SCHEME OF COURSE WORK

Course Details:

Course Title	: RADAR SIGNAL PROCESSING				
Course Code	: 13EC2105	L T P C			: 4 0 0 3
Program:	: M.Tech.				
Specialization:	: Communications and Signal Processing				
Semester	: I				
Prerequisites	: Digital Signal Processing				
Courses to which it is a prerequisite	:	--			

Course Outcomes (COs):

1	Revisit analysis of radar fundamentals and design matched filters in noise environment
2	Perform modeling with various parameter configurations can be efficiently achieved.
3	Comprehend types of pulse compression techniques for increasing range resolution
4	Analyze statistical framework necessary for the development of automatic target detection.
5	Comprehend different phase coding techniques for various radars.

Program Outcomes (POs):

1) Able to apply the knowledge of Electronics and Communication Engineering fundamentals to solve complex problems in communications and signal processing.

2) Able to identify, formulate and analyze problems related to communications and signal processing area and substantiate the conclusions using the first principles of sciences and engineering.

3) Able to Design solutions for communications and signal processing problems and design system components and processes that meet the specified needs with appropriate consideration for public health and safety.

4) Able to perform analysis and interpretation of data by using research methods such as design of experiments to synthesize the information and to provide valid conclusions.

5) Able to select and apply appropriate techniques from the available resources and modern tools, and will be able to predict and model complex engineering activities with an understanding of the practical limitations.

6) Able to collaborate with engineers of other disciplines and work on projects which require multi-disciplinary skills.

7) Able to demonstrate knowledge and understanding of the engineering and management principles and apply the same while managing projects in multidisciplinary environments.

8) Able to communicate fluently on complex engineering activities with the engineering community and society, and will be able to prepare reports and make presentations effectively.

9) Engage themselves in independent and life-long learning in the broadest context of technological change while continuing professional practice in the Communication technologies.

10) Transform into responsible citizens by resorting to professional ethics and norms of the engineering practice.

11) Able to carry out tasks by working independently and also in a group of members.

Course Outcome versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S	S	M	M	M				M		
CO-2	S	S	M	M	M				M		
CO-3	S	S	M	M	S	M			M		

CO-4	S	S	M	S	S	M		M	M		
CO-5	S	S	M	S	S	M		M	M		

S - Strongly correlated, *M - Moderately* correlated, *Blank - No correlation*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	General Radar Range Equation	CO-1	a) Explain importance of radar signal processing with block diagram. Derive radar general range equation.	Lecture/ Discussion	
2	Radar cross section, Swerling Model	CO-3		Lecture/ Discussion	
3	Radar Detection with Noise Jamming, Beacon and Repeater Equations, Bi-static Radar	CO-1	a) With the help of block schematic, discuss in detail about beacon equation. b) What are the losses in radar system and how do you compensate them?	Lecture/ Discussion	
4	Noise model, Signal to Noise ratio, jamming	CO-2		Lecture/ Discussion	
5	Matched Filter, Non-Matched Filters, Matched Filter for Non-White Noise.	CO-1,3	a) What is the need for correlation detection? Explain the operation of a cross correlation receiver. b) Derive the frequency response characteristics of a radar.	Lecture/ Discussion	Seminar
6	Frequency models: Doppler shift	CO-2	a) Distinguish between frequency and spatial models used in radar signal processing. b) What is Doppler shift? Explain its significance in radar signal processing.	Lecture/ Discussion	
7	Spatial Models: Variation with angle cross range multipath	CO-2		Lecture/ Discussion	

8	Fast time sampling, Slow time sampling, Sampling the Doppler spectrum	CO-3	a) Explain the procedure for selecting the pulse repetition interval with neat diagram. b) Derive the expression for Nyquist rate in Doppler.	NPTEL	Assignment
9	**Mid-Test 1**				
10	Radar Waveforms, Ambiguity function	CO-3	Derive an expression for ambiguity function of a single pulse defined by $$\tilde{x}(t) = \frac{1}{\sqrt{\tau_0}} Rect\left(\frac{t}{\tau_0}\right).$$	Lecture/ Discussion	
11	Linear FM Pulse Compression, Stretch Techniques	CO-3		Lecture/ Discussion	
12	Moving Target Indication	CO-4	a) Write a short notes on Blind speeds and staggered PRF's. b) What are limitations to MTI performance?	Lecture/ Discussion	
13	Detection Fundamentals: Neyman-Pearson Detection Rule, Threshold Detection of radar signals	CO-4	Explain Neyman-Pearson detection rule for making detection decision.	NPTEL	
14	Phase Coding Techniques	CO-5	a)Explain about Doppler Tolerant PC waveforms. b) Explain Phase Coded CW Radar with block diagram.	Lecture/ Discussion	
15	Linear FM and Frequency Coding Techniques	CO-5	a) Describe the essential features of Linear FM pulse compression. b) Explain the need for side lobe reduction and stretching techniques.	Lecture/ Discussion	Seminar
16	Poly Phase Codes: Frank Codes, Costas Codes, Non-Linear FM Pulse Compression	CO-5		Lecture/ Discussion	
17	Doppler Tolerant PC Waveforms – Short Pulse, Linear Period Modulation (LPM/HFM). Side lobe Reduction for Phase Coded PC Signals.	CO-5	a) Describe the essential features and advantages of digital compression. b) Distinguish between linear-FM pulse compression and phase-coded pulse compression, describing the form of the transmitted signal and the processing methods appropriate to each.	NPTEL	Assignment
18	**Mid-Test 2**				
19/20	**END EXAM**				

Course Coordinator

(N.Deepika Rani)