



## Course Syllabus: Turbulent Combustion - ME 346

<b>Division</b>	Physical Science and Engineering Division
<b>Course Number</b>	ME 346
<b>Course Title</b>	Turbulent Combustion
<b>Academic Semester</b>	Spring
<b>Academic Year</b>	2018/2019
<b>Semester Start Date</b>	01/27/2019
<b>Semester End Date</b>	05/23/2019
<b>Class Schedule</b> (Days & Time)	10:30 AM - 12:00 PM   Mon Wed

Instructor(s)				
Name	Email	Phone	Office Location	Office Hours
Hong Geun Im	Hong.Im@KAUST.EDU.SA	+966128084726		Mon/Wed 1:00-2:00pm

Teaching Assistant(s)	
Name	Email
N/A	N/A

Course Information	
<b>Comprehensive Course Description</b>	This course offers advanced knowledge in fundamental characteristics of turbulent reacting flows encountered in many engineering applications. The course starts with reviews of background subjects – laminar flames, turbulent flows, conservation equations. Subsequently, phenomenological observations scaling laws pertaining to turbulent combustion characteristics will be discussed. More in-depth coverage of mathematical modeling framework will then be reviewed in premixed, nonpremixed, and partially premixed combustion systems. Experimental methods of turbulent combustion research will also be reviewed.
<b>Course Description from Program Guide</b>	Governing equations of reactive fluid flow. Review of fundamental concepts in turbulence. Non-premixed turbulent combustion. Conserved scalar modeling approach and turbulent non- premixed combustion models. Premixed turbulent combustion fundamentals and combustion regimes. Canonical models for premixed turbulent combustion. Partially premixed combustion. Scaling laws for lifted turbulent jet flames.
<b>Goals and Objectives</b>	<ul style="list-style-type: none"> <li>- Basic physical understanding of turbulent flows.</li> <li>- Basic physical understanding of combustion characteristics in turbulent reacting flows.</li> <li>- Mathematical, experimental, and theoretical approaches to understand turbulent combustion</li> <li>- Understanding turbulent combustion effects in practical systems</li> <li>- Practice literature review and identify original scientific/engineering research project.</li> </ul>
<b>Required Knowledge</b>	ME244 Combustion, ME307 Turbulence or equivalent.

<b>Reference Texts</b>	<p>Main Textbook:  Peters, N., Turbulent Combustion, Cambridge University Press, 2000 (eBook available).</p> <p>Additional References:</p> <p><i>Physical Concepts:</i>  Liñán, A., Williams, F.A., Fundamental Aspects of Combustion, Oxford University Press, 1993 (Out of print. Handouts will be given).  Law, C. K., Combustion Physics, Cambridge University Press, 2006 (printed copy available).  Pope, S. B., Turbulent Flows, Cambridge University Press, 2000 (printed copy available).</p> <p><i>Advanced Modeling:</i>  Echekki, T., Mastorakos, E., Turbulent Combustion Modeling: Advances, New Trends and Perspectives, Springer, 2011 (eBook available).  Poinsot, T., Veynante, D., Theoretical and Numerical Combustion, 2nd ed., Edwards, 2005 (printed copy available).  Swaminathan, N., Bray, K.N.C. (Ed), Turbulent Premixed Flames, Cambridge University Press, 2011.  Fox, R.O., Computational Models for Turbulent Reactive Flows, Cambridge University Press, 2003.</p>
<b>Method of evaluation</b>	<p><b>20.00%</b> - Written report  <b>20.00%</b> - Presentation  <b>20.00%</b> - Homework /Assignments  <b>20.00%</b> - Exam 2  <b>20.00%</b> - Exam 1</p>
<b>Nature of the assignments</b>	<ul style="list-style-type: none"> <li>- Homework problems based on the class materials.</li> <li>- Literature search to review the state of the art in turbulent combustion research</li> <li>- Research proposal - oral presentation and written report</li> <li>- Exam format: in-class, closed book (simple analysis and conceptual questions)</li> </ul>
<b>Course Policies</b>	<p>Homework/projects are expected to be submitted by 5pm on the due date. Late submissions are only allowed by advance notice at least by 24 hours. Acceptance of extension will be at instructor's discretion.</p>
<b>Additional Information</b>	

## Tentative Course Schedule

*(Time, topic/emphasis & resources)*

Week	Lectures	Topic
1	Mon 01/28/2019	Review of conservation equations.
1	Wed 01/30/2019	Review of conservation equations.
2	Mon 02/04/2019	Concept of low-Ma approximation.
2	Wed 02/06/2019	Concept of conserved scalars
3	Mon 02/11/2019	Statistical description of turbulence.
3	Wed 02/13/2019	Statistical description of turbulence.
4	Mon 02/18/2019	Modeling of nonreacting turbulent flows.
4	Wed 02/20/2019	Modeling of nonreacting turbulent flows.
5	Mon 02/25/2019	Turbulent premixed combustion: scales and regimes.
5	Wed 02/27/2019	Turbulent premixed combustion: scales and regimes.
6	Mon 03/04/2019	CCRC Conference on Future of Fuels
6	Wed 03/06/2019	CCRC Conference on Future of Fuels (with assignments).
7	Mon 03/11/2019	Review of laminar flame theory: flame stretch, instabilities.
7	Wed 03/13/2019	Review of laminar flame theory: flame stretch, instabilities.
8	Mon 03/18/2019	Turbulent burning velocities.
8	Wed 03/20/2019	Turbulent burning velocities.
9	Mon 03/25/2019	Spring Break
9	Wed 03/27/2019	Spring Break
10	Mon 04/01/2019	Turbulent premixed combustion modeling 1.
10	Wed 04/03/2019	Turbulent premixed combustion modeling 2.
11	Mon 04/08/2019	Experimental aspects of turbulent combustion.
11	Wed 04/10/2019	Experimental aspects of turbulent combustion.
12	Mon 04/15/2019	Turbulent premixed combustion modeling - new approaches 1.
12	Wed 04/17/2019	Turbulent premixed combustion modeling - new approaches 2.
13	Mon 04/22/2019	Review of laminar nonpremixed flame theory 1.
13	Wed 04/24/2019	Review of laminar nonpremixed flame theory 2.
14	Mon 04/29/2019	Review of laminar nonpremixed flame theory 3.
14	Wed 05/01/2019	Turbulent nonpremixed combustion modeling 1.
15	Mon 05/06/2019	Turbulent nonpremixed combustion modeling 2.
15	Wed 05/08/2019	Turbulent partially premixed combustion 1.
16	Mon 05/13/2019	Turbulent partially premixed combustion 2.
16	Wed 05/15/2019	Project presentation.
17	Mon 05/20/2019	Final Exam Week
17	Wed 05/22/2019	Final report submission.

### Note

The instructor reserves the right to make changes to this syllabus as necessary.