MAE 721 – FUNDAMENTALS OF COMBUSTION
Spring Semester, 2013
COURSE SYLLABUS

Credits: 3 Hr.

Prerequisite: Undergraduate courses in Thermodynamics (MAE 320), Fluid Mechanics (MAE 331) and Heat Transfer (MAE 423), or similar. Graduate courses in these disciplines (e.g. MAE 521, 621, 531, 631, 633, etc.) are desired, but not required.

Textbooks: M. A. Liberman, "*Introduction to Physics and Chemistry of Combustion*: *Explosion, Flame, Detonation*," Springer-Verlag, Berlin-Heidelberg, Germany (2008); ISBN: 978-3-540-78758-7, e-ISBN: 978-3-540-78759-4, DOI: 10.1007/978-3-540-78759-4 Library of Congress Control Number: 2008926558.

J. Warnatz, U. Mass, R. W. Dibble, "*Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation*," Springer; 4th Edition (2006), ISBN: 978-3540259923.

C. K. Law, "*Combustion Physics*," Cambridge University Press, New York (2006). ISBN: 978-0-521-87052-8.

F. A. Williams, "*Combustion Theory*," Benjamin, CA (1985).

I. Glassman, R. Yetter, "*Combustion*," Academic Press, 4th Edition (2008), ISBN: 978-0122858529.

N. Peters, "*Turbulent Combustion*," Cambridge University Press, New York (2006).

S. R. Turns, "*An Introduction to Combustion*," McGraw-Hill Science/Engineering/ Math; 2nd edition (2000), ISBN: 978-0072350449.

T. Poinsot, D. Veynante, "*Theoretical and Numerical Combustion,*" Edwards, Ann Arbor, MI; 2nd edition (2005).

K. K. Kuo, "*Principles of Combustion*," Wiley-Interscience, 2nd Edition (2005), ISBN: 978-0471046899.

Ya. B. Zeldovich, G. I. Barenblatt, V. B. Librovich, G. M. Makhviladze, "*The Mathematical Theory of Combustion and Explosion*," Consultants Bureau, New York (1985).

A number of additional textbooks, journal publications and other reading materials will also be referred frequently.

Instructor: Dr. **V'yacheslav (Slava) Akkerman**: Tue, Thu, 12:30 – 1:45 pm, Room 215 ESB
Office: Room 273 *Annex* ESB, Phone: (304) 293–0802
E-mail: Vyacheslav.Akkerman@mail.wvu.edu
Office Hours: Mon – Fri, 2:00 pm – 5:00 pm, or by appointment

Course Description and Objectives:

Often a useful tool, but occasionally the cause of disasters, fire has accompanied mankind for millennia. Protecting our ancestors from the coldness, darkness, predators and stomach bacteria, combustion has brought primitive, tribal humans into the modern industrial society. In spite of the striking achievements in alternative/renewable energy such as solar, wind, and geothermal, as well as nuclear fission/fusion, about 85% of all energy we use today is still a direct result of burning, and combustibles will likely remain the dominant source of energy for industry, heating and transportation in the foreseeable future, which strongly motivates continued interest in combustion research. Consequently, the deep understanding of combustion fundamentals is essential for development of next-generation clean technologies based on fuels available today.

The course overviews the entire comprehensive, multi-scale/discipline nature of combustion science, starting with combustion thermodynamics and chemical kinetics, including transport phenomena and the internal flame structure, and ending with the combustion hydrodynamics in laboratory and industrial applications. The students will become familiar with the fundamental principles of the combustion theory along with the basic elements of the modern combustion technologies. It is aimed to prepare students for potential advanced research in academia and/or R&D work in industry in the field of combustion. (ABET outcomes a, i, g).

The course assumes intensive students-instructor interaction, including home works, creative projects, solving problems in the classroom, intermediate tests, and the final exam.

Course Content:

1. Combustion Science: the State of the Art
2. Fossil and alternative fuels: current status and perspectives
3. Basics of internal-combustion engines
4. Thermodynamics of chemical systems
5. Adiabatic flame temperature and stoichiometry
6. Chemical kinetics
7. Deflagration and detonation
8. Transport phenomena in premixed and non-premixed flames
9. Laminar diffusion (non-premixed) flames
10. Basics of heterogeneous combustion
11. Laminar premixed flames
12. Limit phenomena. Ignition and extinction
13. Combustion instabilities
14. Stabilization of jet flames. Triple/tribrachial flame structure
15. Flame-acoustic interaction
16. Flame acceleration and deflagration-to-detonation transition
17. Turbulent premixed combustion
18. Turbulent non-premixed combustion
19. Basics of computational combustion
20. Supplementary topics: supernovae, laser ablation, magnetic avalanches, optoelectronics.

Course Grading:

Attendance	10 %
Homework assignments	15 %
1st Mid-Term Exam	10 %
2nd Mid-Term Exam	10 %
Quiz	10 %
Referee reports	15 %
Final Exam	30 %

A	90~100
B	80~89
C	70~80
D	60~70
F	< 60

Academic Integrity:

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code. http://studentlife.wvu.edu/office_of_student_conduct/student_conduct_code. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.

Statement on Social Justice:

WVU is committed to social justice. The instructor of this course concurs with WVU's commitment and expects to maintain a positive learning environment, based upon open communication, mutual respect and nondiscrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color, or national origin. Any suggestions are encouraged as to how to further such a positive and open environment and to anticipate needing any type of accommodation in order to participate in this class. Please advise us and make appropriate arrangements with Disability Services (293-6700).

Days of Special Concern

WVU recognizes the diversity of its students and the needs of those who wish to be absent from class to participate in Days of Special Concern, which are listed in the Schedule of Courses. Students should notify their instructors by the end of the second week of classes or prior to the first Day of Special Concern, whichever is earlier, regarding Day of Special Concern observances that will affect their attendance. Further, students must abide by the attendance policy of their instructors as stated on their syllabi. Faculty will make reasonable accommodation for tests or field trips that a student misses as a result of observing a Day of Special Concern.

Week	Date	Tentative Topic
1	01/15	Combustion Science: the State of the Art
	01/17	Fossil and alternative fuels: current status and perspectives
2	01/22	Basics of internal-combustion engines
	01/24	Combustion and environmental concern
3	01/29	Thermodynamics of chemical systems
	01/31	Adiabatic flame temperature and stoichiometry
4	02/05	Chemical kinetics
	02/07	Deflagration and detonation
5	02/12	Transport phenomena in premixed and non-premixed flames
	02/14	Laminar diffusion (non-premixed) flames
6	02/19	Basics of heterogeneous combustion ***1st Homework Deadline***
	02/21	***Review***
7	02/26	***1st Mid-Term Exam***
	02/28	Laminar premixed flames
8	03/05	Limit phenomena. Ignition and extinction
	03/07	Combustion instabilities
9	03/12	Stabilization of jet flames. Triple/tribrachial flame structure
	03/14	Flame-acoustic interaction ***1st Report Deadline***
10	03/19	Flame acceleration and deflagration-to-detonation transition
	03/21	Turbulent combustion
11	03/26	**Spring Break**
	03/28	
12	04/02	Turbulent premixed combustion ***2nd Homework Deadline***
	04/04	***Review***
13	04/09	***2nd Mid-Term Exam***
	04/11	Turbulent non-premixed combustion
14	04/16	Basics of computational combustion
	04/18	DNS and LES of turbulent combustion
15	04/23	Basics of laser diagnostics ***2nd Report Deadline***
	04/25	Supplementary topics: supernovae, laser ablation, magnetic avalanches, optoelectronics
16	04/30	Additional lecture ***3rd Homework Deadline***
	05/02	***Review***
17	05/07	**Final Exam**
	05/09	