GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING AND VLSI TECHNOLOGY) (26)
RADAR SIGNAL PROCESSING
SUBJECT CODE: 2742602
SEMESTER: IV

Prerequisite: Basic Knowledge of Analog communication and digital communication. Basic knowledge and skill of digital signal processing**.**

Rationale: To introduce and develop skills in the students related to understanding and analyzing various signal models, pulse RADAR Signals, Doppler RADAR Signals, Processing of RADAR Signals at various stages . To introduce various signal detecting schemes, Synthesis and analysis of RADAR Signals. Make them familiar with beam forming and adaptive processing for RADAR Systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
4	0	2#	5	70	30	20	10	10	10	150

Content:

Sr. No	Course Content	Hours	% Weightage
1	**Introduction to RADAR Systems:-**History and Application of RADAR, Basic RADAR Functions, Elements of pulsed RADAR, Review of Signal processing Concepts and operations, A preview of Basic Radar signal processing, radar system components, Advance RADAR Signal processing.	**3**	5
2	**Signal Models:-**Components of **a RADAR signal,** amplitude models, types of clutters, noise model and signal to noise ratio, jamming, and frequency models: the Doppler shift, spatial models, spectral model.	**3**	5
3	**Sampling and quantization of pulsed RADAR Signals:-**Domain and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting a pulse repetition interval, sampling the Doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q imbalance and Digital I/Q.	**4**	10
4	**RADAR Waveforms:-**Introduction, The waveform matched Filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveforms, frequency modulated pulse compression waveforms, Range side lobe control for FM Waveforms, the stepped frequency waveform, Phase modulated pulse compression waveforms, COSTAS Frequency Codes.	**4**	10
5	**Doppler Processing:-**Alternate form of Doppler spectrum, Moving Target indication(MTI),Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair Processing, additional Doppler processing issues, clutter mapping and moving target detector, MTI for moving platforms: adaptive displaced phase centre antenna processing.	**6**	15

6	**Detection Fundamentals:-**Radar Detection as hypothesis testing, threshold detection in coherent systems, threshold detection of RADAR signals.	5	15
7	**Constant False Alarm Rate (CFAR) Detection:** The effect of unknown interference power on false alarm probability, Cell Averaging (CFAR),Order static CFAR, Additional CFAR Topics.	**5**	15
8	**Introduction to Synthetic Aperture Imaging**:- Introduction to SAR Fundamentals, Stripmap SAR Data characteristics, Stripmap SAR Image formation algorithms, spotlight SAR Data characteristics, The polar format image formation algorithm for spotlight SAR, Interferometric SAR.	**5**	10
9	**Introduction to beam forming and space-Time adaptive Processing:-** Spatial Filtering, Space- time signal environment, space-time signal Modelling, processing the space-time signal, Computational issues in STAP, Reduced -dimension STAP, Advanced STAP Algorithms and Analysis, limitations to STAP.	**5**	15

References Books:

1. Fundamental of Radar signal Processing, Mark A. Rechard, McGrawhill, New York 2005
2. Principles of RADAR and Sonar Signal Processing, Francois Le Chevalier, Artech House
3. Radar Systems, Peak Detection and Tracking,Michael O kolawole,2010,Elesvier
4. Introduction to RADAR Systems 3/E,Skolnik, Mc-Graw Hill
5. Radar Principles, Peyton Z. peebles,2009 Wiley India
6. 6.Radar Design Principles-Signal Processing and Environment, Fred E. Nathason, PHI

Course Outcome:

After learning the course the students should be able to

1. Student will be able to interpret, Analyze RADAR Signal and Detections
2. Student Will be able to perform and design Basic RADAR Signal processing Mechanisms.
3. Student will be able to understand various RADAR Waveforms and Applications.
4. Student will be able to design, interpret and analyze the different Detection Methods.
5. Student will be able to understand, interpret and analyze SAR Data and applications.
6. Student will be able to design RADAR beam forming.
7. Student will be able to perform Space time adaptive signal processing for RADAR
8. Student will be able to design, analyze, synthesis complete RADAR Systems and signal processing mechanisms.

List of Experiments: Based on above experiment at least 10 experiment on RADAR Signal processing using SCILAB/MATLAB and RADAR Trainers.

Design based Problems (DP)/Open Ended Problem:

1. RADAR signal processing related to calculation of SNR, Jamming, Doppler shift , spectral analysis and related parameters.
2. Problems based on sampling and Quantization of Radar Signals.
3. Problems related to Doppler shift ,PRF and MTI Radar Signal processing
4. Problems related to Constant False Alarm Rate (CFAR) Detection.
5. Problems based on SAR Data and signal processing.
6. Problems related to beam forming and space-Time adaptive Processing.

Major Equipment: RADAR Trainers, MATLAB, SCILAB, Computers**.**

List of Open Source Software/learning website: www.nptel.ac.in

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.