Tamkang University Academic Year 101, 2nd Semester
Course Syllabus

<table>
<tr><td>Course Title</td><td colspan="2">Estimation and Control</td><td>Instructor</td><td colspan="2">Dr. Tyan, Feng</td></tr>
<tr><td colspan="2">Department/Year/Class</td><td colspan="4">Course Details</td></tr>
<tr><td colspan="2">Aerospace engineering/
2013Spring/
Graduate School</td><td>☐Required
■Selective</td><td colspan="2">☐0（One Semester）
☐1（1st Semester）
■2（2nd Semester）
☐3（3rd Semester）</td><td>Credits</td><td>3</td></tr>
<tr><td colspan="3">Aim of Education</td><td colspan="3">Core Competences</td></tr>
<tr><td colspan="3">1. Be capable of applying scientific knowledge and engineering technique to analyze and solve the fundamental problems of the aeronautics and aerospace engineering.
2. Be able to implement fundamental principles to design and conduct experiments, as well as to analyze and interpret data.
3. To possess the spirit of independent thinking, self-elevating and continuous learning.
4. To have the work ethic and a cooperative attitude and responsibility of team work.
5. To equip with the ability of mastering information, implementing basic knowledge, generating diversified development and good environmental adaptability.</td><td colspan="3">A. To equip with specific aerospace engineering knowledge and expertise.
B. Be able to master information, capable of utilizing computer to assist solving problems, and possess the ability of conducting learning new knowledge.
C. Be able to design and conduct experiments as well as to analyze, and to solve practical aerospace related engineering problems.
D. Be able to write professional research papers in the field of aerospace engineering.
E. Have a creative thinking, complete analyzing, effective communication, the spirit of teamwork and the ability to solve industrial problems.</td></tr>
<tr><td>Course Introduction (50 to 100 words)</td><td colspan="5">This course covers mathematical approaches to the best possible way of estimating the state of a general system. Although the course is firmly grounded in mathematical theory, the approaches that are presented for state estimation are all given with the goal of eventual implementation in software.
The goal of the course is to present state estimation theory in the most clear yet rigorous way possible, while providing enough advanced material and references so that the student is prepared to contribute new material to the state of the art. Engineers are usually concerned with implementation, and so the material presented is geared towards discrete time systems. However, continuous time systems are also discussed for the sake of completeness, and also because there is still room for implementations of continuous time state estimators</td></tr>
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The Relevance among Teaching Objectives, Objective Levels and Core Competences

I. Objective Levels (select applicable ones)：

(I) Cognitive Domain：C1 Remembering、C2 Understanding、C3 Applying、C4 Analyzing、C5 Evaluating、C6 Creating

(II) Psychomotor Domain：P1 Imitation、P2 Mechanism、P3 Independent Operation、P4 Linked Operation、P5 Automation、P6 Origination

(III) Affective Domain：A1 Receiving、A2 Responding、A3 Valuing、A4 Organizing、A5 Charaterizing、A6 Implementing

II. The Relevance among Teaching Objectives, Objective Levels and Core Competences：

(I) Determine the objective level(s) in any one of the three learning domains (cognitive, psychomotor, and affective) corresponding to the teaching objectives. Each objective should correspond to the objective level(s) of ONLY ONE of the three domains.

(II) If more than one objective levels are applicable for each learning domain, select the highest one only. (For example, if the objective levels for Cognitive Domain include C3, C5, and C6, select C6 only and fill it in the boxes below. The same rule applies to Psychomotor Domain and Affective Domain.)

(III) Determine the core competences that correspond to each teaching objective. Each objective may correspond to one or more core competences at a time. (For example, if one objective corresponds to three core competences: A, AD, and BEF, list all of the three in the box.)

Teaching objectives	Relevance	
	Objective Levels	Core Competences
1. Be familiar with the basic operations of vectors and matrices..	C4,P2,A2	AB
2. Understand the basic arithmetic of linear system theory.	C4,P2,A2	ABCD
3. Capable of setting up digital filter (estimator) equations.	C4,P2,A2	ABEG
4. Understand how to use computer to solve estimation problems in engineering.	C4,P3,A4	ABEG
5. Develop the ability of analyzing control problems with mathematics.	C6,P3,A4	ACEF
6		

Teaching Objectives, Teaching Methods and Assessment

Teaching Objectives	Teaching Methods	Assessment
1. Be familiar with the basic operations of vectors and matrices..	lecture and Q&A	homework, midterm exam, final exam
2. Understand the basic arithmetic of linear system theory.	lecture and Q&A	homework, midterm exam, final exam
3. Capable of deriving and setting up Kalman filter (estimator) equations.	lecture and Q&A	homework, midterm exam, final exam
4. Be able to take advantage of computer to solve estimation related problems in the field of aerospace engineering.	lecture and Q&A	homework, midterm exam, final exam
5. Develop the ability of analyzing control problems with mathematic tools.	lecture and Q&A	homework, midterm exam, final exam

This course has been designed to cultivate the following essential qualities of TKU students.	
Essential Qualities of TKU Students	Description
■global perspectives	1. Introduce those fine teaching materials downloaded from the web sites of the top universities of the world (e.g. Purdue, Stanford, National Singapore University, Hong Kong University, etc.) to the class. 2. Play course related videos downloaded from MIT open courses (e.g. MIT course number 16.322) and other resources. 3. Collect problem sets from all the top universities via internet, and create test bank for the course. 4. Adopt the latest and best textbook.
■a vision for the future	
■information literacy	
■ethical and moral principles	
■independent thinking	
□an awareness of healthy living	
■effective teamwork	
□an appreciation of the arts	1. Introduce the application Kalman filter to practical aerospace related engineering problems that they may encounter in the future, e.g. GPS, missile guidance problem, etc.
	1. Use software “MATLAB/Simulink” to help student to understand the Kalman filter and related topics. 2. Use Latex (Beamer), Acrobat to create slides (pdf files) for the course.
	1. Enter the class on time or a litter earlier. 2. Slippers are not allowed in class. 3. No food and drink in class. 4. Students are required to sign the HONOR CODE in exams.
	1. Invite students to explain their rationales on solving problems. 2. Always ask students “why?”.
	N/A
	1. Invite students to discuss and solve problems together as a team in class.
	N/A

Course Schedule			
Week	Date	Subject/Topics	Note
1	2/18	Linear systems theory	
2	2/25	Linear systems theory	
3	3/4	Probability theory	
4	3/11	Probability theory	
5	3/18	Least Squares Estimation	
6	3/25	Least Squares Estimation	
7	4/1	Propagation of state and covariances	
8	4/8	Propagation of state and covariances	
9	4/15	The discrete Kalman filter	
10	4/22	Midterm Exam Week	
11	4/29	The discrete Kalman filter	
12	5/6	The continuous-time Kalman filter	
13	5/13	The continuous-time Kalman filter	
14	5/20	The H-infinity filter	
15	5/27	The H-infinity filter	
16	6/3	Nonlinear Kalman filter	
17	6/10	Nonlinear Kalman filter	
18	6/17	Final Exam Week	
Requirement	1. Make yourself be acquainted with MATLAB. 2. In the midterm and final exam, you are allowed to bring one cheat sheet of the A4 size. In this piece of paper you can write down anything that may help you. 3. Study Hard.		
Teaching Facility	■Computer ■Overhead Projector ■Other（Software: MATLAB）		
Textbook(s)	1. Dan Simon, “Optimal State Estimation,” Wiley Interscience, 2006 2. R. F. Stengel, “Optimal Control and Estimation,” Dover, 1994.		
Suggested Readings	1. R. G. Grown and P. Y. C. Hwang, “Introduction to Random Signals and Applied Kalman Filtering with MATLAB Exercises and Solutions,” John Wiley, 1997 2. A. Gilbert, “Applied Optimal Estimation,” 1974. 3. G. M. Siouris, “An Engineering Approach to Optimal Control and Estimation Theory,” John Wiley & Sons, 1996. 4. F. L. Lewis, “Optimal Estimation with Introduction to Stochastic Control Theory,” John Wiley & Sons, 1986.		
Number of Assignment(s)	8-10 homeworks. (NO late homeworks !!)		

Grading Policy	■homework：15% ■midterm exam：35 % ■final exam：50 %
Note	This syllabus may be uploaded at the website of Course Syllabus Management System at **http://info.ais.tku.edu.tw/csp** or through the link of Course Syllabus Upload posted on the home page of TKU Office of Academic Affairs at http://www.acad.tku.edu.tw/index.asp. **※Unauthorized photocopying is illegal. Using original textbooks is advised. It is a crime to improperly photocopy others' publications.**

Form No.：ATRX-Q03-001-FM201-05