Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	**Erbil Technology College**	
Department	**ICTE**	
Module Name	**Radar System**	
Module Code	**RAS803**	
Degree	**Technical Diploma** [ ] **Bachelor** [/] **High Diploma** [ ] **Master** [ ] **PhD** [ ]	
Semester	**8th Semester**	
Qualification		
Scientific Title	**Lecturer**	
ECTS (Credits)	**5**	
Module type	**Prerequisite** [ ] **Core** [/] **Assist.** [ ]	
Weekly hours		
Weekly hours (Theory)	**(2)hr Class**	**(162)Total hrs Workload**
Weekly hours (Practical)	**(2)hr Class**	**( )Total hrs Workload**
Number of Weeks	**12**	
Lecturer (Theory)	**Sevan H. Ali**	
E-Mail & Mobile NO.	**Sevan.ali@epu.edu.iq**	
Lecturer (Practical)	**Sevan H. Ali**	
E-Mail & Mobile NO.		
Websites	Google Account, ResearchGate, LinkedIn	

Course Book

Course Description	This course offers a comprehensive examination of radar systems, encompassing the fundamental principles, cutting-edge technologies, and real-world applications across several fields. Radar, short for Radio Detection and Ranging, is of utmost importance in contemporary sensing and detection systems. The course integrates theoretical principles with practical implementations to provide students with a thorough comprehension of radar engineering.
Course objectives	• To explore the basic principles of radar operation, including waveforms, signal processing, and the radar equation. Understand the essential components that contribute to radar system performance. • To examine radar antenna types, patterns, and beamforming techniques. Study electromagnetic wave propagation and the impact of the atmosphere on radar signals. • To explore into radar signal processing, including matched filtering, pulse compression, and Doppler processing. Understand how these techniques contribute to target detection and tracking. • To investigate sources of clutter and interference in radar systems and learn methods to mitigate their effects. Explore clutter suppression techniques to enhance radar performance. • To understand the principles of MTI for detecting moving targets and the application of Pulse Doppler radar for velocity estimation.

	• To explore a range of radar applications, including air and spaceborne radar, ground-based radar, weather radar, and surveillance systems. • To investigate advanced radar technologies such as Synthetic Aperture Radar (SAR), passive radar systems, and over-the-horizon radar. Explore emerging trends in radar technology, including cognitive radar and machine learning applications. • To study the process of radar system design, considering specifications, trade-offs, and practical considerations. Engage in hands-on activities to reinforce design principles. • To explore methods for testing radar system performance, calibration, and validation. Gain practical experience in evaluating the effectiveness of radar systems. • To discuss the latest developments and emerging trends in radar technology, including quantum radar and other cutting-edge advancements.
Student's obligation	This radar systems course requires regular attendance at lectures, labs, and hands-on activities. Encourage active participation in class discussions, group activities, and practical exercises. Assignments, projects, and midterm and final test preparation must be completed on time. Hands-on radar equipment and simulation experience requires lab work. Reading the textbook and additional materials regularly is required. Communication with the teacher about issues, questions, or clarification is welcomed. Ethics must be observed in all course activities and assignments and exams.
Required Learning Materials	Software: LAB SOFT

	Task		Weight (Marks)	Due Week	Relevant Learning Outcome
Evaluation	Paper Review				
	Assignments	Homework			
		Class Activity			
		Report			
		Seminar			
		Essay			
		Project			
	Quiz				
	Lab.				
	Midterm Exam				
	Final Exam				
	Total				

Specific learning outcome:

Students who complete this radar systems course should:

1- Explain radar waveforms, signal processing, and the radar equation.
2- Assess radar antenna types, patterns, and beamforming methods' effects on system performance.
3- Use radar signal processing methods including matched filtering, pulse compression, and Doppler processing to improve target recognition and tracking.
4- Determine radar system clutter and interference sources and use clutter reduction to mitigate them.
5- Use MTI and Pulse Doppler radar to detect and estimate moving target velocity.
6- Examine SAR, passive radar, and over-the-horizon radar technology and their usefulness in various settings.
7- Design and optimize radar systems for specific applications using radar system design principles, specifications, trade-offs, and practical factors.
8- Test and evaluate radar system performance, including calibration and validation.
9- Discuss and assess the influence of cognitive radar and machine learning applications on future radar systems.

Course References:	1. Introduction to Radar Systems – Merrill I. Skolnik, 3rd Edition Tata McGraw-Hill, 2001. 2. Radar: Principles, Technology, Applications-Byron Edde, Pearson Education, 2004. 3. Principles of Modern Radar: Basic Principles-Mark A. Richards, James A. Scheer, William A. Holm, Yesdee,2013. 4. 'Radar Handbook ' Ed. By M.I Skolnik, 2nd Edition, Tata McGraw Hill. 5. 'Understanding Radar Systems' by Simon Kinsley and Shaun Quegan, SciTech Publishing, McGraw-Hill.6. "Radar Principles for the Non-Specialist" John C. Toomay SciTech Publishing Third Edition (2018)

Course topics (Theory)	**Week**	**Learning Outcome**
1- Introduction to Radar Systems, Definition and historical context, Basic radar principles and applications	1	To understand the basic concept of radar systems
2- Radar Waveforms, Continuous wave (CW) radar, Pulse radar and its characteristics	2	To understand radar wave forms, CW radar, pulse radar chrematistics
3- Frequency Modulated Continuous Wave (FMCW) Radar, FMCW radar principles and applications	3	To get knowledge about FMCW
4- Radar Signal Processing Basics, Introduction to signal processing in radar, Matched filter and its role in radar signal processing	4	To understand radar signal processing
5- Pulse Compression Techniques, Principles of pulse compression, Application of pulse	5	Be able to understand the pulse compression

compression in radar systems		techniques in radar system
6- Radar Antennas, Antenna basics and types, Patterns and beamforming in radar antennas	6	To understand radar antenna and pattern beamforming
7- Electromagnetic Wave Propagation and Atmospheric Effects, Electromagnetic wave propagation in different media, Atmospheric effects on radar signals	7	Be able understand the EMW propagation
8- Radar Clutter, Types of clutter in radar systems, Clutter suppression techniques	8	To understand radar clutter and clutter suppression techniques
9- Radar Interference, Sources of interference in radar systems, Techniques for interference mitigation	9	To understand radar interference in radar systems
10- Moving Target Indication (MTI) Principles, MTI radar fundamentals, Implementation of MTI for target detection	10	Be able to know the principles of MTI detection
11- Pulse Doppler Radar, Principles of Pulse Doppler radar, Velocity estimation using Pulse Doppler techniques	11	To know about pulse doppler radar and velocity estimation
12- Advanced Radar Techniques and Emerging Trends, Synthetic Aperture Radar (SAR), Passive radar systems, Over-the-horizon radar, Emerging trends: Cognitive radar, machine learning applications	12	Be able to understand Advanced Radar Techniques

Practical Topics	Week	Learning Outcome
1. Radar cross-section	1	In this experiment the radar cross-section or RCS of a 3D object is investigated
2. Distance law for radar	2	In this experiment the distance law for radar is investigated using an example where we consider how the distance effects the amplitude of the reflected signal
3. Radar precision.	3	In this experiment we investigate pulse radar distance measurement.
4. Reflection response	4	In this experiment the amplitude of the reflected signal is investigated as a function of the incident angle and the law of reflection is verified
5. Retroreflector operating response	5	In this experiment the radar signal's reflection or echo off of a retroreflector is investigated
6. Absorption.	6	In this experiment the reflection

		response to various materials is investigated
7. Phantom targets	7	In this experiment we explore the potential conditions needed for phantom targets to appear
8. Range resolution and angular resolution	8	In this experiment the range and angular resolution of the training radar is examined using an example
9. Ground clutter	9	In the following experiment we will explore the effects of ground clutter on the radar's ability to detect and track targets
10.Chaff	10	In this experiment we detect and track targets attempting to camouflage themselves with the aid of passive interference
11.Flight transponders	11	In this experiment the functionality of a secondary radar unit is investigated
12.Tracking of civil aircraft and military aircraft	12	In this experiment the

		tracking of missiles is examined in the Track While Scan - operating mode and single target mode.

Questions Example Design

Extra notes:

External Evaluator

1- **Asst. Prof. Dr. Ilham Kadim Onees**
2- **Mrs. Jabr Majid Sadiq**