Module/Subject Syllabus Summary

Mathematical Methods in Physics and Engineering

Mechanical Engineering

Master Degree Studies

Subject:	**Mathematical Methods in Physics and Technology**
Subject type:	*Compulsory*
Subject code:	
Year:	I
Semester:	I
Form of studies:	*Full-time course*
Type of classes and hours per semester:	*60*
Lecture	*30*
Exercise	*0*
Laboratory practice	*0*
Project	*30*
ECTS credits:	*5*
Form of credit:	*Lecture examination / project assessment*
Lecture language:	*English*

Subject objective	
C1	Acquiring skills: recognition and analysis of physical phenomena and familiarization with the implementation of mathematical methods in the physical and technical problems.
C2	Developing the skills to formulate differential equations describing the analysed problem, in which the physics laws are known.
C4	Acquainted with the analytical methods of solving partial differential equations applied to selected issues in physics and engineering.
C4	Understanding the differential method and its possible applications to computer solving physical problems.

Prerequisites in knowledge, skills and other competencies	
1	Student knows the basics of vectors and matrices calculus
2	Student can solve indefinite integrals by parts and substitution
3	Student knows how to solve ordinary and partial linear second-order differential equations

Educational effects	
	Knowledge:
EK 1	Student knows how to use vectors and matrices to describe the mechanical phenomena
EK 2	Student knows how to use differential equations in selected physical and mechanical problems.

EK 3	Student knows the selected analytical methods of solving partial differential equations of physics.
EK4	Student knows the methods for numerical solutions of partial differential equations for selected topics in physics.
	Skills:
EK5	Student is able to formulate a partial differential equation to describe the typical physical phenomenon.
EK6	Student knows how to solve simple one-dimensional problems.
EK7	Student can apply boundary conditions for the chosen method of solution.
EK8	Student knows how to solve selected problems of physics using vectors and tensors calculus.
	Social competence:
EK9	

Curriculum content of Subject	
Class form: lecture	
	Curriculum
W1	**Vector and matrix calculus in physics.** Application to the description of mechanical phenomena. The physics laws in the vector and tensor formulation.
W2	**First and second degree Lagrange equations.** Constraints and their classification. Application to systemss of material constrained points.
W3	**The calculus of variations**. Euler-Lagrange equation. Application to classical mechanics. Hamilton's principle.
W4	**The mathematical description of mass and heat transfer.** The equation of heat conduction. Diffusion equations. Applications of heat and mass flow equations in model physical systems.
W5	**Partial differential equations in mechanics problems.** The equations of the theory of elasticity. Static deformation of plates and membranes. Transverse vibration of plates and beams. Vibrations of membranes and strings
W6	**Fundamentals of differential method.** The difference equations for: Laplace's equation, Poisson's equation, wave equation and thermal conductivity equation. The use of differential method for vibration membrane and homogeneous beam.
W7	**The differential equation of quantum physics.** The Schrödinger equation for stationary states. The Schrödinger time-dependent equation. Aplication to the hydrogen atom and the tunnelling barrier potential.
Class form: exercise	
	Curriculum
ĆW1	
ĆW2	
Class form: project	
	Curriculum
L1	
L2	
Class form: project	
	Curriculum

P1	The use of vector calculus to describe the fundamental laws of mechanics and Kepler's laws.
P2	Solutions for the problems of minimizing the length, equal areas, brachistochrones in a gravitational field. Isoparametric problem with constrains.
P3	Solutions for the diffusion of the solution of the established initial state. Solutions to the problem of cooling the spherical bodies.
P4	Vibrations of membranes and strings. Transverse vibration of beams.
P5	Application of difference method to the diffusion and heat flow in solid state.
P6	Diagonalization of the moment of inertia tensors. Finding the normal vibrations in coupled oscillators.
P7	The solutions of one-dimensional quantum-mechanical problem of a particle in a box and one-dimensional harmonic oscillator.

Teaching methods	
1	Traditional lecture assisted with multimedia tools
2	Independent problem solving.

Student workload	
Form of activity	Average hours to complete the activity
Contact hours with the lecturer, including:	63
Contact hours with the teacher, realized in the form of lectures and Project- the total number of hours in the academic year	60
Contact hours with the teacher, carried out in the form of consultation and exam - the total number of hours per academic year	3
The student's own work, including:	
Self-rethinking the content of the lecture - the total number of hours per academic year	20
Independent execution of the solution of design problems - the total number of hours the academic year.	45
Preparing for the written tests and exam	10
Total student work time	133
Total ECTS for the subject:	5
Total of ECTS for practical classes (exercises, projects , laboratory)	3

Basic reference literature	
1	W. Rubinowicz, W. Królikowski, Mechanika teoretyczna, PWN, Warszawa 1998.
2	E. Kącki, *Równania różniczkowe cząstkowe w zagadnieniach fizyki i techniki,* WNT, Warszawa, 1993.
3	H. F. Weinberger, *A First Course in Partial Differential Equations,* Wiley, New York.

4	T. Trajdos, *Matematyka dla inżynierów,* WNT, Warszawa, 1987.
5	G. M. Fichtenholtz, *Rachunek różniczkowy i całkowy*, Tom II i III, PWN, Warszawa, 1978.
Complementary reference literature	
1	F. W. Byron, R.W. Fuller, Matematyka w fizyce klasycznej i kwantowej, Tom 1, PWN, Warszawa 1975.
2	G. Białkowski, Mechanika klasyczna, PWN, Warszawa 1975.
3	R. L. Liboff, Wstęp do mechaniki kwantowej, PWN, Warszawa 1987.

Educational effect matrix					
Educational effect	Specific educational effect reference to curriculum-wide effects (PEK)	Subject objective	Curriculum content	Teaching methodology	Evaluation methods
EK 1	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W1,P1*	*1, 2*	*O1, O2*
EK 2	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W2,W4-7, P2,P3-5*	*1,2*	*O1, O2*
EK 3	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W2-5,W7, P2,P3-5,P7*	*1,2*	*O1, O2*
EK 4	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W6, P5*	*1,2*	*O1, O2*
EK 5	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W2-5, P2-4*	*1, 2*	*O1, O2*
EK 6	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W2, W5, P4*	*1, 2*	*O1, O2*
EK 7	MBM2A_W02, MBM2A_W03, MBM2A_U02, MBM2A_U11	*C1,C2,C3,C4*	*W2,W6, P4,P5*	*1, 2*	*O1, O2*
EK 8	MBM2A_W02, MBM2A_W03,	*C1,C2,C3,C4*	*W1, P6*	*1, 2*	*O1, O2*

	MBM2A_U02, MBM2A_U11				

Evaluation methods and criteria		
Evaluation method symbol	Evaluation method description	Pass threshold
O1	*Project assessment*	*100%*
O2	*Lecture examination*	*60%*

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