جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Advanced Combustion Theory - ME 340

Division	Physical Science and Engineering Division
Course Number	ME 340
Course Title	Advanced Combustion Theory
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Mon Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Hong Geun Im	Hong.Im@KAUST.EDU.SA	+966128084726		M/W 13:00-14:00

Teaching Assistant(s)

Name	Email
N/A	

Course Information

Comprehensive Course Description	The scope of the ME340 will be largely focused on physical aspects of fundamental laminar flame theory with application of numerical simulations. The course builds on ME244 Combustion which emphasizes on chemical aspects, and complements ME378 Experimental Combustion which focuses on experimental aspects of basic flames. The latter may be taken concurrently. The course will serve as a preparation for ME346 Turbulent Combustion. The topics covered include: conservation equations for reacting flows, transport properties, asymptotic analysis of one-dimensional flames, concept of conserved scalar and coupling function, ignition/extinction, aerodynamics of flames, flame instabilities, fundamental one-dimensional laminar flames and Chemkin applications for premixed flames and opposed diffusion flames.
Course Description from Program Guide	Review of fundamental concept of and phenomenology of combustion. Singularities in nonlinear problems. Matched asymptotic expansion technique. Large activation energy, Dankhler number and rate ratio asymptotics. Ignition/extinction. Laminar burning velocity. Diffusion flame. Aerodynamic effect. Preferential diffusion, differential diffusion, and heat loss effects. Hydrodynamic and acousticnstabilities. Reduced mechanisms.
Goals and Objectives	The students will learn basic knowledge and skills on the following subjects: - Fundamental understanding of flame structures and dynamics - Reduced order model description of laminar flames - Basics of large activation energy asymptotics for flame analysis - Review of historical background of classical laminar flame theory - Learn the formulations behind the computational modeling of laminar flames
Required Knowledge	ME244 Combustion or equivalent.

Reference Texts	**Main Textbooks:** Law, C. K., Combustion Physics, Cambridge University Press, 2006. Liñán, A., Williams, F.A., Fundamental Aspects of Combustion, Oxford University Press, 1993 (Out of print. Handouts will be given). **Useful References:** Glassman, I., Yetter, R. A., Glumac, N. G., Combustion, 5th ed., Academic Press, 2014. Williams, F. A., Combustion Theory, 2nd ed., Westview Press, 1985 (reprinted 1994). Kee, R. J., Coltrin, M. E., Glarborg, P., Chemically Reacting Flow: Theory and Practice, Wiley, 2003.
Method of evaluation	**20.00**% - Exam 1 **30.00**% - Exam 2 **20.00**% - Homework /Assignments **30.00**% - Course Project(s)
Nature of the assignments	Independent mini research project on analyzing one-dimensional flames using Chemkin software.
Course Policies	Extension of assignment submission must be requested by email at least 24 hours prior to the due date.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/27/2018	Review of chemical thermodynamics
1	Wed 08/29/2018	Review of chemical kinetics
2	Mon 09/03/2018	Conservation equations: general derivation
2	Wed 09/05/2018	Conservation equations: description of transport processes
3	Mon 09/10/2018	Asymptotic analysis of premixed flames
3	Wed 09/12/2018	Laminar flame speed
4	Mon 09/17/2018	Analysis of flame extinction
4	Wed 09/19/2018	PREMIX: formulations and numerical methods
5	Mon 09/24/2018	PREMIX: simulations and analysis
5	Wed 09/26/2018	Laminar premixed flame structure
6	Mon 10/01/2018	Flame stabilization
6	Wed 10/03/2018	Aerodynamics of flames: stretch definition
7	Mon 10/08/2018	Aerodynamics of flames: stretch examples
7	Wed 10/10/2018	Asymptotic analysis of nonpremixed flames
8	Mon 10/15/2018	Asymptotic analysis of nonpremixed flame extinction
8	Wed 10/17/2018	Coupling functions and conserved scalar
9	Mon 10/22/2018	Laminar nonpremixed flames: Burke-Schumann analysis
9	Wed 10/24/2018	Conserved scalar and flame sheet limit
10	Mon 10/29/2018	Mixture fraction variables: general derivation
10	Wed 10/31/2018	Numerical simulation of counterflow flames
11	Mon 11/05/2018	OPPDIF: formulation and numerical method
11	Wed 11/07/2018	Exam 1
12	Mon 11/12/2018	OPPDIF: simulation and analysis
12	Wed 11/14/2018	Laminar nonpremixed flame structure
13	Mon 11/19/2018	Implications in turbulent combustion modeling
13	Wed 11/21/2018	Theory of ignition and extinction: the S curve
14	Mon 11/26/2018	Asymptotic analysis of ignition
14	Wed 11/28/2018	Numerical analysis of ignition and extinction
15	Mon 12/03/2018	Multi-stage ignition of complex fuels
15	Wed 12/05/2018	Project presentation
16	Mon 12/10/2018	Exam 2

Note

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