

## Session 2164

### A Distance Learning Subject in Polymer Engineering

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#### Abstract

The Department of Materials Science and Engineering at MIT has for many years offered a graduate subject in Mechanical Properties of Polymers, which includes such topics as rubber elasticity, anisotropic elasticity, mechanics of composites, viscoelasticity, yield and fracture. In recent years this subject has made increasing use of web-based delivery, which offers a number of conveniences and enhanced topic coverage. This web-based coverage is now part of MIT's Open Courseware Initiative, so it is available worldwide. Most recently, the availability of the web material along with videotaped lectures has been important in making the subject a part of a distance-learning venture MIT is conducting with the Malaysia University of Science and Technology (MUST). The subject will be offered for the first time in Malaysia in Spring 2004, and this paper will outline steps taken by MIT and MUST in implementing it.

#### I. The Overall MUST Program

The Malaysia University of Science and Technology (MUST) is a recently-founded academic institution intended to provide a dramatic improvement in Malaysia's infrastructure for research and development, principally by educating highly skilled persons for that country's technical industries. In 2002, MIT and MUST entered into a collaborative agreement in which MIT would provide assistance to MUST in several areas, in particular the development of academic and research programs at the Masters Degree level<sup>1</sup>.

The MUST/MIT subjects are taught in Malaysia by MUST faculty, with MIT faculty providing assistance to MUST faculty in subject development and delivery. This differs from other MIT distance-learning subjects in which MIT faculty deliver lectures either in person at the remote site or by electronic transmission from the MIT campus in Cambridge, MA USA. MIT subjects selected for replication at MUST are videotaped as they are taught at MIT, and the videotapes of lectures along with web-based courseware are made available to MUST. MIT faculty also travel to MUST for direct discussions with the MUST instructor of the subject to assist in lecture development. MIT provides assistance when MUST students or faculty have questions regarding the content or homework as they are delivered at MUST. To prevent MIT faculty workloads from being overloaded by these additional demands on their own regular teaching duties, an MIT teaching assistant at MIT funded by the MUST/MIT program is appointed to act as an intermediary between the two institutions.

There are currently 7 MUST/MIT academic programs either underway or planned for implementation later in 2004:

1. Biotechnology
2. Transportation and Logistics
3. Information Technology
4. Construction Engineering and Management
5. Materials Science and Engineering
6. Systems Engineering and Management
7. Energy/Environment

## II. The MUST Program in Materials Science and Engineering

This presentation will address one of the subjects in program #5, Materials Science and Engineering, which began development in Fall 2003. A brief description of this program's academic requirements follows:

Total credits:	=	144 units <sup>2</sup>
Thesis:	=	36 units
Core	=	36 (three subjects)
6 Required Subjects	=	72 units

MSE 501 Thermodynamics and Kinetics of Materials  
MSE 502 Materials Selection, Design, and Economics  
MSE 503 Mechanical Properties of Materials

MSE 504 Fabrication Technology  
MSE 505 Mechanical Behavior of Plastics  
MSE 506 Magnetic Materials: Principles and Applications  
MSE 507 Electronic Materials Design

UCC 501 Core Subject Being Offered: Systems Analysis and Design  
UCC 502 Sustainable Development: Theory, Economics and Policy  
MSE 600 Thesis (Required)

In preparation for taking the graduate subjects, MUST students first take the following fundamental subjects during the summer months:

FNC001 Mathematical Methods for Engineers  
FNC002 Engineering Probability and Statistics  
FNC003 Introduction to Computers and Engineering Problem-Solving  
FNC004 Economics  
FNC006 Biology  
FNC008 Mechanics of Materials  
FNC009 Introduction to Materials Science

FNC010 Mathematics for Biotechnologists  
FNC011 Fundamentals in Chemical Engineering

In addition to subject work, every MUST graduate student is required to complete an individual research thesis continuing over two semesters. The thesis is a scholarly treatment of a subject or an investigative treatment of a problem, which is sufficiently limited in scope to ensure thoroughness. A thesis advisor and thesis committee supervises the work on the thesis, but the student is expected to take the initiative at every stage.

MIT faculty also act as coadvisors for MUST thesis students, and funding is available when appropriate for collaborative research projects to be conducted both in Malaysia and at MIT.

### III. The MIT Subject in Mechanical Behavior of Plastics

Mechanical Properties of Plastics (MIT subject 3.91<sup>3</sup>) is one of MIT's principal graduate subjects in polymeric materials. It is a core subject in the doctoral Polymer Program of the Department of Materials Science and Engineering, and also in the MIT interdepartmental Program in Polymer Science and Technology (PPST). 3.91 was developed originally by Prof. F.J. McGarry in the 1960's, and has been offered continually at MIT ever since. Prof. D. Roylance has co-taught the subject since the mid-1970's, and became the sole instructor with Prof. McGarry's retirement in June 2002.

As its name implies, 3.91 is aimed at presenting the concepts underlying the response of polymeric materials to applied loads. These include both the molecular mechanisms of the response and the mathematical description of the relevant continuum mechanics. It is dominantly an “engineering” subject, but with an atomistic flavor. The subject content follows approximately that of the excellent text by I.M. Ward<sup>4</sup>, which is the assigned text for the subject:

- Polymer structure
- Deformation of elastic solids
- Rubber-like elasticity
- Linear viscoelasticity
- Composite materials and laminates
- Yield
- Fracture

The subject is delivered at MIT in a conventional lecture format, but with projection of web-available notes<sup>5</sup> replacing most of what formerly had been chalked on the blackboard. Students are given hardcopies of the notes before lecture, so note-taking is largely devoted marking up the copies with comments on the content rather than rote copying of the blackboard. Even though it is sometimes claimed, only partly in jest, that copying the blackboard is the only thing that keeps students awake during lecture, this web-enhanced approach seems to be an improvement over the traditional chalk-based method for both undergraduates and graduates. It is also helpful to the instructor in organizing the subject and keeping on schedule.

The web-based delivery is well suited to distance-learning endeavors, as well. The materials are freely available worldwide on the web, and have also been ported to MIT's Open Courseware Initiative<sup>6</sup> (OCW). OCW provides a common format for all MIT subjects, and also such benefits as searchability. For the MIT/MUST collaboration, the web materials have also been ported to the *Stellar*<sup>7</sup> system – this also provides a common visual appearance, as well as enhanced security features to restrict access to sensitive content.

#### IV. Conclusions

Distance learning is a good idea and is here to stay. It provides a means of improving the resources of the receiving institution much more rapidly than would be possible otherwise, and it affords the giving institution a chance to provide value to a larger community than its local members. The opportunity to experience international collaboration enriches both faculty, and the funding provided by these programs can be used to leverage pedagogical improvements at both institutions. The MIT/MUST venture is an example of one particular approach to distance learning, in which the actual subject delivery is done by the “distant” faculty at their own institution, but using the experience and expertise of the “local” institution to assist the development of the distant curriculum.

Assessment of teaching effectiveness is done routinely at MIT by means of student evaluations done both at midterm (when there is still time for instructors to effect changes if necessary) and at the end of term. This is in addition to the usual grading of student work and examinations during the teaching term. Departmental student organizations (the Student Undergraduate Materials Society and the Graduate Materials Council) also hold assessment colloquia among themselves and pass their observations to appropriate faculty curricular committees, where student representatives sit as members. The consensus is that web-assisted teaching provides a worthwhile convenience, but does not replace the need for good instructor organization and delivery.

Since the MUST version of the Polymer Mechanical Properties subject is just beginning, it is too early to assess either the effectiveness of the procedures described above in assisting MUST faculty in implementing the subject, or the effectiveness of the subject as perceived by students in Malaysia. Earlier versions of the MIT subject, and other subjects in the MUST/MIT program, have been reviewed favorably, however. We are hopeful the MUST/MIT Polymers subject will also be successful, and these evaluations when they are available along with planned improvements will be the subject of a later ASEE submission. An early assessment of the successes and deficiencies of the Spring 2004 implementation at MUST will be available for oral presentation at the June 2004 ASEE meeting.

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## References

<sup>1</sup> Web URL: [http://web.mit.edu/mit-tdp/www/must\\_overview.html](http://web.mit.edu/mit-tdp/www/must_overview.html)

<sup>2</sup> The subject unit listings follow the system used at MIT, in which 12 units implies a 12-hour per week workload (e.g. 3 lecture hours, 2 laboratory hours, and 7 homework hours); this would be equivalent to a 3- or 4-unit subject at many institutions.

<sup>3</sup> Web URL: <http://web.mit.edu/course/3/3.91/www/>

<sup>4</sup> I.M. Ward and D.W. Hadley, *An Introduction to the Mechanical Properties of Solid Polymers*, John Wiley & Sons, Chichester, 1993.

<sup>5</sup> Web URL: [http://web.mit.edu/course/3/3.91/www/schedule\\_04.html](http://web.mit.edu/course/3/3.91/www/schedule_04.html)

<sup>6</sup> Web URL: <http://ocw.mit.edu/index.html>

<sup>7</sup> Web URL: <http://stellar.mit.edu/>

## DAVID ROYLANCE

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