Cairo University
Faculty of Engineering

Department of Aerospace Engineering

Course Specifications

Program(s) on which this course is given:	M. Sc. – Flight Mechanics and Control Option
Department offering the program:	Aerospace Engineering
Department offering the course:	Aerospace Engineering
Academic Level:	Graduate
Date	
Semester (based on final exam timing)	☐ Fall ☐ Spring

A- Basic Information

1. Title:	Modern Control of Aerospace Systems			**Code:**	Aero 650			
2. Units/Credit hours per week:	Lectures	2	Tutorial	1	Practical	-	Total	3

B- Professional Information

1. Course description:	The course addresses Modern Control Systems with application to Aerospace Systems and Specifically Aircraft and satellites. The course starts with an introduction to Automatic control and the concept of feedback control. The elements of the feedback control loop are identified with concentration on the modeling of Aerospace systems. Examples of linear models of Aircraft, satellites and mechanical systems are obtained from their respective nonlinear governing equations. The concept of linearization with its limitations and benefits is thus introduced. State space and transfer function models are introduced at this stage. Their connection is established and discussed. Special forms of State Space models (Canonical Forms) are shown and their special value to control system design is shown. Similarity transformations between various models are established and the unifying aspects of similar models are clarified. Tools and mathematics of obtaining the transient response of the state space model are developed. Emphasis is then put on State Space methods of Control System Design. The basic concepts of State Space approach are established, namely Stability, Controllability and Observability. State feedback is then developed and the concepts of pole placement and their effect on transient response and relationship to state feedback are established. Finally, different methods of closed loop control system design are shown using state space methodology.
2. Intended Learning Outcomes of Course (ILOs):	**a) Knowledge and Understanding**
	Modelling of Physical Systems, Linearization. Significance and use of linear theory and the property of linear models. Concept of feedback.
	Properties and features of State Space Modeling. Design of Feedback systems using state space approach.
	b) Intellectual Skills
	Ability to formulate physical systems into mathematical models.
	Understanding the relationship between properties of the designed system and its transient and steady state response. What we actually do by feedback control systems.
	c) Professional and Practical Skills
	Computation and plotting of system transient response-Ability to relate system behavior to the location of its poles and zeros. Understanding similarity transformations between models.

	Ability to design feedback control systems to achieve certain response and stability goals.
	d) General and Transferable Skills
	Matlab (mathematical programming tool) - Simulations- Solution of transient response problems. Matrix algebra- Laplace Transform mathematics and their connection to the physical behavior linear systems.

3. Contents

Topic	Total hours	Lectures hours	Tutorial/ Practical hours
1-Introduction to Automatic control and the concept of feedback control. 2- Modeling of Aerospace systems. Nonlinear physical models and linearization.	3	2	1
3- Examples of linear models of Aircraft, Satellites and mechanical systems.	6	4	2
4- State space and transfer function models. Relationship between state space and transfer function models.	6	4	2
5- Similarity transformations and the unifying aspects of similar models.	3	2	1
6-Special Canonical forms of State Space models	3	2	1
7- Transient response of the state space model. Tools and computations. Relationship to poles and zeros.	3	2	1
8-Basic concepts of the State Space approach: Stability, Controllability and Observability.	9	6	3
9- State Space methods of Control System Design	12	8	4
Total Hours	45	30	15

4. Teaching and Learning Methods	Lectures (30)	Practical Training/ Laboratory ( )	Seminar/Workshop ( )
	Class Activity (-)	Case Study (-)	Projects (-)
	E-learning ( )	Assignments /Homework (15)	Other:

5. Student Assessment Methods

• **Assessment Schedule**	**Week**
-Assessment 1: Class test	5
- Assessment 2: Class assignments (Homework)	Every other week (6 assignments)
-Assessment 3; Project Assignment	N/A
-Assessment 4; Presentations	N/A
-Assessment 5; Midterm Exam	7

-Assessment 6; Final Exam	End of semester
• **Weighting of Assessments**	
-Mid-Term Examination	15%
-Final-term Examination	60%
-Class assignments (Homework)	15%
-Class Test (s)	10%
-Presentation	N/A
-Total	100%
6. List of References	
1-Fortmann and Hitz, An Introduction to Linear Control Systems, Published by Marcel Dekker, Inc.	
2-Bernard Friedland, Control System Design, An Introduction to State Space Methods, Mc Graw Hill	
3-William L. Brogan, Modern Control Theory, Prentice Hall	
4-Richard Dorf and Robert Bishop, Modern Control Systems, Addison-Wesley.	
5-Robert Nelson, Flight Stability and Automatic Control, Mc Graw Hill	
7. Facilities Required for Teaching and Learning	
Projector	
Course Coordinator:	**Prof. Mohamed Bahey Argoun**
Head of Department:	**Prof. Ayman Hamdy Kassem**