AME 515: Advanced Heat and Mass

Units: 3

Term—Day—Time: Fall 2021 – T/TH 9-10:50AM

Location: OHE100C

Instructor: Ramtin Sheikhhassani

Office: OHE 500J

Office Hours: 11AM-12:30 PM T/TH

Contact Info: sheikhha@usc.edu

Teaching Assistant: None

Office:

Office Hours:

Contact Info:

Course Description

The main theme of the course is for the students to learn the analytical techniques for solving heat and mass diffusion problems in various geometries. The application is intended for heat transfer in solids and mass diffusion in porous materials such as biological tissues. Specifically, the following topics will be included:

1. Fundamentals: Physics of heat and mass transfer.
2. One-dimensional problems.
3. Separation of variables.
4. Problems in cylindrical geometry.
5. Heat conduction and mass is spherical coordinates.
6. Laplace transform methods.
7. Integral transform techniques.
8. Special topics.

Catalogue Description**:** Review of analytical methods in heat conduction and mass diffusion; anisotropic and composite media; porous quiescent fluid media; numerical computation of series solutions.

Learning Objectives

At the end of the course, students will have acquired the skills to obtain analytical solutions to differential equations pertaining to heat and mass diffusion. They will understand the modeling aspects of transport through solid and biporous media.

Prerequisite(s): AME 526
Co-Requisite(s): AME 525
Concurrent Enrollment: None
Recommended Preparation: Undergraduate degree in AE, ME, CE, ChE

Course Notes

Grading Type: Letter Grade.
The course will be available on DEN (Distance Education Network)

Technological Proficiency and Hardware/Software Required

Matlab proficiency.

Required Readings and Supplementary Materials

Recommended Textbook (not required): Heat Conduction
by M.N. Ozisik
John Wiley & Sons
ISBN: 0-471-05481-X

Other Recommended Reading
Mathematics of Diffusion
By J. Crank
Oxford University Press;
ISBN: 0198534116

Description and Assessment of Assignments

Weekly assignment of homework problems to be turned in and one term project might be assigned.

Grading Breakdown

Including the above detailed assignments, how will students be graded overall? Participation should be no more than 15%, unless justified for a higher amount. All must total 100%.

Grading Scheme:	Homework …….. Mid-Term Examination (7th week) ……..…… Final Examination (as per the schedule of classes) …….	20% 35% 45%

Assignment Rubrics

Each assignment will be weighted in the basis of how long it is.

Assignment Submission Policy

Assignment are to be submitted via Gradescope.

Grading Timeline

Usually one week after turning in.

Additional Policies

- Final grade will depend entirely on the performance on the above components, and will be independent of the financial support requirements (e.g., minimum grade requirement for tuition reimbursement).
- Work-related travel should be scheduled during time periods outside of the mid-term and final exams. Accommodation to take exams on different dates will be made only for family emergencies and documented illness or health-related emergencies. Other exceptions will be considered on a case-by-case basis.

Course Schedule: A Weekly Breakdown

Week	TOPICS	Homework
1	FUNDAMENTALS 1.1 Derivation of the heat equation and the mass diffusion equation 1.2 Fick's law; temperature and concentration as a driving potential 1.3 Diffusion problems in solids, liquids, and porous media 1.4 Boundary conditions	To be assigned by instructor
2	ONE-DIMENSIONAL PROBLEMS 2.1 Infinite and finite media situations. Similarity solutions.	To be assigned by instructor
3	SEPARATION OF VARIABLES 3.1 Product solutions of two- and three-dimensional problems	To be assigned by instructor
4	3.2 Problems with heat generation and solute production 3.3 Eigenfunction expansions in the rectangular coordinate systems	To be assigned by instructor
5	PROBLEMS IN CYLINDRICAL GEOMETRY 4.1 Fourier-Bessel series for temperature and concentration. 4.2 Problems with sources	To be assigned by instructor
6	4.3 Product solutions. Application to cartesian and cylindrical geometries for homogeneous boundary conditions.	To be assigned by instructor
7	DIFFUSION IN REGIONS BOUNDED BY SPHERES 5.1 Legendre and spherical Bessel function series	To be assigned by instructor
	Mid-Term Examination	
8	5.2 Fully-three dimensional unsteady problems for spheres and spherical cavities. 5.3 Application to drops, bubbles and particles: condensation, evaporation; dissolution of gas bubbles.	To be assigned by instructor
9	NUMERICAL EVALUATION OF SERIES SOLUTIONS 6.1 Fourier, Legendre and Bessel Series summation, error analysis.	To be assigned by instructor
10	6.2 Stability and convergence of solutions	To be assigned by instructor
11	COMPOSITE MEDIA AND CONTACT RESISTANCE PROBLEMS 7.1 Heat conduction in laminated composites.	To be assigned by instructor
12	7.2 Averaged thermal properties for laminates and spherical dispersions.	To be assigned by instructor
13	7.3 Thermal modeling of nominally flat partially contacting solid surfaces 7.4 Modeling of fluid permeation through porous membranes	To be assigned by instructor
14	MASS DIFFUSION IN POROUS AND BIOPOROUS MEDIA 8.1 Modeling of porous media as diffusive transport (Darcy's law). Pressure as a driving potential	To be assigned by instructor
15	8.2 Percolation and diffusion of liquids and gases. 8.3 Targeted drug delivery	To be assigned by instructor
	FINAL EXAMINATION (Date as per schedule of classes)	

Statement on Academic Conduct and Support Systems

Academic Conduct:
Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-

part-b/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:

Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. https://engemannshc.usc.edu/rsvp/

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. http://dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. https://diversity.usc.edu/

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, http://emergency.usc.edu

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.
Provides overall safety to USC community. http://dps.usc.edu