EE6617: DETECTION AND ESTIMATION - THEORY AND APPLICATIONS IN COMMUNICATIONS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Detection and Estimation - Theory and Applications in Communications

Subject Code
EE - Electrical Engineering
Course Number
6617

Academic Unit
Electrical Engineering (EE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
EE3210 Signals and Systems; or EE3008 Principles of Communications; or Courses in Signal Processing and Communications

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

The course provides students with principles in three areas of Estimation and Detection:

- Estimation and Detection theory
- Statistical signal processing and optimization
- Applications in Communications.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Engage in exploring and discussing the general frameworks in detection and estimation through interactive learning activities, enhancing conceptual understanding.		x	x	
2	Collaboratively identify detection and estimation problems, applying mathematical formulations, statistical signal processing skills, and optimization tools in group problem-solving scenarios.		x	x	
3	Apply detection and estimation techniques to practical problems in communications and signal processing through hands-on applications, fostering critical thinking and practical skills.		x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Interactive lectures where fundamentals of estimation and detection, skills in statistical signal processing, tools in optimization, and their applications in communications are explored through active discussions, real-time problem-solving, and multimedia resources, encouraging student engagement and participation.	1, 2, 3	3 hrs/wk for 12 weeks
2	Mini project	Mini-projects where students apply Matlab coding to solve real-world estimation and detection problems, enhancing practical skills and active learning experiences.	2, 3	
3	Case study	Case studies designed for students to investigate the latest R&D advancements in detection and estimation technologies and their applications to emerging fields, promoting critical analysis and connection to real-world developments.	2, 3	3 hrs/wk for 1 week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3	30	
2	#Assignments (min.: 3)	1, 2, 3	20	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Remark: To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. # may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)

Assessment Task
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal level

Assessment Task
Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal level

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

Assessment Task
Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

Additional Information for AR

Constructive Alignment with Programme Outcomes

PILO 1-4 The course exposes students to various estimation and detection problems arising in the field of communications and/or information engineering. The learning experience will be enriched by mini-projects and case studies.

PILO 2,3,4 Students are required to complete assignments designed to corroborate fundamental understanding of the theory. Mini-projects are designed for students to gain practical experience and coding skills in real applications of the estimation and detection technologies.

Part III Other Information

Keyword Syllabus

Fundamentals
Vector spaces, linear subspaces, random variables, probability density function, cumulative distribution function, statistical signal representation.
Detection and estimation theory
Hypothesis testing, Neyman-Pearson criterion, minimum probability error detector, non-coherent detection, parameter estimation, minimum variance estimation, Cramer-Rao bound, maximum likelihood estimation, least squares, Bayesian estimator
Applications to communications and signal processing

The mini-projects are designed to supplement the lecture aspects of the course, and will provide practical learning experience on how various detection and estimation techniques are applied to design communication and signal processing systems.

Reading List

Compulsory Readings

	Title
1	Detection and Estimation for Communication and Radar Systems by Kung Yao, Flavio Lorenzelli, Chiao-En Chen, Cambridge University Press, ISBC: 978-0-521-76639-5, 2013.

Additional Readings

	Title
1	Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory by Steven M. Kay, Prentice Hall, ISBN: 0133457117, 1993.
2	Fundamentals of Statistical Signal Processing, Volume II: Detection Theory by Steven M. Kay, Prentice Hall, ISBN: 013504135X, 1998
3	Statistical Signal Processing: Detection, Estimation, and Time Series Analysis by Louis L. Scharf, Addison Wesley, ISBN: 0201190389, 1991.
4	Matlab tutorial: http://www.youtube.com/playlist?list=PL1D547802F5F38A94