(faculty stamp)

Syllabus

1. Name of the subject: FUNDAMENTALS OF NUMERICAL METHODS	**2. Course code:**
3. Valid in academic year: 2016/2017	
4. Course: MSc (second degree programme)	
5. Type of studies: full time stationery course	
6. Field of study: POWER ENGINEERING	
7. Profile of studies: General academic	
8. Programme: CLEAN FOSSIL AND ALTERNATIVE FUELS ENERGY (KIC INNOENERGY)	
9. Semester: 1	
10. Responsible unit: Institute of Thermal Technology (RIE-6)	
11. Lecturer: Prof. dr hab. inż. Ryszard Białecki	
12. Group of subjects: Specializations subject	
13. Status: Obligatory	
14. Language of instruction: English	
15. Prerequisites: mathematics, heat transfer	
16. Course objectives: The aim of the course is to introduce students to the fundamentals of numerical techniques.	

17. Learning outcomes:[1]

Nr	Learning outcomes description	Method of assessments	Type of classes	Reference to learning outcomes
1	Student is able to give overview of available techniques of solving Partial Differential Equations	Oral exam	Lectures, labs	**K2A_W07**, **K2A_W05; K2A_U19; K2A_U20**
2	Student is able to define problems and introduce feasible simplifications	Computer labs, exam	Lectures, labs	**K2A_W07**, **K2A_W05 K2A_U19**, **K2A_U20,**
3	Student is able to explain the limitations and strengths of numerical methods	Exam	Lectures, Project, Computer lab	**K2A_W07 K2A_W05**, **K2A_U19, K2A_U20**
4	Student is able to demonstrate her/his ability to use commercial and open source programmes. Student is able to build complex models of technological processes	Computer labs	Project, Seminar	**K2A_W07**, **K2A_U08**, **K2A_U09, K2A_U19**, **K2A_U20, K2A_K03**
5	Student is able to use advanced methods facilitating the process of solving practical technical and economic problems in the field of power engineering		Lecture, labs	**K2A_U23**

[1] 5-8 learning outcomes should be given

18. Type of classes and their duration

Lecture: 30h Computer lab: 30h

19. Content of the course:

The course consists of lectures, computer lab and individual projects. Lectures cover: Limitations of numerical methods. Elements of differential geometry. Discretization of conservation, variation and reciprocity principles, as a basis of numerical methods. Weighted residuals, choice of weighting functions. Collocation, Galerkin and other formulations (least squares, sub-region collocation, moments). Application of weighted residuals for the solution of sets of algebraic equations, differential and integral equations. Trial functions for weighted residual solutions of differential equations. Functions satisfying boundary conditions (Ritz method), functions satisfying differential equation (Trefftz method), functions satisfying neither boundary conditions nor differential equation. Finite element method. Functions of finite support, local coordinates. Transformation of coordinates systems. Weak Galerkin formulation. Matrix assembly. Neumann and Robin boundary conditions. Dirichlet boundary conditions and their direct and penalty function implementation.

During computer lab, the students will program simple examples using MatLab and write a short project to solve heat conduction using Finite Elements.

Lectures are conducted in an interactive way with use of audiovisual tools. During the lecture problem questions/topics are raised, students take part in the discussion and brainstorms, trying to find solution/answers, assess existing solutions as well as develop critical thinking. Students are encouraged to participate in discussions which are moderated by the tutor. Students will be able to explain and discuss the dynamic nature of complex systems and change over time. They will be able to apply the tools and concepts of system dynamics and systems thinking in their present lives.

20. Examination: no

21. Basic literature:

1. A.J. Nowak (ed) Numerical methods in heat transfer, International Studies in Science and Engineering. Institute of Thermal Technology, 2009
2. O.C. Zienkiewicz, R.L. Taylor and J.Z. Zhu Finite Elements Methods . Its Basics and Fundamentals, 6^{th} ed. Elsevier Oxford 2005

22. Other reading:

1. Handbook of Numerical Heat Transfer 2^{nd} ed., W.J. Minkowycz, E. M. Sparrow and J.Y. Murthy (ed) J. Wiley, Hoboken, 2006
2. Scientific journals availabale in university network (Scopus, Science direct etc.)

23. Work load of the student necessary to achieve the learning outcomes

Lp.	Type of classes	Number of contact hours / student work
1	Lectures	30/30
2	Recitations	/
3	Lab	30/30
4	Project	
5	Seminar	
6	Other (participation in consultations associated with project execution)	
	number of hours (subtotal)	60/60

24. Total number of hours: 120

25. Number of ECTS credits:[2] 4

26. Number of ECTS credit points gained during classes (contact hours): 2

27. Number of ECTS credits gained during practice oriented classes (labs, projects): 2

[2] 1 ECTS point – 30 hours workload

26. Remarks:

Teaching tools: **learning by doing**

The overall assessment consist of two steps:

1. Check of fulfilling of module LO consequently OLOs criteria.
2. Assessment and grading of the quality of students work and reached LO.

EIT OLOs assessed in the subject :

- Value judgments and sustainability competencies (EIT OLO 1)
- Creativity skills and competencies (EIT OLO 3)
- Research skills and competencies (EIT OLO 5)
- Intellectual transforming skills and competencies (EIT OLO 6)

The Method of assessments indicated in point 17 includes assessment of learning outcomes and OLOs

Grading:

Grading formula: $FG=PMWF_{lec}*PMG_{lec}+ PMWF_{lab}*PMG_{lab}$

Where:

- FG-final grade
- $PMWF_{lec}$ – Lecture part weighting factor – 0,6
- PMG_{lec} – Grade of achieved LOs relevant to lecture
- $PMWF_{lab}$ – Laboratory part weighting factor – 0,4
- PMG_{lab} – Grade of achieved LOs relevant to laboratory

All LO weighting factors associated with part of the module (PM) equal 1.

Accepted:

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(Date and signature of the responsible instructor)	*(date and signature of teh director of the institute, chair, Director of Foreign Language College/head or director of inter-faculty unit)*