NANYANG TECHNOLOGICAL UNIVERSITY

Teaching, Learning and Pedagogy Division

Reg. No. 200604393R

COURSE OUTLINE

Academic Year	2017	**Semester**	S1 & S2
Course Coordinator	A/P Wong Teck Neng (Semester 1) A/P Leong Kai Choong (Semester 2)		
Course Code	MA3003		
Course Title	Heat Transfer		
Pre-requisites	MA2007 Thermodynamics		
No of AUs	3AU		
Contact Hours	Lecture (26 hrs), Tutorial (18 hrs)		
Proposal Date	6 Dec 2017		

Course Aims

This course aims to provide you with a good understanding of the fundamental concepts of heat transfer by conduction, convection, radiation and the analysis and design of heat exchangers. Applying the fundamental concepts, you will be able to formulate the appropriate heat transfer models to analyse and solve real-world physical or engineering problems.

Intended Learning Outcomes (ILO)

On completion of this course, you should be able to:

1. Formulate one-dimensional, steady-state and time-dependent heat conduction problems.
2. Develop analytical solutions for one-dimensional heat conduction and extended surfaces.
3. Apply the thermal resistance concept in heat transfer in solving steady-state, one-dimensional heat conduction problems.
4. Apply the lumped capacitance method to analyse transient heat conduction problems.
5. Apply velocity and temperature boundary layer to heat transfer problems involving flat plates and within the tube.
6. Apply convection correlations for forced and free convection heat transfer in internal and external flow configurations.
7. Perform thermal analysis and sizing of heat exchangers using the log-mean-temperature-difference and effectiveness approaches.
8. Analyse radiation exchange between black and multi-gray surfaces using the radiation network method.

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Course Content

	Topic	Hours
1.	Introduction to heat transfer. Heat transfer mechanism, Simultaneous heat transfer mechanisms.	2
2.	Heat conduction equation in Cartesian coordinates, cylindrical & spherical coordinates. Boundary & initial conditions, formulation of heat conduction problems.	2
3.	One dimensional steady state conduction across a plane wall & across radial systems. Conduction with heat generation: plane wall, solid cylinder.	2
4.	Heat transfer from extended surfaces.	2
5.	Transient conduction: lumped capacitance method.	2
6.	Velocity and thermal boundary layers. Laminar and turbulent flow. The conservation equations. Dimensionless groups & their significance.	3
7.	External forced convection. Laminar & turbulent flow over a flat plate.	2
8.	Free convection	1
9.	Internal forced convection. Forced convection heat transfer in pipes.	3
10.	Heat exchanger analysis, logarithmic mean temperature difference. Effectiveness-NTU method.	3
11.	Blackbody radiation, View factors. Radiation exchange between multi-gray surfaces.	4

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Final Examination (2.5 hours, closed book)	1, 2, 3, 4, 5, 6, 7,8	EAB SLO Draft 2017* a, b, c	60%	Individual	
2. CA1: Quiz#1	1,2,3	EAB SLO Draft 2017* a, b, c	10%	Individual	
3. CA2: Quiz#2	1,2,3, 4, 5,6	EAB SLO Draft 2017* a, b, c	10%	Individual	
4. Assignment	1, 2, 3, 4, 5,6	EAB SLO Draft 2017* a, b, c, e, l	10%	Individual	
5. Attendance and class participation	1, 2, 3, 4, 5, 6, 7,8	EAB SLO Draft 2017* a, b, c, i, j, l	10%	Individual	
Total			100%		

* "EAB SLO Draft 2017" stands for the EAB Accreditation Manual Draft Version: Aug 2017

Formative feedback

- The outcome of the quiz will be discussed after the quiz to provide feedback and correct any mistakes/misapplication of concepts made by the class.
- You are encouraged to participate in class by presenting your approach to tutorial problems to the class. The Instructor is to comment on your solutions to assist your learning process and clarify any doubts. This also invites you to think about the subject matter critically.
- Open ended assignments are used as a yard stick to measure your progress and simulate the learning process.
- Feedback will be welcomed through the course, where you could write in to the lecturers for constructive suggestions.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	The lectures provide important background concepts, and include demonstrations and many worked examples to help you to achieve all learning outcomes 1) to 8).
Tutorials	
(a) Class participation	You are expected to attend and participate in every tutorial session. You should bring along their notebook computers or tablets (with projection accessories) and be prepared to share what you have done for each tutorial question. This helps you to achieve all Learning Outcomes 1) to 8).
(b) Assignment	You are expected to hand in two sets of hand-written homework assignments to your tutors. This helps you to achieve Learning Outcomes 1) to 8).

Reading and References

Textbook

Cengel, Y.A. and Ghajar, A.J., Heat and Mass Transfer: Fundamentals and Applications, 5th Edition (SI Units), McGraw Hill, 2015

Reference Textbook

1. Incropera, F.P., DeWitt, D.P., Bergmann, T.L., and Lavine, A.S., Fundamentals of Heat and Mass Transfer, 6th Edition, Wiley, 2007.
2. Mills, A.F. Basic Heat and Mass Transfer, 2nd Edition, Prentice-Hall, 1999.

Course Policies and Student Responsibilities

(1) General

You are expected to complete all assigned pre-class readings and activities, attend and participate in every tutorial session. You are expected to take responsibility to follow up with course materials, assignments and course related announcements. You are expected to submit assignments by the stipulated deadlines.

(2) Quizzes

Note that it is compulsory for you to take both quizzes for this course. In the case of absence due to medical reasons, you must arrange with the Course Coordinator for a make-up quiz not later than two weeks after that quiz, failing which you would be considered to be absent and given 0 mark for that component of the CA. The original medical certificate (MC) with the appropriate *Leave of Absence form* should be endorsed by respective tutor and submitted to the MAE Undergraduate Office with a scanned version emailed to the Course Coordinator and the tutor concerned.

***(3)* Attendance, Class Participation & Homework**

(i) You are expected to attend and participate in every tutorial session. You should bring along your notebook computers or tablets (with projection accessories) and be prepared to share what you have done for each tutorial question.

(ii) You are expected to hand in two sets of hand-written homework assignments to your tutors on informed dates by the stipulated deadlines. Late submissions may be penalised.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need

to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Dr Wong Teck Neng	N3-2c-100	67905587	mtnwong@ntu.edu.sg
Dr Leong Kai Choong	N3-02c-71	67905596	MKCLEONG@ntu.edu.sg
Dr Lee Seri	N3.2-02-44	6790 6940	SeriLee@ntu.edu.sg

Planned Weekly Schedule

Textbook: Çengel, Y.A. and Ghajar, A. *Heat and Mass Transfer: Fundamentals and Applications*, 5th Edition (SI Units), McGraw-Hill, 2015.

	Topic	Course LO	Readings/Activities
1.	Introduction to heat transfer. Heat transfer mechanism, Simultaneous heat transfer mechanisms.	Obtain a broad overview of the basic principles of heat transfer Specific ILO (1)	Chapter 1
2.	Heat conduction equation in Cartesian coordinates, cylindrical & spherical coordinates. Boundary & initial conditions, formulation of heat conduction problems.	Understand multi- dimensional and time depend of heat transfer Specific ILO (2,3)	Chapter 2
3.	One dimensional steady state conduction across a plane wall & across radial systems. Conduction with heat generation: plane wall, solid cylinder.	Understand the concept of thermal resistance and its limitations. Specific ILO (2,3)	Chapters 2 and 3
4.	Heat transfer from extended surfaces.	Analyze finned surface, and assess how efficiently and effective fins enhanced heat transfer Specific ILO (2)	Chapter 3
5.	Transient conduction: lumped capacitance method.	Understand the conditions which lumped system analysis applicable Specific ILO (4)	Chapter 4: Section 4-1
6.	Velocity and thermal boundary	Understand the physical mechanism of momentum and	Chapters 6

	layers. Laminar and turbulent flow. The conservation equations. Dimensionless groups & their significance.	heat transfer in convection. Specific ILO (5)	
7.	External forced convection. Laminar & turbulent flow over a flat plate.	Distinguish between laminar and turbulent flows, understand the various approach to evaluate the local and averaged convection coefficients. Specific ILO (5)	Chapter 7
8.	Free convection	Understand the physical mechanism of natural convection. Specific ILO (6)	Chapter 9
9	Internal Forced Convection. Forced convection heat transfer in pipes.	Analyze heating and cooling a fluid flowing in a tube under various thermal conditions. Specific ILO (5)	Chapter 8
10	Heat exchanger analysis, logarithmic mean temperature difference. Effectiveness-NTU method.	Perform thermal analysis and sizing of heat exchangers. Specific ILO (7)	Chapter 11
11	Blackbody radiation, View factors. Radiation exchange between multi-gray surfaces.	Determine radiation heat transfer between diffuse and gray surfaces. Specific ILO (8)	Chapters 12 and 13