**COURSE DESCRIPTION**

1. **Course title:** COMPUTER METHODS IN GEOMECHANICS
2. **Course code:** SII-BPIOP/16
3. **Validity of course description:** 2014/2015
4. **Level of studies:** Master course
5. **Mode of studies:** intramural studies
6. **Field of study:** Mining and Geology [FACULTY SYMBOL] RG
7. **Profile of studies:** general academic
8. **Programme:**
   - **Specialization:** Underground Construction and Surface Protection
9. **Semester:** II
10. **Faculty teaching the course:** Faculty of Mining and Geology, Department of Geomechanics, Underground Construction and Management of Mining Areas Surface Protection
11. **Course instructor:** Grzegorz Smolnik, PhD
12. **Course classification:** specialty items
13. **Course status:** compulsory
14. **Language of instruction:** English (lecture), Polish (project)
15. **Pre-requisite qualifications:** Rock Mechanics, Strata Mechanics, Underground Construction, Underground Mining Exploitation Techniques
16. **Course objectives:** The aim of the subject is to make students familiar with computer methods used in geomechanics. Particular attention is devoted to the methods which are especially suitable for simulation of behavior of jointed rock masses like Distinct Element Method. Attention is paid to practical training to pass the knowledge and teach students in such a way that they will be able to use numerical tools to solve engineering problems by themselves.
17. **Description of learning outcomes:**

<table>
<thead>
<tr>
<th>Nr</th>
<th>Learning outcomes description</th>
<th>Method of assessment</th>
<th>Teaching methods</th>
<th>Learning outcomes reference code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Student is familiar with computer methods used for solving engineering tasks</td>
<td>Written exams (during lectures), project report</td>
<td>Lecture, Project</td>
<td>K_W11+++</td>
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<tr>
<td>2</td>
<td>Student has deep knowledge of numerical methods</td>
<td>Written exams (during lectures)</td>
<td>Lecture</td>
<td>K_W01++</td>
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<tr>
<td>3</td>
<td>Student is able to obtain information from literature, databases, data sheets, manufacturers’ catalogs and manuals and other carefully selected sources which are written also in English. He/she can interpret and validate the data and to draw conclusions and formulate and justify opinions</td>
<td>Discussion of numerical modelling results</td>
<td>Project</td>
<td>K_U01+++</td>
</tr>
<tr>
<td>4</td>
<td>Student is able to communicate in English (B2 level of Common European Framework of Reference for Languages)</td>
<td>Written exams (during lectures), discussion of numerical modelling results</td>
<td>Lecture, Project</td>
<td>K_U06+</td>
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<tr>
<td>5</td>
<td>Student can design an underground structure as well as the measures for retrofit or recovery of the structure (at least part of)</td>
<td>Project report</td>
<td>Project</td>
<td>K_U19+</td>
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<tr>
<td>6</td>
<td>Student can play a role as a part of a team and is able to take different tasks in a teamwork.</td>
<td>Cooperation of students working together in small divisions</td>
<td>Project</td>
<td>K_K03+</td>
</tr>
</tbody>
</table>

18. **Teaching modes and hours**
   - Lecture 15h
   - Project 15h

19. **Syllabus description:**

   **Lecture:**
   Basic notions. Plain strain conditions, plain stress conditions. Degrees of freedom. Basic constitutive equations for deformable bodies. Fundamentals of Finite Element Method (3 hours)
Fundamentals of Distinct Element Method. Introduction to UDEC (Universal Distinct Element Code) and PFC (Particle Flow Code). Continuous and discontinuous functions, Cauchy’s approach. (1 hour)

Joint models. Shear strength of joints (Amonton, Newland & Alley, Paton and Barton & Zhao joint strength criteria). Tensile strength of joints. Normal and shear stiffness coefficients. Dilation in joints. (3 hours)


Modelling procedures in Distinct Element Method (UDEC and 3DEC codes). Initial and boundary conditions. Simulation and results. Strain, stress, displacement changes in a rock mass due to mining activities. (3 hours)

Introduction to Particle Flow Code. (3 hours)

Project:

Tunnels in jointed rock masses

Initial stress state in layered rock mass (1 hour)

Introduction to modelling in UDEC. (2 hours)

Numerical model of a vicinity of tunnels in a blocky rock mass. Generation of joints. Material and joint models. Initial and boundary conditions. (3 hours)

Simulation of tunnels excavation. Strain, stress, displacement changes in a rock mass due to excavation of blocks. Instability of blocks around tunnels. Simulation of local water flow and its impact on the stability of service tunnel (4 hours)

Shotcrete and cables reinforcement. Impact of the support on the behavior of blocks around tunnels’ periphery. (3 hours)

Simulation of mining tremor and/or earthquake. Stress wave. Viscous boundaries. Damping. Dynamic mode. Performance of support subjected to dynamic loading conditions. (2 hours)

20. Examination:

21. Primary sources:

22. Secondary sources:

23. Total workload required to achieve learning outcomes

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Teaching mode :</th>
<th>Contact hours / Student workload hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>15 / 25</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>/</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>/</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>15 / 18</td>
</tr>
<tr>
<td>5</td>
<td>BA/MA Seminar</td>
<td>/</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>/</td>
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<tr>
<td></td>
<td>Total number of hours</td>
<td>30 / 43</td>
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</table>

24. Total hours: 73
25. Number of ECTS credits: 2
26. Number of ECTS credits allocated for contact hours: 1
27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 1
28. Comments:

Approved:

27.09.2014r, Grzegorz Smolnik
(date, Instructor’s signature)

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(date, the Director of the Faculty Unit signature)