Undergraduate Program @ IISc

The Materials Curriculum
Design Under Extreme Constraints

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Indian Institute of Science

- Established in 1909; Centenary celebrations during 2008-09
- First batch of students entered in 1912
- Primarily a post-graduate institution
- Early decades: Diplomas and Associateships were awarded by IISc; PhDs were awarded by other universities (e.g. University of Madras)
- Became a deemed university in 1958
Indian Institute of Science

- Primarily a post-graduate institution
- Course programs: ME/MTech in engineering disciplines
- Research programs:
  - Integrated PhD in science (Intake: BSc)
  - MSc(Engg) in engineering (BE or MSc)
  - PhD in science and engineering (BE, ME, MSc)
The 'Old' UG program at IISc

Post-BSc program leading to a BE degree

- 2-year program initially; okay since the 'regular' BE those days was a 5-year program
- Converted to a 3-year program in 1964
  But the 'regular' BE degree became a 4-year program in 1981
- Became a 4-year Integrated ME program in the late 1980s
- Scrapped altogether; last batch graduated in 2000.
The New BS Program

- Discussions over several years.
- First batch admitted in 2011.
- First 4-year bachelors program in sciences?
- Followed quickly by others, most notably the Delhi University
- Six streams of specialization: Math, Physics, Chemistry, Biology, Materials, and Environment
The Big Idea

Foster interdisciplinary thinking

- Students choose a major and a minor from the available streams: Maths, Physics, Chemistry, Biology, Materials, and Environment
- Engineering courses
- Humanities

**Flexibility**: Minor need not be declared. Those credits can be used either for the major or for free-ranging.
Course Structure

• Common courses during the first 3 semesters.
  – 52 credits

• Students declare their major and minor at the end of the 3rd semester.

• During the remaining 5 semesters:
  – Major (52 credits, including 10-16 for project)
  – Minor (15 credits)
  – Engineering electives (9 credits)
  – Humanities seminars (4 credits)

• Total: 132 credits
Common Courses

- Math: 9 credits
- Physics: 9 credits
- Chemistry: 9 credits
- Biology: 9 credits
- Engineering: 10 credits
  - Programming (3), Electronics (3), Materials (2), Environment (2)
- Humanities: 6 credits
Challenges in Curriculum Design

- 52 credits overall, of which 16 are for the final year project
- 36 credits for both lecture and lab courses
- Leverage the available expertise
- Coverage vs Depth
- Core vs. Specialized topics
- Define a core, and leave the rest as electives
- Unified treatment wherever possible, especially in the core subjects
What is Core?

- Materials tetrahedron: Chemistry-Processing-Properties-Performance
- Structure - Thermodynamics – Kinetics
- Metals – Ceramics – Polymers – Electronic Materials
- Properties: Structural and Functional Materials
- Synthesis:
  - Modeling of materials behaviour and materials processing: Length and time scales
  - Materials Design
Materials Curriculum

- **Major** (36 Credits)
  - Core 21 Credits (16 : 5)
  - Elective 15 Credits
  - Project 16 Credits

- **Minor** (15 Credits)
  - Core 3 Credits
  - Soft Core 6 Credits (out of 15)
  - Electives 6 Credits
# Materials Major

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<th>Semester 4</th>
<th>2:1</th>
<th><strong>Structure of Materials</strong></th>
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<td><strong>Materials Thermodynamics</strong></td>
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<th>Semester 5</th>
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<td><strong>Introduction to Materials Processing</strong></td>
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<td><strong>Mechanical Processing Lab</strong></td>
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| Semester 8 | 0:16 | **Project** |


Materials Minors  
16 Credits

Core (3 Credits)  
Structure and Characterization of Materials

Soft Core (6 Credits out of 15)  
Materials Thermodynamics  
Electronic Properties of Materials  
Materials Kinetics  
Introduction to Materials Processing  
Mechanical Behaviour of Materials

Electives (7 Credits)
UG Electives

**Semester 6**
Microstructures in Materials (MT)

**Semester 7**
Semiconductor Devices and Integrated Circuit Technology (CeNSE)

Design and Selection of Materials (MT)
Electives For III Year

Fundamentals of Biomaterials and Living Matter (Bio-Engineering)
Introduction to Biomechanics of Solids (Bio-Engineering)
Corrosion Technology (MT)
Polymer Science and Engineering-I (MT)
Topics in Basic and Applied Electrochemistry (IPC)

Phase Transformations (MT)
Finite Element Analysis for Materials Engineers (MT)
Interfacial Phenomena in Materials Processing (MT)
Fracture (MT)
Solidification Processing (MT)
Materials: Synthesis, Extraction and Manufacturing (MT)
Defects and Materials Properties (MRC)
Functional Materials Lab (MRC)
Introduction to Biomaterials (MRC)
Thin Films, Nanomaterials and Devices (MRC)
Electives for IV Year

Crystal Growth and Thin Films (CeNSE)
Elements of Solid and Fluid Mechanics (CPDM)
Defects in Materials (MT)
Modeling and Simulations in Materials Engineering (MT)
Science of Materials Processing (MT)
Introduction to Biomaterials Science and Engineering (MT)
Electron Microscopy (MRC)
Computational Modeling of Materials (MRC)
Nanostructured Materials (MRC)
Lessons from our (short) experience

We need 6-9 credits more than what we have (36).

Chemistry and Biology are reducing their project credits to 10.

In Materials, we nudge students towards engineering electives such as Solid Mechanics, Fluid Mechanics, Devices, Crystal Growth.

We encourage materials electives such as materials design, modeling.
Students who do not declare a minor can take 2 to 3 more courses in materials.

Students who do declare a minor have other constraints; however, we can ask them to choose courses such as Condensed Matter Physics, or Solid State Chemistry.

Will get a chance to revise and/or re-design the curriculum in 2015 when the first batch graduates.