<table>
<thead>
<tr>
<th>New Course Code and Title</th>
<th>MS733M: Electron Microscopy of Materials</th>
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</thead>
<tbody>
<tr>
<td>Course Coordinator</td>
<td>Dong Zhili and Martial Duchamp</td>
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<tr>
<td>Details of Course</td>
<td>Rationale for introducing this course</td>
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<td></td>
<td>This course will educate on the use of complementary materials characterization techniques through understanding the advantages and limitations of commonly used analytical electron microscopy characterization tools. Students will be acquainted with the principles, instrumentation and operation of scanning/transmission electron microscopy (SEM/TEM) for the characterization of inorganic materials. Practical methods of designing experiments, sample preparation, data collection / interpretation will be highlighted. Laboratory demonstration sessions will reinforce and consolidate the themes of the lectures.</td>
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<td>Aims and objectives</td>
<td>Students will gain an understanding of the importance of various analytical electron microscopy tools individually and complementary to each other in designing and solving real-world industrial problems. This course will prepare students for their continuous studies as PhD candidates that require electron microscopy for nanomaterials characterization.</td>
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| Course Syllabus (Refer to page 2) | 1. Introduction to Electron Microscopy  
2. Transmission Electron Microscope (TEM)  
4. Spectroscopy inside a TEM  
5. Simulation and Analysis |
| Assessment (Individual Assessment) | Continuous Assessment  
- 2 open ended papers (20% each)  
- Quiz  
Total: 100 % |
| To be offered with effect from (state Academic Year and Semester) | AY2017/18 Semester 2 |
| Cross Listing (if applicable) | N/A |
| Prerequisites (if applicable) | NTU MS4640 or equivalent courses in overseas universities |
| Preclusions (if applicable)   | N/A |
### Mode of Teaching & Learning
(Lectures, regular tests, Q&A, problem-based learning)

- Lectures, problem-based learning, lab demonstration

### Basic Reading List

- **Compulsory Reading**

- **Supplementary Reading**

### Maximum Class Size

- 30

### Hours of Contact/Academic Units

- 39 hours / 3 AU

### Workload Per Week

- Lecture hours per week
- Tutorial hours per week
- Total hours

- 3 hours
- 39 hours

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School of Materials Science and Engineering
Course Syllabus

The following topics will be covered:

1: Introduction to Electron Microscopy
   - Crystal systems and Bravais lattices
   - Direct lattice and reciprocal lattice
   - History
   - Optics
   - Electron beam - material interaction, modes of operation
   - Specimen Preparation

2: Transmission Electron Microscope (TEM)
   - Electron diffraction-a
   - Electron diffraction-b
   - Mass-thickness contrast
   - Diffraction contrast-a
   - Diffraction contrast-b
   - Phase contrast-a
   - Phase contrast-b
   - JEMS software
   - Lens aberration and CEOS corrector

3: Scanning (Transmission) Electron Microscope
   - Scanning electron microscopy: contrast formation
   - Instrumentation & Signal collection
   - STEM alignment (Ronchigram)
   - Interpretation of HR STEM images
   - Introduction to spectrum-imaging

4: Spectroscopy inside a TEM
   - Energy-dispersive X-ray spectroscopy: Theory
   - Energy-dispersive X-ray spectroscopy, in practice
   - Electron energy-loss spectroscopy: Theory
   - Electron energy-loss spectroscopy, in practice

5: Simulation and analysis
   - Digital micrograph (Gatan), Record an EEL datacube
   - Digital micrograph (Gatan), analysis of EEL datacube
   - DR probe light
   - DR probe (STEM simulation)