3.044 ABET Statements

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1 Subject objectives and outcomes

Objectives

1. Teach understanding of structure formation via several classes of phase transformations.

   Outcomes On completion, students should understand:

   (a) Heat conduction as a facilitator and limitation for inducing or avoiding solid-solid phase transformations.

   (b) Structure formation during solidification from a liquid, including freezing and precipitation reactions.

   (c) Structure changes during deformation of a solid polymer or metal.

   (d) Relationship between process parameters and structure in various vapor phase processes.

2. Develop an appreciation for the role of cost in materials choice and processing decisions, and its relationship with process scale.

   Outcomes On completion, students should:

   (a) Understand the various factors involved in the cost of producing a material, and how they scale with production volume.

   (b) Be able to estimate cost for simple processes given the input costs.

   (c) Appreciate the tradeoffs between cost and quality when there are multiple methods for producing a given part/material.

3. Give students an understanding of conservation laws and constitutive equations as they apply to convective and diffusive (or viscous) transport of mass, heat and momentum.

   Outcomes On completion, students should be able to:

   (a) Use microscopic species/heat/mass/momentum balances to derive steady and unsteady differential equations for diffusion, heat conduction and fluid flow.

   (b) Use macroscopic balances to obtain simple solutions to larger-scale problems such as design of continuous flow reactors.

   (c) Have a qualitative understanding of turbulent flow phenomena.

4. Teach solution of simple 1-D diffusion, heat conduction or fluid flow problems using the transport equations.

   Outcomes

   (a) Calculate heat flux in mixed convective/conductive heat transfer limited situations, such as furnace walls.

(b) Use simple 1-D unsteady (thermal) diffusion equation solutions, *e.g.* Gaussian, error function, to solve heat conduction problems.
(c) Understand the relationship between timescale to reach steady-state, size, and (thermal/momentum) diffusivity.
(d) Use momentum conservation to solve 1-D (Cartesian or cylindrical) steady-state fully-developed laminar flow problems.
(e) Understand the relationship between flow velocity and drag force for several flow geometries.

5. Develop the technique of dimensional analysis of problems, and illustrate its importance.

   Outcomes

   (a) Use dimensionless numbers throughout the course to condense transport behavior involving five or more parameters to simple expressions with just two or three parameters.
   (b) Apply graphs and correlations of dimensionless parameters to transport problems for which there are empirical correlations but no analytical solutions, such as drag force on a sphere moving relative to a fluid, or heat transfer through a turbulent natural convection boundary layer.
   (c) Understand the use of dimensionless numbers in physical modeling.

6. Teach students enough transport to be able to be conversant in the topic with chemical and mechanical (and other) engineers who spend more time learning these subjects and have access to more powerful tools, as students will likely work in multidisciplinary teams with such engineers throughout their careers.

   Outcomes

   (a) Understand the role of each of the terms in all of the transport equations presented in the subject, and how each affects the solution to a problem.
   (b) Use the finite difference technique with explicit timestepping to approximately solve 1-D unsteady heat conduction problems by means of a spreadsheet, and understand the relationship between the discretization and the stability and accuracy of the results.

2 Subject strategies

1. Lectures covering all of the phenomena listed above, with application to problems in materials processing and performance.
2. Weekly homework assignments in which students practice application of concepts learned in lecture to problems in materials processing and performance.
3. Connection between some lecture topics and projects in 3.042 to give context and tangible application to the material.
4. Test correction, in which students who have taken a mid-term test revisit their marked solutions during the subsequent recitation hour to correct mistakes and complete unfinished parts of the test.

3 Subject assessment methods

1. Portfolio analysis, based on the weekly homework assignments.
2. Testing, including two mid-term tests in mid March and late April, and a three-hour final exam during finals week. Each mid-term score is the weighted average of the in-lecture and corrected scores (see strategy 4 above). The final has closed-book and open-book components, the former focusing on qualitative understanding and the latter on quantitative problem solving.

3. Self assessment, in the forms of:
    - Index cards given out at each lecture on which students record the "muddiest" part of the lecture
    - Detailed subject evaluations in the middle and at the end of the semester.
4. Instructor's assessment, in the form of a memorandum assessing effectiveness in achieving the above objectives and outcomes, and making recommendations for changes to better achieve them.

4 Correlation Matrix

Objectives

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2. Develop an appreciation for the role of cost in materials choice and processing decisions, and its relationship with process scale.
3. Give students an understanding of conservation laws and constitutive equations as they apply to convective and diffusive (or viscous) transport of mass, heat and momentum.
4. Teach solution of simple 1-D diffusion, heat conduction or fluid flow problems using the transport equations.
5. Develop the technique of dimensional analysis of problems, and illustrate its importance.
6. Teach students enough transport to be able to be conversant in the topic with chemical and mechanical (and other) engineers who spend more time learning these subjects and have access to more powerful tools, as students will likely work in multidisciplinary teams with such engineers throughout their careers.

ABET criteria

a. Ability to apply knowledge of mathematics, science, and engineering

b. Ability to design and conduct experiments, as well as to analyze and interpret data

c. Ability to design a system, component or process to meet desired needs

d. Ability to function on multi-disciplinary teams

e. Ability to identify, formulate, and solve engineering problems

f. Understanding of professional and ethical responsibility

g. Ability to communicate effectively

h. The broad education necessary to understand the impact of engineering solutions in a global and societal context

i. recognition of the need for, and an ability to engage in life-long learning

j. Knowledge of contemporary issues

k. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

ABET criterion	a	b	c	d	e	f	g	h	i	j	k
Objective 1	H		H		H			M		M	H
Objective 2	M		H	M	H	M		H		H	H
Objective 3	H		H		H			M		M	H
Objective 4	H		H		H						H
Objective 5	H		H		H						H
Objective 6	M		M	M	M			M	M	M	H

Table 1: 3.185 Correlation Matrix