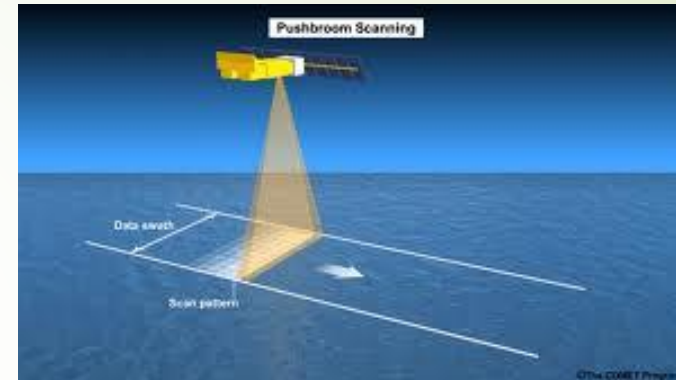
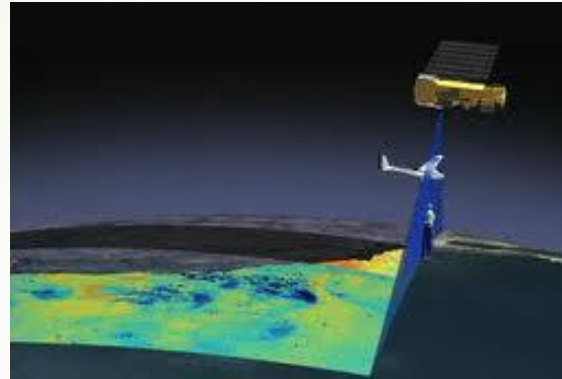


# Ecol – 501 Remote Sensing and GIS



Course Teacher

e-Learning Module

**Dr. S. Jayakumar**

Professor

Department of Ecology and Environmental Sciences

Pondicherry University

Puducherry



Co-funded by the  
Erasmus+ Programme  
of the European Union

# Content

1. General Information
2. Course description
3. Course goal
4. Course outcome
5. Course structure
6. Course assessment
7. References

# 1. General Information

Course Code	:	ECOL - 501
Course Title	:	Remote Sensing and Geographical Information System
Number of Credits	:	4.5 ECTS
Course duration	:	18 Weeks
Level	:	Postgraduate
Course Teacher	:	Prof. S. Jayakumar
Prerequisite	:	Basic understanding on Mathematics (school higher level), English
		language skill, computer operation (Windows/Mac).

## 2. Course description

This 3 ECTS course provides the students the fundamentals of remote sensing and Geographical information system. It teaches the characteristics of different frequencies of electromagnetic radiation and its interaction with atmosphere and earth's surface. This course introduces the reflective, thermal and microwave remote sensing to students. It also makes the students understand the aerial photography, photogrammetry and global positioning system. It introduces the concept of image interpretation and various sensor characteristics. It makes the students understand the concept of data structures and basic spatial modelling concepts.

### 3. Course goals

The main course objective is to make the students understand the fundamentals and applications of remote sensing and Geographical information system in natural resources management. To enable the students understand the different types of remote sensing, sensor characteristics, payload. To make the students understand how EMR interacts with earth's surface. To give students fundamental and applications of GPS. To introduce the students to the theory of spatial data structure, projections and coordinate systems. To make them understand the thematic maps, weightage and spatial modeling.

## 4. Course outcome

By the end of the course, successful students will:

1. Know the principles of remote sensing, GIS and GPS
2. Understand the interactions of EMR with earth's materials.
3. Be able to distinguish the significance between reflective, thermal and microwave remote sensing
4. Understand the payload characteristics and how to determine different resolutions
5. Know the basics of coordinate system and projections
6. Know the concept of digitalization, and thematic map preparation.
7. Know the basic data structure in GIS and their significance.
8. Be familiar with the data integration and weightages used in spatial modeling.
9. Know the basic concept of modeling and how to conceptualize a model.
10. Understand the applications of RS and GIS in various fields.

# 5. Course structure

## 5.a. Course Content

<b>Week -1</b>	<b>Fundamentals of remote sensing</b>
	Components of RS
<b>Week -2</b>	Electromagnetic radiation
	Atmospheric window and effects of atmosphere
	Principles of Scanner and CCD array
<b>Week -3</b>	Types of Sensor and bands
	The pixel
	Spectral reflectance of soil, water and vegetation
<b>Week - 4</b>	Thermal Remote Sensing
	Microwave Remote Sensing
<b>Week - 5</b>	Satellite and Sensors
	Satellite orbits and for different resolution
<b>Week - 6</b>	Digital image processing-mosaicing, histogram equalization
	Image Classification
<b>Week - 7</b>	Air borne and space borne data: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography
<b>Week - 8</b>	Planning of aerial photos and characters of aerial photo
	Types of Aerial photos, Photogrammetry
<b>Week - 9</b>	Elements of aerial photo interpretation
<b>Week - 10</b>	Satellite data availability - Indian space agency - data centre and USGS Earth Explorer

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# 5. Course structure

## 5.a. Course Content

<b>Week - 11</b>	<b>GIS terms and terminologies</b>
<b>Week - 12</b>	GIS components
	How to create a thematic map from satellite image
	Raster and Vector data structure
<b>Week - 13</b>	Map Projection and coordinate system
	Digital Cartography and elements of map
<b>Week - 14</b>	Overlay analysis
	Weighted overlay analysis
<b>Week - 15</b>	Fundamentals and applications of Navigation system
	Classification Methods and RS in forestry
<b>Week - 16</b>	RS in forestry and water
<b>Week - 17</b>	RS in LULC Mineral Disaster
	RS in Forest fire
	RS in Agriculture

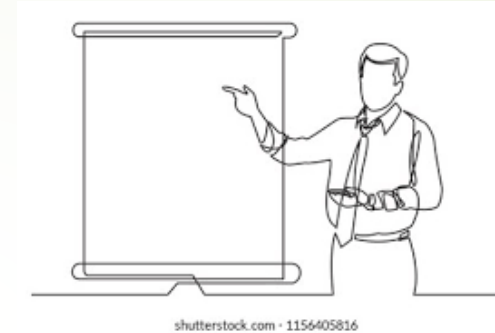


# 5. Course structure

## 5.b. Mode of delivery



On-line lectures



In-class lectures



Microsoft OneDrive



Microsoft Teams

**Students will get enrolled in Pondicherry University Learning Management System and the classes will be handled in hybrid mode**



Browser address bar: lms.pondiuni.edu.in/course/view.php?id=75

Navigation menu: University Portal, SAMS, Office365 Apps, Courses, Site Announcements, LOGIN, Contact Support

PULSE PONDICHERRY UNIVERSITY LEARNING SYSTEM

My courses (8) Bookmarks

# ECOL501 Remote Sensing and GIS

Course management Turn editing on

Dashboard > My courses > ECOL501

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- Site home
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- Turn editing on

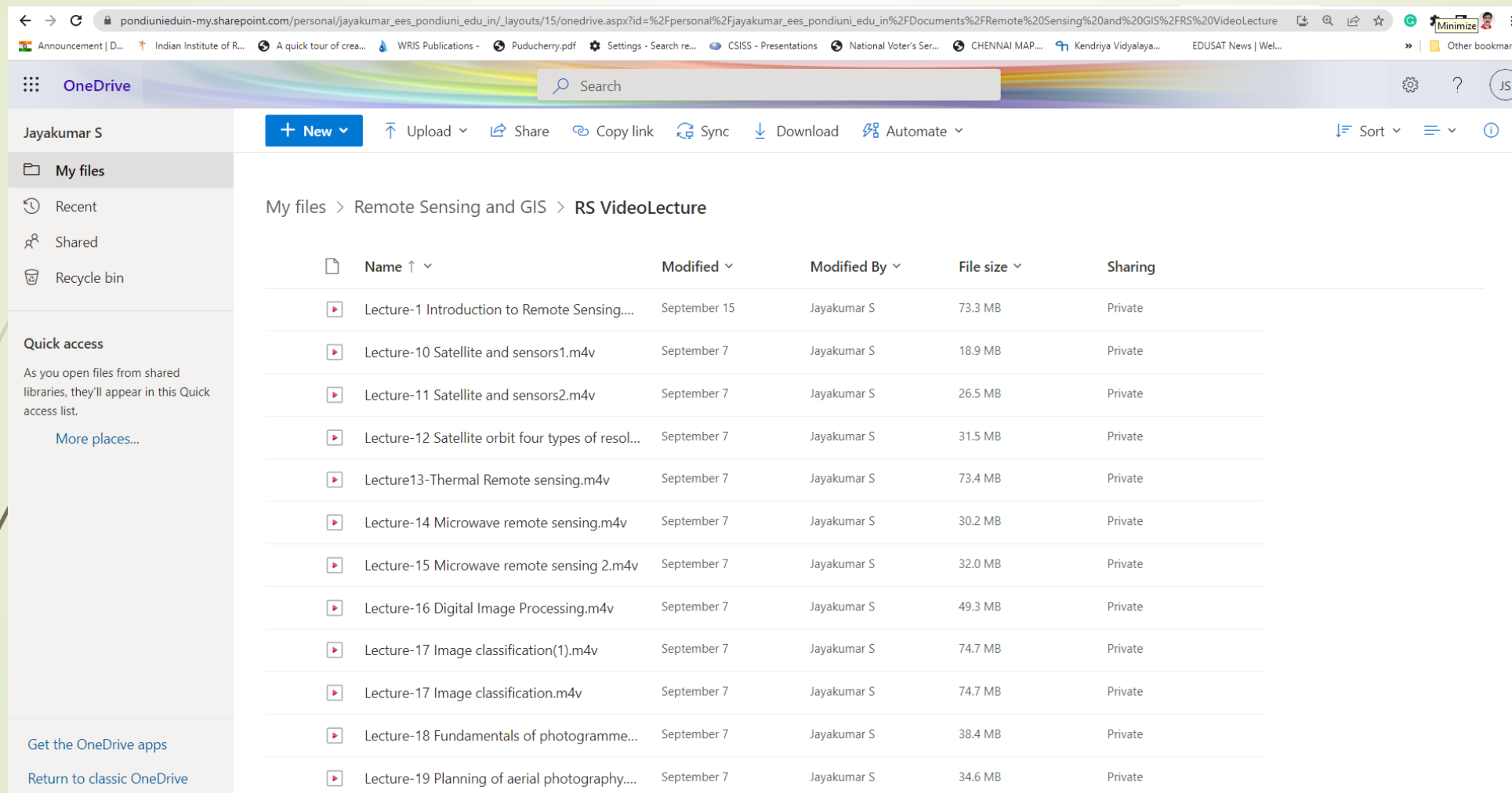
General Collapse all

Announcements





## Video Lectures stored in Microsoft One drive



The screenshot shows a web browser displaying a Microsoft OneDrive account for Jayakumar S. The page is titled "My files > Remote Sensing and GIS > RS VideoLecture". A table lists 19 video files, each with a play button icon, name, modification date, modified by, file size, and sharing status.

Name	Modified	Modified By	File size	Sharing
Lecture-1 Introduction to Remote Sensing...	September 15	Jayakumar S	73.3 MB	Private
Lecture-10 Satellite and sensors1.m4v	September 7	Jayakumar S	18.9 MB	Private
Lecture-11 Satellite and sensors2.m4v	September 7	Jayakumar S	26.5 MB	Private
Lecture-12 Satellite orbit four types of resol...	September 7	Jayakumar S	31.5 MB	Private
Lecture13-Thermal Remote sensing.m4v	September 7	Jayakumar S	73.4 MB	Private
Lecture-14 Microwave remote sensing.m4v	September 7	Jayakumar S	30.2 MB	Private
Lecture-15 Microwave remote sensing 2.m4v	September 7	Jayakumar S	32.0 MB	Private
Lecture-16 Digital Image Processing.m4v	September 7	Jayakumar S	49.3 MB	Private
Lecture-17 Image classification(1).m4v	September 7	Jayakumar S	74.7 MB	Private
Lecture-17 Image classification.m4v	September 7	Jayakumar S	74.7 MB	Private
Lecture-18 Fundamentals of photogramme...	September 7	Jayakumar S	38.4 MB	Private
Lecture-19 Planning of aerial photography...	September 7	Jayakumar S	34.6 MB	Private

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## Introduction to remote sensing

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Open Share Copy link Download Lecture-1 Introductio...mp4 1 / 41

### Introduction to Remote Sensing

#### Definition

1. Remote Sensing is the acquisition of physical data of an object without touch or contact (Fintz and Simonett, 1976)
2. Remote Sensing is the acquisition of data about an object or scene by a sensor that is far from the object (Holwell, 1983)
3. Information about the earth's land and water areas from the images/data acquired at a distance (Campbell, 1987)



Video settings About video Comments Help

0:40 / 6:26

## Components of remote sensing

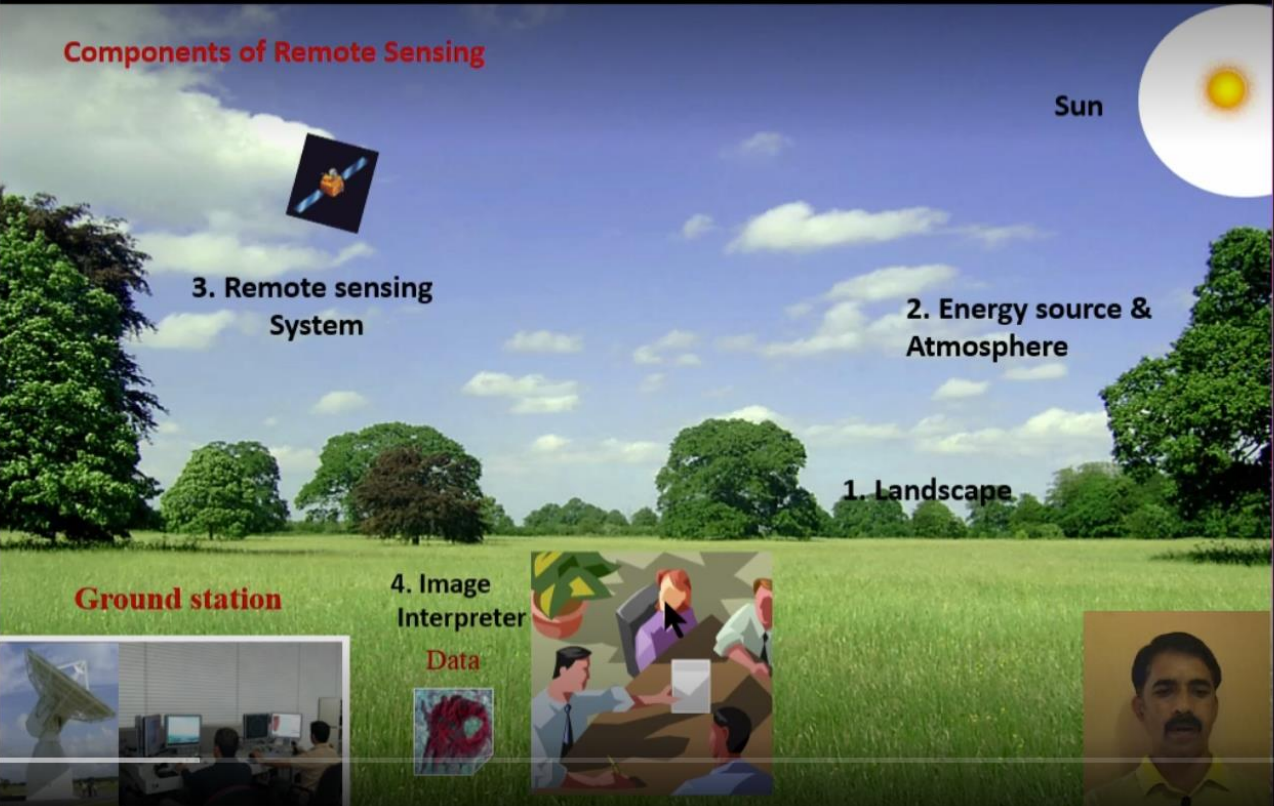
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### Introduction to Remote Sensing

#### Components of Remote Sensing



1. Landscape

2. Energy source & Atmosphere

3. Remote sensing System

4. Image Interpreter

Ground station

Sun

Play (Alt + K) 0:48 / 7:56

Video settings About video Comments Help

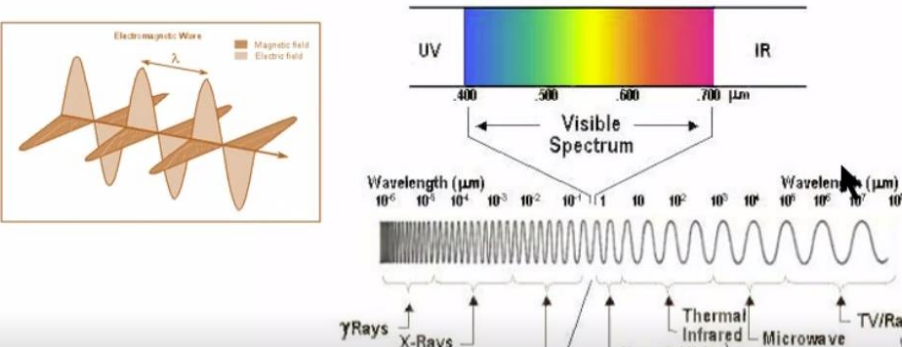
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# Electromagnetic Radiation

Introduction to Remote Sensing

## Electromagnetic Spectrum

Electromagnetic radiation is, the energy propagated through space between electric and magnetic fields. The electromagnetic spectrum is, the extent of that energy ranging from cosmic rays, gamma rays, X-rays to ultraviolet, visible and infrared radiation including microwave energy and television & radio waves.



The collection of all possible wavelengths is called the 'electromagnetic spectrum'.

- Traditional Photographs
- Water Depth Mapping
- Vegetation Type and Health
- Minerals
- Soil Moisture
- Minerals
- Works at Night
- Sees Through
- Oil Spills
- Works at Night
- Sees Through

## Effects of Atmosphere

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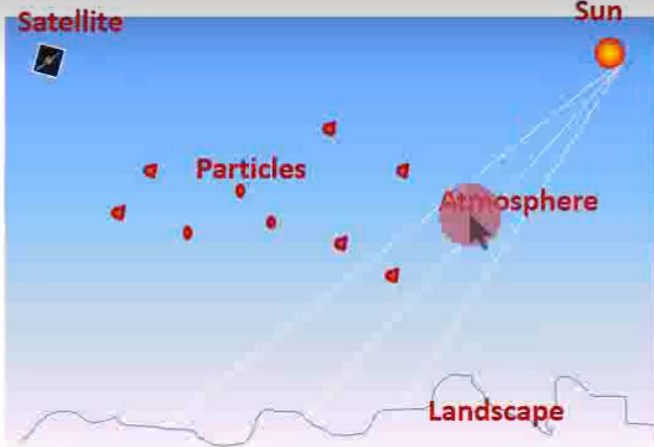
### Remote Sensing

#### Effects of atmosphere

The **radiation** from the sun and the **reflection** from the surface of the earth pass through the atmosphere before they reach the satellite sensor

**Scattering, Absorption and Reflection** are three main things to be considered when measuring radiation

Diffusion of radiation by particles in the atmosphere is called sca



Video settings About video Comments Help

07:57 / 18:45

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## Principles of scanner and CCD arrays

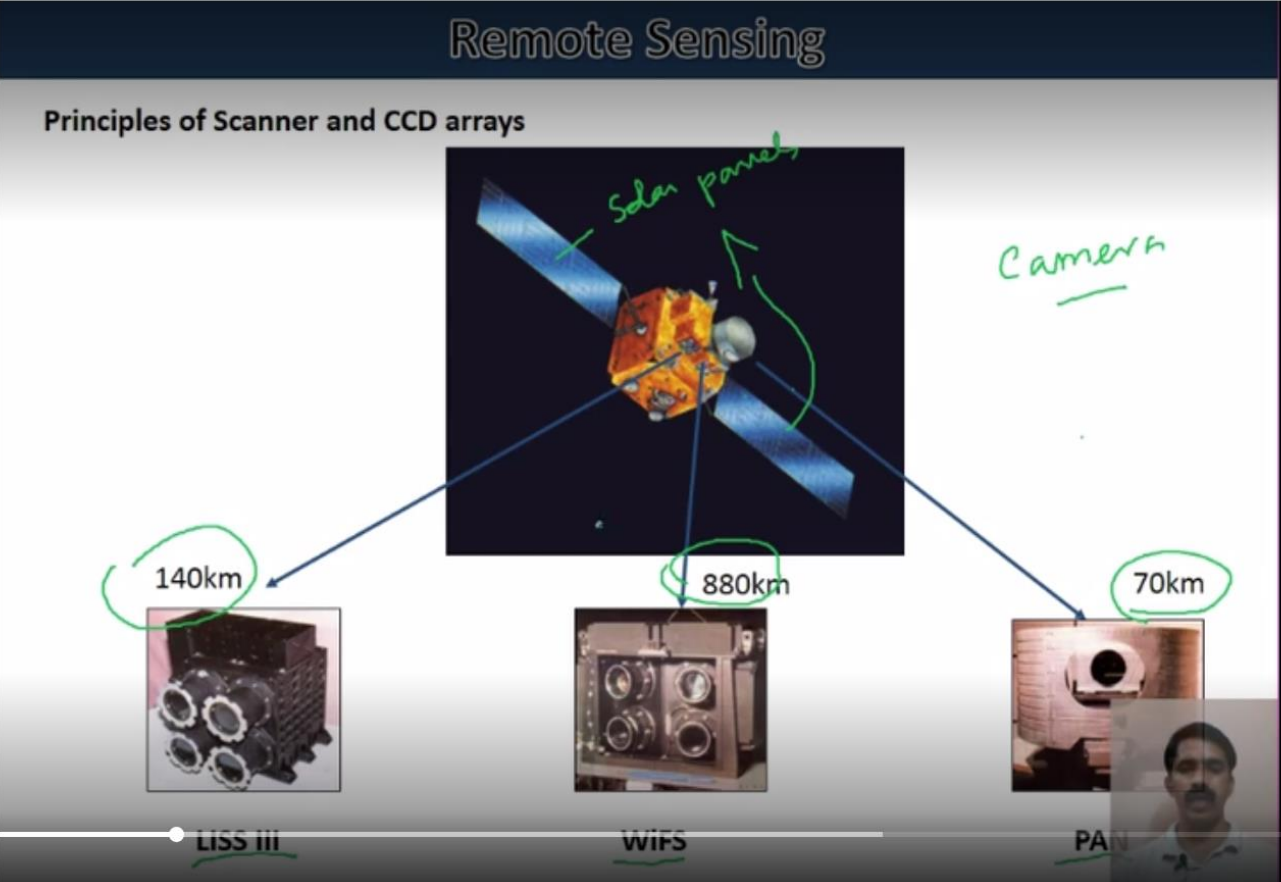
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### Remote Sensing

#### Principles of Scanner and CCD arrays



The diagram illustrates the principles of scanner and CCD arrays on a satellite. A central satellite is shown with two large blue solar panels and a camera. Three arrows point from the satellite to three different sensor types: LISS III (140km), WIFS (880km), and PAN (70km). Handwritten green annotations include 'Solar panels' pointing to the satellite's solar panels, 'Camera' pointing to the satellite's camera, and circles around the 140km, 880km, and 70km labels. The video player interface shows a play button, volume control, and a progress bar at 2:05 / 8:01.

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# Types of scanner, bands and pixels

Remote Sensing

**Bands / Channels** - range of EMR  $\begin{matrix} B \\ G \\ R \\ IR \\ T \end{matrix}$

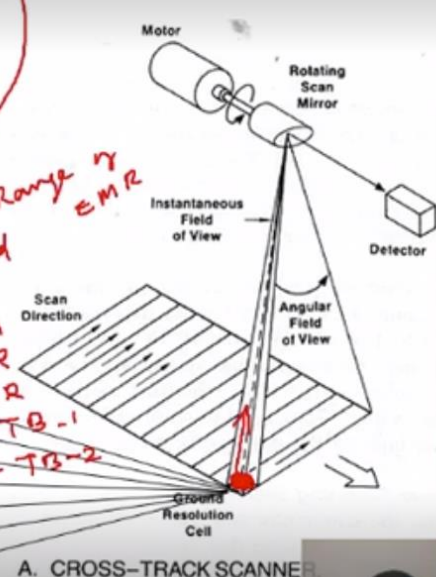
For each scanned area (pixel), a number is delivered for each channel. For each channel a chronological matrix is delivered. If all numbers from all channels are considered together they represent the 'spectral signature' of the scanned area. This gives the data set for the area.

ON Digital Number / Pixel value

23	25	25	36	98	25	36
112	65	95	98	85	25	41
25	220	246	58	224	112	156
145	156	148	159	213	156	25
78	82	84	61	32	75	69
75	36	95	95	85	32	56
222	251	236	185	176	195	135

0-? Layer

Spectral bands



A. CROSS-TRACK SCANNER

- Video settings
- About video
- Comments
- Help

## The Pixel

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### Remote Sensing

#### The Pixel

- Digital images are made up of pixels.
- A pixel is the smallest unit on a satellite image, which is generally equivalent to one word or byte (sometimes 2 bytes).
- Displayed in the correct order all the pixels build up a meaningful image.
- The value of a pixel corresponds to the intensity of radiation reflected by the observed object within the wavelength range to which the sensor is sensitive.
- This value is referred to as the Digital Number (DN).


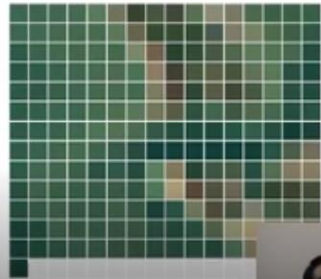


Image (pixels)



Play (Alt + K) 0:41 / 7:03

Video settings About video Comments Help

# Spectral characteristics of surface features

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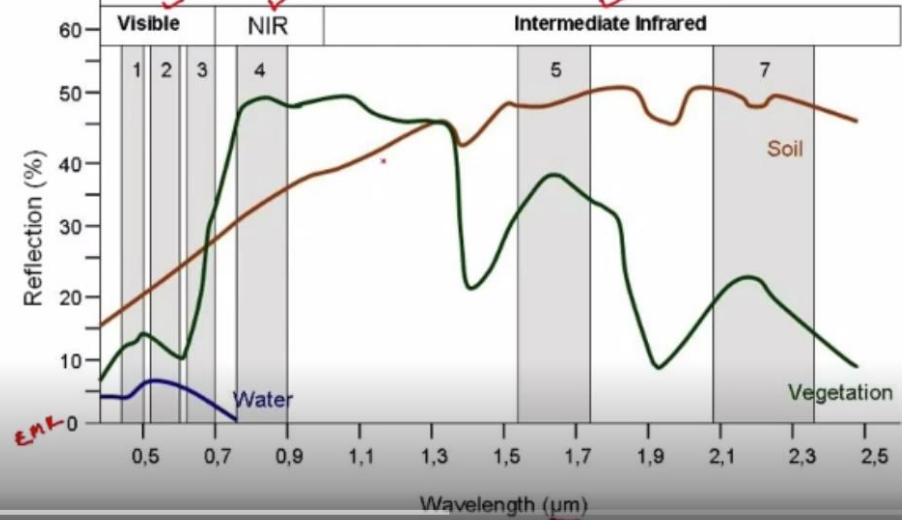
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## Remote Sensing

### Spectral characteristics of Surface features

a. Soils, b. Vegetation, c. Water



Wavelength (µm)	Soil Reflection (%)	Water Reflection (%)	Vegetation Reflection (%)
0.5	15	5	10
0.7	25	5	10
0.9	35	5	50
1.1	40	5	45
1.3	45	5	45
1.5	45	5	20
1.7	50	5	35
1.9	50	5	10
2.1	50	5	20
2.3	48	5	15
2.5	45	5	10

EMK

01:36 / 10:26

# Thermal Remote sensing

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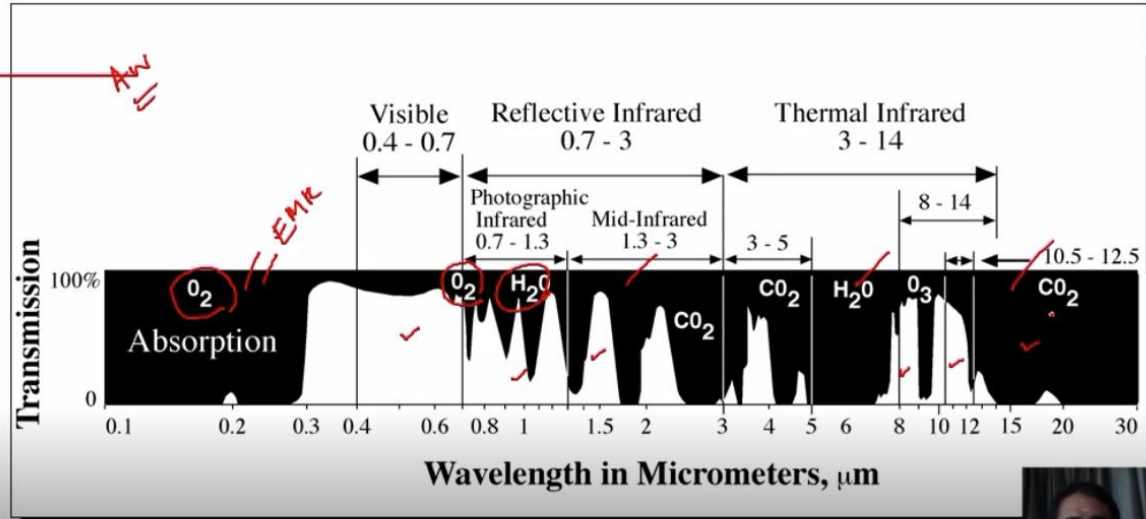
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Wondershare Filmora Scrn is using the webcam

### Thermal Sensing

Thermal sensing is one form of multispectral sensing, where sensing is limited only to the thermal portion of the electromagnetic spectrum



The graph shows Transmission (0% to 100%) on the y-axis and Wavelength in Micrometers,  $\mu\text{m}$  (0.1 to 30) on the x-axis. Key regions and absorption bands are labeled:

- Visible:** 0.4 - 0.7  $\mu\text{m}$
- Reflective Infrared:** 0.7 - 3  $\mu\text{m}$ 
  - Photographic Infrared: 0.7 - 1.3  $\mu\text{m}$
  - Mid-Infrared: 1.3 - 3  $\mu\text{m}$
- Thermal Infrared:** 3 - 14  $\mu\text{m}$ 
  - 8 - 14  $\mu\text{m}$
  - 10.5 - 12.5  $\mu\text{m}$

Absorption bands are marked with red checkmarks and labels:  $\text{O}_2$  (at ~0.76, 1.27, 1.43, 4.4, 7.7, 13.8  $\mu\text{m}$ ),  $\text{H}_2\text{O}$  (at ~0.94, 1.1, 1.38, 1.87, 2.13, 2.7, 3.25, 6.3, 6.7, 8.3, 9.7, 11.3, 13.3, 16.4, 18.7, 21.3, 22.8, 24.5, 27.0, 28.5, 31.0  $\mu\text{m}$ ), and  $\text{CO}_2$  (at ~2.1, 2.7, 3.3, 4.3, 4.8, 15.0, 16.0, 26.5, 27.0  $\mu\text{m}$ ). Handwritten red annotations include 'EMR' and 'AW'.

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Play (Alt + K) 01:55 / 36:06 PU/Master Course/Prn - 3 Dr. S. Jayakumar

# Microwave Remote sensing

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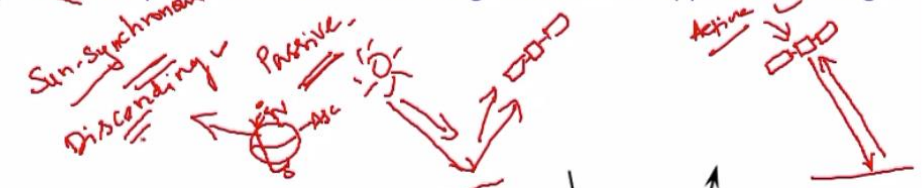
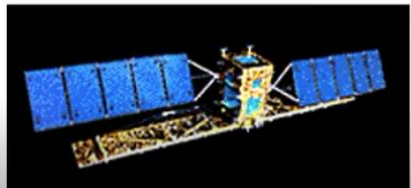
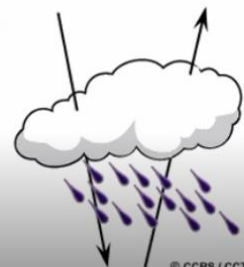
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## Microwave Remote Sensing

**Microwave Remote Sensing**

- Active microwave radar systems are the most advanced type of Earth observing satellite.
- Instruments, which can image the ground or sea at any time of day or night and through cloud cover

The microwave portion of spectrum includes wavelength within the approximate range 1 mm to 1 m.

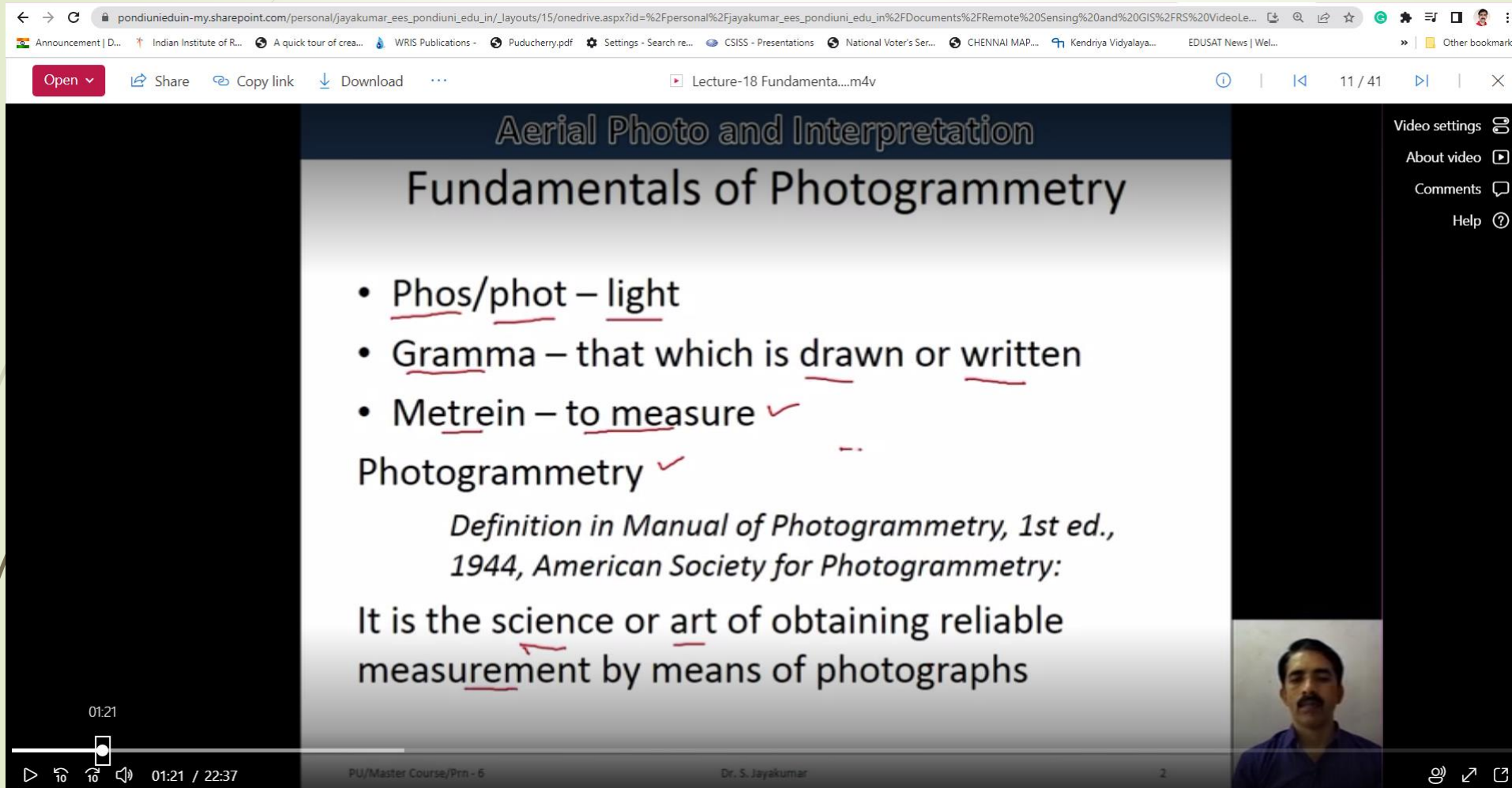




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Video settings About video Comments Help

Play (Alt + K) 08:15 / 17:40 PU/Master Course/Prn - 4 Dr. S. Jayakumar

## Aerial photography and Photogrammetry



The screenshot shows a video player interface. The video title is "Aerial Photo and Interpretation Fundamentals of Photogrammetry". The content of the video includes a list of bullet points defining the components of the word "Photogrammetry":

- Phos/phot – light
- Gramma – that which is drawn or written
- Metrein – to measure ✓

Below the list, it says "Photogrammetry ✓".

*Definition in Manual of Photogrammetry, 1st ed., 1944, American Society for Photogrammetry:*

It is the science or art of obtaining reliable measurement by means of photographs

The video player shows a progress bar at 01:21 / 22:37. The video title in the player is "Lecture-18 Fundamenta...m4v". The video settings menu is visible on the right side of the player.

## Planning of Aerial photography

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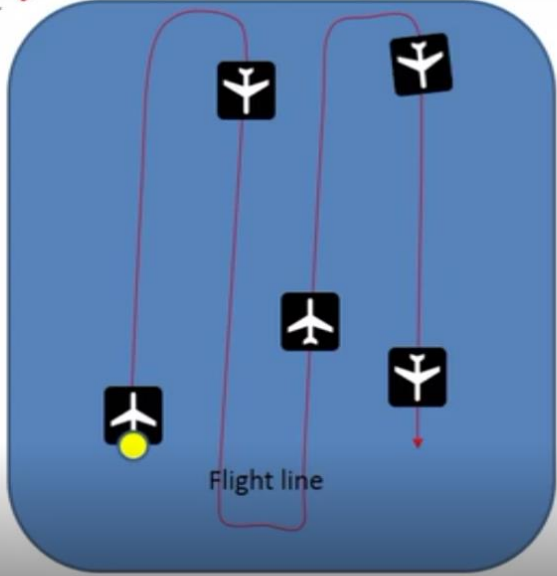
Open Share Copy link Download Lecture-19 Planning o...m4v 12 / 41

### Aerial Photo and Interpretation

#### Planning of aerial photography

Flight planning is one of the most important operations in the overall photogrammetric project ✓

- Flight Map ✓
- Specification
  - Camera
  - Film requirements
  - Scale
  - Flying height
  - Time period (weather related)
  - End lap (overlap)
  - Side lap
  - Tilt, etc.



Video settings  
About video  
Comments  
Help

01:05 / 18:39 PU/Master Course/Prn - 6 Dr. S. Jayakumar 13

## 5. Course structure

### 5.c. In-class discussion

The discussion will focus on how to map natural resources using the relevant satellite data, classification technique and selecting appropriate scale.

### 5.d. In-class assignments & field assignment

Understanding satellites and sensors available and preparedness for field study, data collection, and data quality standards and ground truth verification.

### 5.e. Reading and discussion of assigned papers for seminars

Understanding the level of RS and GIS technique integrated in the study, debate the novel approach in the methodology, need for such studies, data and tools utilized.

### 5.f. Group project presentation

Students will conduct group project and make a presentation in the class.



## 6. Course Assessment

Type of assessment	Percentage of Marks
In-class discussion	5
Assignment	5
Seminars	10
Group projects	10
Internal assessment test (MCQ types)	10
Final assessment	60
<b>Total</b>	<b>100</b>

## 7. References

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9. Geographic Information System Basics” by Jonathan E. Campbell, UCLA, Michael Shin, UCLA. Available for free: <http://2012books.lardbucket.org/books/geographic-information-system-basics/index.html>