Course code: System Dynamics and Control

Course Context and Overview (100 words): Modeling and simulation form an integral role in the engineering design process. An accurate mathematical description of a system provides the design engineer the flexibility to perform trade studies quickly and accurately to expedite the design process. Most often, the mathematical model of the system contains components of different engineering disciplines. A modeling methodology that can handle these types of systems might be used in an indirect fashion to extract added information from the model. In the present study, system analysis is being performed upon creation of the bond graph. This course will guide students from the process of modeling using bond graphs, through dynamic systems analysis in the time and frequency domains, to classical and state-space controller design methods.

Prerequisites Courses: Knowledge of engineering mathematics and engineering physics

Course outcomes (COs):

On completion of this course, the students will have the ability to:	Unit
CO1 : Understand the physics behind different systems	Unit 1
CO2 : model systems using new modeling technique called Bond graph	Unit 1,2
CO3 : Derive SFG and transfer function of systems using Bond Graph	Unit 2,3
CO4 : Apply control theory on systems	Unit 3,4,5
CO5 : make MATLAB code for analysis of systems	Unit 5

Course Topics:

Topics	Lecture Hours		Student Development
UNIT - I **1. Topic : Introduction to Physical System Dynamics**			Skill Development
1.1 Modeling of Physical System Dynamics: A Unified Approach	8	8	
1.2 Introduction to Bond graphs, Ports, Bonds and Power			
1.3 2-port elements, modulation, Junction elements, Causality.			
UNIT - II **2. Topic : Derivation of System equations from Bond graphs**	8	8	Skill Development
2.1 Bond graph modeling of multi-energy systems			
2.2 Analysis of linear systems			
2.3 Derivation of Signal flow graphs from Bond graphs			

UNIT - III 3. **Topic : Derivation of system parameters**	8	8	Skill Development
3.1 Transfer functions			
3.2 Bode plots			
3.3 State variable analysis			
3.4 Eigen values and Eigen vectors			
UNIT – IV 4. **Topic : Control Theory**	8	8	Employability
4.1 Introduction			
4.2 Canonical forms			
4.3 Stability Criteria			
UNIT-V 5. **Topic : Controllers**	8	8	Employability
5.1 PID			
5.2 Simulation and case studies			
5.3 Computer simulation of Dynamic Systems			

Textbook references (IEEE format):
Text Book:

1. Karnopp, Margolis, Rosenberg, System Dynamics: Modeling and Simulation of Mechatronic Systems, Fourth Edition, Wiley (Higher education), 2005.

2. Karnopp, Margolis & Rosenberg, System Dynamics: A Unified Approach, Wiley , 1990.

3. Amalendu Mukherjee & R. Karmakar, Modeling & Simulation of Engineering Systems through Bond Graphs, Narosa, 2000.

4. Amalendu Mukherjee, Ranjit Karmakar and Arun Kumar Samantaray, Bond Graph in Modeling, Simulation and Fault Identification, I. K. International Publishing House Pvt. Ltd, 2006.

Reference books:

5. Eronini Umez-Eronini, System Dynamics & Control, Brooks/ Cole Publishing Company, 1999.

6. B. C. Kuo, Feedback Control Systems, Prentice Hall.

7. K. Ogata, Modern Control Engineering, Prentice Hall. 8. Bernard Friedland, Control Systems Design, McGraw-Hill.

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

Bondgraph.org

Evaluation Methods:

Item	Weightage
Teacher's assessment (Project/case/assignment/quiz attendance etc.)	30 %
Midterm	20 %
Final Examination	50 %

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