**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**](mailto: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 systems  Overview of course. Brief discussion on concepts in the course. | Ch 1. |
| 2 | Mathematical description of Systems  Causality, lumpedness  Linear Time-invariant systems, Op amp circuit implementation | Ch 2. |
| 3 | Linearization  Examples  RLC networks  Discrete time systems | Ch 2 |
| 4 | Review of Linear Algebra  Basis, representation, orthonormalization | Ch 3 |
| 5 | Linear algebraic equations, diagonal and Jordan form  Square Matrix | Ch 3 |
| 6 | Lyapunov Equation  Singular Value Decomposition, Norms of Matrices | Ch 3 |
| 7 | State space solutions  Solution of LTI State equations  Discretization  Solution of discrete time state equations | Ch 4 |
| 8 | **Mid Term Exam** |  |
| 9 | Equivalent State Equations  Canonical Forms, Realizations  Solution of LTV equations  Equivalent Time varying equations | Ch 4 |

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| 10 | Intro to Stability  Input-output stability  Internal stability | Ch 5 |
| 11 | Lyapunov theorem  Stability of LTV systems | Ch 5 |
| 12 | Controllability, observability and indices  Canonical decomposition  Discrete time state equations  Controllability after sampling | Ch 6 |
| 13 | State feedback  Regulation and Tracking  Feedback from estimated states | 8.1 – 8.5 |
| 14 | Intro to minimal realizations  Coprime factors  Implications of coprimeness | 7.1 – 7.2 |
| 15 | Intro to Pole placement and model matching  Unity feedback configuration, pole placement  Implementable transfer functions | 9.1 – 9.3 |