STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Applied matematics**		Code **1010125111010346018**
Field of study **Structural Engineering**	Profile of study (general academic, practical) **(brak)**	Year /Semester **1 / 1**
Elective path/specialty **Road-Train Engineering**	Subject offered in: **Polish**	Course (compulsory, elective) **obligatory**
Cycle of study: **Second-cycle studies**	Form of study (full-time,part-time) **part-time**	
No. of hours Lecture: **16** Classes: **10** Laboratory: **-** Project/seminars: **-**		No. of credits **3**
Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**	
Education areas and fields of science and art **technical sciences**		ECTS distribution (number and %) **3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basic knowledge with range of differential and integral calculus, ordinary differential equations, linear algebra and analytical geometry (from first degree studies).
2	**Skills**	Capability to find derivatives, integrals, analyze the function of real variable, solve ordinary differential equations, apply matrix calculus.
3	**Social competencies**	Understanding of need of competences broadening, readiness to undertaking of co-operation.

Assumptions and objectives of the course:

-the main aim is the understanding of basic notions of the theory in order to apply them to solving technics problems, making use of tensor calculus to solving eigenvalue problems, finding general and particle solutions of partial differential equations of first and second order, finding Fourier series and Fourier transforms of a given function, solving boundary problems and boundary-initial problems of partial differentiable equations by applying Fourier transforms and Fourier series, understanding basic notions of calculus of variations (minimum of functional, extremizing function, the Euler-Lagrange equation)

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. explain notion of linear space, the dimension and basis of the linear space, the linear operator (tensor), the transformation of coordinate system, eigenvalues and eigenvectors of linear operators - [X1A_W03++]

2. explain the notion of general, particle solution of partial differential equation, the Cauchy problem, the equation of characteristisc, the canonical form of second order equation, examples in phisics - [X1A_W03++, X1A_W02++]

3. explain the notion of functional, the minimum of functional, the extremizing function, the Euler-Lagrange equation - [X1A_W03++, X1A_W02++]

4. explain the notion of Fourier series, Fourier transform, explain the algorithm of solving partial differential equations by Fourier transform (Fourier series) - [X1A_W03++, X1A_W02++]

5. understand the meaning of mathematics and its applications for development of engeneering branches and civilization - [X1A_W01++]

Skills:

1. find the dimension of linear space, calculate coordinates of an element in a new basis, solve the eigenvalue problem of linear operator given by a matrix (tensor), find the set of principle directions. - [X1A_U01+++]

2. find the general and particle solution of partial differential equation of first and second order - [X1A_U01+++, X1A_U02++, X1A_W01++]

3. find the extremizing function by solving Euler-Lagrange equation, give basic examples of calculus of variations - [X1A_U01+++, X1A_U02++, X1A_U04++, X1A_W01++]

4. find the Fourier series and Fourier transform of a given function - [X1A_U01+++, X1A_U02++, X1A_U04++]

Social competencies:

1. can think and behave in good mathematical manner in the area of tensor calculus, partial differential equations, Fourier series and Fourier transform and calculus of variation - [K_K01+, K_K04++, K_K06+]

Assessment methods of study outcomes

The lecture:

-written test concerning mainly the theoretic part of the subject (but practical exercises are also admissible.

Classes :

evaluation of written tests and the direct activity during the classes (solving problems and preparing reports)

-continuous evaluation during each meeting - taking into account the activity in discussion and in cooperation concerning practical exercises.

Getting extra points related with activity, in partucular:

-presenting reports concerning applications of theory in different branches or putting the theory in history of mathematics

-notes concerning the improvement of basic materials;

-active participation in consultations.

Course description

Actualisation 2017/2018

Applied methods of education:
1) Lectures:
- lecture with multimedia presentation supplemented with examples given on the blackboard
- interactive lecture with questions to students or specific students
- theory presented in connection with the current knowledge of students
- presenting a new topic preceded by a reminder of related content known to students from other subjects
- taking into account various aspects of the issues presented
- student activity is taken into account during the course of the assessment
2) Classes:
- solving sample tasks on the blackboard
- initiate discussion on solutions
- sets of tasks to do homework

Particular attention is paid to the application of mathematics in technical sciences.

Issues:

I. Tensor calculus
1. Background of elementary linear algebra
2. Linear space (linear dependence and independence of vectors, a basis of a linear space)
3. Basic products of vectors.
4. Linear operators (Tensors as linear operators)
5. Transformations of a coordinate system
6. Eigenvalue problem
II. Partial differential equations
1. Basic notions
2. The boundary and initial conditions
3. Linear partial differential equations of first order
4. Partial differential equations of second order (canonical form, the most known examples, conversion to the canonical form)
III. Fourier series and Fourier transforms
1. Separating of variables as justification for the theory of Fourier series
2. Approximating the function by a trigonometric series.
3. Fourier series of a given function, Fourier sine (cosine) series, Fourier series expansion in the interval [-l,l], Fourier series in a complex form
4. Fourier integral of a function f absolutely integrable on R
5. Sine, cosine and complex Fourier transform
6. Fundamental properties of Fourier transform useful in applications
7. Applications of Fourier series and Fourier transforms to differential equations, algorithm of finding solution of differential equations by Fourier transforms
IV. Calculus of variations
1. Several examples which lead to variational problems defined by integral functional
2. The necessary condition for minimizing problem - the Euler-Lagrange equation
3. Analogies between the extremum of a real valued function on a real line and the extremum of a functional.
4. Finding of an extremizing function in several classical problems

Basic bibliography:

1. D. J. Hartfiel, Elementary Linear Algebra, PWS Publishers (a division of Wadsworth) Inc., Boston 1987.
2. M. Itskov, Tensor Algebra and Tensor Analysis for Engineers with Applications to Continuum Mechanics, Springer-Verlag, Berlin Heidelberg New York, 2007.
3. G. E. Mase, Theory and Problems of Continuum Mechanics, McGraw-Hill Company Inc., 1970.
4. G. T. Mase and G. E. Mase, Continuum Mechanics for Engeneers, CRC Press LLC, London New York Washington 1999.
5. Tyn Myint-U, Partial Differential Equations of Mathematical Physics, American Elesevier Publishing Co.,Inc., 1973.
6. H. F. Wienberger, A First Course in Partial Differential Equations, John Wiley&Sons Inc., 1965.
7. R. Weinstock, Calculus of Variations, McGraw-Hill Book Company Inc., 1952.
8. T. Trajdos, Matematyka dla inżynierów, Wydawnictwo Naukowo-Techniczne, Warszawa, 1974
9. I. M. Gelfand i S. W. Fomin, Rachunek wariacyjny, Państwowe Wydawnictwo Naukowe, Warszawa, 1972
10. R. Leitner i J. Zacharski, Zarys matematyki wyższej, Wydawnictwo Naukowo-Techniczne , Warszawa, 1998
11. W. Krysicki i L. Włodarski, Analiza matematyczna w zadaniach, Państwowe Wydawnictwo Naukowe, Warszawa, 1974
12. T. Jurlewicz, Z. Skoczylas, Algebra liniowa 1 Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław, 2003
13. T. Jurlewicz, Z. Skoczylas, Algebra liniowa 2 Definicje, twierdzenia, wzory, Oficyna Wydawnicza GiS, Wrocław, 2005
14. T. Jurlewicz, Z. Skoczylas, Algebra liniowa 1 Przykłady i zadania , Oficyna Wydawnicza GiS, Wrocław, 2003
15. T. Jurlewicz, Z. Skoczylas, Algebra liniowa 2 Przykłady i zadania, Oficyna Wydawnicza GiS, Wrocław, 2005

Additional bibliography:

1. D. L. Powers, Elementary Differential Equations with Boundary Value Problems, PWS Publishers (a division of Wadsworth) Inc., Boston 1985.
2. E. W. Swokowski, Calculus with analytic geometry, PWS Publishers (a division of Wadsworth) Inc., Boston 1983.

Result of average student's workload

Activity	Time (working hours)
1. Active participation in meetings (lectures and classes)	26
2. Active participation in consultations with posing questions	14
3. Solving exercises designed for independent work	10
4. Independent studying theoretical questions (notions, algorithms, theorems, proofs)	10
5. Preparing to tests	10

Student's workload

Source of workload	hours	ECTS
Total workload	70	3
Contact hours	40	2
Practical activities	30	1