D.B.F. Dayanand College of Arts and Science, Solapur

Department of Geology

B.Sc. III

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Subject	**GEOLOGY**
Paper No. and Title	**Paper – XVI Applied Geology Part – II**
Module (Flipped classroom) Title	**RS-1**
Module Tag	**DAYA.GEO.VMD1**
Key words	**Remote Sensing**

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Module No. 1

Title – Concept and applications of remote sensing

- **Prerequisites –**

Remote sensing has a strong connection with basic concepts of physics.Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth. Some examples are:

- Cameras on satellites and airplanes take images of large areas on the Earth's surface, allowing us to see much more than we can see when standing on the ground.
- Sonar systems on ships can be used to create images of the ocean floor without needing to travel to the bottom of the ocean.
- Cameras on satellites can be used to make images of temperature changes in the oceans.

Some specific uses of remotely sensed images of the Earth include:

- Geological, geomorphological, lithological etc. mapping.
- Mapping for natural disaster prediction and management.
- Tracking clouds to help predict the weather or watching erupting volcanoes, and help watching for dust storms.
- Tracking the growth of a city and changes in farmland or forests over several years or decades.
- Discovery and mapping of the rugged topography of the ocean floor (e.g., huge mountain ranges, deep canyons, and the “magnetic striping” on the ocean floor).

- **Learning outcome:**
  - Develop critical understanding of basic principles of photogeology and remote sensing.
  - Understand various components of remote sensing.
  - Understand the various applications of remote sensing and GIS.

- **Objectives of the Module**

  Students should learn about the details of the meaning and concepts in remote sensing.

Content	Objectives (Learner should be able to)	Cognitive Level
Definition Introduction and applications	Definition and meaning of remote sensing	Remembering
	Fundamental concepts and components of remote sensing	Remembering
	Applications of remote sensing in various fields of studies	Remembering
	Visualization method	Applying
	Proper thought process	Understanding
	Asking question and some simple concept	Evaluating

Table of Content:

1. INTRODUCTION

Geology and various other domains require data collection in the field, which is time consuming. However, quick, economic and comprehensive method of acquisition of geospatial data through a modern tool like remote sensing is possible in the last four decades. This course introduces students to the basic physical principles behind remote sensing technology to efficiently use it for different earth resources applications. In this module, the basic concepts, advantages, components, process and applications of a typical remote sensing program is discussed.

2. DEFINITION AND CONCEPT

As the name suggests, remote sensing is a method of collecting information about any ground object under investigation from a distance without being in contact. There are many definitions found in the literature, however, the most accepted definition was given by the American Society for Photogrammetry and Remote Sensing in 1988. Accordingly, Remote Sensing can be defined as *"The art, science and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from non-contact sensor systems."*

In much of remote sensing, the process involves an interaction between incident radiation and the targets of interest. This method of data collection typically involves aircraft-based and satellite-based sensor technologies, which are classified as either passive sensors or active sensors.

3. ADVANTAGES AND LIMITATIONS

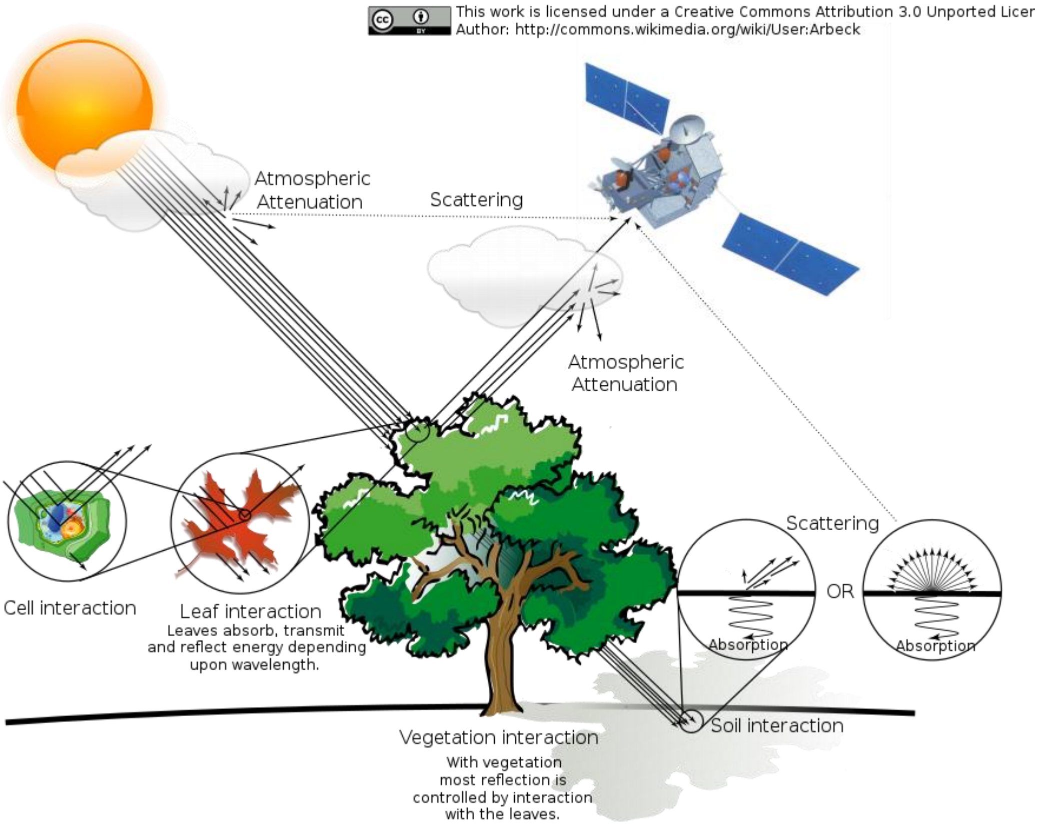
Advantages:

A. **Synoptic Overview:** The remote sensing images provide a synoptic overview or bird's eye view of a larger area, enabling us to study the relationship among different ground objects and delineation of regional features/trends.
B. **Feasibility Aspects:** Due to inaccessibility to ground survey in many parts of the terrain, remote sensing is the only scientific method for data collection.
C. **Time Saving:** Remote sensing saves time and manpower as larger area can be covered by this technique.

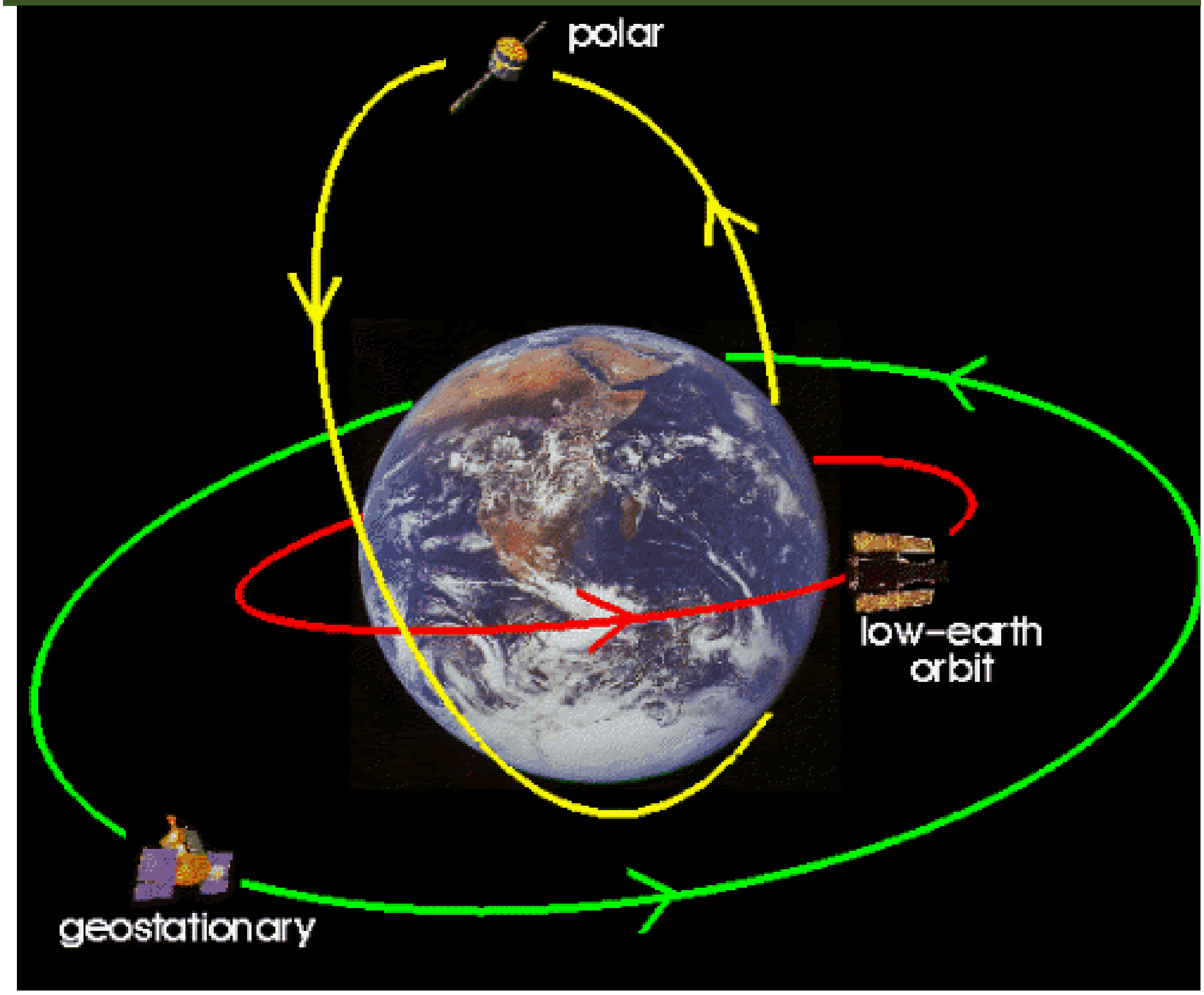
D. **Unobtrusiveness:** If the remote sensors collect the information passively by recording the electromagnetic energy reflected or emitted by the ground object, the area of interest is not disturbed. It also ensures collection of information in its natural state.
E. **Systematic Data Collection:** Remote Sensing devices collect the information of the ground surface in a systematic manner with a specific time interval, removing the sampling bias introduced in some in situ investigations.
F. **Derivation of Biophysical Data:** Under controlled conditions, remote sensing can provide fundamental biophysical information, e.g., location, elevation, temperature, moisture content, etc.
G. **Multi-disciplinary Applications:** The same remote sensing data may be used by researchers or workers from different disciplines, e.g., geology, forestry, agriculture, hydrology, planning, defense, etc. and therefore, increase the overall benefit-to-cost ratio.

Limitations:

A. **Understanding limit of application:** The greatest limitation of this technique is that its utility is often oversold. Remote Sensing alone cannot provide all the information needed for any scientific study. The applicability of these tools and techniques are limited to selection of appropriate sensors, its resolutions, time of data collection and appropriate post-processing operations.
B. **Expensive technique:** The collection and interpretation of remote sensing data is expensive, as it requires specific instrumentation and skills. However, the enormous advantages of this technique overrule this limitation



4. TYPES OF SATELLITE



A. A **Geostationary** satellite is an earth-orbiting satellite, placed at an altitude of approximately 35,800 kilometres (22,300 miles) directly over the equator, that revolves in the same direction the earth rotates (west to east). At this altitude, one orbit takes 24 hours, the same length of time as the earth requires to rotate once on its axis. The term geostationary comes from the fact that such a satellite appears nearly stationary in the sky as seen by a ground-based observer.

B. A **polar orbit** is one in which a satellite passes above or nearly above both poles of the body being orbited on each revolution. It has an inclination of about 60 – 90 degrees to the body's equator. A satellite in a polar orbit will pass over the equator at a different longitude on each of its orbits.

C. A **low Earth orbit** (**LEO**) is an Earth-cantered orbit close to the planet, often specified as an orbital period of 128 minutes or less (making at least 11.25 orbits per day). The LEO is placed into the space at an altitude of 2,000 km.

5. PLATFORMS AND SENSORS

Platforms refer to the structures or vehicles on which remote sensing instruments are mounted. There are three broad categories of remote sensing platforms: ground based, airborne, and satellite.

A. ***Ground base:*** A wide variety of ground-based platforms are used in remote sensing. Some of the more common ones are hand held devices, tripods, towers and cranes. Instruments that are ground-based are often used to measure the quantity and quality of light coming from the sun or for close range characterization of objects. For example, to study properties of a single plant or a small patch of grass, it would make sense to use a ground-based instrument.

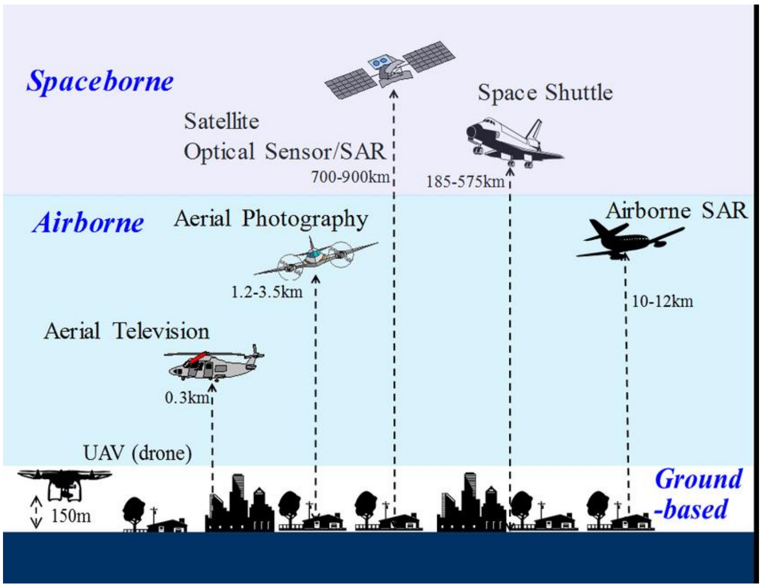
B. ***Airborne:*** Airborne platforms were the sole non-ground-based platforms. Airplanes are the most common airborne platform. Nearly the whole spectrum of civilian and military aircraft is used for remote sensing applications. However, as requirements for greater instrument stability or higher altitudes become necessary, more sophisticated aircraft must be used.

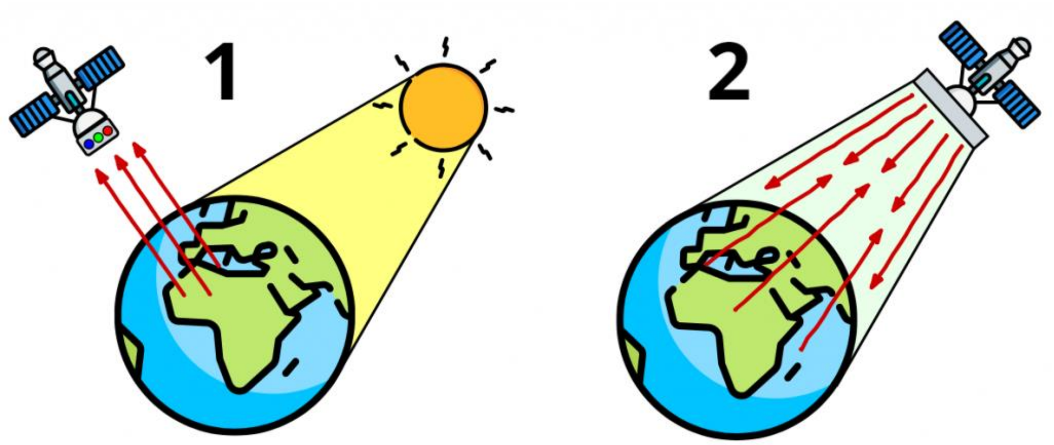
C. ***Satellite:*** The most stable platform aloft is a satellite, which is spaceborne. The first remote sensing satellite was launched in 1960 for meteorology purposes. Now, over a hundred remote sensing satellites have been launched and more are being launched every year. The Space Shuttle is a unique spacecraft that functions as a remote sensing satellite and can be reused for a number of missions.

Sensors: Remote sensors collect data by detecting the energy that is reflected from Earth. These sensors can be on satellites or mounted on aircraft. Remote sensors can be either passive or active. Passive sensors respond to external stimuli. They record natural energy that is reflected or emitted from the Earth's surface. The most common source of radiation detected by passive sensors is reflected sunlight.

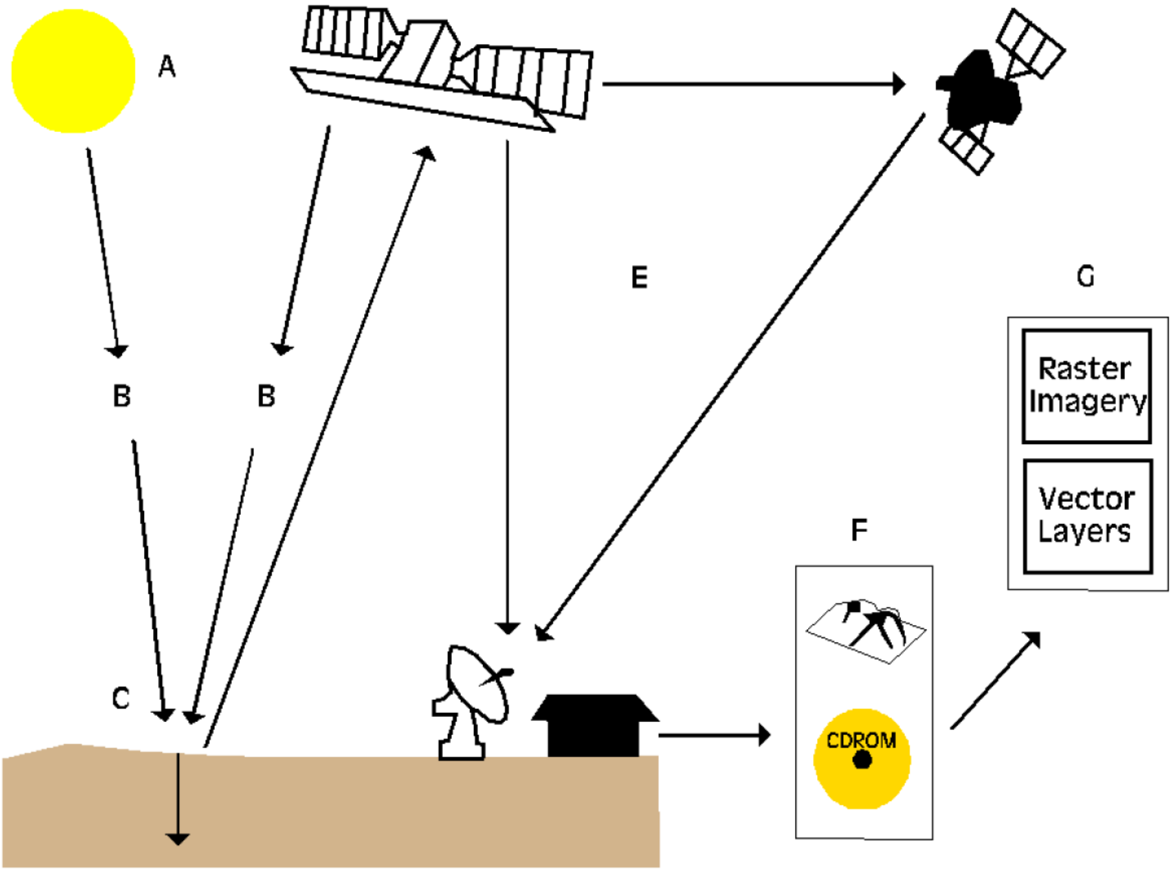
A. Passive sensors: Passive sensors record naturally occurring electromagnetic radiation that is reflected or emitted from the terrain. Remote sensing in the day light under the influence of solar energy falls under this category. (Fig.1)

B. Active sensors: In contrast, active sensors use internal stimuli to collect data about Earth. For example, a laser-beam remote sensing system projects a laser onto the surface of Earth and measures the time that it takes for the laser to reflect back to its sensor. (Fig.2)





6. PROCESS AND COMPONENTS



A. Electromagnetic energy source.
B. Interaction with atmosphere
C. Interaction with target
D. Recording of energy by sensors
E. Transmission, Reception and Processing
F. Interpretation and analysis
G. Applications

7. APPLICATIONS

Broad Area	Key Applications
Geology	Landform characterization, Structural mapping, identification of fold, fault, etc., Lithological Mapping, Soil Characteristics, Mineral and hydrocarbon exploration, Hydrothermal alteration, Engineering Geology, Geothermal anomaly
Hydrology	Groundwater exploration, Paleo-channels, recharge site selection, Glacial retreat/progress
Terrain Mapping	Digital Elevation Model, 3-D Terrain Visualization
Forestry	Species identification, Biomass estimation, Deforestation
Land Use/ Land Cover	Mapping and change detection
Urban Planning	Cadastral Mapping
Environmental Monitoring	Coal and forest fires, Landfill, Soil Erosion, Atmospheric Pollution, Environmental Impact Assessment, Urban Heat Islands
Agriculture	Crop yield estimation, Soil moisture
Disaster Management	Earthquake, flood, landslide damage assessment Land subsidence
Utility, Transportation	Route Planning, identification of road/trails
Social Science	Archaeological site, Population Density Estimation
Ocean/ Coastal Monitoring	Ocean color / phytoplankton concertation, Potential fishing zones, Sea Surface Temperature, Oil Spill
Defense Application	Terrain Evaluation, 3-D visualization

8. SUMMARY

Remote Sensing is obtaining information about an object without touching the object. The objects under investigation behave uniquely in different wavelengths of electromagnetic radiation incident upon it, enabling us to differentiate one object from another. Remote sensing has been advantageous over the conventional field data collection in respect to synoptic overview, time saving, systematic and multi-disciplinary applications. Since its beginning, the tool has been used for many application areas from meteorology to earth resources mapping, monitoring and conservation. A typical remote sensing program involves collection of surface reflections or emissions of electromagnetic energy using sensor system on-board a specific platform, calibration, distribution, pre-processing, enhancement, visual interpretation and / or digital image processing for automatic/semi-automatic thematic information generation. Selection of appropriate remote sensing data with specific spectral, spatial, temporal and radiometric resolution depends upon the nature of application. The resultant thematic information may also be used as a prime source of input data for GIS-based modelling and decision-making tasks.

Learning resources:

1. **Books:**

1. Sabins, Flyod F. (1986), Remote Sensing: Principles and Interpretation, 2nd Edn., W H Freeman & Co, New York.
2. Jensen, John R. (2006), Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edn., Pearson Prentice Hall. ISBN: 0131889508, 978-0131889507.
3. Gupta, Ravi P. (2003), Remote Sensing Geology, 2nd Edn., Springer Publications. ISBN: 354043185, 978-3540431855.
4. Lillesand Thomas, Keifer Ralph W. and Chipman Jonathan (2015). Remote sensing and Image Interpretation, 7th Edn. John Wiley & Sons, New York.
5. Mather, Paul M. and Koch, Magaly (2010), Computer Processing of Remotely-Sensed Images : An Introduction, 4th Edn., Wiley-Blackwell Publications. ISBN: 978-0-470-74239-6.
6. Warner, Timothy A., Nellis, M. Duane and Foody, Giles M. (Eds.) (2009), The SAGE Handbook of Remote Sensing, 1st Edn., SAGE Publications Ltd. ISBN: 141293616, 978-1412936163.
7. Jensen, John R. and Jensen, Ryan R. (2012), Introductory Geographic Information Systems, 1st Edn., Pearson Prentice Hall. ISBN: 013614776, 978-0136147763.

2. **Syllabus of B. Sc. III Geology**
   https://drive.google.com/file/d/120EHc9HiM6KicNhnx6IYn_PEHqL47zf8/view?usp=sharing
3. **Material OER/URL/Instructor-made/**
   A. Lecture notes
   https://drive.google.com/file/d/1NLcO1fTBix7_BlHQESfvYuFtPbFMt4tT/view?usp=sharing
   B. Online book:
   https://drive.google.com/file/d/1ZYtYwAeSLe74HfjyEOwC-xTC4DCMDEfM/view?usp=sharing
4. **Instructor-made -**
   C. Power Point Presentation:
   https://drive.google.com/file/d/1XJLWQmHfG7pBgU0dC8U1WEPZ2U0ej3kg/view?usp=sharing
   D. Video -
   https://www.youtube.com/watch?v=PG8NkuZnDdc&t=1s

   E. Question Bank:

https://drive.google.com/file/d/1cjwQMidZxKzbTfliz-JMVUfraT_99LH3/view?usp=sharing

   F. Quizzes / Practice tests:

https://forms.gle/aCzAoR7TLRMJU5a58
https://forms.gle/DTSrpujovoz52CET6
https://forms.gle/uvmJsRygp8upeDxw9
https://forms.gle/Bj2hdw3rQxfRXrqo8

Detailed Plan of Out-of-class and In-class activities

Sub Unit 1 - **Concept and applications of remote sensing**

Objectives –

- Definition of remote sensing
- Knowledge of components on remote sensing.
- Its applications in various fields.

Units	**Out-of-class activity** **Details of Activity**	**In-class activity** **Details of Activity**	**Assessment**
1.1	Students should read out the topic from a book Students study the ppt.	Discussion on the topic Check the level of understanding through Question – answer session	Question – answer session
1.2	Students should read out the topic from a book Students should watch video on given links	Discussion on the topic Help students to understand the concept and components of remote sensing Help students to know various applications of remote sensing	Question to write in detail On-line quiz