NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B. Tech in Electronics and Instrumentation Engineering
Course Code:	2EIDE07
Course Title:	System Identification
Course Type:	([ ] Core/[ ] Value Added Course/[√] **Departmental Elective**/ [ ] Institute Elective/[ ]University Elective/[ ]Any other)
Year of introduction:	2023-2024

Credit Scheme

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLO):

At the end of the course, students will be able to –

1. explain system identification and estimation techniques
2. identify the model structure & order determination for an unknown process from empirical data
3. apply estimation techniques for parametric & nonparametric models
4. design and validate the model for practical process applications

Syllabus: Total Teaching hours: <u>45</u>

Unit	Syllabus	Teaching hours
Unit-I	**Introduction** Introduction, Development of parameter estimators, Least-Squares estimation – linear least-squares, generalized least-squares, nonlinear least-squares, Sufficient statistics, Analysis of estimation errors, MMSE, MAP and ML estimators, sequential least-squares, asymptotic properties, General convergence results	08
Unit-II	**System identification** Identification based on differential equations, Laplace transforms, frequency responses, difference equations. Stationary, auto-correlation, cross-correlation, power spectra. Random and deterministic signals for system identification: pulse, step, pseudo random binary sequence (PRBS), signal spectral properties, persistent excitation.	10

| Unit-III | **Model identification** | 10 |
| | Estimates of the plant impulse, step and frequency responses from identification data, Correlation and spectral analysis for non-parametric model identification, parametric Models-Equation error, output error models, and determination of model order. | |

| Unit-IV | **Methods of estimation and identification** | 12 |
| | Parametric estimation using one-step a head prediction error model structures and estimation techniques for ARX, ARMAX, Box-Jenkins, FIR, Output Error models. Residual analysis for determining adequacy of the estimated models. Recursive system identification. | |

| Unit-V | **Nonlinear filters** | 05 |
| | Kalman filtering and other nonlinear filters | |

Self-Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents

Suggested List of Experiments: --

Suggested Readings/ References:

1. Arun K Tangirala Principles of System Identification: Theory and Practice, First Edition, CRC Press,2014
2. Karel J. Keesman, System Identification: An Introduction, Springer-Verlag London,2011
3. L.Ljung, System Identification: Theory for the User, 2nd Edition, Prentice-Hall,1999
4. Y.Zhu, Multivariable System Identification for Process Control, Pergamon,2001
5. T. Söderström and P. Stoica, System Identification, Prentice Hall International, Hemel Hempstead, Paper back Edition,1994.
6. O.Nelles, Nonlinear System Identification, Springer-Verlag, Berlin,2001

Suggested Case List: --

L= Lecture, T=Tutorial, P= Practical, C= Credit

w.e.f. academic year 2023-24 and onwards.