
Course: Advanced Materials Processing

Instructor: Dr. Radhika Barua
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Meeting times: M,W (4:30-5:45 pm)

Format: Online-synchronous (ROND)

Instructor Office Hours: T, F (4:30-5:30 pm)
Or by appointment

Meeting Link: https://vcu.zoom.us/j/2503750974

Reference Books (not mandatory):

- Poirier, D. R., and G. H. Geiger. *Transport Phenomena in Materials Processing*. John Wiley and Sons Ltd, 1998.
- Lorraine F. Francis, Materials Processing, Academic Press, 2015
- Flemings, Merton C. *Solidification Processing*. McGraw-Hill College, 1974.

Course Description

Materials processing is a critical component of the field of Materials Science & Engineering. How a material is shaped into its final form has great importance to a material's structure (i.e., crystallographic structure, phases, microstructure) and, therefore, to its properties & performance. It also plays a critical role in determining the cost of the final product and is central to materials selection and design.

To this end, students in this course will be introduced to crucial heat transfer, chemical diffusion, and fluid flow principles involved in the processing of metals, ceramics, and polymers, from starting raw materials through to the final functional forms. The unified approach will be based on the state of matter most central to the shaping of the material: melt, solid, powder, dispersion/solution, and vapor. Case studies of both conventional and newer additive manufacturing methods will provide students with an overview of the processing technologies that they will likely encounter in their careers.

Attendance and Class Policy

Attendance at all lectures is recommended. Notebooks and calculators should be brought to each class. Please turn off your cell phones

Grading Policy

Homework	5 problem sets are planned, each with about 1.5 weeks between a distribution and due date. These will likely be more mathematical than conceptual.	60 %
Project	Students will write a 4-page report and compile a power-point presentation (10 slides minimum) based on an in-depth case-study focused on a materials processing method not discussed in class.	20 %
Quiz	There will be two quizzes focused on fundamental concepts, which will take place in real-time online.	20 %

Course Calendar

(Please treat this as a general guideline. You may expect small changes to it)

Lecture	*Topics*	*Key Activities*
Week 1	Introduction to Materials Processing: Definitions, scope, and approach Overview of Processing Steps using Metals, Ceramics & Polymers.	
Week 2	Melt Processes: • Melt Rheology and Flow Fundamentals • Heat Transfer Fundamentals & Solidification	• *Homework 1 distributed*
Week 3	Case-study on select Melt Processes: • Shape casting • Extrusion • Fused Deposition Modelling FDM	
Week 4	Solid Processes: • Deformation and Plastic Flow under tension & stress • Effects of temperature, strain rate and friction on deformation	• *Homework 1 due* • *Homework 2 distributed*
Week 5	Case-study on select Solid Processes: • Wire drawing • Forging; • Thermoforming	
Week 6	Open day for schedule adjustment, followed by Quiz 1	• *Homework 2 due*
Week 7	Powder Processes: • Powder characteristics & flow • Sintering & microstructure development during densification	• *Homework 3 distributed*
Week 8	Case-study on select Powder Processes: • Uniaxial and isostatic pressing • Selective Laser Sintering (SLS) • Post-processing of green bodies	
Week 9	Dispersion & Solution Processes: • Rheology of Colloidal Dispersions/Polymer Solutions • Characteristics of volatile liquids for dispersions/solutions	• *Homework 3 due* • *Homework 4 distributed*
Week 10	Case-study on select Dispersion & Solution Processes: • Shape casting; • Spin coating; • Inkjet printing with liquid monomers	
Week 11	Vapor Processes: • Kinetic theory of gases in the context of vapor processes • Thin films and epitaxial growth	• *Homework 4 due* • *Homework 5 distributed*
Week 12	Case-study on select Vapor Processes: • Sputtering • Chemical vapor deposition • Post-processing of thin films	
Week 13	Open day for schedule adjustment, followed by Quiz 2	*Homework 5 due*
Week 14	Project Presentations	Project Report due

Grading Rubric

Final grades will be assigned based on your overall final score on a scale of 0 to 100 points as follows:

A	> 90
B	80 to 89
C	70 to 79
D	60 to 69
F	< 59.9

Academic Integrity Policy

The VCU Honor System policy describes the responsibilities of students, faculty, and administration in upholding academic integrity while at the same time respecting the rights of individuals to the due process offered by administrative hearings and appeals. According to this policy, "Members of the academic community are required to conduct themselves following the highest standards of academic honesty, ethics and integrity at all times." In addition, to support a commitment to the Honor System, all members of the VCU community are required to:

- Adhere to the Honor System policy and its procedures;
- Report any suspicion or knowledge of possible violations of the Honor System;
- Answer truthfully when called upon to do so regarding Honor System matters;
- Maintain appropriate confidentiality regarding related to Honor System matters.