COURSE INFORMATON					
Course Title	*Code*	*Semester*	*L+P Hour*	*Credits*	*ECTS*
Statistical and Adaptive Digital Signal Processing	BME561		(3+0+0)	3	10

Prerequisites	-

Language of Instruction	English
Course Level	Master's Degree
Course Type	Technical Elective
Course Coordinator	Prof. Ali Ümit Keskin
Instructors	Assist. Prof. Gokhan Ertas
Assistants	
Goals	To provide knowledge on applications of statistical and adaptive signal processing techniques to biomedical engineering
Content	Fundamentals of discrete time signal processing, random variables, vectors and sequences, discrete random processes, stationary discrete time stochastic processes, analysis of linear systems with stationar random inputs, World decomposition, Yule Walker equations, Innovation Representation of random vectors and Innovation process, signal modeling, AR, MA, ARMA models, optimum filtering problem, principle of orthogonality, solution of normal equations, Linear Prediction, algorithms and structures for optimum linear filters, Wiener filter theory, signal modeling and parametric spectral estimation, Levinson and Schür Algorithms, Lattice Filters, Gram Schmidt orthogonalization, Joint Process estimation, Adaptive filters, Steepest Descent method, LMS adaptation algorithm, Kalman filter theory, application to adaptive filters with stationary and nonstationary inputs, Method of Least Squares, deterministic normal equation, Recursive Least Squares adaptive filters, Recursive Least Squares Lattice Filters.

Course Learning Outcomes	Program Learning Outcomes	Teaching Methods	Assessment Methods
1) Knowledge of basics of biomedical signals and signal representation	2,4,5,6,7,11	1,2	A,C,D
2) Knowledge of statistical and adaptive signal processing	2,4,5,6,7,11	1,2	A,C,D
3) Applications of statistical and adaptive signal processing techniques to biomedical engineering	2,4,5,6,7,11	1,2,4	A,C,D

Teaching Methods:	1: Lecture, 2: Question-Answer, 3: Lab, 4: Case-study
Assessment Methods:	A: Testing, B: Experiment, C: Homework, D: Project

COURSE CONTENT		
Week	**Topics**	**Study Materials**
1	Fundamentals of discrete time signal processing, random variables, vectors and sequences	Lecture Notes, Articles
2	Discrete random processes, stationary discrete time stochastic processes, analysis of linear systems with stationar random inputs.	Lecture Notes, Articles
3	World decomposition, Yule Walker equations, Innovation Representation of random vectors and Innovation process.	Lecture Notes, Articles
4	Signal modeling, AR, MA, ARMA models, optimum filtering problem.	Lecture Notes, Articles
5	Principle of orthogonality, solution of normal equations, Linear Prediction, algorithms and structures for optimum linear filters.	Lecture Notes, Articles
6	Wiener filter theory, signal modeling and parametric spectral estimation.	Lecture Notes, Articles
7	ARA SINAV	Lecture Notes, Articles
8	Levinson and Schür Algorithms.	Lecture Notes, Articles
9	Lattice Filters, Gram Schmidt orthogonalization, Joint Process estimation, Adaptive filters.	Lecture Notes, Articles
10	Steepest Descent method, LMS adaptation algorithm.	Lecture Notes, Articles
11	Kalman filter theory, application to adaptive filters with stationary and nonstationary inputs.	Lecture Notes, Articles
12	Method of Least Squares, deterministic normal equation.	Lecture Notes, Articles
13	Recursive Least Squares adaptive filters.	Lecture Notes, Articles
14	Recursive Least Squares Lattice Filters.	Lecture Notes, Articles

RECOMMENDED SOURCES	
Textbook	M. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley&Sons, 1996. / R. M. Gray, L. D. Davisson, An Introduction to Statistical Signal Processing, 2010. / D.G. Manolakis, V.K. Ingle, S.M. Kogan, “Statistical and Adaptive Signal Processing”, McGraw-Hill, 2000.
Additional Resources	S. Haykin, “Adaptive Filter Theory,” Prentice Hall, 4th Edition, 2002. / Ali H. Sayed, “Adaptive Filters,” Wiley, 2008. / B. Farhang-Boroujeny, “Adaptive Filters: Theory and Applications,” Wiley, 1998.

MATERIAL SHARING	
Documents	-
Assignments	-
Exams	-

ASSESSMENT		
IN-TERM STUDIES	**NUMBER**	**PERCENTAGE**
Mid-terms	1	50
Homework	10	20
Presentation	1	30
Total		**100**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE		40
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE		60
Total		**100**

COURSE CATEGORY	Expertise/Field Courses

	COURSE'S CONTRIBUTION TO PROGRAM						
No	Program Learning Outcomes	Contribution					
		0	1	2	3	4	5
1	Ability to reach wide and deep knowledge through scientific research in the field of Biomedical Engineering, evaluate, interpret and apply.						**X**
2	Ability to use scientific methods to cover and apply limited or missing knowledge, and to integrate the knowledge of different disciplines to identify, define, formulate solutions to complex engineering problems.					**X**	
3	Ability to construct Biomedical Engineering problems, develop methods to solve the problems and use innovative methods in the solution.					**X**	
4	Ability to develop new and/or original ideas, tools and algorithms; develop innovative solutions in the design of system, component or process.						**X**
5	Ability to have extensive knowledge about current techniques and methods applied in Biomedical Engineering and their constraints.					**X**	
6	Ability to design and implement analytical modeling and experimental research, solve and interpret complex situations encountered in the process.						**X**
7	Ability to use a foreign language (English) at least at the level of European Language Portfolio B2 in verbal and written communication.						**X**

8	Ability to lead in multidisciplinary teams, develop solutions to complex situations and take responsibility.					**X**	
9	Ability to pass process and the results in Biomedical Engineering field, in national and international area in or outside of the field, systematically and clearly in written or oral form.					**X**	
10	Awareness of the social, legal, ethical and moral values and environmental dimensions. The ability to conduct research and implementation work within the framework of these values.					**X**	
11	Awareness of the new and emerging applications in Biomedical Engineering field, and the ability to examine them and learn if necessary.					**X**	
12	Ability to read, understand, present, critise research work and conduct original theoretical or applied research.				**X**		

ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION			
Activities	Quantity	Duration (Hour)	Total Workload (Hour)
Course Duration (Excluding the exam weeks: 12x Total course hours)	12	3	36
Hours for off-the-classroom study (Pre-study, practice)	14	5	70
Midterm examination	2	3	6
Homework	5	6	30
Presentation	1	20	20
Final examination	1	3	3
Total Work Load			240
Total Work Load / 25 (h)			9.6
ECTS Credit of the Course			10