



THE UNIVERSITY OF ARIZONA

COLLEGE OF ENGINEERING

Department of Materials Science and Engineering

New models of On-line education and training

Pierre A. Deymier

Department of Materials Science and Engineering

School of Sustainable Engineered Systems

University of Arizona

Tucson AZ 85721





1. The School of Sustainable Engineered Systems will be a leader in the improved design of linkages between our natural and engineered systems to sustainably provide material resources, water, energy, infrastructure, and manufactured products through innovative education, research, and outreach.
2. School established summer 2009

SSES: an interdisciplinary program of departments

Chemical and Environmental Engineering

The University of Arizona
Civil Engineering and Engineering Mechanics



MATERIALS SCIENCE AND ENGINEERING



THE UNIVERSITY OF ARIZONA,
Department of Mining and Geological Engineering
Natural Resources • People • Environment

Systems & Industrial Engineering



Maintain existing disciplinary strengths while fostering excellence in interdisciplinary innovation and research collaborations to solve grand challenge problems.

Water Related Activities

Water treatment

- (a) Emerging and trace contaminants (ChEE: Snyder, Arnold)
- (b) Advanced Treatment (UV, ultrasonic) (ChEE: Saez, Sierra, Snyder, MSE: Keswani)
- (c) Biological treatment and Bioremediation: (ChEE: Field, Sierra)

Desalination

- (a) Inland desalination (ChEE: Ela, Arnold)
- (b) Energy and water (ChEE: Ogden, Ela)

Water infrastructure

- (a) Resilient water infrastructure (CEEM: Lansey)

Infrastructure

Water-Energy network

(a) Planning sustainable and resilient networks (CEEM: Lansey, SIE: Son)

Transportation

(a) Modeling and optimization (SIE: Head, Son, CEEM: Chiu)

Incorporating social and human behavior into engineering models

(a) Decision making, agent-based modeling (SIE: Son)

(b) Incentives (CEEM: Chiu)



INNOVATION IN DISTANCE EDUCATION

Intel On-line Bachelor Program Online Master of Engineering International Dual Degree





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Example of industry-academia partnership
in
undergraduate on-line education

Intel On-line Bachelor Program





Intel On-line Bachelor Degree Program

Partnership between Intel's Fab/Sort Manufacturing (FSM), College of Engineering and The University of Arizona

The Fab, Sort, Manufacture (FSM) College of Engineering, Intel's corporate university, and the College of Engineering at the University of Arizona have partnered to bring FSM employees a distance learning opportunity to earn a **Bachelor degree in Materials Science and Engineering or Chemical Engineering**. With employees all over the world, the distance learning nature of this program is designed to provide Intel FSM employees with the flexibility to engage in this education opportunity while managing their work and life needs. As adjunct faculty of the Department of Materials Science and Engineering, **FSM faculty also bring Intel technical expertise to on-line elective courses and enrich the MSE undergraduate program.**





Not accredited to deliver BS Degrees

Industry Partner: The Fab,
Sort, Manufacture (FSM) College of
Engineering, Intel's corporate
university

Accredited to deliver BS Degrees

Academic Partner: The
College of Engineering, University
of Arizona, Depts of MSE and ChEE

Customer: Intel technicians,
world wide, who aspire to become
Engineers



Intel On-line Bachelor Program

A flexible curriculum makes it possible

Fall Semester		Spring Semester	
Subject	Units	Subject	Units
Freshman Year			
CHEM 151 General Chemistry I	4	ENGL 102 First-Year Composition	3
ENGL 101 First-Year Composition	3	MATH 129 Calculus II	3
ENGR 102 Intro to Engineering	3	MSE 110 Solid State Chemistry	4
MATH 124 Calculus I w/apps or MATH 125 Calculus I	5/3	PHYS 141 Introductory Mechanics	4
Tier I INDV*	3	Tier I TRAD	3
Total	18/16 Total		17
Sophomore Year			
MATH 223 Vector Calculus	4	MATH 254 Introduction to Ordinary Differential Equations	3
PHYS 241 Introductory Electricity and Magnetism	4	MSE 365 Structure and Properties of Materials	4
MSE 222 Introduction to MSE I	3	MSE 223L Materials Processing Lab	2
MSE 345 Thermodynamics	4	MSE 223R Introduction to MSE II Tier I INDV*	3
Total	15 Total		15

Junior Year			
MSE Tech Elective	3	MSE 360L Materials Lab	1
MATH Elective	3	MSE Tech Elective	3
MSE 350 Numerical Methods in Materials Science & Engineering	3	MSE 480 Experimental Methods for Microstructural Analysis	3
ECE 207 Elements of Electrical Engineering	3	MSE 415 Transport Phenomena/Kinetics	4
Tier I TRAD	3	Advanced Basic Science Elective	3
Total	15	Total	14
Senior Year			
ENGR/MSE 498A Senior Capstone	3	ENGR/MSE 498B Senior Capstone	3
MSE Tech Elective	3	MSE Tech Elective	3
Tech Elective	3	Tech Elective	3
Tech Elective	3	Tech Elective	3
Tier II INDV	3	Tier II Arts/Humanities	3
Total	15	Total	15



Involvement of Intel-faculty in teaching elective courses

Intel/UA Instructors:

1. Intel employees,
2. Selected by FSM College of Engineering
3. Screened by MSE Undergraduate Curriculum Committee (UCC)
4. UA Designated Campus Colleagues
5. Paid by Intel, UA provides nominal fee to Intel Foundation/Course



Joint Intel-UA elective courses

Intel/UA Elective Courses (4):

1. Course designed by FSM College of Engineering/ MSE-UCC
2. Syllabus approved by UCC and UA
3. Grading and examination approved by MSE-UCC
4. Course evaluation done by FSM College of Engineering/shared with UA
5. Course content containing IP decided by Intel FSM CoE
6. Enrollment limited to Intel/UA students
7. Offered Summer session

MSE 300: Chemical Science of Semiconductor Processing for Manufacturing I

MSE301: Chemical Science of Semiconductor Processing for Manufacturing II

MSE302: Defect Analysis for Manufacturing

MSE303: DC and RF Plasma Engineering for Engineering

MSE304: Silicon CMOS Reliability Physics for Engineering



Workforce Ready Curriculum

for training critical thinkers and lifelong learners

Fundamental Recitations  Laboratories



MSE110: Solid State Chemistry
MSE 223R: Intro to MSE II
MSE/ANTH/Chem/ENGR 257B: Mat. Sci. of Art & Archeological Objects
MSE 365: Struct. & Properties of Materials
MSE471: Formation & Structure of Glasses
MSE 480: Experimental Methods for Microstructural Analysis
MSE/ECE 446/546: Semiconductor Processing
ENGR 498/MSE 498: Senior Capstone.

MSE110L: Solid State Chemistry Laboratory
MSE 223L: Materials Processing Laboratory
MSE250: Glass Processing Laboratory
MSE258: Mat. Sci. of Art & Archeological Objects Laboratory
MSE 360L: Materials Laboratory
MSE471: Form. & Struct. Glasses Laboratory
MSE 488: Scanning Electron Microscopy
MSE 489: Transmission Electron Microscopy of Materials
MSE 414: Casting Laboratory
MSE 447/547L: Semiconductor Processing Lab
MSE399/499: Independent study
ENGR 498/MSE 498: Senior Capstone.



The Micro / Nano Fabrication Center



USIF
 Envision Tomorrow





On-line course delivery methods

- **Synchronous versus Asynchronous**

- **Platform: D2L Courseware** (Desire2Learn

Incorporated is a provider of enterprise eLearning solutions and develops online Learning Management Systems used at more than 1100 institutions in 20 different countries around the world.)



Example of potential Water industry for partnership in on-line education

THE CAMPUS VEOLIA NETWORK



Veolia is one of a handful of companies to have created its own "school." Our diplomas, specific to our occupations, are awarded following the completion of courses leading to a high degree of qualification and recognition by the government.

Created in 1994, Campus Veolia now has 20 sites worldwide, including six in France. In each of the 11 countries with a Campus, the network offers a curriculum tailored to needs expressed at the national level.

Training programs and initiatives are geared to local requirements while adhering to the high quality teaching standards embodied in Veolia's training policy.





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Example of topical on-line Master of Engineering

M. Eng.

in

**Innovation Sustainability and
Entrepreneurship (ISE)**



s ses

**School of Sustainable
Engineered Systems**





Topical On-line Master of Engineering in Innovation, Sustainability and Entrepreneurship

Not **Discipline-based** (Chemical Engineering,
Environment Engineering, etc.)

Topic-based program (Transportation, water,
resilience, etc.)



Topical On-line Master of Engineering in Innovation, Sustainability and Entrepreneurship

The program is geared toward students and industry professionals, who are interested in the translation and transfer of technologically-promising research discoveries into sustainable technologies and processes. It offers a combination of business-oriented classes and engineering courses to help engineers bridge the gap between innovative ideas and sustainable economic development strategies.



Topical On-line Master of Engineering in ISE: Curriculum

Degree requirements for Materials for Sustainability & Innovation: 30 units of graduate coursework as follows:

- **12 units of coursework with a focus on business and management:**

ENTR/SIE 557* – Project Management (S)

ENGR/SIE 514* – Law for Engineers/Scientists (S)

ENGR/SIE 567* – Financial Modeling for Innovation (F)

Choose one from the following courses:

SIE 515* – Technical Sales & Marketing (F&S)

SIE 522* – Engineering Decision Making Under Uncertainty (F)

- **18 units of coursework covering advanced materials and cutting-edge developments in materials science and engineering.**

12 units of required courses

MSE 550 – Materials Selection for the Environment (S)

MSE 596a* – Special Topics: Materials for Innovation (F)

MSE 551 - Integrated Computational Materials Science and Engineering (ICMSE) (F)

ENGR/MSE 502 - Research Proposal Preparation (with additional component on SBIR/STTR) (F)

6 units of signature foundational course work:

MSE 510 – Thermodynamic Characterization of Materials (F)

MSE 534* – Advanced Topics in Optical and Electronic Materials (S)

* offered online

* soon to be offered online

S = Spring, F = Fall



On-line Master of Engineering in ISE

Topics being considered:

1. Resilient Infrastructure
2. Water
3. Transportation
4. Advanced manufacturing
5. Etc.



Potential customers for a water-based M.Eng.

- Municipalities
- Water companies
- Companies supplying water treatment products
- Others...



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Example of transatlantic Graduate Education Program

Dual PhD Degree



University of Rennes (France)

Institut d'Electronique Microelectronique et
Nanotechnology, University of Lille (France)



Université
Lille1
Sciences et Technologies



UA-CNRS Laboratoire International Associe

MSE Department is developing strong international research and education programs, in particular at the University of Rennes (France), Institut d'Electronique Microelectronique et Nanotechnology, University of Lille (France)

Mile Stones:

- Established a CNRS International Associated Laboratory (P. Lucas, Director): MATEO "Materiaux et Optique" (Materials and Optics)
- LIA in its second 3 year renewed period



A CNRS (Centre National de la Recherche Scientifique) delegation led by its president, Mr. **Alain Fuchs**, visited Tucson (Arizona) from September 8 to 13, 2013.

<http://www.france-science.org/Official-visit-of-CNRS-delegation.html>





Example of International Dual PhD Degree Program

- Signed an International Memorandum of Agreement with partner Universities
- Created a joint PhD program allowing students to alternate class and research between UA and partner institution and to obtain a double PhD Diploma



Graduate students from the dual PhD program in Materials Science

Five students have now graduated with a dual PhD degree,
A sixth one to be completed in Dec. 2014



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