

# **MKEM 1763**

## **System Identification and Estimation**

**Introduction**

**Objectives & Synopsis**

**Outcomes**

**Syllabus**

**Lecture Planning**

**Assessment & Time table**

**References**

# Lecturer MKEM 1763

## Prof Dr Mohd Fuaad Rahmat

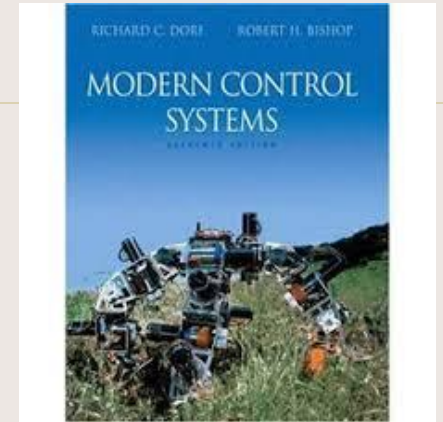


### Qualifications

- B.Eng.(Electrical), UTM 1989
- MSc.(Control System), The University of Sheffield 1993
- PhD(Instrumentation), Sheffield Hallam University 1996
- 29 years experience as academician
- Head of Department Off-Campus Program, 1999-2008
- Head of Department, CIED, 2011-2012
- Academic Coordinator Master Taught Course, 2012-2014
- Dean, UTMSPACE, 2015-2018

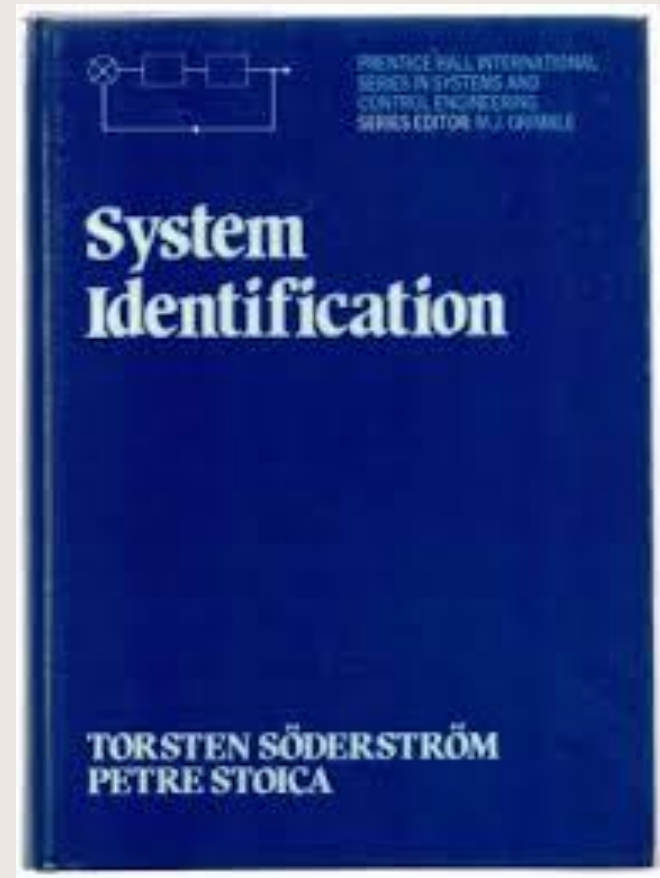
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- Selected publication:  
<https://sites.google.com/a/fke.utm.my/proffuaad/selected-publications>
- MKEM 1763:  
<http://fuaad.fke.utm.my/subjects/mem1763-sysid-est>



# Objectives

- To expose student regarding the theory of system identification and estimation.
- To introduce student the basic concept of reverse modeling including experimental protocol, test signal, model structure, parameter estimation and model validation.



# Synopsis

- This course is an introduction to the system identification and parameter estimation.
- It covers an introduction to system identification, acquiring and pre-processing data, nonparametric model estimation methods, parametric model estimation methods, partially known estimation methods, model estimation methods in closed loop systems, recursive model estimation methods, analyzing, validating, and converting models and system identification case study

# Synopsis

- **This requires an in-depth understanding of control system engineering, modern control system and digital control system.**
- **The emphasis will be on the theoretical basis as well as practical implementations.**
- **Key components studied in details are time response analysis, frequency response analysis, correlation analysis, power spectrum density analysis, model structure, parametric model, parameter estimation method, test signals and model validation methods.**

# **Course learning outcomes (CLO)**

**At the end of the course the students should be able to**

- CO1: Able to explain the fundamental basis of system identification**
- CO2: Able to comprehend the fundamental basis of parameter estimation**
- CO3: Able to applied both fundamental above in real case study**

# Time table

## FACULTY OF ELECTRICAL ENGINEERING TIMETABLE FOR SEMESTER 1 SESSION 2018/2019

**PROF. DR. MOHD FUA'AD RAHMAT**

	2	3	4	5	6	7	8	9	10	11	12	13
	8.00-8.50	9.00-9.50	10.00-10.50	11.00-11.50	12.00-12.50	13.00-13.50	14.00-14.50	15.00-15.50	16.00-16.50	17.00-17.50	18.00-18.50	20.00-22.50
<b>SUN</b>	SPACE/PERSISIR					<b>B</b>	SPACE/PESISIR					
<b>MON</b>						<b>R</b>	SKEE 3133 05/06 P19A - BT 7					
<b>TUES</b>				MKEM 1763 P19a - BT 3		<b>E</b>						
<b>WED</b>						<b>A</b>						
<b>THURS</b>	MKEM 1763 P19a - BT 3			SKEE 3133 05/06 P19A - BT 6		<b>K</b>						



# Assessment MKEM 1763

- **Test 1 (15%)**
  - **TEST 1: W6, 16 Oct 2018, Tuesday**
- **Test 2 (15%)**
  - **TEST 2: W12, 27 Nov. 2018, Tuesday**
- **Assignment (30%)**
  - **Release in October & submit in December 2018**
- **Final exam (40%)**
  - **January 2019, no worries, next year!**

# Chapter 1: Introduction to System Identification

- **Model based control design process**
- **Model types and model representations**
- **Developing models with the system identification software**
- **Acquiring data from a system**
- **Preprocessing data from a system**
- **Removing offsets and trends**
- **Outliers**
- **Filtering and down sampling**
- **Data scaling**

# Chapter 2: Nonparametric Model Estimation methods

- Time response
- Frequency response
- Impulse response
- Correlation – auto and cross correlation
- Frequency spectrum
- PRBS signal – pseudo random binary signal

# Chapter 3: Parametric Model Estimation methods

- **Parametric model representations**
  - **General Linear Polynomial Model**
  - **ARX model, ARMAX model, Output error model, Box and Jenkins model, AR model**
  - **Transfer function model**
  - **Zero-pole gain model**
  - **State space model**
  - **User defined model**
  - **Polynomial models versus state space model**

# Semester Break.....



# Chapter 4: Case Studies

- **Hot Air Blower System with temperature sensor**
- **Hydraulic Actuator with Servo Valve**
- **Pneumatic actuator system with control valve**
- **DC motor control for speed and position**
- **<http://homes.esat.kuleuven.be/~smc/daisy/>**

# Chapter 5: Parametric Model Estimation methods

- **Least Square**
- **Generalized Least Square**
- **Recursive Least Square**
- **Predictive Error**
- **Model validation methods**
  - **Akaike's information criterion**
  - **Final prediction error criterion**
  - **Minimum description length criterion**

# Learning resources

- **Ljung, L. System Identification: Theory for the User. Second edition. PTR Prentice Hall, Upper Saddle River, NJ, 1999**
- **Söderström, T., and P. Stoica. System Identification. Prentice Hall International, London, 1989**



# Learning resources

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- **Ljung, L., and T. Glad. Modeling of Dynamic Systems. PTR Prentice Hall, Upper Saddle River, NJ, 1994**
- **Karel J Keesman, System Identification: An Introduction, Springer**

# Other learning resources

- **Norman S. Nise, Control Systems Engineering (6th Edition), John Wiley and Sons. 2011**
- **Katsuhiko Ogata, Modern Control Engineering (5th Edition). Pearson Education International, Inc., 2010**
- **Richard C. Dorf and Robert H. Bishop, Modern Control Systems (12th Edition), Pearson Educational International, 2011**
- **Rao V. Dukkupati, Analysis and Design of Control systems Using MATLAB, Published by New Age International (P) Ltd., Publishers, 2006**
- **Benjamin C. Kuo, Automatic Control Systems (7th Edition), Prentice-Hall International, Inc., 1995**
- **Katsuhiko Ogata, MATLAB For Control Engineers, Pearson Education International, Inc., 2008**



# End of Preamble

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