Course Title (in English) | Continuum Mechanics
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Course Title (in Russian) | Механика сплошных сред
Lead Instructor(s) | Nigmatulin, Robert

Is this syllabus complete, or do you plan to edit it again before sending it to the Education Office?
The syllabus is a final draft waiting for form approval

Contact Person | Robert Nigmatulin
Contact Person's E-mail | nigmar@ocean.ru

1. Annotation

Course Description
Continuum mechanics is a section of mechanics and theoretical physics, or rather the continuation of theoretical mechanics that deals with analysis of deformable bodies. However, mathematics in continuum mechanics represents the main constructive tool. Continuum mechanics allows to demonstrate the power of logic and mathematical thinking. Based on a few fundamental postulates and principles, using the mathematical apparatus can reveal non-trivial, and even striking results.

Foundation of continuum mechanics consists of:
1) material continuum model in the form of a deformable (with mechanical stresses and other macroparameters) continuous medium, described via several piecewise continuous differentiable functions. Building such a model is carried out by averaging the parameters of real materials that have a discrete atomic and molecular structure;
2) differential, integral, tensor calculus and the theory of dimensions with the fundamental idea of invariance under transformation of coordinate systems and systems dimension;
3) The laws of conservation of mass, momentum, angular momentum and energy, the laws of thermodynamics, expressed in terms of macroscopic parameters of the material continuum;
4) mechanical (rheological), thermal and electrical experiments that allow us to find connections between macroparameters of different substances at different mechanical, thermal, electromagnetic and physical-chemical processes.
These representations constitute, in particular, the mathematical theory of thermo-electro-magneto-mechanical field.

This course uses tensor representations in the Cartesian coordinate system of the observer. But it will one shown in detail how to to write the continuum mechanics equations in the arbitrary curvilinear coordinate system. This way the common link is not lost and the exposition becomes easier and clearer.

<table>
<thead>
<tr>
<th>Course Prerequisites</th>
<th>Solid knowledge of calculus, linear algebra, complex variables, fundamentals of mechanics. Basic understanding of the theory of ordinary and partial differential equations.</th>
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2. Structure and Content

<table>
<thead>
<tr>
<th>Course Academic Level</th>
<th>Master-level course suitable for PhD students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ECTS credits</td>
<td>6</td>
</tr>
<tr>
<td>Topic</td>
<td>Summary of Topic</td>
</tr>
<tr>
<td>--------</td>
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<tr>
<td>Tensor calculus</td>
<td>Scalar, vector, tensor. Tensor calculus.</td>
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<tr>
<td>Conservation laws</td>
<td>Integral, differential, and jump equations derived from conservation laws. Integral and differential mass, momentum, angular momentum and total energy balance equations. Internal energy equation and the first law of thermodynamics.</td>
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<tr>
<td>One-dimensional motions</td>
<td>Differential equations for mass and momentum in case of one-dimensional motion with plane, cylindrical and spherical symmetries. Spherical bubble in liquid.</td>
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</table>

### 3. Assignments
### Assignment Type

<table>
<thead>
<tr>
<th>Assignment Type</th>
<th>Assignment Summary</th>
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</thead>
<tbody>
<tr>
<td>Homework</td>
<td>Weekly homework assignments</td>
</tr>
<tr>
<td>Project</td>
<td>Individual theoretical projects</td>
</tr>
<tr>
<td>Test/Quiz</td>
<td>Midterm exam</td>
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<tr>
<td></td>
<td>Final exam</td>
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</tbody>
</table>

### 4. Grading

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Graded</th>
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<table>
<thead>
<tr>
<th>Grade Structure</th>
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<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Activity weight, %</th>
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<tbody>
<tr>
<td>Homework Assignments</td>
<td>20</td>
</tr>
<tr>
<td>Projects</td>
<td>10</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>30</td>
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<tr>
<td>Final Exam</td>
<td>40</td>
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### Grading Scale

- **A:** 90
- **B:** 80
- **C:** 70
- **D:** 60
- **E:** 50
- **F:** 0

**Attendance Requirements:** Mandatory

### 5. Basic Information

**Maximum Number of Students**

<table>
<thead>
<tr>
<th>Maximum Number of Students</th>
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<tbody>
<tr>
<td>Overall:</td>
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<tr>
<td>Per Group (for seminars and labs):</td>
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</table>
Course Stream: Science, Technology and Engineering (STE)
Course Term (in context of Academic Year): Term 2

Students of Which Programs do You Recommend to Consider this Course as an Elective?

<table>
<thead>
<tr>
<th>Masters Programs</th>
<th>PhD Programs</th>
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<tbody>
<tr>
<td>Advanced Manufacturing and Materials</td>
<td>Computational and Data Science and Engineering Systems</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>Engineering Systems</td>
</tr>
<tr>
<td>Computational Science and Engineering</td>
<td>Life Sciences</td>
</tr>
<tr>
<td>Data Science</td>
<td>Materials Science and Engineering</td>
</tr>
<tr>
<td>Energy Systems</td>
<td>Mathematics and Mechanics</td>
</tr>
<tr>
<td>Materials Science</td>
<td>Petroleum Engineering</td>
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<tr>
<td>Mathematical and Theoretical Physics</td>
<td>Physics</td>
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<tr>
<td>Petroleum Engineering</td>
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<tr>
<td>Photonics and Quantum Materials</td>
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<tr>
<td>Space and Engineering Systems</td>
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Course Tags: Math, Physics, Engineering

6. Textbooks and Internet Resources

<table>
<thead>
<tr>
<th>Web-resources</th>
<th>Description</th>
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<tbody>
<tr>
<td>Course notes</td>
<td>Will be provided by the instructor</td>
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7. Facilities

8. Learning Outcomes

<table>
<thead>
<tr>
<th>Knowledge</th>
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<tbody>
<tr>
<td>Knowledge of fluid and solid mechanics</td>
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<tr>
<td>Knowledge and use of contemporary methods and tools</td>
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<table>
<thead>
<tr>
<th>Skill</th>
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<tbody>
<tr>
<td>Analytical reasoning and problems solving</td>
</tr>
<tr>
<td>Creative thinking</td>
</tr>
<tr>
<td>Written, electronic, and graphical communication</td>
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<tr>
<td>Experience</td>
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<td>------------</td>
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<tr>
<td>First-hand experience in mathematical modeling of motion of fluids and solids</td>
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### 9. Assessment Criteria

- Input or Upload Example(s) of Assignment 1:
- Input or Upload Example(s) of Assignment 2:
- Input or Upload Example(s) of Assignment 3:
- Input or Upload Example(s) of Assignment 4:
- Input or Upload Example(s) of Assignment 5:

### 10. Additional Notes