University: Cairo **Faculty:** Engineering **Department:** Aerospace Engineering

Course Specifications

Program: Aerospace Engineering
Major Field: Aircraft Structures
Department: Aerospace Engineering Department
Academic Year Level: Third Year Undergraduate
Term: Second Term
Year of Approval: March 2015.

A- Basic Information

Title: Mechanics of Light Structures
Code: AER303B
Credit Hours: 3
Weekly Hours: Lectures 3, Tutorials 2, Total 5
Prerequisite Courses: AER303A (Analysis of Aircraft Structures (A))
Prerequisite to: AER403A (Design of Aircraft Structures)

B-Professional Information

1-Overall Aims of Course

Introduce the student to advanced topics of structural analysis of airframe elements.

2-Intended Learning Outcomes

A-Knowledge and Understanding

Upon completion of this course the student should be able to:

- Understand the basic elements of analysis of thermal and initial effects in structures
- Understand the basic elements of finite element analysis of plate and stiffened-plate structures
- Understand the basic elements of structural dynamics
- Understand the basic elements of analysis of laminated composite materials

B-Intellectual Skills

Upon completion of this course the student should be able to:

- Solve thermal and initial action problems in bars
- Solve thermal action problems in rectangular and circular 2D strips
- Solve thermal problems of beams taking material non-homogeneity into consideration
- Solve thermal and initial action problems of truss and frame structures using energy methods
- Solve thermal and initial action problems of truss and frame structures using the finite element method
- Develop finite elements for the analysis of plate structures under in-plane loads

- Analyze plate and stiffened plate structures under in-plane load by the finite element method
- Develop finite elements for the analysis of plate structures under bending load
- Analyze plate and stiffened plate structures under bending load by the finite element method
- Solve free and forced vibration problems of single degree of freedom systems
- Solve free and forced vibration problems of multi degree of freedom systems
- Solve free vibration problems of uniform bars and beams
- Solve free and forced vibration of truss and frame structures using energy methods
- Solve free and forced vibration of truss and frame structures using the finite element method
- Calculate constitutive matrices of laminated composite materials under external loads
- Check failure of laminated composite materials under combined load

C-Professional and Practical Skills

Upon completion of this course the student should be able to

- Analyze airframe elements subject to thermal and initial actions
- Analyze airframe plate and stiffened plate sub-structures using the finite element method
- Analyze airframe sub-structures undergoing free and forced vibrations
- Analyze airframe laminated composite sub-structures

3-Course Contents

Topic	Lecture Hour	Tutorial Hour
Chapter 1: Analysis of Thermal and Initial Actions in Structures		
Governing equations	2	
Thermal and initial effects in bars	1	½
Thermal effects in rectangular 2D strips	2	1
Thermal effects in circular 2D strips	1	½
Thermal effects in beams with nonhomogenity	2	1
Thermal and initial effects in trusses by energy methods	2	1
Thermal and initial effects in frames by energy methods	2	2
Thermal and initial effects in statically indeterminate trusses and frames by energy methods	2	2
Thermal and initial effects in trusses by the finite element method	2	2
Thermal and initial effects in frames by the finite element method	2	2
Chapter 2: Finite Element Analysis of Plate Structures		
General Procedure	1	
Plate elements for in-plane action	2	
Plate elements for bending action	2	
Analysis of plates under in-plane load	2	2
Analysis of plates under bending load	2	2

Analysis of skin-stringer structures under in-plane load	1	2
Analysis of skin-stringer structures under bending load	1	2
Chapter 3 Dynamical Analysis of Structures		
Free and forced vibration of single degree of freedom systems	2	
Free and forced vibrations of multi degree of freedom systems	2	2
Free vibration of uniform bars and beams	2	1
Hamilton's principle	1	
Lagrane's equations	1	
Free and forced vibration of frame structures by energy methods	2	3
Free and forced vibration of frame structures by finite element method	2	2
Chapter 4: Analysis of Laminated Composite Materials		
Introduction to composite materials	1	
Constitutive relationships for a lamina	2	1
Constitutive relationships for a laminate	2	2
Failure of a laminate under combined load	2	1

4-Teaching and Learning Methods

- Board instructions
- Student discussions
- Homework problems
- Discussion of exercise problems

5-Student Assessment Methods

- Recording lecture and tutorial attendance to assess seriousness and follow up
- Reports of exercise problems to assess understanding of solution methods
- Mid-term exam to assess material comprehension
- Final exam to assess overall material comprehension

Assessment Schedule

Assessment 1	Energy lecture and tutorial sessions
Assessment 2	At the end of every chapter
Assessment 3	At the end of chapter 3
Assessment 4	At the end of the term

Weighting of Assessments

Attendance	8%
Reports	8%
Mid-Term exam	16%
Final exam	68%

6-List of References

6-1 Course Notes

Negm, H.M., “Analysis of Light Structures”, Third year notes on aircraft structures, Aerospace Department, Faculty of Engineering, Cairo University.

6-2 Essential Textbooks

Timoshenko, S.P. and J.N. Goodies, “Theory of Elasticity”, McGraw-Hill, Third edition, 1970.

Argyris, J.H. and S.Kelsey, “Energy Theorems and Structural Analysis”, Butterworth, 1960.

Przemieniecki, J.S., “Theory of Matrix Structural Analysis”, McGraw Hill, 1968.

Timoshenko, S.P., D.H. Young and W.Weaver IR., “Vibration Problems in Engineering”, John Wiley, Fourth Edition, 1974.

Hurty, W.C., and M.F. Rubinstein, “Dynamics of Structures”, Prentice-Hall, 1964.

Ashton, J.E., J.C. Halpin and P.H. Petit, “Primer on Composite Material Analysis”, Technomic, 1969.

6-3 Recommended Books

Bruhn, E.F., “Analysis and Design of Flight Vehicle Structures”, Tri-State, 1973

Zienkiewicz, O.C., “The finite element method in engineering science”, McGraw-Hill, 1971.

Meirovitch, L., “Analytical Methods in Vibrations”, Macmillan, 1967

Jones, R.M., “Mechanics of Composite Materials”, Scripta, 1975.

7-Facilities Required for Teaching and Learning

- Board
- Course notes
- Exercise sheets
- Department library
- College library
- University library

Course Coordinator:
Prof. Hani M. Negm, Professor of Aircraft Structures
Head of Department: Prof. Ayman H. Kassem
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