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| **University of Management & Technology**  School of Science & Technology  Department of Electrical Engineering  logo | |
| EE 324 Control systems | |
| **Pre-requisite** | **Linear Algebra, Differential Equations, Signals and Systems** |
| **Instructors** | **Jameel Ahmad;** [**jameel.ahmad@umt.edu.pk**](mailto:jameel.ahmad@umt.edu.pk)  **Farhan Iqbal;** [**farhan.iqbal@umt.edu.pk**](mailto:farhan.iqbal@umt.edu.pk)  **Asif Hussain;** [**asif.hussain@umt.edu.pk**](mailto:asif.hussain@umt.edu.pk)  **Muhammad Ilyas Khan;** [**ilyas.khan@umt.edu.pk**](mailto:ilyas.khan@umt.edu.pk) |
| **Course**  **Objectives** | * To introduce modeling concepts in electrical and no-electrical domains. * Application of Laplace transform to solve dynamic circuits/systems and obtaining the transfer function. * To analyze dynamic systems and study their transient behavior. * To study and analyze feedback control systems and to determine their stability and steady state behavior. * To study, design and analyze feedback systems in time and frequency domain using root-locus, Bode’s and Nyquist plots and. * To introduce state space design paradigm and its link with classical techniques. * To develop command on the use of Matlab/Simulink to analyze feedback systems.   The course directly contributes to **objectives** a, d, e and f of the HEC Electrical Engineering Curriculum. |
| **Expected**  **Outcomes** | In accordance with **HEC curriculum** outcomes a, b, d, e, g, h & i, upon completion of this course, students will understand:   * The difference between open loop and closed-loop systems * Laplace transform method, Transfer function of a system * Transient and Steady state response * Root-locus Analysis and Design * Frequency-Response Analysis and Design using Bode and Nyquist Plots * States Space Modeling and analysis. |
| **Textbook(s)**  **Reference:** | **Feedback Control Of Dynamic Systems**, Gene F. Franklin, 5/E, Pearson Education **Control Systems Engineering** , Norman S. Nise, 6th edition, Wiley Dec 2010 |
| **Grading Policy** | * Assignments & Quizzes: **20%**, Lab: **20%** * Midterm: **20%,** Final Exam: **40%** |

**Course Schedule**

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| **Lectures** | **Topics** | **Textbook(TB)/**  **Reference(Ref) Readings** |
| 01-02 | **Overview:**   * Introduction and Motivation to Control Systems; Basic types of control systems. | 1.1-1.2 |
| 03-05 | **Dynamic Models:**   * Models of Electric circuits, Electromechanical systems and Heat-flow systems. * Solution of first and second order differential equations; transient and study state part of the solution; interpretation of time constant, damping ratio and natural frequency. | 2.1-2.3 and handouts |
| 06-10 | **Dynamic Responses:**   * Review of Laplace Transforms and its application to solution of differential equations. * Transfer function, System Modeling Diagrams and block diagram reduction techniques. Effect of Pole Locations. Time-Domain Specifications. Effects of Zeros and Additional Poles. * Stability and Routh’s stability criterion. | 3.1-3.5 and handouts |
| 11-14 | **Basic Properties of Feedback.**   * The basic equations of control. * Control of study state error. * PID control. | 4.1-4.3 |
| **Mid-Term Exam (8th Week)** | | |
| 17-20 | **The Root-Locus Design Method.**   * Root locus of basic feedback systems. * Sketching Root-Locus; selected root loci. * Design using dynamic compensation. | 5.1-5.5 |
| 21-24 | **The Frequency-Response Design Method.**   * Frequency response and sketching Bode’s plots. * Nyquist stability criterion and stability margins. * Closed loop frequency-response. | 6.1-6.6 |
| 25-28 | **State Space Design.**   * Advantages of state space. * State space modeling. * Analysis of state equations | 7.1-7.4 |
| 29-30 | **Course review.** |  |
| **End Term Exam ( 16th Week)** | | |