General Information:

Name of Course:	**Maths for Structural Engineers (MSc)**
Course Code:	**MSN083MNEP**
Semester:	**1st**
Number of Credits:	**4**
Allotment of Hours per Week:	**2/1** Theoretic/ Practical Lessons per Week
Evaluation:	Exam
Prerequisites:	**-**

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Introduction
This course provides you deeper grounds (than at Bsc level) to the mathematical models used in advanced courses of the structural engineering curriculum. It serves as a complement and basement to the course "Numerical methods for civil engineers".

Learning Outcomes:
Upon successful completion of this course, students should be able to:

1. Define and identify important mathematical structures used in many fields of numerical methods, like inner product (Hilbert), normed (Banach), metric spaces. Give typical examples of them and show the connection among them.
2. Define the concept of a linear space, (linear) subspace, span, linear (in)dependency of vectors, basis, dimension.
3. Define orthogonality, normalization, orthonormal basis, orthogonal projection in general linear spaces. Orthogonal complement, direct sum. Describe and compute Gram-Schmidt orthogonalization method.
4. Identify special matrix classes (diagonal, diagonally dominant, band, triangular, symmetric, hermitian, orthogonal, normal), rearrange matrices into appropriate forms. Compute determinants.
5. Solve linear systems by Gauss-Jordan method, explain the structure of solutions. Sensibility linear systems. Solutions by iterative methods (Jacobi, Gauss-Siedel), comparison by usability, convergence.
6. Compute eigenvalues, eigenvectors of matrices. Diagonalize them. Use least squares method.
7. Solve non-linear equations by fix point iteration, Newton-Raphson method.
8. Elements of approximation (interpolation) theory, function sequences, ~ series. Taylor-, Fourier-series and their application: Lagrange, Hermite, spline, Fourier interpolations.
9. Numerical differentiation, integration.
10. Implement Picard-iteration, Taylor series expansion, Euler's, Heun's, Runge-Kutta's methods for solving first order ordinary differential equations (ODEs).
11. Solve second order ODEs with Euler's method and using finite differences.
12. Classify partial differential equations, solve them by separation on appropriate meshes, give analytic solutions in special examples and numerical solutions by means of central differences.

General Course Description:

After the necessary and intuitive theoretical introduction some typical examples are discussed and solved by paper and pencil followed by more difficult or simply just much bigger ones which lead to the must of numerical computations done with the aid of the Maple computer algebra system. Some of those numerically efficient methods are discussed. At the end of each topic students will have the appropriate mathematical knowledge to identify and apply these methods in their professional work.

Methodology:
The course is based mainly on face to face lectures combined with exercises guided by the instructor and individual work with regular consultations.

Schedule:

1. Define the concept of a linear space, (linear) subspace, span, linear (in)dependency of vectors, basis, dimension.
2. Define orthogonality, normalization, orthonormal basis, orthogonal projection in general linear spaces. Orthogonal complement, direct sum. Describe and compute Gram-Schmidt orthogonalization method.
3. Identify special matrix classes (diagonal, diagonally dominant, band, triangular, symmetric, hermitian, orthogonal, normal), rearrange matrices into appropriate forms. Compute determinants.
4. Define and identify important mathematical structures used in many fields of numerical methods, like inner product (Hilbert), normed (Banach), metric spaces. Give typical examples of them and show the connection among them.
5. Solve linear systems by Gauss-Jordan method, explain the structure of solutions. Sensibility linear systems. Solutions by iterative methods (Jacobi, Gauss-Siedel), comparison by usability, convergence.
6. Compute eigenvalues, eigenvectors of matrices. Diagonalize them. Use least squares method.
7. Practicing for the first assessment.
8. National holiday on Monday (No lecture). First mid term test in time of laboratory classes.
9. Autumn break.
10. Solve non-linear equations by fix point iteration, Newton-Raphson method. Elements of approximation (interpolation) theory, function sequences, ~ series. Taylor-, Fourier-series and their application: Lagrange, Hermite, spline, Fourier interpolations.
11. Numerical differentiation, integration. Implement Picard-iteration, Taylor series expansion for solving first order ordinary differential equations (ODEs).
12. Implement Euler's, Heun's, Runge-Kutta's methods for solving first order ordinary differential equations (ODEs).
13. Solve second order ODEs with Euler's method and using finite differences.
14. Classify partial differential equations, solve them by separation on appropriate meshes, give analytic solutions in special examples and numerical solutions by means of central differences. Practicing for the second assessment.
15. Lecture: summary of the course, preparation for the final exam. Second mid term test in time of laboratory classes.

Attendance:
Attending is required all classes, and will impact the grade (max. 10%). Unexcused absences will adversely affect the grade, and in case of absence from more than 30% of the total number of lesson will be grounds for failing the class. To be in class at the beginning time and stay until the scheduled end of the lesson is required, tardiness of more than 20 minutes will be counted as an absence. In the case of an illness or family emergency, the student must present a valid excuse, such as a doctor's note.

Evaluation + Grading
Grading will follow the course structure with the following weight: the assignments taken at the end of each topic is equally weighted and gives 90% of the term mark**.** The remaining 10% will be assessed according to participation, progress, effort and attitude. Please note that attendance will adversely affect one's grade, both in direct grade reduction and in missing work. The final grade will be based on the following guidelines:

5. Outstanding work. Execution of work is thoroughly complete and demonstrates a superior level of achievement overall with a clear attention to details. The student is able to synthesize the course material with new concepts and ideas in a thoughtful manner, and is able to communicate and articulate those ideas in an exemplary fashion.

4. High quality work. Student work demonstrates a high level of craft, consistency, and thoroughness throughout its work. The student demonstrates a level of thoughtfulness in addressing concepts and ideas, and participates in group discussions. Work may demonstrate excellence but less consistently than above at grade '5'.

3 Satisfactory work. Student work addresses all of the assignment objectives with few minor or major problems.

2. Less than satisfactory work. Overall work is substandard, incomplete in significant ways, and lacks craft and attention to detail.

1. Unsatisfactory work. Work exhibits several major and minor problems with basic conceptual premise, lacking both intention and resolution. Overall the assignments are severely lacking, and is weak in clarity, craft and completeness.

Grading Scale:

Numeric Grade:	5	4	3	2	1
Evaluation:	89%-100%	77%-88%	66%-76%	55%-65%	0-50%

Students with Special Needs:
Students with a disability and needs to request special accommodations, please, notify the Deans Office. Proper documentation of disability will be required. All attempts to provide an equal learning environment for all will be made.

Readings and Reference Materials:

- Elementary Linear Algebra, application version – 11th edition, Howard Anton, Chris Rorres, Wiley, 2014
- TEXTBOOK: NUMERICAL METHODS WITH APPLICATIONS, Autar K Kaw, Egwu E Kalu, Duc Nguyen http://nm.mathforcollege.com/topics/textbook_index.html

  To access the website, go to http://numericalmethods.eng.usf.edu/