1. Annotation

Course Description

The course will introduce the basic phenomena of aerosol science, particle formation in the gas phase and their behavior, concepts and measurement techniques for the aerosol particles. Students will synthesize (carbon nanotubes, NaCl, metal, metal oxide and polymer) nanoparticles by two aerosol techniques: gas-to-particle and liquid-to-particle conversions. Students will be trained to operate spark-discharge aerosol synthesis reactor for production of nanoparticles and single-walled carbon nanotubes and spray drying and pyrolysis reactors.

The student will perform the on-line measurements of number size distribution of aerosol synthesized nanoparticles by differential mobility analyzer (size range: 2-1000 nm). Students will become familiar with processes of the aerosol particle collection (filtration, electrostatic precipitation, thermophoretic precipitation). The produced samples of nanoparticles will be observed with means of transmission and scanning electron microscopies.

Totally 34 lecture hours and 15 exercise hours, 5 hours for seminar lessons, 6 presentation hours will be arranged. Students will write a short essay and give a presentation on one of the selected topics.

Course Prerequisites

The prerequisites for the course are the knowledge of the basic Physics, Chemistry and Materials science.
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>
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<td>----------------------------------------------------------------------</td>
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<tr>
<td>Course requirements, Introduction. AN (3 hours)</td>
<td>Course information. Introduction. Definitions. Particle size, shape, density. Aerosol size distributions functions, concentrations. Electrical properties.</td>
</tr>
<tr>
<td>Optical properties of aerosol particles. YG (2 hours)</td>
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<tr>
<td>Aerosol dynamics (2 hours). Discussion/Problem solving. (1 hour)</td>
<td>Nucleation. Condensation. Coagulation.</td>
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<tr>
<td>Aerosol characterisation. AN (2 hours). Discussion/Problem solving. (1 hour)</td>
<td>Inertial, electrical, optical, gravimetric analysis. Direct aerosol characterization: DMA, CPC, impactors, gas analyzers.</td>
</tr>
<tr>
<td>Gas-to-particle approach. AN (1,5 hours). Deposition methods of aerosol nanoparticles. AN (1,5 hour)</td>
<td>Principles and examples. Particle removal mechanisms. Filtration. Electrostatic deposition. Thermophoresis; photophoresis. Inertial techniques.</td>
</tr>
<tr>
<td>Interaction with solid surfaces. DK (2 hours)</td>
<td>Collision theory; diffusion to wall. Impaction. Deposition from rotating flow: cyclone filter. Film formation. Discussion/Problem solving. (1 hour)</td>
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<tr>
<td>Droplet-to-particle conversion. DK (2 hours).</td>
<td>Particle formation. Aerosol flow reactor. Study cases.</td>
</tr>
<tr>
<td>8. Aerosol science in chemical engineering. DK (2 hours). Discussion/Problem solving. (1 hour)</td>
<td>Traditional industrial flame synthesis methods Ultra-spray pyrolysis Aerosol CVD Fluidized-bed and slurry reactors.</td>
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</tbody>
</table>

3. Assignments
### Assignment Summary

**Other**

Assessment (6 credits):
- The assessment of the course is based on the assessments of:
  1. the exercise report (20%),
  2. results of quizzes and home work (20%),
  3. essay (20%)
  4. given presentation (20%),
  5. peer evaluation report (15%),
  6. activity during lessons and seminars (5%).
- The essay must follow the special instructions provided and will be graded on the basis of the various aspects, such as clarity, language, argumentation, use of references and general structure.
- Presentations will be evaluated on the basis of the presented material, general structure, and presentation skills of the students.
- Lectures: attendance of 12 (of 13) lectures.
- The exercise report will be assessed on the basis of information given related to four exercises carried out, description and results of the experiments, calculations, and conclusion.
- In the beginning of each lecture 5-10 min quizzes, based on the lecture content taught at the previous lecture, will be given to students.
- The assessment criteria will be carefully and explicitly explained to the students in the beginning of the lessons.

### 4. Grading

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Graded</th>
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<tbody>
<tr>
<td>Grade Structure</td>
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<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Activity weight, %</th>
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<tbody>
<tr>
<td></td>
<td>34</td>
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</table>

### Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
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<tbody>
<tr>
<td>A</td>
<td>86</td>
</tr>
<tr>
<td>B</td>
<td>76</td>
</tr>
<tr>
<td>C</td>
<td>66</td>
</tr>
<tr>
<td>D</td>
<td>56</td>
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<tr>
<td>E</td>
<td>46</td>
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</tbody>
</table>
5. Basic Information

<table>
<thead>
<tr>
<th>Course Stream</th>
<th>Science, Technology and Engineering (STE)</th>
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<tbody>
<tr>
<td>Course Term (in context of Academic Year)</td>
<td>Term 2</td>
</tr>
<tr>
<td>Course Delivery Frequency</td>
<td>Every year</td>
</tr>
<tr>
<td>Course Tags</td>
<td>Math, Physics, Engineering</td>
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</table>

6. Textbooks and Internet Resources

7. Facilities

8. Learning Outcomes

<table>
<thead>
<tr>
<th>Knowledge</th>
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<tbody>
<tr>
<td>After the course the students will be able</td>
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<tr>
<td>- to mathematically describe the movement of an aerosol particle under the influence of external forces (gravity, temperature, light, flow, electric field, etc.);</td>
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<tr>
<td>- to calculate the particle size distribution;</td>
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<tr>
<td>- to describe the mechanisms of the particle formation by gas-to-particle and droplet-to-particle approaches;</td>
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<tr>
<td>- deep learning of two selected topics based on writing an essay and giving a presentation.</td>
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<tr>
<td>- to design the system for production and to synthesise nanoparticles with certain particle size and certain composition;</td>
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<tr>
<td>- to enhance presentation and scientific writing skills, group/team work skills;</td>
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<tr>
<td>- to give peer evaluation/feedback.</td>
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</tbody>
</table>

The learning outcomes. After the course the students will be able

- to mathematically describe the movement of an aerosol particle under the influence of external forces (gravity, temperature, light, flow, electric field, etc.);
- to calculate the particle size distribution;
- to produce nanoparticles with certain particle size and certain composition;
- to describe the mechanisms of the particle formation by gas-to-particle and droplet-to-particle approaches.
### 9. Assessment Criteria

<table>
<thead>
<tr>
<th>Input or Upload Example(s) of Assignment 1:</th>
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<tbody>
<tr>
<td>Input or Upload Example(s) of Assignment 2:</td>
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<tr>
<td>Input or Upload Example(s) of Assignment 3:</td>
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<tr>
<td>Input or Upload Example(s) of Assignment 4:</td>
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<tr>
<td>Input or Upload Example(s) of Assignment 5:</td>
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</tbody>
</table>

### 10. Additional Notes

Upload a File (if needed)

https://ucarecdn.com/51d8d7aa-7082-4575-b55e-b98e1133f39a/