Course Type	Course Code	Name of the Course	L	T	P	Credits
DC	NMNC526	Microwave Remote Sensing	3	1	0	4

Learning outcomes:
Students will learn the principles of microwave remote sensing, Polarimetry, Microwaves in the real world, Detecting microwaves, Atmospheric sounding, Active microwaves, Interferometry, Application of microwave remote sensing in different fields and case studies.

Course Objective:
The proposed course provides basic understanding of microwave remote sensing, its components, microwave radiometers and radars, polarimetry and interferometry, interaction with discrete objects, scattering and emission from surface and volume, and its application in different fields

Units	Course Content	L+T	Learning Outcomes
Unit 1	Overview of microwave systems, a brief history of microwaves; Physical fundamentals: physical properties of EM waves, Energy and power of waves, combination of waves, most important aspect of microwave-phase as a (relative) distance measure, combining two waves in 2-D, quantifying the interference pattern, passive case, multiple source interference pattern, beam width and angular resolution; Huygens' wavelets, propagation of microwaves, sources of microwaves.	4L+0T	Students will be able to understand the microwave systems and its characteristics
Unit 2	Polarimetry: Describing polarized waves, superposition of polarized waves, representing polarization, passive polarimetry, polarimetry in Radar, important polarimetric properties.	4L+3T	Students will be able to understand the polarimetric aspect of microwave remote sensing
Unit 3	Microwaves in the real world: continuous media and the atmosphere, interaction with discrete objects, scattering and emission from volumes, reflection and emission from smooth surfaces, scattering and emission from rough surfaces, non-random(periodic) surfaces, scattering and emission from natural surfaces, special scatterers.	4L+0T	Students will be able to understand the scattering and emission of microwaves from surface & volume in the real world
Unit 4	Detecting Microwaves: General approach, conceptual approach to microwave systems, basic microwave radiometer, antenna, receiver,	3L+2T	Students will be able to understand the microwave systems detecting microwaves

	coherent systems, active systems, system performance, calibration;		
Unit 5	Atmospheric sounding: Atmospheric sounding, principle of measurement, theoretical basis of sounding, viewing geometries, passive rainfall mapping; Passive imaging: principles of measurement, oceans, sea ice, land.	3L+3T	Students will be able to understand the theoretical basis of sounding and its measurement principles in oceans, sea ice, land
Unit 6	Active microwaves: Principle of measurements, generic equations of radar performance, radar altimeters, improving directionality, scatterometers, imaging radar-need for imaging radar, image, radar image construction, SLAR (RAR), SAR, radar equation for SAR, geometric distortions in radar images, operational limits, SAR acquisition modes, working with SAR images, SAR data formats, extracting topography using stereo SAR Radargrammetry.	9L+3T	Students will be able to understand the working principle of Radars, why imaging Radar, working with SAR images, Radargrammetry
Unit 7	Interferometry: needs for interferometric measurements, principles of interferometry, passive imaging interferometry, radar interferometry, Topographic height estimation using InSAR, vegetation height estimation using InSAR, PolInSAR and SAR Tomography, differential SAR interferometry (DInSAR) and Persistent Scatterer Interferometry (PSI) for land surface deformation estimation.	9L+3T	Students will be able to understand the need of Interferometric measurement and principle of Interferometry Students will also be able to estimate topographic height, land surface deformation, vegetation height, using InSAR, DInSAR, PSI, PolInSAR, SAR Tomography
Unit 8	Application of microwave remote sensing in different fields and case studies.	6L+0T	Students will be able to understand the application of microwave remote sensing in different fields Students will also be able to understand the application of microwave remote sensing in specific field through case studies
	Total	**42L+14T = 56**	

Textbook

1) Woodhouse, I.H., (2009): Introduction to Microwave Remote Sensing. CRC Press, Taylor & Francis.

Reference Books

1) Massonet, D. & Souyris, J.C. (2008): Imaging with Synthetic Aperture Radar. EPFL press distributed by CRC press.
2) Lee, J.S., & Pottier, E. (2009): Polarimetric Radar Imaging. From Basics to Applications. CRC Press, Taylor & Francis.