(BM-310) - Control Systems for Biomedical Engineers

Course Outline:

Theory:

1. **Introduction**
    1. Introduction to control systems
    2. Open loop and close loop control systems.
    3. Examples of control systems in Biomedical Engineering.
2. **Modeling in the Frequency Domain**
    1. Electrical/Electronic/Mechanical systems transfer function
    2. Electric circuits analog
3. **Modeling in the Time Domain**
    1. General State-Space Representation and Analysis
    2. Converting a Transfer Function to State Space & vice versa.
4. **Time Response**
    1. Poles, Zeros, and System Response
    2. Transient and steady state response of first and second order systems
5. **Reduction of Multiple Subsystems**
    1. Block Diagrams and reduction techniques
    2. Signal-Flow Graphs and Mason's Rule.
6. **Control System Stability**
    1. Routh-Hurwitz Criterion and Special Cases
7. **Root Locus Techniques**
    1. Root Locus and its Properties
    2. Sketching the Root Locus plots.
8. **Frequency Response Techniques**
    1. Bode and Polar Plots
    2. Stability via the Nyquist Diagram
    3. Gain Margin and Phase Margin

List of Practicals:

1. To be familiar with the Matlab programming and control system toolbox.
2. Find the closed-loop transfer function of the system.
3. To find the impulse and step responses of the control system.
4. To compute the transient response parameters of control systems.
5. To find the partial fraction residues and poles of the system.
6. To find the Eigen values of the system.
7. Transfer function to state space conversion.
8. To find the closed-loop pole locations to check the stability of the system.
9. To obtain the root locus of the system.
10. To obtain the Bode plot of the system.
11. To plot the Nyquist diagram of the system.
12. To find the gain and phase margins of the system
13. Open ended lab 1
14. Open ended lab 2
15. Open ended lab 3
16. Open ended lab 4

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Control Systems Engineering, by: Norman S. Nise, 7th Edition.
2. Modern Control Engineering, by: Katsuhiko Ogata, 5th Edition.
3. Biomedical Applications of Control Engineering, by Selim S. Hacısalihzade

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