Course title: Advances in remote sensing: Thermal, Hyperspectral, Microwave, LIDAR and UAV			
Course code: NRG 181	**No. of credits:** 4	**L-T-P:** 26-13-34	**Learning hours:** 73
Pre-requisite course code and title (if any): NRG 172 & NRG 178			
Department: Natural Resources			
Course coordinator: Dr Nithiyanandam		**Course instructor:** Dr Nithiyanandam	
Contact details: nithiyanandam.y@terisas.ac.in			
Course type: Core		**Course offered in:** Third semester	

Course Description:

This course will provide an opportunity to understand and work with advanced developments in Remote Sensing and covers a wide range of remote sensing data interpretation and processing techniques.

Course objectives:

To teach basics of Thermal, Hyperspectral, Microwave and UAV remote sensing, and to inculcate practical skill for processing advance remote sensing datasets for various applications including natural resources management.

Course content

Module	**Topic**	**L**	**T**	**P**
1.	Thermal remote sensing ▪ Introduction: Laws and definitions –Thermal emission characteristics – Physics behind thermal mapping (including thermal inertia)– Errors and assumption in thermal remote sensing – Modelling Thermal data ▪ Processing and Analysis: Radiometric Calibration of Satellite and Airborne Thermal data – TIR Image processing – Emissivity databases – visual and quantitative image interpretation of TIR data – Data fusion ▪ Applications of thermal imagery – UHI and coal mine fire mapping.	6	3	
2.	Hyperspectral remote sensing ▪ Introduction: Imaging spectroscopy–History and development of Hyperspectral remote sensing – working principles of imaging spectrometers – hyperspectral sensors ▪ Processing and Analysis: Data preparation and Transformation– Atmospheric correction–End member detection and extraction– spectral unmixing–target and anomaly detection ▪ c. Applications of hyperspectral imagery – Mineral and vegetation mapping.	6	3	
3.	Microwave remote sensing ▪ Introduction: Active and passive microwave systems – basic principle of Radar/SAR (Geometric and statistical properties and imaging geometry) –Radar Relief displacement (Foreshortening, Layover, Shadow & Speckle) ▪ Processing and interpretation: Filters– Radar interferometry and polarimetry ▪ c. Applications of microwave remote sensing – ocean topography and flood mapping.	8	4	
4.	LIDAR ▪ Introduction: Principles and Geometry– sensor and platforms ▪ Processing and interpretation: Data processing – Quality control– information extraction. ▪ c. Applications of LIDAR – land surface topography and 3D mapping.	4	2	
5.	Unmanned Aerial Vehicle (UAV): Overview of the technology, data visualization, and interpretation.	2	1	
	Total	**26**	**13**	**0**
Exp. No.	**Labs**			
1.	Land surface emissivity estimation and compare outputs of two estimation techniques			4
2.	Estimate land surface temperature and analyse its spatial variation with respect to different land cover types			4

3.	Pre-processing hyperspectral datasets (Data preparation, Spectral analysis, atmospheric correction)			2
4.	Spectral analysis comparing hyperspectral and multi-spectral datasets			2
5.	Target detection using the hyperspectral data			2
6.	Dimension reduction analysis with hyperspectral data			2
7.	SAR imagery pre-processing			4
8.	Radar Bathymetry			4
9.	Lidar data visualisation, quality checking and basic processing in latosols			4
10.	Surface and terrain model creation using Lidar data (			4
11.	UAV data visualization			2
	Total	**26**	**13**	**34**

Evaluation criteria

Test I: 15 % (Module 1& 2) (learning outcome 1 & 2)
Test II: 15% (Module 3&4) (learning outcome1 & 2)
Practical: 30% (Module 1:5) (learning outcome 3)
Test III: 40% (Module 1:5) (learning outcome 1 & 2)

Learning outcomes:

Upon completion of this course, a fully engaged student shall be able to:

1. Comprehend the basics of thermal, hyperspectral, microwave, LIDAR and UAV remote sensing.
2. Process and interpret thermal, hyper spectral, microwave, LIDAR datasets.
3. Utilize skills obtained for different applications of thermal, hyper spectral, microwave, LIDAR remote sensing.

Pedagogical approach: Interdisciplinary learning, discovery learning, peer teaching, practical and case studies.

Materials: Books

Module 1:

- Kuenzer, C., & Dech, S. (2013). Thermal Infrared Remote Sensing, ISBN 978-94-007-6639-6.
- Quattrochi, D., & Luvall, J. (2004), Thermal Remote Sensing in Land Surface Processing, CRP Press, ISBN: 978-0-415-30224-1.

Module 2:

- Marcus Borengasser, William S. Hungate, Russell Watkins (2007) Hyperspectral Remote Sensing: Principles and Applications, CRC Press.
- Ruiliang Pu (2017), Hyperspectral Remote Sensing: Fundamentals and Practices, CRC press.

Module 3:

- H. Woodhouse (2005). An introduction to microwave remote sensing. Taylor and Francis, London.
- J.S. Lee, E.Pottier (2008), Polarimetric Radar Imaging: From Basics to Applications, CRC Press
- Oliver and Quegan (1998). Understanding synthetic aperture radar images. Artech House.
- Van Zyl, J., & Kim, Y (2011), Synthetic Aperture Radar Polarimetry, John Wiley & Sons, Inc,
- Van Zyl, J., & Kim, Y (2011), Synthetic Aperture Radar Polarimetry, John Wiley & Sons, Inc,

Module 4:

- Qihao Weng (2011), Advances in Environmental Remote Sensing: Sensors, Algorithms, and Applications, CRC Press.
- Qihao, Weng (2012), An Introduction to Contemporary Remote Sensing, McGraw-Hill Professional, ISBN: 978-0-071-74011-1.

Module 5:

- Gianluca C, Andras S, Gergely S (2017), Small Flying Drones, Applications for Geographic observation, Springer, ISBN:978-3-319-66576-4

Journals references

- ISPRS Journal of Photogrammetry and Remote Sensing
- Journal of Indian Society of Remote Sensing
- Remote Sensing of Environment

Magazines

- Coordinates
- Geospatial world

- GIM International **Others** Other online materials including case studies will be shared time to time.
Additional information (if any)
Student responsibilities: The students are expected to read supplementary materials provided along with the course to get holistic knowledge about the subject. Further expected to complete practical exercises and assignments on time.

Course Reviewers:

1. Professor Qiao Weng, Director, Center for Urban and Environmental Change; Professor, Department of Earth & Environmental Systems, Indiana State University, Terre Haute, IN 47809, USA.
2. Professor Muralikrishna V Iyyanki, Dr Raja Ramanna Distinguished fellow at DRDO, Hyderabad, India.
3. Dr. Nusret Demir, Space Sciences and Technologies Division, Akdeniz University, Turkey.