	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 Specialization
Department offering the program:	Aerospace Engineering
Department offering the course:	Aerospace Engineering
Academic Level:	Graduate- M. Sc.
Date	
Semester (based on final exam timing)	☐ Fall ☐ Spring

A- Basic Information

1. Title:	**Analysis and Design of Multivariable Feedback Control Systems**			**Code:**		**Aero 660**		
2. Units/Credit hours per week:	Lectures	2	Tutorial	1	Practical	-	Total	3

B- Professional Information

1. Course description:

This course deals with analysis and design techniques for multivariable feedback systems. The course starts with modeling of Multivariable systems in both state space and transfer function formulations. Then basic properties of multi-input multi-output linear time invariant systems are reviewed. These systems generally exhibit coupling between its variables which need to be addressed. The decoupling problem is introduced in a general theoretical context and specifically for aerospace systems. Decoupling controllers are designed using well known design techniques such as diagonal dominance design.

The problem of Stability of the nearly decoupled multivariable system is addressed. Individual controllers for the diagonal channels are designed using classical design techniques. Other methods of control of Multivariable Systems such as robust control are also discussed.

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.

c) Professional and Practical Skills

Ability to design feedback control systems to achieve certain response and stability goals.

d) General and Transferable Skills

Matlab programming and Simulation

3. Contents			
Topic	**Total hours**	**Lectures hours**	**Tutorial/ Practical hours**
1-Modeling of multivariable Aerospace systems and obtaining the response- Checking system couling. 2-Sources of coupling in the open loop models of physical Aerospace Systems,	6	4	2
3- The decoupling problem- Effect on stabilty	6	4	2
4-The inverse Transfer Function Formulation.	6	4	2
5-Diagonal Dominance Design- Obtaining Dominance. Method of Resenbrock- Method of Argoun and Van DeVegte.	3	2	1
6-Stability Considerations.			
6-Design of the Diagonal Channel Controllers	3	2	1
7- Transfer into a state space model	3	2	1
8-Other methods of design of Multivariable Systems.	9	6	3
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**