COURSE SYLLABUS
Advanced Mathematics for Automotive Engineering

UP.02.F.01.O.20.01

1. Program information

1.1	Higher education institution	University of Pitești
1.2	Faculty	Mechanics and Technology
1.3	Department	Automobiles and Transport
1.4	Field of studies	Automotive Engineering
1.5	Level of education	Master
1.6	Program / Qualification	Automotive Engineering for Sustainable Mobility

2. Discipline information

2.1	Name of discipline					**Advanced Mathematics for Automotive Engineering**					
2.2	Instructor of the lecture activities					Prof. PhD Nicolae–Doru STĂNESCU					
2.3	Instructor of the seminar activities					Prof. PhD Nicolae–Doru STĂNESCU					
2.4	Year of the studies	I	2.5	Semester	I	2.6	Type of evaluation	E	2.7	The discipline regime	F/O

3. Estimated total time

3.1	Number of hours per week	2	3.2	Lecture	1	3.3	Seminar	1
3.4	Total hours of the course syllabus	28	3.5	Lecture	14	3.6	Seminar	14
Distribution of the time allocated to the individual study								ore
Study by handbook, course support, bibliography and notes								30
Additional documentation in the library, on specialized electronic platforms and in the field								15
Preparation of seminars / laboratories, topics, reports, portfolios, essays								20
Tutorial								16
Examinations								16
Other activities ...								

3.7	Total hours of individual study	97
3.8	**Total hours per semester**	**125**
3.9	**Number of credits allocated to the disciplines**	**5**

4. Prerequisites (where applicable)

4.1	Curriculum	Not applicable
4.2	Skills	Mathematical Analysis, algebra, Vector Calculation

5. Conditions (where applicable)

5.1	For the lecture	Classroom equipped with board, video projector, projective screen, computer, equipment and software for on-line activities
5.2	For the seminar	Classroom equipped with board, video projector, projective screen, computer, equipment and software for on-line activities

6. Specific skills acquired

Professional skills	CP1 – innovative design and design with the purpose of producing products, technologies that ensure sustainable (sustainable) mobility CP2 – numerical modeling and simulation of the different components of the vehicles CP3 – calibration of different vehicle subsystems for energy optimization purposes CP4 – experimental research with the purpose of validating the prototypes resulting from the activities of conception, design, modeling and numerical simulation
Transversal skills	CT1 – documentation and use of information CT2 – professional communication CT3 – project management CT4 – responsible execution of professional tasks under autonomous conditions CT5 – carrying out activities exploiting the ideas of

7. Course goal(s)

7.1 The main goal of the discipline	Completion of the mathematical knowledge acquired during the bachelor studies and formation of a high qualification specialist which can approach problems of research and design of modern technique; highlighting of the theoretical results by technical examples and applications
7.2 Specific goals	*Cognitive objectives* • Knowledge of the mathematical modern methods applied in the field of Automotive Engineering; • Explanation of the solving principles and methods for the practical problems; *Procedural objectives* • Application of the basic principles and methods for solving of some well defined

	situations in the field of Automotive Engineering; • Explication, interpretation and evaluation of the obtained results. *Attitude objectives* • Promotion of the discipline of correct and in time performed work and of team work; • Promotion of the enterprise spirit, dialog, positive attitude and respect for the Engineer career.

8. Contents

8.1. Lecture		No. hours	Teaching methods	Remarks Resources used
1	Numerical methods: Interpolation polynomials – Lagrange, Newton and Hermite methods. Spline functions. Uniform approximations; methods of best approximation	2	Lecture Exposure with support material Explication Description and exemplification Heuristic conversation Debate State of the problem Exercises	Board Sketches Tables Video projector Computer
2	Dynamical system: Extension of the solutions of differential equations; dependence of the solution on parameters and initial conditions. Bifurcations and elementary catastrophes. Fractal geometry, chaotic systems. Applications in technique	4		
3	Elements of optimization theory in finite dimensional spaces. Application of the generalized inequality of averages in optimization. Linear programming ("SIMPLEX" algorithm, the problem of optimum transport); problems of optimization for non-linear convex functions (points of extreme and the principle of maximum for convex functions); examples; the Caratheodory theorem. Minimization of some convex functions on finite dimensional convex subsets. Examples	2		
4	Elements of variational calculus. Applications. Principles of maximum. Other methods for solving of some problems of extreme. The geometrical and kinematic impulse for the determination of the extremes of some functionals. Examples. Necessary and sufficient conditions of extreme for some functionals defined with the aid of integrals; differential equations of the variational calculus. Conditional extremes of the functionals. Applications to the isoperimetric problems, in mechanics and technique. Connection with the Dirichlet problem and with sub-harmonic functions. Other methods for the solving of problems of extreme (extreme points for some classes of functions). Principles of maximum for some classes of functions. Connections to the theory of probabilities and complex analysis. The problem of optimal control	4		
5	Methods for the approximation of the solutions of some variational problems of some differential equations or with partial derivatives. Other problems of the approximation theory. Impulse for the theory of approximation of solutions of some variational problems. Methods of approximation of such solutions. Applications to the approximate solution of some differential equations or with partial derivatives with border conditions. Iterative methods for approximate solving of some Cauchy problems. Application of the Stone-Weierstrass theorem and of Krein-Milman theorem to the approximation of some classes of function by exponential function on boundless intervals. Approximation with polynomials on such intervals. Approximation with the trigonometric system of some "measured" functions in a finite number of moments of time. Examples that impulse this kind of approximation	2		

Minimal bibliography (selected chapters of)

1. V. I. Arnold, *Catastrophe Theory(3 ed.),* Springer, 1992.
2. L. Elsgolts, *Differential Equations and the Calculus of Variations.* (Traducere din Rusă). Ed. Mir, Moscow, 1970.
3. K. Falconer, *Fractal Geometry,* John Wiley, 1990.
4. K. Falconer, *Techniques in Fractal Geometry,* John Wiley, 1997.
5. Pandrea, N., Stănescu, N.-D., Dynamics of the Rigid Solid with General Constraints by a Multibody Approach, John Wiley & Sons, Chichester, UK, 2016.
6. Pandrea, N., Popa, D., Stănescu, N.-D., Classical and Modern Approaches in the Theory of Mechanisms, John Wiley & Sons, Chichester, UK, 2017.
7. N.-D. Stănescu, L. Munteanu, V. Chiroiu, N. Pandrea, *Sisteme Dinamice. Teorie şi Aplicaţii*, Editura Academiei Române, Bucureşti, 2007 (vol. I), 2011 (vol. II).
8. N.-D. Stănescu, *Mechanical Systems with neo-Hookean Elements*, LAP, Saarbrücken, Germany, 2011.
9. P. P. Teodorescu, N.-D. Stănescu, N. Pandrea, *Numerical Analysis with Applications in Mechanics and Engineering*, John Wiley & Sons, Hoboken, 2013.

10. I. Zeldovitch, A. Mychkis, *Elements of Applied Mathematics.* Mir Publishers, Moscou, 1976.

8.2. Applications: Seminar		No. hours	Teaching methods	Remarks Resources used
1	Interpolation polynomials	2	Lecture Exposure with support material Explication Description and exemplification Heuristic conversation Debate State of the problem Exercises	Board Sketches Tables Video projector Computer
2	Dynamical systems	4		
3	Theory of optimization	2		
4	Variational calculus	4		
5	Approximation of the solutions of some variational problems and of some differential equations or with partial derivatives	2		

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1. V. I. Arnold, *Catastrophe Theory(3 ed.),* Springer, 1992.
2. L. Elsgolts, *Differential Equations and the Calculus of Variations.* (Traducere din Rusă). Ed. Mir, Moscow, 1970.
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8. N.-D. Stănescu, *Mechanical Systems with neo-Hookean Elements*, LAP, Saarbrücken, Germany, 2011.
9. P. P. Teodorescu, N.-D. Stănescu, N. Pandrea, *Numerical Analysis with Applications in Mechanics and Engineering*, John Wiley & Sons, Hoboken, 2013.
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8.3. Homework

Problems from the different topics taught at courses

9. Corroboration of the contents of the discipline with the expectations of the epistemic community representatives, professional associations and employers in the field related to the program

In order to update and enrich the content of the disciplines, the staff participated at the following activities:
- working meetings with specialists in the field and employers (Automobile Dacia, RTR, EuroAPS, Johnson Controls, Componente Auto);
- change of good practices with colleagues from other universities (Bucureşti, Timişoara, Iaşi, Cluj-Napoca, Braşov, Ploieşti);
- workshops with the participation of specialists in the field.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Implication in debates	Debates at course	10 %
	Homework	Portfolio	10 %
	Verification test	Written test – solving of some problems	20 %
	Final evaluation	Written test – solving of some problems	50 %
10.5 Seminar	Solving of problems	Written test	10 %
10.6 Minimum standard of performance	Obtaining of minimum 0.5 points at homework, minimum 0.5 points at the implication in debates, minimum 0.5 point at seminar; minimum 2.5 points at the final evaluation and the sum of points is equal at least to 5 points		

Date (of filling)	Instructor (lecture),	Instructor (seminar),
21.09.2020	Prof. PhD Nicolae-Doru STĂNESCU	Prof. PhD Nicolae-Doru STĂNESCU
Date (of approval)	Head of department (DFMI)	Head of department (DAT)
25.09.2020	Assoc. PhD Eng. Monica IORDACHE	Lect. PhD Eng. Helene BĂDĂRĂU ȘUSTER