MEEN 4315/5315 – Nanoscale Energy Transport (Spring 2026)

Instructor: Dr. Richard Zhang (zihao.zhang@unt.edu) **Office:** Discovery Park F115V

Time & place: Tuesdays & Thursdays 2:30 PM – 3:50 PM @ Discovery Park D212

Office hours: Tuesdays & Thursdays 1:30 PM – 2:30 PM @ Discovery Park F115V

Course description: Nano/microscopic concepts and methodology in thermal science, including quantum mechanical statistical thermodynamics, Boltzmann transport equation, and nano-microscale heat conduction and radiation phenomena, with applications in modern technologies.

Required textbook: Zhuomin Zhang, *Nano/Microscale Heat Transfer*, 2nd Edition, Springer, 2020. ISBN: 978-3-030-45038-0
Optional Reference: Gang Chen, *Nanoscale Energy Transport and Conversion,* Oxford, 2005.

Pre-requisites: Heat transfer (MEEN 3210), thermodynamics (MEEN 3110), fluid dynamics (MEEN 3120), and differential equations (MATH 3410), or equivalent.

Topics/Chapters covered and lecture schedule:

- Weeks 1-2 (Ch. 1, 2): Review of macroscopic transport theory; introduction to microscale phenomena and nanoscience and nanotechnology
- Weeks 3-5 (Ch. 3): Statistical mechanics and equilibrium distributions, quantum statistics, specific heat of ideal gases
- Weeks 6-7 (Ch. 4): Basic kinetic theory and transport properties of ideal gases; microfluidics and microscale convection heat transfer
- Week 8 (Ch. 5): Properties of solids: specific heat and quantum size effect, thermal conductivity of solids; *Term research paper topics assigned*
- Weeks 10-12 (Ch. 5, 6): Understanding solids and crystal band structures; thermal conductivity of thin films; boundary scattering; thermoelectricity
- Weeks 13-14 (Ch. 8, 9): Fundamental mechanisms of radiative heat transfer
- Week 15 (Ch. 7, 10): Nanoscale heat conduction concepts; nonequilibrium ultrafast laser heating; Boltzmann transport equation methods; nanoscale thermal radiation concepts
- Week 16: Term research paper presentations (10 minutes each, in-class peer-evaluated)

Homework: 7 problem set assignments (collaboration is encouraged, but do not copy each other's assignments) due on Canvas at 11:59 p.m. every other Friday.

Exams: Individual in-class midterms on February 26 (Thursday) and April 16 (Thursday). No teamwork and sharing. Open notes, open book, but no phones. You may use a computer to read materials or perform calculations, though a basic calculator is sufficient.

Term Paper: An individually developed term research paper (up to 10 pages formatted, with reference bibliography) due on Canvas 11:59 p.m. May 1 (Friday).

Grading: Homework: 30%, midterms (2×): 20%, and term paper with presentation: 30%.

Academic dishonesty: There is a zero-tolerance policy. Cheating including and not limited to copying, plagiarism, unauthorized sharing, etc. will result in an automatic failure in this course and the matter will be reported to the department and/or institutional disciplinary committee.