1. This request is submitted by the Department of AEROSPACE ENGINEERING.

2. Course prefix, number and complete title of course: MEMA 619 Materials Modeling of phase Transformation and Microstructural Evolution

3. Course description (not to exceed 50 words): Computer modeling and simulation of microstructural evolution during various phase transformation processes in solid materials, including spinodal decomposition, ordering, martensitic transformation, ferroelectric and ferromagnetic domain evolution, dislocation dynamics, and crack propagation.

4. Prerequisite(s): Graduate Status and approval of instructor

Cross-listed with: AERO 619 and MSEN 619

Cross-listed courses require the signature of both department heads.

5. Is this a variable credit course? ☐ Yes ☐ No If yes, from ________ to ________

6. Is this a repeatable course? ☐ Yes ☐ No If yes, this course may be taken ________ times.

Will this course be repeated within the same semester? ☐ Yes ☐ No

7. Has this course been taught as a 489/689? ☐ Yes ☐ No If yes, how many times? 1

Indicate the number of students enrolled for each academic period it was taught. 2, pending 09A

8. This course will:

a. required for students enrolled in the following degree program(s) (e.g., B.A. in history)
N/A

b. an elective for students enrolled in the following degree program(s) (e.g., M.S., Ph.D. in geography)
MS, MEN, PhD in Aerospace Engineering and related fields

9. If other departments are teaching or are responsible for related subject matter, the course must be coordinated with these departments. Attach approval letters.

10. Prefix Course # Title (excluding punctuation)

<table>
<thead>
<tr>
<th>MEMA</th>
<th>619</th>
<th>MATL</th>
<th>MODEL</th>
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Approval recommended by: Level 6

Head of Department Date

Chair, College Review Committee Date

Head of Department (if cross-listed course) Date

Dean of College Date

Submitted to Coordinating Board by:

Dean of College Date

Associate Director, Curricular Services Date

Effective Date

Questions regarding this form should be directed to Sandra Williams at 845-8201.
Curricular Services – 11/07
Texas A&M University
Departmental Request for a New Course
Undergraduate • Graduate • Professional
• Submit original form and attach a course syllabus.

1. This request is submitted by the Department of AEROSPACE ENGINEERING
   AEROMEMAMSEN 619 Materials Modeling of Phase Transformation and Microstructural Evolution

2. Course prefix, number and complete title of course:
   AEROMEMAMSEN 619 Materials Modeling of Phase Transformation and Microstructural Evolution

3. Course description (not to exceed 50 words):
   Computer modeling and simulation of microstructural evolution during various physical processes in solid materials, including spinodal decomposition, ordering, martensitic transformation, ferroelectric and ferromagnetic domain evolution, dislocation dynamics, and crack propagation.

4. Prerequisite(s):
   Graduate Status and approval of instructor

   Cross-listed with: AERO 619 and MSEN 619

   Cross-listed courses require the signature of both department heads.

5. Is this a variable credit course? □ Yes □ No
   If yes, from _________ to _________

6. Is this a repeatable course? □ Yes □ No
   If yes, this course may be taken _________ times.
   Will this course be repeated within the same semester? □ Yes □ No

7. Has this course been taught as 489/689?
   □ Yes □ No
   If yes, how many times? _____
   Indicate the number of students enrolled for each academic period it was taught. _____

8. This course will be:
   a. required for students enrolled in the following degree programs(s) (e.g., B.A. in history)
      N/A
   b. an elective for students enrolled in the following degree program(s) (e.g., M.S., Ph.D. in geography)
      MS, MENG, PHD in Aerospace Engineering, Mechanical Engineering, Materials Science and Engineering, and related fields

9. If other departments are teaching or are responsible for related subject matter, the course must be coordinated with these departments.
   Attach approval letters.

10. Prefix Course # Title (excluding punctuation)

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Approval recommended by:

Head of Department: N/A
Date: 10/2/08

Chair, College Review Committee: N/A
Date: 10/2/08

Dean of College: N/A
Date: 11/6/08

Submitted to Coordinating Board by:

Associate Director, Curricular Services

Questions regarding this form should be directed to Sandra Williams at 845-8201.
Curricular Services – 11/07
SYLLABUS

AEROSPACE ENGINEERING
AERO/MEMA/MSEN 619 – Materials Modeling of Phase Transformation and Microstructural Evolution
Spring 2009
Day/Time/Place: TBA

Course Description and Prerequisites

The course covers computer modeling and simulation of microstructural evolution during various phase transformation processes in solid materials, including spinodal decomposition, ordering, martensitic transformation, ferroelectric and ferromagnetic domain evolution, dislocation dynamics, and crack propagation. The course also briefly reviews relevant applied mathematics (analytical and numerical), mathematical definitions of materials science concepts, and mathematical formulation of materials science principles. Students will receive broad multidisciplinary training in materials theory, modeling and simulation, practice basic programming skills based on the distributed template programs, perform assigned projects with topics customized to meet their individual research interests, and present their results to the class.

Prerequisites: Graduate Status and approval of instructor

Learning Objectives

Understand various phase transformations in crystalline solids
Understand thermodynamics and kinetics of microstructure evolution
Understand mathematical approach to description of various microstructure processes
Practice basic programming skills
Perform simulations and analyze the results
Exposure to state-of-the-art research in the relevant fields

Instructor Information

Name: Yongmei Jin
Telephone number: (979) 862-2427
Email address: jin@aero.tamu.edu
Office hours: TBA
Office location: 743B H. R. Bright Building (HRBB)
TA name: TBA

Textbook and/or Resource Materials

None
Recommended references
Grading Policies

Course Topics, Calendar of Activities, Assignments, Test Dates

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Topic</th>
<th>Required Reading</th>
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<tbody>
<tr>
<td>1-3</td>
<td><strong>Mathematical Methods</strong></td>
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<tr>
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<td>Tensor Algebra, Variational Calculus, Numerical Methods</td>
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<td><strong>Crystallography</strong></td>
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<td>Crystal Lattice, Lattice Rearrangement, Coherent Interface</td>
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<td>5-6</td>
<td><strong>Density Field and Microstructure</strong></td>
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<td>Concentration, Polarization, Magnetization, Long-Range Order Parameter,</td>
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<td>Conserved Field, Non-Conserved Field, Microstructures</td>
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<td>7-8</td>
<td><strong>Thermodynamic Potential</strong></td>
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<td>Bulk Free Energy, Landau-Type Polynomial Potential, Non-Convexity of</td>
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<td>Thermodynamic Potential, Stability (Metastability, Instability), Phase</td>
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<td>Transitions</td>
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<td><strong>Interface and Gradient Thermodynamics</strong></td>
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<td>Phase Boundary, Domain Wall, Twin Boundary, Grain Boundary, Free</td>
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<td>Surface, Interfacial Energy</td>
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<td>10-15</td>
<td><strong>Long-Range Interaction Energy</strong></td>
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<td>Microelasticity, Electrostatics, Magnetostatics, Configuration-Dependent</td>
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<td>Energy, Domain Self-Assembling</td>
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<td>16-18</td>
<td><strong>Kinetic Equation</strong></td>
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<td>Cahn-Hilliard Equation of Non-Linear Diffusion, Ginzburg-Landau</td>
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<td>(Allen-Cahn) Equation for Structural Relaxation, Landau-Lifshitz-Gilbert</td>
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<td>Equation for Magnetodynamics</td>
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<td><strong>Decomposition</strong></td>
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<td><strong>Ordering</strong></td>
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<td>22-23</td>
<td><strong>Martensitic Transformation</strong></td>
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<td>24-25</td>
<td><strong>Ferroelectric and Ferromagnetic Domain Evolution</strong></td>
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<td>26-28</td>
<td><strong>Crystal Defects: Dislocations and Cracks</strong></td>
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<td><strong>Multi-Physics and Multi-Scale Modeling</strong></td>
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<td>Linking Microstructure Evolution to Continuum Constitutive Model and</td>
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<td>Atomistic Computation</td>
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Other Pertinent Course information

Students are expected to attend class.

**Americans with Disabilities Act (ADA) Policy Statement**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodations of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

**Academic Integrity Statement and Policy**

For additional information, please visit: http://www.tamu.edu/aggiehonor

"An Aggie does not lie, cheat, or steal, or tolerate those who do."

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