EE 622: Multivariable Control Systems

IIT Dharwad (July – November 2024)

Instructor: Gopal Krishna Kamath M Classroom Number: LG08 Slot: D

Course Assessment:

SI No.	Component	Weightage	Marks	Duration	Date and Time	Venue
1	Mid-Semester Examination	20%	60	2 hours	As per Academic Office	As per Academic Office
2	Quiz 1	15%	45	1 hour	August 24, 2024 10am – 11am	UG3 (Permanent Campus)
3	Quiz 2	15%	45	1 hour	November 2, 2024 11am – 12pm	UG3 (Permanent Campus)
4	Assignments/Project	20%	60	Submission 1 week after Assignment release	Continuous Evaluation	Continuous Evaluation
5	End-Semester Examination	30%	90	3 hours	As per Academic Office	As per Academic Office
		Total Marks	300			

Textbooks:

1. Linear Systems by Thomas Kailath
2. Linear Systems Theory by João P. Hespanha

Reference Books:

1. Linear System Theory and Design by Chi-Tsong Chen
2. Feedback Systems: An Introduction for Scientists and Engineers by Karl Johan Aström and Richard M. Murray
3. Linear Systems by Panos J. Antsaklis and Anthony N. Michel
4. Modern Control Systems by Richard Dorf and Robert Bishop
5. Finite Dimensional Linear Systems by Roger W. Brockett

i.	Title of the Course	**Multivariable control systems**
ii.	Credit Structure	(3-0-0-6)
iii.	Adequate prior exposure, if any	Exposure to control systems
iv.	Course Content (separate sheet may be used, if necessary)	**Review of basic mathematics:** Review of differential equations, Fourier and Laplace transform, basic linear algebra: matrices, rank, inverses, decompositions etc., **Review of frequency domain modelling:** revision of frequency domain modelling, transfer functions **Introduction to State Variables:** Motivation for State Variables, Implementation of Differential Equations, Formal Definitions **Basic Realization Theory:** Similarity Transformation, Canonical Realizations: Jordan and real canonical forms, Minimal realization **Connections to Transfer Functions:** Characteristic/Minimal Polynomials, matrix exponentials, Markov parameters and other invariants **Review of frequency domain analysis:** Recall root locus, stability analysis using Routh-Hurwitz criteria, bode plots, Nyquist plots etc. **Observability, Controllability:** Canonical Realizations, Decomposition of Uncontrollable and Unobservable realizations, State Feedback, Asymptotic Observers, Separation Principle and Pole Placement Theorem **Extensions to MIMO systems:** Transfer matrices, Controllability, Observability and Pole Placement, Controller/Observer forms, Minimality and relations to Controllability and observability, MIMO Realization theory
v.	Texts/References (separate sheet may be used, if necessary)	1. T. Kailath, Linear Systems, Prentice-Hall, New Jersey, 1st edition, (11 February 1980) 2. Richard Dorf and Robert Bishop, Modern Control Systems, Pearson; 13th edition (5 January 2016) 3. Karl Johan Aström, Richard M. Murray, Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press (21 April 2008) 4. João P. Hespanha, Linear Systems Theory, Princeton

		University Press (2 October 2009) 5. Karl Johan Aström, Richard M. Murray, Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press, 2nd edition (2 March 2021) 6. João P. Hespanha, Linear Systems Theory, Princeton University Press (2 October 2009), 2nd edition, 13 February 2018
vi.	Instructor (s)	Ameer Mulla
vii.	Name of dept to whom the course is relevant	Electrical Engineering, Mechanical Engineering
viii	Justification	This course aims at providing an introduction to the time domain approach of control of linear systems and optimal control systems. The contents of this course are decided targeting the PG students working in Electrical and Mechanical Engineering department so as to provide them a starting point in the field of control system design.