# STUDY MODULE DESCRIPTION FORM

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| Name of the module/subject<br>**Applied matematics** | | Code<br>**1010102111010346018** |
| Field of study<br>**Civil Engineering Second-cycle Studies** | Profile of study (general academic, practical)<br>**(brak)** | Year /Semester<br>**1 / 1** |
| Elective path/specialty<br>**Railways** | Subject offered in:<br>**Polish** | Course (compulsory, elective)<br>**obligatory** |
| Cycle of study:<br>**Second-cycle studies** | Form of study (full-time,part-time)<br>**full-time** | |
| No. of hours<br>Lecture: **30** Classes: **15** Laboratory: **-** Project/seminars: **-** | | No. of credits<br>**3** |
| Status of the course in the study program (Basic, major, other)<br>**(brak)** | (university-wide, from another field)<br>**(brak)** | |
| Education areas and fields of science and art<br>**technical sciences** | | ECTS distribution (number and %)<br>**3 100%** |

## Responsible for subject / lecturer:

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## Prerequisites in terms of knowledge, skills and social competencies:

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| 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 - [K_W01]
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 - [K_W01]
3. explain the notion of functional, the minimum of functional, the extremizing function, the Euler-Lagrange equation - [K_W01]
4. explain the notion of Fourier series, Fourier transform, explain the algorithm of solving partial differential equations by Fourier transform (Fourier series) - [K_W01]
5. understand the meaning of mathematics and its applications for development of engeneering branches and civilization - [K_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. - [K_U13]
2. find the general and particle solution of partial differential equation of first and second order - [K_U13]
3. find the extremizing function by solving Euler-Lagrange equation, give basic examples of calculus of variations - [K_U05]
4. find the Fourier series and Fourier transform of a given function - [K_U05]

### Social competencies:

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| 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_K02] |

## 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

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

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## Basic bibliography:

1. Biegus A., (2008), Stalowe budynki halowe, Wydawnictwo Arkady, Warszawa, s. 342 (in Polish)
2. Bogucki W., (1982) Poradnik projektanta konstrukcji metalowych. Tom 1, Wydawnictwo Arkady, Warszawa, s. 560 (in Polish)
3. Bogucki W., (1980) Poradnik projektanta konstrukcji metalowych. Tom 2, Wydawnictwo Arkady, Warszawa, s. 788 (in Polish)
4. Bródka J., Broniewicz M., (2010), Projektowanie konstrukcji stalowych wg Eurokodów, Polskie Wydawnictwo Techniczne, Warszawa, s. 739 (in Polish)
5. Bródka J., Kozłowski A., (2009), Projektowanie i obliczanie połączeń i węzłów konstrukcji stalowych. Część 1. Polskie Wydawnictwo Techniczne, s. 600 (in Polish)
6. Bródka J., Kozłowski A., (2009), Projektowanie i obliczanie połączeń i węzłów konstrukcji stalowych. Część 2. Polskie Wydawnictwo Techniczne, s. 843 (in Polish)
7. Giżejowski, Ziółko J., (2010), Budownictwo ogólne. Tom 5. stalowe konstrukcje budynków projektowane wg eurokodów z przykładami obliczeń, Wydawnictwo Arkady, Warszawa, s. 1085 (in Polish)
8. Jankowiak W., (1992), Wybrane konstrukcje stalowe. Część 1. Wydawnictwo Politechniki Poznańskiej, Poznań, s. 301 (in Polish)
9. Jankowiak W., (1994), Wybrane konstrukcje stalowe. Część 2. Zbiorniki. Zasobniki. Konstrukcje wiszące, Wydawnictwo Politechniki Poznańskiej, Poznań, s. 165 (in Polish)
10. Kozłowski A., (2012), Konstrukcje stalowe. Przykłady obliczeń wg PN-EN 1993-1. Część 1. Wybrane elementy i połączenia, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów, s. 396 (in Polish)
11. Kozłowski A., (2012), Konstrukcje stalowe. Przykłady obliczeń wg PN-EN 1993-1. Część 2. Stropy i pomosty, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów, s. 498 (in Polish)
12. Kurzawa Z., (2011), Stalowe konstrukcje prętowe. Część 1. Hale przemysłowe oraz obiekty użyteczności publicznej, Wydawnictwo Politechniki Poznańskiej, Poznań, s. 368 (in Polish)
13. Kurzawa Z., (2011) Stalowe konstrukcje prętowe. Część 2. Struktury przestrzenne, przekrycia cięgnowe, maszty i wieże, Wydawnictwo Politechniki Poznańskiej, Poznań, s. 235 (in Polish)
14. Pałkowski Sz., (1994), Konstrukcje cięgnowe, Wydawnictwo Naukowo-Techniczne, Warszawa, s. 200 (in Polish)
15. Pałkowski Sz., (2010), Konstrukcje stalowe. Wybrane zagadnienia obliczania i projektowania, Państwowe Wydawnictwo Naukowe, Warszawa, s. 215 (in Polish)
16. PN-EN 1990 Eurocode: Basis of structural design
17. PN-EN 1991 Eurocode 1: Actions on structures
18. PN-EN 1993 Eurocode 3: Design of steel structures
19. PN-90/B-03200 Konstrukcje stalowe. Obliczenia statyczne i projektowanie (in Polish)

## Additional bibliography:

1. Biegus A., (1997), Nośność graniczna stalowych konstrukcji prętowych, Państwowe Wydawnictwo Naukowe, Warszawa-Wrocław, s. 183 (in Polish)
2. Bogucki W., (1976), Budownictwo stalowe. Część 1, Wydawnictwo Akady, Warszawa, s.451 (in Polish)
3. Bogucki W., (1977), Budownictwo stalowe. Część 2, Wydawnictwo Akady, Warszawa, s.444 (in Polish)
4. Bogucki W., Żyburtowicz M., (2008), Tablice do projektowania konstrukcji metalowych, Wydawnictwo Arkady, Warszawa, s.399 (in Polish)
5. Jankowiak W., (1983), Konstrukcje metalowe, Państwowe Wydawnictwo Naukowe, Warszawa-Poznań, s. 916 (in Polish)
6. Kurzawa Z., Chybiński M., (2008), Projektowanie konstrukcji stalowych, Wydawnictwo Politechniki Poznańskiej, Poznań, s. 322 (in Polish)
7. Łubiński M., Filipowicz A., Żółtowski W., (2008), Konstrukcje metalowe. Część 1. Podstawy projektowania, Wydawnictwo Arkady, Warszawa, s. 646 (in Polish)
8. Łubiński M., Żółtowski W., (2007), Konstrukcje metalowe. Część 2. Obiekty budowlane, Wydawnictwo Arkady, Warszawa, s. 566 (in Polish)
9. Rykaluk K., (2006), Konstrukcje stalowe. Podstawy i elementy, Dolnośląskie Wydawnictwo Edukacyjne, Wrocław, s. 431 (in Polish)

## Result of average student's workload

| Activity | Time (working hours) |
|---|---|
| 1. Active participation in meetings (lectures and classes) | 45 |
| 2. Active participation in consultations with posing questions | 10 |
| 3. Solving exercises designed for independent work | 10 |
| 4. Independent studying theoretical questions (notions, algorithms, theorems, proofs) | 10 |
| 5. Preparing to tests | 20 |

## Student's workload

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| Source of workload | hours | ECTS |
|---|---|---|
| Total workload | 75 | 3 |
| Contact hours | 50 | 2 |
| Practical activities | 25 | 1 |

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