## COURSE INFORMATION

| Course Code | AAM 555 | Course Name | Theory of Beams, Plates and Shells | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type of Course** | **Level of Course** | **Semester** | **Language** | **Theory** | **Application (Practice)** | **Laboratory** | **Local Credits** | **ECTS** |
| Elective | Graduate | - | English | 3 | 0 | 0 | 3 | 6 |

| | |
|---|---|
| **Department** | : Aerospace Engineering |
| **Prerequisites/Requirements for Admission** | : None |
| **Mode of Delivery** | : Face to Face |
| **Course Coordinator** | : Asst. Prof. Reza AGHAZADEH |
| **Course Lecturer(s)** | : Asst. Prof. Reza AGHAZADEH |
| **Course Assistant(s)** | : |
| **Course Description/Aim** | : Objective of this course is to give basic knowledge about the theories which are used to determine the displacement, strain and stress fields in beams, plates and shells. For this purpose, the differences between theory of elasticity and structural theories are pointed out. Formulation of structural theories by using equilibrium as well as energy (variational) methods is demonstrated. Some exact and approximate solution methods which are used in certain types of beams, plate and shell problems are introduced. |
| **Course Contents** | : Review of theory of elasticity, variational principles, classical (Euler-Bernoulli) beam theory, Timoshenko beam theory, introduction to theory of plates, bending of rectangle plates, laterally loaded rectangular plates, Navier solution, Levy solution, fundamental equations for circular plates, circular plates under symmetrical and asymmetrical loads, application of energy methods and numerical methods, vibrations of plates, introduction to thin elastic shell theory, membrane theory of shells and bending theory, cylindrical shells and shells in the form of a surface of revolution. |
| **Recommended Optional Program Components** | : None |
| **Compulsory Attendance** | : 70% attendance is mandatory. |

### Course Learning Outcomes

| # | Learning outcome | Teaching Methods/Techniques | Assessment method(s) |
|---|---|---|---|
| At the end of this course; students will be able to: | | | |
| **1** | Calculate the problems of beams, plates and shells with various boundary conditions and loads | Lecture, Case Study, Discussion, On-line Activity | Exam |
| **2** | Apply the energy method to solve problems involving beams, plates and shells | Lecture, Case Study, Discussion, On-line Activity | Exam |
| **3** | Use numerical methods for problems involving beams, plates and shells when exact solution is impossible or not effective | Lecture, Case Study, Discussion, On-line Activity | Exam |
| **4** | Analyze using theory of bending of shells | Lecture, Case Study, Discussion, On-line Activity | Exam |

## COURSE INFORMATION

### Weekly Detailed Course Content

| Week | Content | Recommended Resource(s) | Time (Hours) |
|---|---|---|---|
| **1** | Introduction, basic concepts in mechanics | Textbook/Lecture Notes | 3 |
| **2** | Review of Theory of Elasticity | Textbook/Lecture Notes | 3 |
| **3** | Variational principles and classical (Euler-Bernoulli) beam theory | Textbook/Lecture Notes | 3 |
| **4** | Timoshenko Beam Theory | Textbook/Lecture Notes | 3 |
| **5** | Classical (Kirchhoff) Plate Theory | Textbook/Lecture Notes | 3 |
| **6** | Circular plates under axisymmetric loads | Textbook/Lecture Notes | 3 |
| **7** | Buckling of plates (Using classical plate theory) | Textbook/Lecture Notes | 3 |
| **8** | Mindlin Plate Theory / Midterm Exam | Textbook/Lecture Notes | 3 |
| **9** | Direct use of variational methods in the solution of plate problems | Textbook/Lecture Notes | 3 |
| **10** | Vibrations of plates | Textbook/Lecture Notes | 3 |
| **11** | Mathematical basics for the study of shell theories | Textbook/Lecture Notes | 3 |
| **12** | Classical Theory of Shells | Textbook/Lecture Notes | 3 |
| **13** | Simplifications on the general theory | Textbook/Lecture Notes | 3 |
| **14** | Solutions to sample problems using simplified shell theories | Textbook/Lecture Notes | 3 |
| **15** | Final Exam | Textbook/Lecture Notes | 3 |
| **16** | Final Exam | Textbook/Lecture Notes | |

### Sources

| | |
|---|---|
| **Course Notes / Textbooks** | : None |
| **Supplemental Readings** | : "Stresses in Plates and Shells", Ansel C. Uğural, McGraw-Hill, 1999.<br>"Solid Mechanics: A Variational Approach", Clive L. Dym and Irving H. Shames, McGraw-Hill, 1973.)<br>"Theory of Plates and Shells", S. P. Timoshenko and S.W. Krieger, McGraw-Hill, 1959.<br>"The behaviour of Thin Walled Structures: Beams, Plates and Shells", Jack R.Vinson, Kluwer Academic Publishers, 1989.<br>"Beams, Plates and Shells", L. Hamilton Donnell, McGraw-Hill, 1976.<br>"Mechanics of Laminated Composite Plates-Theory and Analysis", J.N. Reddy, CRC 1997.<br>"Thin Elastic Shells", H. Krauss, Wiley, 1967. |

## COURSE INFORMATION

### Evaluation System

| Work Placement | Number | Percentage of Grade (%) |
|---|---|---|
| Attendance | | |
| Quizzes | | |
| Homework | 3 | 20 |
| Presentation | | |
| Laboratory/Practice | | |
| Report(s) | | |
| Graduate Thesis/Project | | |
| Seminar | | |
| Projects | | |
| Midterm exam(s) | 1 | 35 |
| Others | | |
| Final exam | 1 | 45 |
| | *Total* | 100 |
| | Percentage of semester work | 55 |
| | Percentage of final exam | 45 |
| | **Total** | 100 |

### Workload Calculation

| Activity | Number | Time (hours) | Total Workload (hours) |
|---|---|---|---|
| Course Hours | 14 | 3 | 42 |
| On-line Activity Hours | | | |
| Individual study | 14 | 7 | 98 |
| Midterm exam(s) | 1 | 4 | 4 |
| Final exam | 1 | 4 | 4 |
| Homework | 3 | 10 | 30 |
| Presentation | | | |
| Project | | | |
| Application (Practice) | | | |
| Laboratory | | | |
| | | **Total** | 178 |
| | | **ECTS Credit** *(Total/30)* | 6 |

### Contribution of Learning Outcomes to Program Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| **LO1** | 5 | 5 | 2 | 4 | 4 | 3 | 2 | 2 | 3 |
| **LO2** | 5 | 5 | 2 | 4 | 4 | 3 | 2 | 2 | 3 |
| **LO3** | 5 | 5 | 2 | 4 | 4 | 3 | 2 | 2 | 3 |
| **LO4** | 5 | 5 | 2 | 4 | 4 | 3 | 2 | 2 | 3 |

**Contribution Level:** 1: “Very low”, 2: “Low”, 3: “Medium”, 4: “High”, 5: “Very High”
**LO:** Learning Outcome of the Course
**PO:** Program Outcome