Syllabus for the Mechanical Engineering PhD Qualifying Exam in Heat Transfer

Revised: 3/4/2026

I)   The exam will test students' undergraduate-level knowledge (as covered, for example, in MEGR 3116) of the thermal science and heat transfer topics listed below.

II)   The Heat Transfer PhD Qualifying Exam is open book: Students are allowed to bring with them and use a hard copy of *Fundamentals of Heat and Mass Transfer*, any edition, by F. P. Incropera and D. P. DeWitt. Note: Students won't be allowed use of any other text.

Exam Topics:

1) Thermal conduction
   a) Fourier's law;
   b) unsteady conduction in one dimension;
   c) the lumped capacitance method for transient conduction;
   d) one-dimensional, steady state conduction in constant- extended bodies and fins;
   e) use of Heisler charts for solving 1-D, transient conduction in plates, cylinders and spheres.
   f) Numerical methods for transient and steady-state conduction

2) Thermal convection
   a) forced (external) convection over flat plates, cylinders, and tube banks;
   b) ;
   c) analysis and solution of internal convection problems involving constant surface heat flux or constant surface temperature;
   d) use of correlations for solving convective heat transfer problems:
      i)   in laminar, fully developed pipe flow;
      ii)   in the thermally developing entry region of laminar pipe flows;
      iii)   turbulent flow in circular pipes;
   e) be able to use correlations to solve problems under 2a), 2b) and 2c) above.
3) Thermal radiation

a) Understand and be able to apply fundamental concepts involving radiation at a single surface, including:
- i) radiation intensity and its relation to emission, irradiation and radiosity;
- ii) black body radiation, including Planck's distribution and the Stefan-Boltzmann law;
- iii) surface radiation processes and properties, including:
  - Iiia) absorption and absorptivity;
  - Iiib) reflection and reflectivity;
  - Iiic) transmission and transmissivity;
- iv) radiation involving gray surfaces;

b) Be able to analyze radiation problems involving two or more surfaces:
- i) using view factors;
- ii) using the radiosity method and the associated electrical circuit analogy.

Suggested References:

1) *Fundamentals of Heat and Mass Transfer*, any edition, F. P. Incropera and D. P. DeWitt.
2) *Schaum's Outline of Heat Transfer*, any edition.
3) *Principles of Heat Transfer*, any edition, F. Kreith.