**University of Management and Technology**

**Course Outline**

Course code…**EE504**………………...... Course title……**Linear Systems**……

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| Program | **MS Electrical Engineering** |
| Credit Hours | **Three** |
| Duration | **One semester: 16 weeks** |
| Prerequisites | **Linear Algebra** |
| Resource Person | **Dr Sajjad Shami** |
| Counseling Timing(Room# 3C-15 ) | **Wed, Fri 5:30 to 6:30 pm** |
| Contact | **Sajjad.shami@umt.edu.pk****0343-4995535** |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

**Learning Objectives and Outcomes:**

This course is intended as a first semester graduate course on linear systems theory, design and implementation with application to signal processing, communications, estimation and control. The objective is to present a comprehensive coverage of the basic tools needed by an electrical engineering graduate student specializing in the above areas.

Upon completion of the course, the students will be able to :

1. Define and explain linear spaces and linear operators
2. Develop mathematical descriptions of systems
3. Discuss and explain state-space models, solutions and realizations
4. Identify and utilize controllability and observability of linear systems
5. Work with Minimal realizations and coprime fractions
6. Differentiate among state feedback, state estimators and observers
7. Explain stability parameters of linear and non-linear systems
8. Develop expertise in MATLAB with respect to theory and design of linear systems

**Learning Methodology:**

Lectures with powerpoint slides, interactive sessions, participative discussions, plus hands-on work on MATLAB.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

**Marks Evaluation Marks in percentage**

Quizzes **20%**

Assignments

Mid Term **30%**

Attendance & Class Participation

Term Project

Presentations

Final exam **50%**

Total **100%**

**Recommended Text Books:**

Linear System Theory and Design by Chi-Tsong **Chen** (1999/2012)

**Reference Books:**

Linear Systems Theory by João P. **Hespanha** (2009)

Linear Algebra and its Applications by G. **Strang** (2006)

**Calendar of Course contents to be covered during semester**

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| --- | --- | --- |
|  **Week** |  **Course Contents**  | **Reference Chapter(s)** |
|  1 | Introduction to linear systemsOverview of course. Brief discussion on concepts in the course. | Ch 1. |
|   2 | Mathematical description of SystemsCausality, lumpednessLinear Time-invariant systems, Op amp circuit implementation | Ch 2. |
|  3 | LinearizationExamplesRLC networksDiscrete time systems | Ch 2 |
|  4 | Review of Linear AlgebraBasis, representation, orthonormalization | Ch 3 |
|  5 | Linear algebraic equations, diagonal and Jordan form Square Matrix | Ch 3 |
|  6 | Lyapunov EquationSingular Value Decomposition, Norms of Matrices | Ch 3 |
|   7 | State space solutionsSolution of LTI State equationsDiscretizationSolution of discrete time state equations | Ch 4 |
|  8 | **Mid Term Exam** |  |
|  9 | Equivalent State EquationsCanonical Forms, RealizationsSolution of LTV equationsEquivalent Time varying equations | Ch 4 |

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|  10 | Intro to StabilityInput-output stabilityInternal stability | Ch 5 |
|  11 | Lyapunov theoremStability of LTV systems | Ch 5 |
|   12 | Controllability, observability and indicesCanonical decompositionDiscrete time state equationsControllability after sampling | Ch 6 |
|  13 | State feedbackRegulation and TrackingFeedback from estimated states | 8.1 – 8.5 |
|  14 | Intro to minimal realizations Coprime factorsImplications of coprimeness | 7.1 – 7.2 |
|  15 | Intro to Pole placement and model matchingUnity feedback configuration, pole placementImplementable transfer functions | 9.1 – 9.3 |