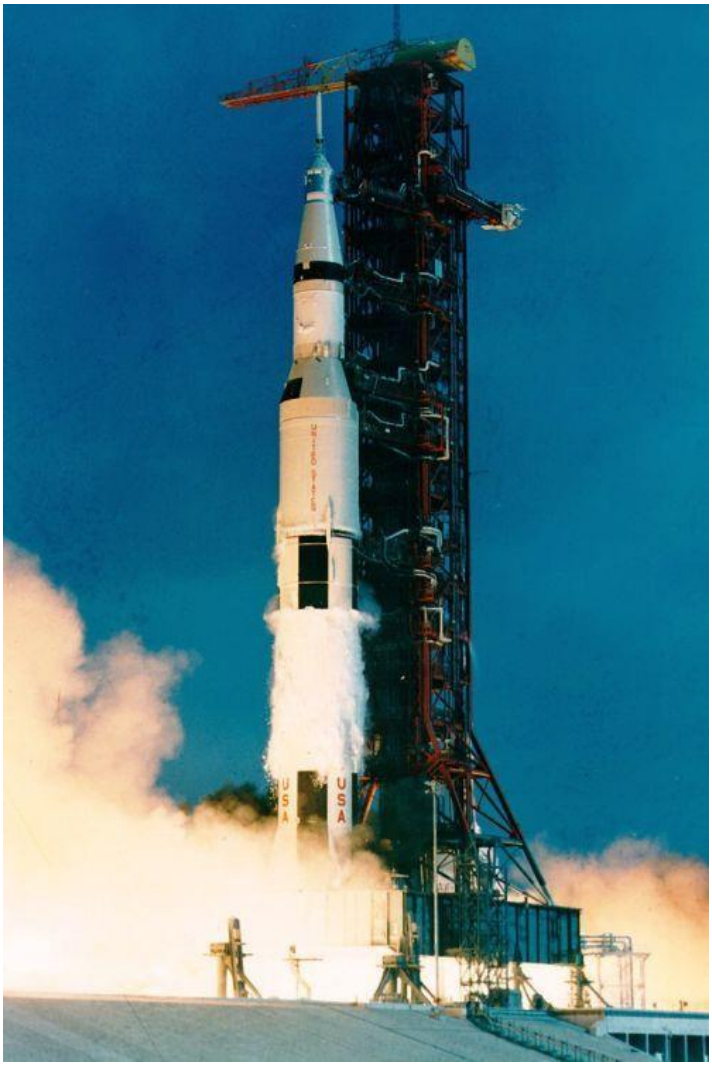
The first successful interplanetary probes are launched. Two Mariner probes travel to Venus.

1961 to 1966 – Ranger series

A series of nine probes was sent to the Moon to take photos of the lunar surface in preparation for a Moon landing.

1969 – Moon landing

Apollo 11 is the first space flight to land people on the Moon. Neil Armstrong is the first astronaut to set foot on the Moon. Twelve astronauts walk on the Moon during 6 missions. Ed Cernan was the last man to step foot on the Moon in 1972.



April 1981 – First Space Shuttle launch

NASA launches its first Space Shuttle. These are designed as reusable vehicles that would increase accessibility to orbit. Space Shuttles have been used to place many satellites into orbit

and to construct the International Space Station. The final space shuttle was launched in July 2011.

10 Dec 2010 – First private launch into Earth orbit

SpaceX, a private company working towards commercial space travel, launches Falcon 9. This unmanned capsule orbits the Earth twice before landing in the Pacific Ocean.

5 August 2011 – Juno launches to Jupiter

Juno is launched to begin its 5-year journey to Jupiter. It arrived in orbit around Jupiter in July 2016 and has been beaming back data and observations since then.

Beyond 2000 – On-going space exploration

Countries and organizations continue to send probes and make plans to send people to the Moon, Mars, and beyond. These include Japan, the European Space Agency, India, China, Russia and the USA.

2012 onwards – Private companies

Private companies, such as Space X, Orbital ATK, Virgin Galactic, and New Zealand company Rocket Lab, are increasingly active in the space industry.

25 May 2017 – World's first private orbital launch site in NZ

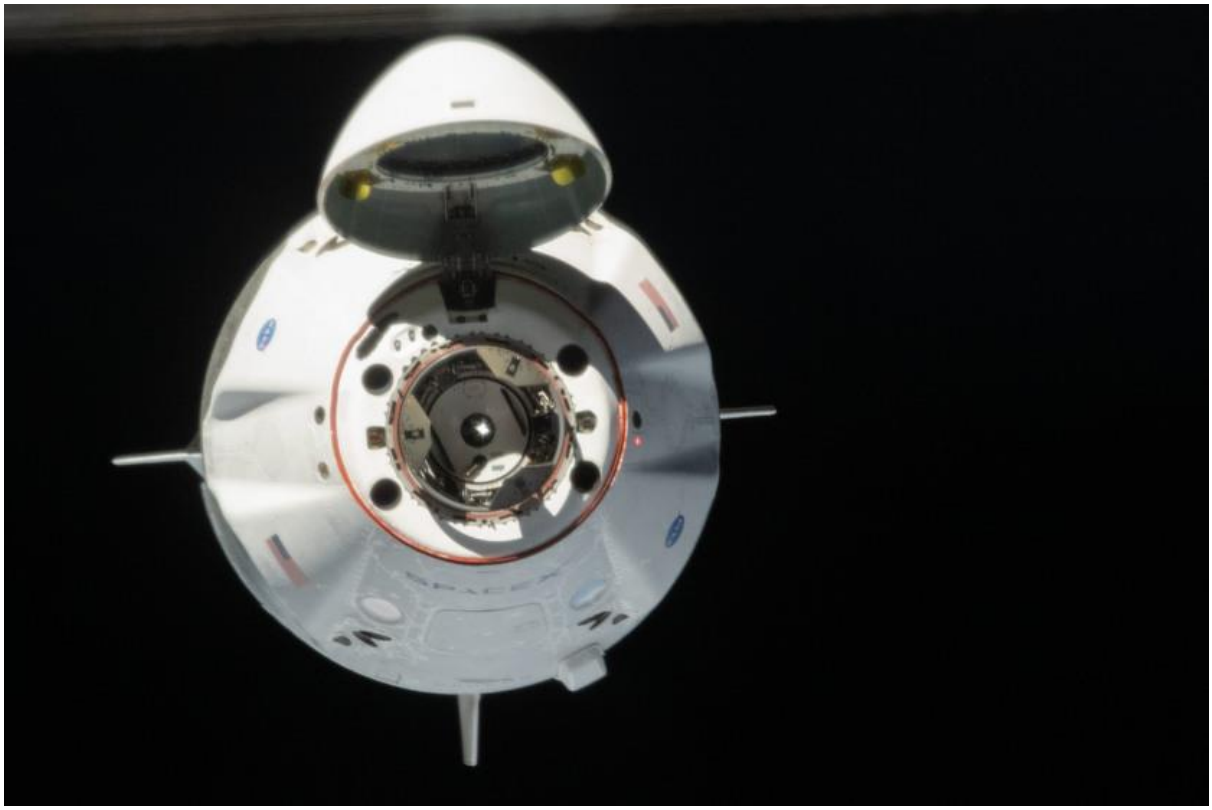
Rocket Lab launches its Electron rocket from its Māhia Peninsula-based orbital launch site, in New Zealand. Rocket Lab is only the 3rd private company in the world to launch a rocket into space and their Mahia facility is the world's first private orbital launch site.

11 November 2018 – First commercial rocket launch from New Zealand

Rocket Lab achieves its first commercial deployment from Mahia. 'It's Business Time', took off at 4.50 pm on Sunday 11 November. It lifted 6 satellites and a technology demonstrator into low Earth orbit.

30 May 2020 – First launch of a private crewed flight

Private company Space X, in partnership with NASA, launches a 2-person crewed spacecraft, Dragon 2 to the International Space Station (ISS).



9 February 2021 – The Middle East enters the Martian space race

The United Arab Emirates Space Agency's Hope orbiter reaches Mars orbit in February and begins collecting data to get a complete picture of the Martian atmosphere and its layers.

19 February 2021 – NASA lands another rocket on Mars

The NASA rover Perseverance lands on Mars as part of an epic quest to bring back rocks that could tell whether life ever existed on the red planet.

14 May 2021 – Chinese rover lands on Mars

China National Space Administration successfully landed the rover Zhurong on Mars, making China the second nation to land on Mars, after the USA.

11 July 2021 – Virgin Galatic space flight

Billionaire Sir Richard Branson and his crew successfully reach the edge of space on board the Virgin Galactic rocket plane – becoming the first of the new space tourism pioneers to try out their vehicles.

12 November 2024 – Dawn Aerospace sets global record

Dawn Aerospace's Mk-II Aurora rocket-powered aircraft becomes the fastest aircraft to climb from ground level to 20 km. Other firsts include the first New Zealand-designed and built aircraft to fly supersonic and the highest altitude achieved by an aircraft flying from New Zealand – an apogee of 25 km.

Configuration

A basic rocket configuration typically includes a structure (body), payload, guidance system, and a propulsion system (rocket motor).

Here's a more detailed breakdown:

- **Structure (Body):**

This forms the framework of the rocket, including the cylindrical body, fairings (protective coverings), and fins for stability.

- **Payload:**

This is the cargo the rocket carries, such as satellites, probes, or spacecraft.

- **Guidance System:**

This system ensures the rocket follows the desired trajectory, using sensors and computers to make course corrections.

- **Propulsion System:**

This system provides the thrust needed to propel the rocket, typically through a rocket motor.

- **Rocket Motors:** These are the engines that burn propellant to create thrust.
- **Propellant:** Rockets use either solid or liquid propellants, which are fuels and oxidizers that burn to produce high-pressure gases that are expelled through a nozzle.
- **Nozzle:** The nozzle directs the exhaust gases, creating thrust and propelling the rocket forward.