Introduction to Launch Vehicle Analysis and Design

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Lecture - 01

Introduction

Hello, and welcome to the NPTEL course on Introduction to Launch Vehicle Analysis and Design. It is my pleasure to be with all of you in this journey, which you are going to have from today for a period of eight weeks. I am Ashok Joshi, the instructor for the course and I will talk about an important discipline which currently is also a hot topic; how do we put together a launch vehicle?

So that is as someone would say, begin at the beginning and with that object in mind, I would first like to introduce briefly the overall philosophy of this object that we are going to deal with.

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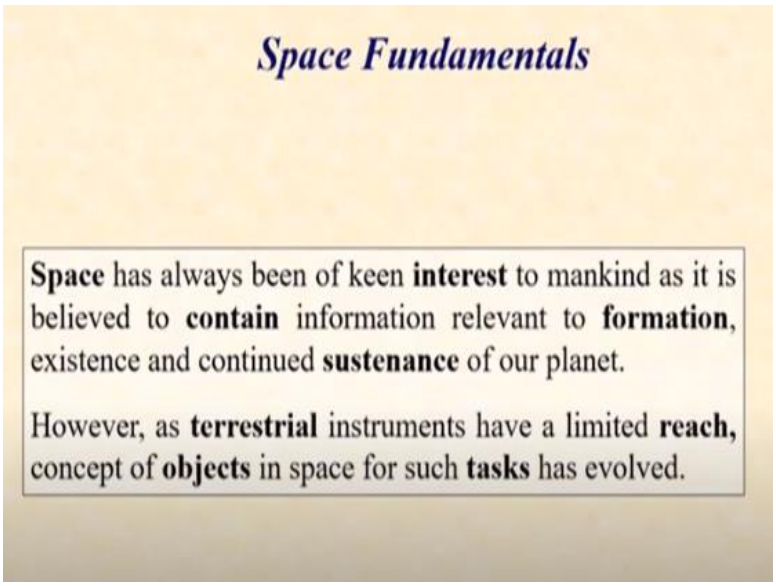

So let us first look at the fundamentals of the space itself. Of course, space has always been of keen interest to all of us and it is believed that it contains information relevant to the formation, existence, and continued sustenance of our planet. However, as terrestrial instruments have a limited reach, the concept of objects in space for such tasks has also evolved over a period of time.

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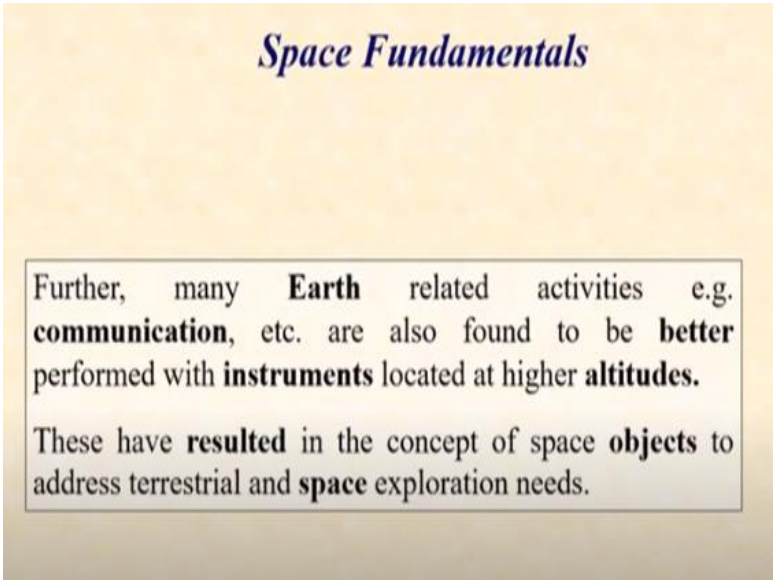

While space objects are lot more visible, people have also realized that many Earth related activities such as communication are also better performed with instruments located at higher altitudes. In fact, this particular philosophy is clearly evident in many of the communication towers, which are mounted on higher locations, so that they can have better visibility or better range over Earth.

Of course, with space, we have taken this idea to several higher levels. And this has resulted in the concept of space objects, which address not only the space exploration needs, but also address the various kinds of earthbound or terrestrial needs.

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Of course, it is very interesting and useful to trace how the various things have evolved over a period of time. What is visible currently to us is the scenario over the last 70 years or so that we can relate to. It is also noteworthy that the initial efforts were simultaneous in Russia, USA and Germany. Of course, after World War II these countries went their own way and mounted their own ambitious space research programs.

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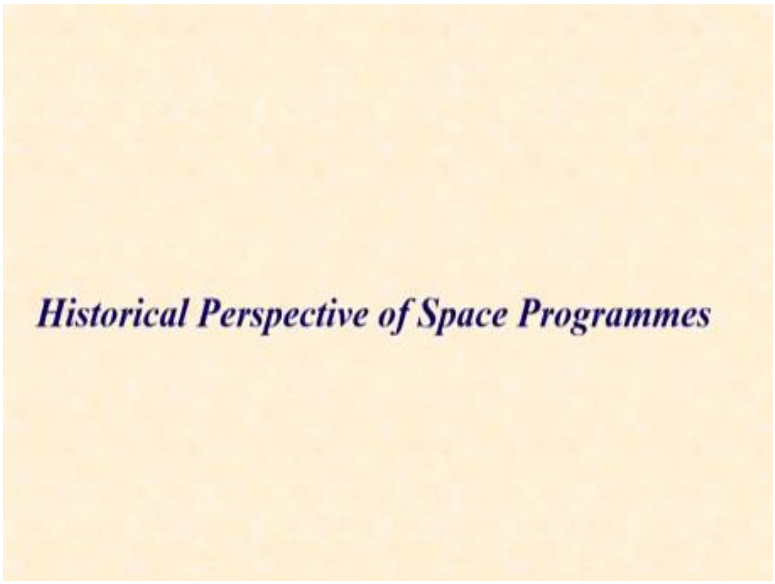

Let us take a quick look at the history of how the space programs have evolved and understand some of the things that we are currently looking at.

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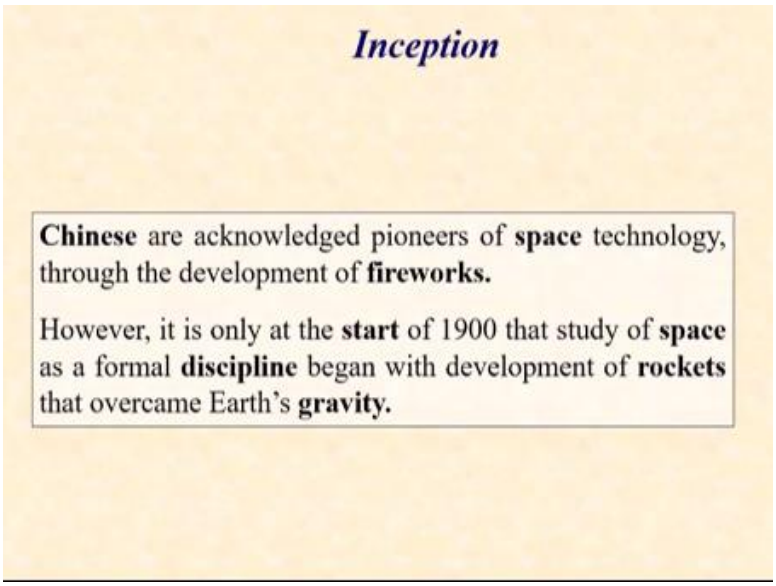

So, the inception, or the beginning is generally attributed to Chinese with the development of fireworks, which happened there. Of course, it is only at the beginning

of 1900 that the study of space as a formal discipline began. And that was the time when rockets came into being. And the main objective was that can you overcome the Earth's gravity.

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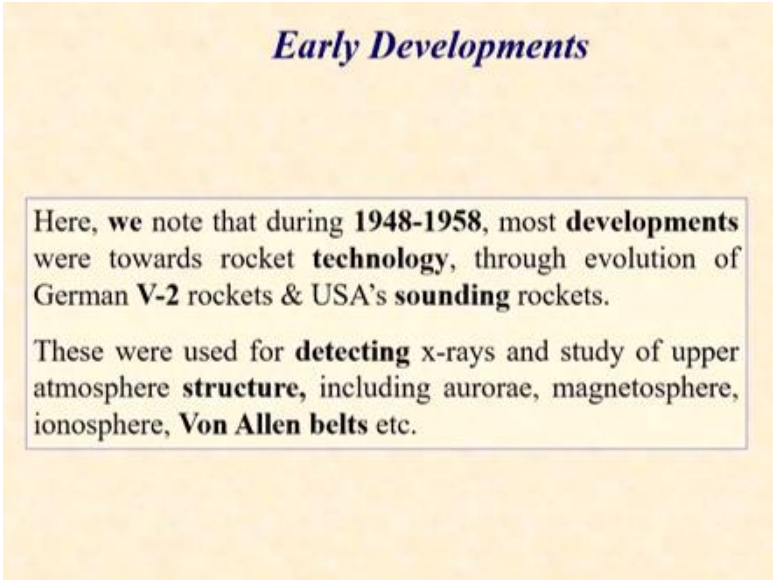

These things continued in the experimental form, until we reached the decade 1948 to 1958, where the evolutions were lot more focused, particularly with German V-2 rockets, and USA's sounding rockets, which came into being and became quite popular and visible. These rockets are primarily used for detecting x-rays and study of upper atmosphere structure including aurorae, magnetosphere, ionosphere, Von Allen belts, etc.

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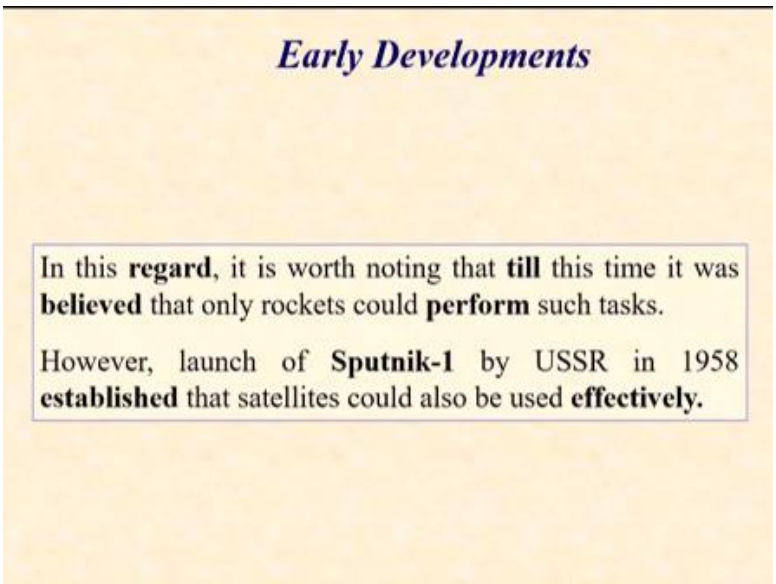

Of course, it is worth noting here, that until this time, there was a belief that only rockets could perform such tasks. And that is why you would notice that in the initial stages, most of the space missions were restricted to rockets. However, this particular belief was broken. When USSR in 1958, launched Sputnik-I, and established the fact that satellites could also be used effectively.

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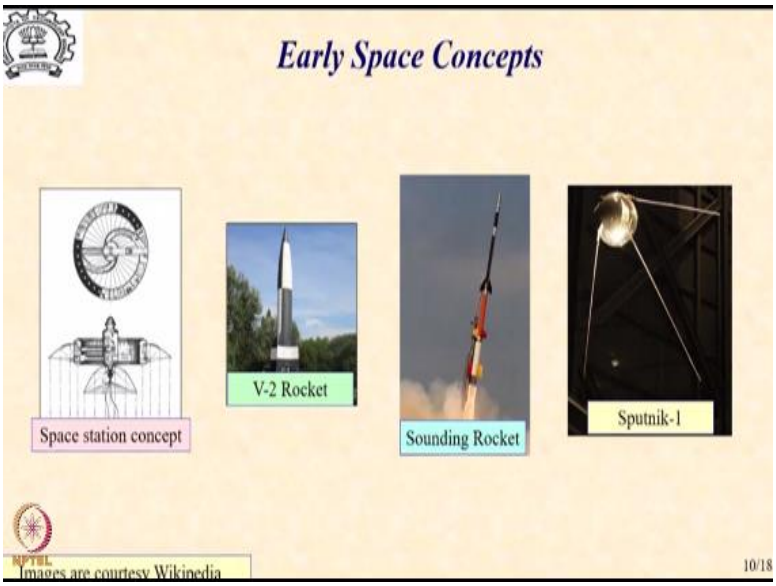

I just want to show you couple of early images of the space objects that were created. So, you have in the middle, the V-2 rockets and the sounding rocket. And then of course, on the extreme right you have the Sputnik. But interestingly, around the same time, they were also a realization of much bigger and much more sophisticated objects such as space station, which were only in the conceptual stage at that time. But people had started thinking along those lines.

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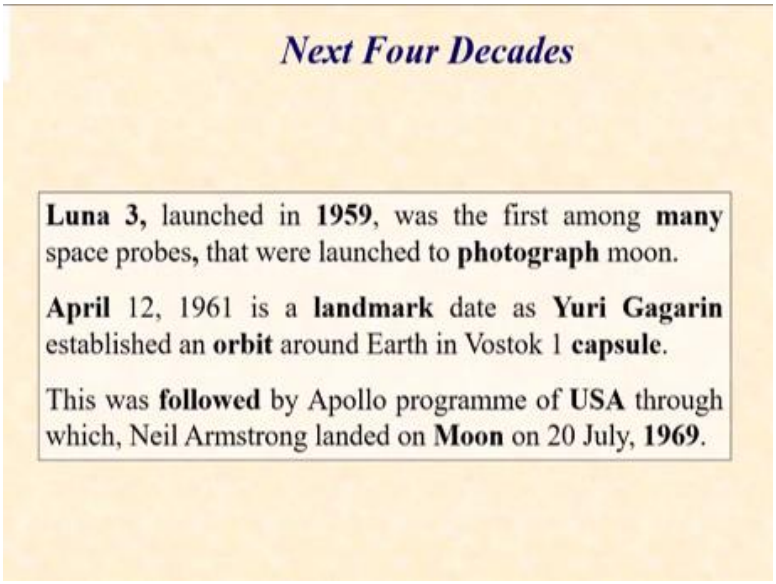

The next four decades that is 1960 to 2000 were very productive in space technology starting with Luna 3, which was launched in 1959, one of the many space probes that were launched to photograph moon. Of course, all of us remember this date, April 12, 1961 is a landmark as Yuri Gagarin established an orbit around Earth in Vostok 1 capsule and which paved the way for humans in space.

Of course, this was followed by the Apollo program of USA, through which Neil Armstrong landed on moon on 20th July 1969. And then really the development became fast paced.

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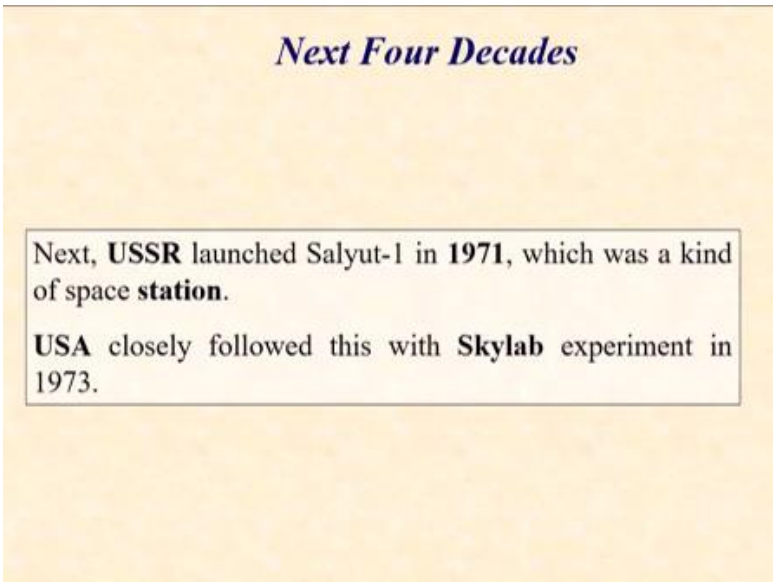

Within two years, USSR launched Salyut-1. It was kind of a space station. It was not exactly conforming to the concept that was evolved earlier. And the US closely followed this with Skylab experiment in 1973.

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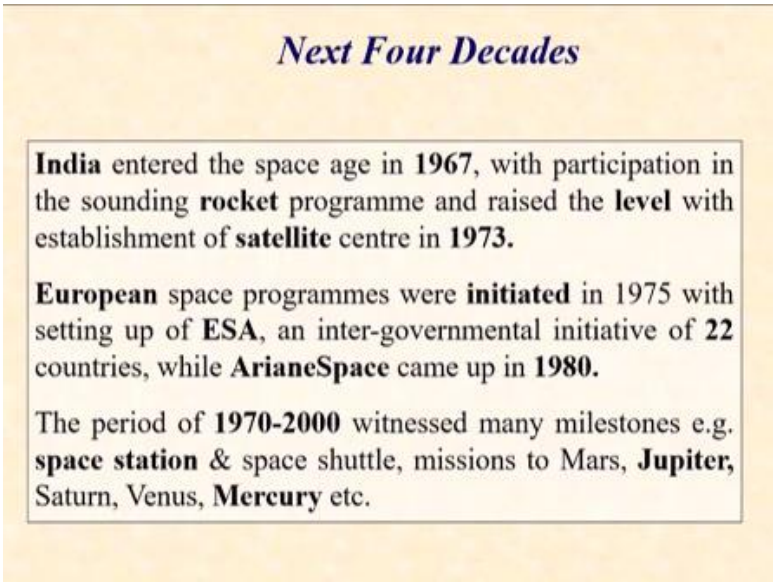

Of course, the India was a late starter in the space age and entered it in 1967 and even at that time, it was with participation in the sounding rocket program of the US. So initially we were only launching the sounding rockets from what was then called TERLS that is TERLS pronounced TERLS or called Thumba Equatorial Rocket Launch Station. It was on the coast where currently now our Vikram Sarabhai Space Center sits.

Of course, we raised the level in 1973, with establishment of satellite center. And then of course, many other centers of ISRO started coming up. It is also worth noting how these things evolved in Europe. So European space programs actually started later than ours that is in 1975 with the establishment of the European Space Agency, which is an inter-governmental initiative of 22 countries, while the ArianeSpace, a private player in US came up in 1980.

Of course, this period of 1970 to 2000, witnessed many milestones, there was space station and space shuttle, missions to Mars, Jupiter, Saturn, Venus, Mercury, etc.

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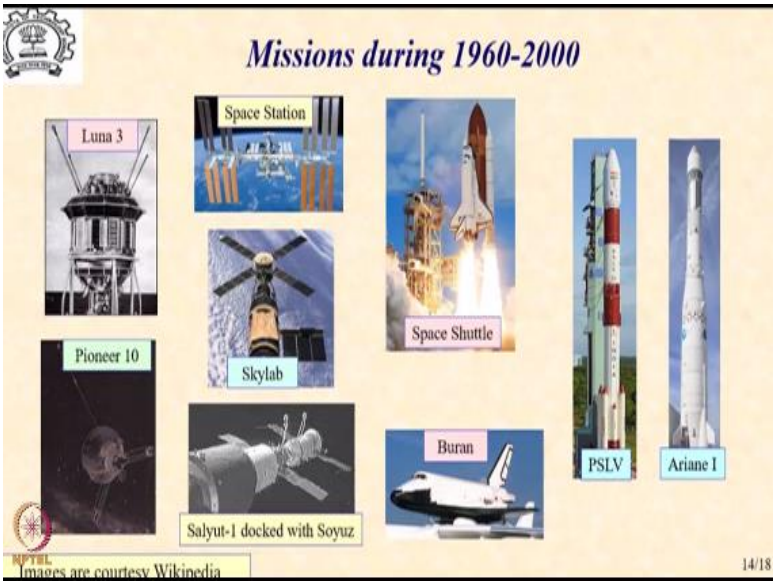

So, I just thought I will give you a snapshot of the various objects that came into being and also sustained themselves. These images that I have taken are all courtesy Wikipedia.

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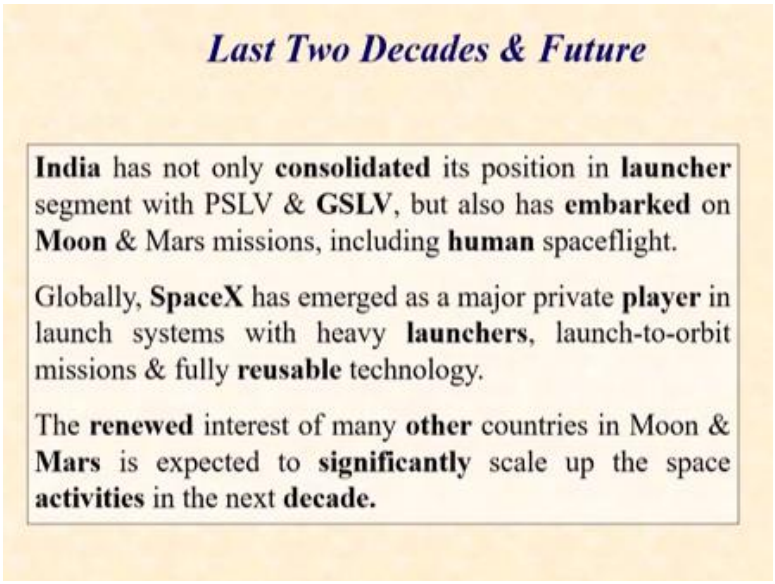

So let us look at more closely over the last two decades and what future holds for the space technology. Of course, all of us know that India has not only consolidated its position in launcher segment with PSLV, GSLV, GSLV Mark III, but has also embarked on Moon and Mars missions, including human spaceflight.

Globally of course, we have also seen that SpaceX has emerged as a major private player in launch systems with heavy launchers, launch-to-orbit missions, and fully usable technology. So, the renewed interest of many other countries in Moon and Mars,

and other planets of course, is expected to significantly scale up the space activities in the next decade.

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So here we have Falcon 9 Heavy from SpaceX, their concept of Starship Hopper, Orion spacecraft, USA's Delta IV heavy rocket, India's GSLV and so on.

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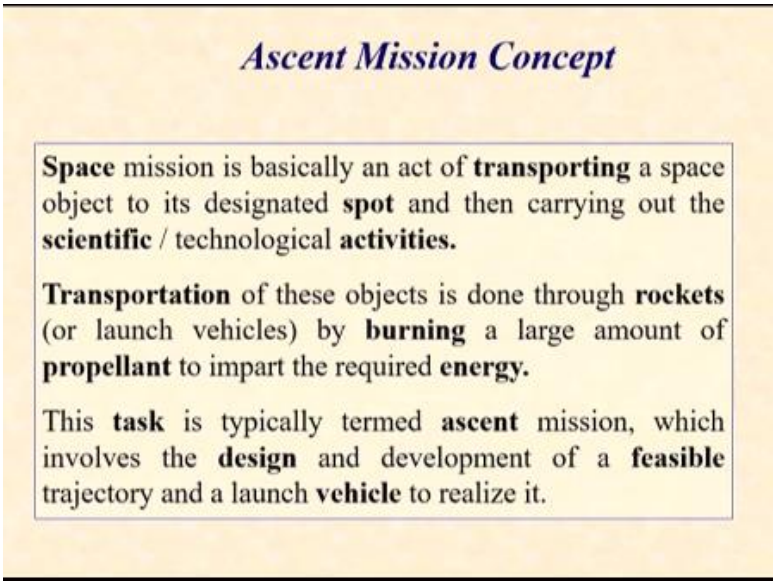

And this brings us to the first step of what is the primary objective of the present course that is the ascent mission. So, if you look at the space mission, I am sure you would have seen a large number of videos and other material. It is basically an act of transporting a space object which we typically call satellite, spacecraft, space-station are different terminologies, to its designated spot in space.

And then carry out scientific, technological activities such as exploration, communication, etc. Of course, we also know that transportation of these objects is done through rockets, also called launch vehicles by burning a large amount of propellant to impart the required energy.

So, this task of burning a large amount of propellant to impart the required energy is typically termed ascent mission, which involves the design and development of feasible trajectory that is the flight path of the object and a vehicle which would make it a reality.

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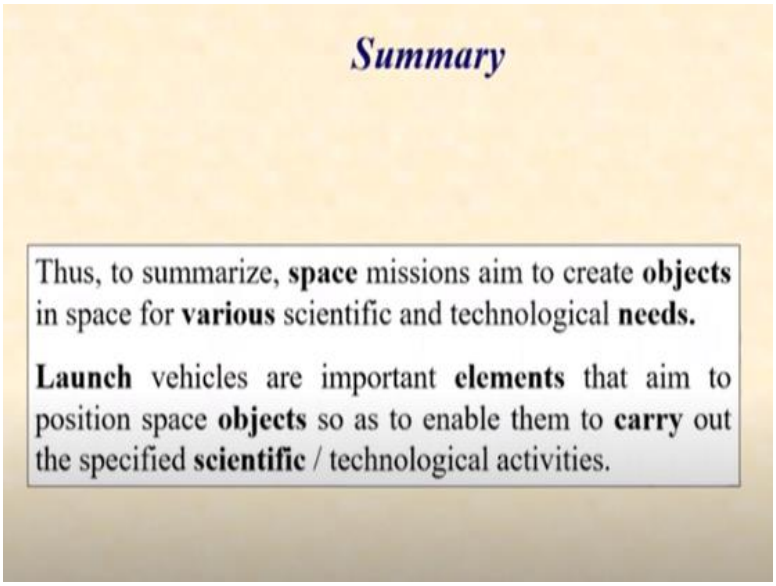

So, to summarize, space missions aim to create objects in space for various scientific and technological needs. Launch vehicles are important elements that aim to position space objects, so as to enable them to carry out the specified scientific and technological activities. So, we have come to this introduction to the subject. We will next look at the aim and scope of the present course. So, bye and see you in the next lecture. Thank you.