PME6650: Radiative Heat Transfer (in English)

Fall 2016

Department of Power Mechanical Engineering, National Tsing Hua University

一、課程說明 (Course Description)

1. Enhance understanding of radiative transfer and its relevance to industrial and societal problems
2. Discuss basic and advanced concepts of radiative transfer and to review some fundamental experimental facts
3. Increase analytical skills and ability to examine critically and cope with complex engineering problems
4. Formulate practical engineering problems of contemporary interest involving radiative transfer
5. Provide experience in treating multiple mode (i.e., combined convection, conduction, and radiation) heat transfer problems in which radiation plays an important role

二、預修課程（Prerequisite）

Undergraduate course on Heat Transfer

三、指定用書(Text Books)

1. F. P. Incropera, D. P. Dewitt, T. L. Bergman, and A. S. Lavince, Principles of Heat and Mass Transfer, 7th ed., John Wiley& Sons, Inc., 2013.
2. M. F. Modest, *Radiative Heat Transfer*, 3rd ed., Academic Press, 2013.

四、參考書籍(References)

1. J. R. Howell, M. P. Menguc, and R. Siegel, *Thermal Radiation Heat Transfer*, 5th ed., CRC Press, 2011.

五、教學方式(Teaching Method)

Lectures and hands-on projects

六、教學進度(Syllabus)

1. Introduction to thermal radiation
2. Radiative properties of surfaces
3. Radiative exchange between surfaces
4. Radiative transfer in participating media
5. Solution techniques for RTE
6. Radiative properties of participating media
7. Combined mode heat transfer

七、成績考核(Evaluation)

Class participation:	10	
Exams:	50	(25 points for each exam)
Term project:	40	(5 points will be deducted for those present NOT in English)

Each student is expected to attend class on time with strong interests in learning. You will lose points by skipping class while gain points by asking good questions or initiating discussion. Because this class is expected to be taught in English, students are expected to participate in English as well.

Exams:

There will be one mid-term and a final exam. See the tentative schedule for examination dates. Please see the instructor immediately if a conflict arises. All exams will be **OPEN BOOK ONLY**. You can bring English textbooks and other English books as you wish. Conversely, lecture notes, Chinese textbook, and materials not in the book form are not permitted at all. You will need a calculator for both exams.

Term project:

Every student is asked to do a term project independently by the end of semester. The term project includes an oral presentation, a written report, and hands-on results (artworks). An A4 page of abstract is ought to be delivered in the middle of semester for instructor's review. The presentation and PPT file must be in English because the official language of course is English. 5 points will be deducted for students who either present not in English or use non-English PPT file. All topics related to radiative heat transfer are welcomed. The presentation will be held at the end of the semester and each presentation will take around 15 minutes with 3 minutes Q&A. The presentation will be graded based on following items: the fitness of title and length of presentation, the organization and fluency, clarity of figures and tables, completeness of contents, and time management as well as gestures.

The hands-on results can be anything original, such as a software program, animation files, photos, painting, toys, devices, elements, simulation, engineering analysis, etc. These hands-on results are teaching aids, which assist audiences understanding the repot. The size of real subject should be smaller than the volume of $50 \times 50 \times 50$ cm^3. Results will be graded on items as follows: the innovation, design and analysis, relevance to the report, manipulation easiness, and beauty. If similar results were referred, your contributions and advancements from prior works should be clearly specified. The results cannot be a figure or figures, immature paintings, or animations obtained from websites or elsewhere. If any real sample or devices is going to be fabricated, no more than NTD 2,000 can be provided for purchasing raw materials. But appropriate receipts are necessary.

Project deliverables include terms in the following:
– Abstract and revised one
– Progress briefs
– Classroom presentation
– Written report at the end of semester
– Hands-on result

For the report, the page limit and format are not restricted if the instructor can appreciate your works. However, you may want to refer a conference or journal template to make the report look professional. Contents should include review of the literature/state-of-the-art in the field. One should formulate the problem (state the problem, make and justify assumptions/idealizations, formulate governing equations, approach for evaluation of radiative properties, and boundary conditions. The report also needs to identify/describe a suitable solution technique and obtain representative results (only if time permits). Moreover, it is expected to propose experiments for theory validation, including design of experimental setup and discussion of anticipated difficulties in performing experiments and/or interpreting results.

Tentative topics for the project are listed below:
– Radiative Heating in Hyperthermic Tissue Treatment
– Radiation Absorption and Scattering in Photocatalysis
– Radiation-Conduction Heat Transfer in Glass Foams
– Radiative Heating in Fiber Glass Manufacturing
– Radiative Heat Transfer in Laser-Jet CVD
– Thermal Protection of Mars Rover using Aerogels

Academic Honesty:

Academic integrity and honesty is essential to achieve high-quality education and to keep the prestige of the institution. We will not tolerate any academic misconduct, such as cheating. Cheating includes, but is not limited to: copying directly from unauthorized source, such as friends, classmates or a solutions manual; allowing another person to copy your work; signing another person's assignment or having another person finish your own work; taking a test or quiz in someone else's name, or having someone else take a test or quiz in your name; or asking for regrade of a paper that has been altered from its original form.

八、可連結之網頁位址 (Website for course materials)

國立清華大學數位學習平台 http://moodle.nthu.edu.tw/

九、暫定時間表(Tentative schedule)

No	Date	Topic covered	Due
–	09/15	**National holiday**	
1	09/22	Syllabus; Introduction to thermal radiation	
2	09/29	Governing equations for radiative heat transfer	
3	10/06	Radiative properties of surfaces	
4	10/13	Radiative exchange between surfaces	1st Abstract
5	10/20	Radiative transfer in non-participating media	2nd Abstract
6	10/27	Solution techniques for RTE	
7	11/03	Radiative properties of participating media	
8	11/10	Combined mode heat transfer	Progress brief (I)
*	11/17		**Mid-term exam**
9	11/24	The Monte Carlo method for surface exchange	

10	12/01	Other methods for surface exchange	
11	12/08	Radiative properties of molecular gases	
12	12/15	Radiative properties of semi-transparent media (I)	Progress brief (II)
13	12/22	Radiative properties of semi-transparent media (II)	
14	12/29	Approximation methods for thermal radiation	
*	01/05	**Demonstration of term project (1/2)**	
*	01/12	**Demonstration of term project (2/2)**	**Final exam**

* You need to come to our classroom unless the task due is finished or given up.
– You do not need to come to our classroom.
The deadline for withdrawing class is November 28

十、專題範例 (Example for term project)

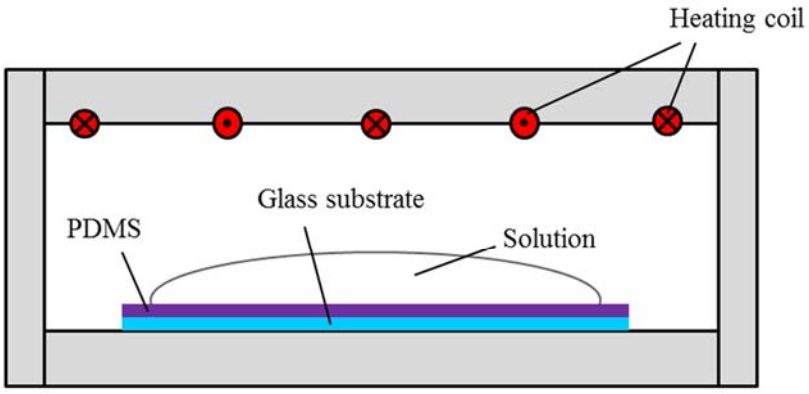

Figure 1 Heating solution using thermal radiation to generate temperature non-uniformity for remedying coffee-ring effects.

十一、教師及助教聯絡方式 (Contact information of the instructor and teaching assistant)

Instructor: Dr. Yu-Bin Chen (陳玉彬 博士)
Professor, Department of Power Mechanical Engineering, NTHU
Engineering I Building, Room 512 (工一館 512 室)
Tel. (03)571-5131#33767; ybchen@pme.nthu.edu.tw

Grader: TBD

Office hours: Monday 19:10 - 21:00 or by appointment with the instructor

Class time: Thursday 9:10 – 12:00

Classroom: Engineering I Building, Room 201 (工一館 201 室)