



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Applied Instrumentation

Course / Subject Code : ME01067041

Course / Subject Name : Process Modeling and Identification

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	PEC-01

Prerequisite:	Nonlinear and digital control, Control system design, Process Control
Rationale:	Process mathematical models, starting from measured data, is an important step in many engineering methods. This course contains a number of important process models and foundations for linear system identification and modeling. Topics covers selecting a good model structure, appropriate parametrizations, criteria for model selection and statistical properties of the obtained estimates. The course deals with least squares estimation, prediction error techniques, state space models and realization theory. The emphasis is on methods that offer a good generalization. The methods are illustrated with many practical examples and applications.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understands models of the process	U
02	Understand the concepts of standard system for linear dynamical systems	U
03	Apply identification techniques for nonlinear dynamical systems.	A
04	Analyse the process data and obtained models	N
05	Evaluate the best models and other nonlinear identification methods.	E

*Revised Bloom's Taxonomy (RBT) *

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Process Modeling: Introduction, State-space model: General form and canonical form, Input/output model: transfer function and coprime polynomials, Plant Parametric model: Linear and bilinear parametric models	4	10%
2.	Introduction to process identification: Frequency domain expression,	4	10%



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Applied Instrumentation

Course / Subject Code : ME01067041

Course / Subject Name : Process Modeling and Identification

	signal spectra, model structure, least square method, procedure steps for process identification		
3.	Identification of LTI process: sets of linear models, transfer function models, state-space models, distributed parameter models, model structures and identifiability	8	20%
4.	Identification of Time varying and nonlinear systems: linear time-varying models, models with nonlinearities, nonlinear state space models, Black box models	8	20%
5.	Nonparametric time and frequency domain methods: transient response and correlation analysis, frequency response analysis, Fourier analysis, spectral analysis	8	20%
6.	Parametric estimation methods: Minimizing prediction errors, Linear regressions, least squares method, maximum Likelihood method	6	10%
7.	Convergence and consistency: Conditions on the data set, Prediction-error approach, consistency and identifiability, correlation approach	4	10%
	Total		100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	20	20	15	5

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. S. M. Kay, *Fundamentals of Statistical Signal Processing: Estimation Theory*, Prentice Hall, 1993
2. R. L. Eubank, *Kalman filter primer*, Chapman & Hall, 2006.
3. L. Ljung, *System identification: theory for the user*, 2E, Prentice Hall, 1999
4. R. Pintelon and J. Schoukens, *System identification: a frequency domain approach*, Wiley & Sons, 2012
5. S. A. Billings, *Nonlinear system identification: narmax methods in the time frequency and spatio temporal domains*, Wiley, 2013
6. Petros A. Ioannou and Jing Sun, *Robust Adaptive Control*, Dover, 2012.
7. Nelles, O. *Nonlinear System Identification*, Springer-Verlag, Berlin, 2001, ISBN: 3-54067369
8. Karel J. Keesman, "System Identification, an introduction", Springer, 2011.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Applied Instrumentation

Course / Subject Code : ME01067041

Course / Subject Name : Process Modeling and Identification

(b) Open source software and website:

1. Demonstration of the System Identification toolbox and practise using data repositories, e.g., <http://homes.esat.kuleuven.be/~smc/daisy/daisydata.html>.
2. <https://www.scilab.org/>

Suggested Course Practical List: If any

List of Laboratory/Learning Resources Required:

Suggested Project List:

Suggested Activities for Students: If any

CO- PO Mapping:

Semester ____	Course Name (Course Code:)											
	POs											
Course Outcomes												
CO1												
CO2												
CO3												
CO4												
CO5												

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

Any Other:
