Course Title: Control Systems Design
Course Code: COEG 401
Credit Hours: 3

Course Description:
This course extends the design methods from control engineering, to learn using control system design tools, and to introduce equipment for realisation of analog and digital control systems.

Course Contents:

Unit 1: Introduction
The control problem; System specification: Demands and desires; System realisation: Analog and digital systems, design tools and approaches

Unit 2: System Description and Analysis
Single-Input-Single-Output (SISO) systems; Multi-Input-Multi-Output (MIMO) systems; Linearization; Block-diagrams, Transfer functions (matrices), State space methods; Controllability and observability

Unit 3: System Simulation and Realization
Bock diagrams and op-amp circuits; Realisation of transfer functions and state space models, system cascade and parallel realization

Unit 4: PID-Controllers
Control actions and automatic controllers; Sensors, controllers and actuators; Device analysis; Documentation

Unit 5: Control System Structures
Feedback control: dynamic response, Effect of disturbances; Feed forward control: from disturbance and reference; Cascaded control systems: Internal feedback

Unit 6: Digital Control and Discretization
Introduction to digital control and its integration, Digital process control strategies / architectures, Discretization techniques: Forward Euler and Zero-order hold, Introduction to Z-transform and difference equation, S-plane to Z-plane mapping, Stability analysis of closed loop system in Z-plane

Unit 7: Real Time Process Control
Real time control, Conventional, Interrupts, Control complexity, Non-linearity, Process coupling, time delays, Controllability, Sequential control and direct digital control, Combinatory control; Case studies

Unit 8: Control System Implementation in digital computer
Introduction to Bus System and Bus protocol, Introduction to operating system and its operation, system task management and resource protection, real time operation and system integration, real time operating system, discretization of PID controller and implementation in digital computer,

Position and velocity form, Wind-up, Switchover problem and solution, Algorithm, Performance limit of PID, Cascade control, Smith controller, Gain scheduling, Adaptive control

Unit 9: Sequential Control
Boolean logic programming, Functional blocks, Grafcet diagram, Generator sequencing control, PLC application cases for industrial control

Unit 10: Man-Machine Interface
Ergonomics, Organization of MMI, Quantitative and qualitative parameters, MMI hardware, Design guidelines, User friendliness, Human cognition

References:
1. C. T. Chen, *Analog and Digital Control System Design,* Saunders, College Publishing
2. K. Ogata, *Modern Control Engineering,* PHI
3. W. Wolovich, *Automatic Control Systems: Basic Analysis and Design*, Saunders College Publishing
4. S. Thompson, *Control Systems Engineering and Design*, ELBS (Longman)
5. Gene F. Franklin. J. David Powell. Abbas Emami-Naeini, *Feedback Control of Dynamic system,* Addison-Wesley
6. K. J. Astrom and B. Wittenmark, *Computer Controlled Systems: Theory and Design,* PHI
7. B. Friedland, *Control System Design,* McGraw-Hill
8. J. A. Borrie, *Modern Control Systems: A Manual of Design Methods,* PHI
9. B.C. Kuo, *Automatic Control Systems*, PHI
10. Raymond T. Stefani, Bahram Shahian, Clement J. Savant, Gene H. Hostetter, *Design of Feedback Control Systems*, Oxford
11. G. Olsson and G. Piani, *Computer Systems for Automation and Control*, PHI
12. C. H. Houpis and G. B. Lamont, *Digital Control Systems: Theory, Hardware, Software*, McGraw-Hill

Evaluation:
In-Semester Evaluation: 50%
End-Semester Evaluation: 50%