Kingdom of Saudi Arabia Ministry of Higher Education **Qassim University** College of Engineering		**المملكة العربية السعودية** وزارة التعليم العالي **جامعة القصيم** **كليه الهندسه**

Combustion and Fuel

College: Engineering

Department: Mechanical Eng. Dept.,

First: Course Definition

1- Course Code: ME 678

2- Units: 3 credit hrs

3- Semester:

4- Prerequisite: N

5- Co-requisite: N

6- Location (if not on main Campus):

Second: Course Objectives

1- To build up knowledge of the concepts and theories of a of classical fuel combustion.
2- To develop understanding of the basic principles and concepts of advanced fuel combustion and control process
3- To provide students with the required skills for analyzing thermal cycles.
4- To be familiar with the fundamental physical and chemical principles regarding formation and control of air pollutants in industrial and technological processes.

Third: Course Specifications

1- Topics to be covered

Subject	No of Weeks	Units
INTRODUCTION TO COMBUSTION PROCESSES Energy and Combustion, the Fuel-Engine Interface, Engineering Science and Combustion, Engineering and Applied Combustion	1	3
COMBUSTION AND ENTROPY Equilibrium and Chemical Reactions, Entropy, Gibbs and Hemholtz Functions, Equilibrium Constants, The Fuel Cell.	2	6
CHEMICAL KINETICS Kinetic Theory of Gases, Collision Theory and Chemical Reactions, Complex Chemical Kinetics Mechanisms, Nitrogen-Oxygen	1	3

Chemical Kinetics, Basic Flame Theory.		
SOLID FUELS Solid Fuel Thermo-chemistry, Coal and Other Solid Fuel Resources, Solid Fuel Combustion, Solid Fuel Combustion Pollution Control, Boiler Energy Balance.	1	3
LIQUID FUELS Liquid Fuel Properties, Crude Oil and Distillate Fuels, Synthetic Liquid Fuels, Unconventional Liquid Fuels, Liquid Fuel Combustion and Burners.	1	3
GASEOUS FUELS Gaseous Fuel Properties, Natural Gas, Coal-Derived Gaseous Fuels, Biomass and Synthetic Natural Gas, Hydrogen, Gaseous Fuel Burners.	1	3
SPARK-IGNITION ENGINE COMBUSTION Thermodynamics and Spark-Ignition Engine Modeling, Fuel Thermo-chemistry and Spark-Ignition Engines, Spark-Ignition I.C. Engine Combustion Chemistry, Spark-Ignition I.C. Engine Emissions, Spark-Ignition Engine Fuel Alternatives. The Wankel Rotary Engine.	2	6
COMPRESSION-IGNITION ENGINE COMBUSTION Thermodynamics and Compression-Ignition Engine Modeling, Fuel Thermo-chemistry and Compression-Ignition Engines, Compression-Ignition I.C. Engine Combustion Chemistry, Compression-Ignition I.C. Engine Emissions, Compression-Ignition Engine Fuel Alternatives, Advanced Spark- and Compression-Ignition Combustion Concepts.	2	6
GAS TURBINE ENGINE COMBUSTION Thermodynamics and Gas Turbine Engine Modeling, Gas Turbine Fuel Thermo-chemistry, Gas Turbine Combustors, Gas Turbine Engine Fuel Alternatives, Gas Turbine Engine Emissions, The Free Piston and Stirling Engines.	1	3
THERMAL DESTRUCTION Introduction, Thermal Destruction Combustion Chemistry, Basic Elements of Thermal Destruction, Thermal Destruction Components, Thermal Destruction Configurations, Environmental Regulations and Thermal Destruction.	1	3
SEMESTER PROJECT DESIGN OF COMBUSTION ENGINE	2	6

2- Course components (Total 60 hrs in the Semester)

Lecture (hr)	Exercise (hr)	Other
45	**----**	**---**

3- Intended Learning Outcomes of the Course (ILO's)

a. *Knowledge*

i) Description of the knowledge to be acquired:

1. Outline the basics, theory and physical concepts of combustion.
2. Recognize the different types fuels used in combustion.
3. Understand and analyze the combustion in the internal combustion engines.
4. Recognize the different configurations of flames and boundary layer combustion.
5. Understand Combustion stoichiometry and chemical equilibrium.
6. Advanced treatment of fundamental combustion processes.

ii) Teaching strategies to be used to develop that knowledge:

- Class lectures .
- Term projects.
- Students' presentations.
- Group discussion.

iii) Methods of assessment of knowledge acquired:

- Exams.
- Quizzes.
- Homework assignments.
- Term projects.

b- Cognitive (Intellectual) Skills

i) Cognitive skills to be developed:

- Analyze the combustion process.
- Differentiate among different fuels combustion.
- Capability of recognition different engine designs.
- Analysis & discussion of the engine data.

ii) Teaching strategies to be used to develop these cognitive skills:

- Class lectures.
- Case studies analysis.
- Problem assignments and Students' presentations.
- Reports.
- Group discussion
- Term projects.

iii) Methods of assessment of students' cognitive skills:

- Students' seminars and presentations.
- Quizzes.
- Term projects.

- Written reports.

C. Interpersonal Skills and Responsibility

i) Description of the interpersonal skills and capacity to carry responsibility to be developed:
- Decision making based on engineering analysis.
- Communication skills.
- Team work.

ii) Teaching strategies to be used to develop these skills:
- Class lectures.
- Term projects.
- Case studies analysis.

iii) Methods of assessment of students' interpersonal skills and capacity to carry responsibility:
- Term project .
-Written reports.
-Students' seminars and presentations.

d. Communication, Information Technology and Numerical Skills

i) Description of the skills to be developed in this domain:
- Use of the internet search for course related issues.
- Write acceptable technical report.
- Verbally present technical report.

ii) Teaching strategies to be used to develop these skills:
- Reading assignments and Students' presentations.
- Case study (data collection, Internet search, and reporting).
- Reports.
- Group discussion.

iii) Methods of assessment of students numerical and communication skills:
- Term projects.
- Written reports.
-Students' seminars and presentations.

e. Psychomotor (if applicable) & Other Non-cognitive Skills

i) Description of the skills to be developed in this domain:
- Not Applicable.

ii) Teaching strategies to be used to develop these skills:
- Not Applicable.

iii) Methods of assessment of student's psychomotor skills:
Not Applicable

4- Student Assessment Schedule

Serial	*Assessment tool (test, group project, examination etc.)*	*Week due*	*Weight*
1	Four quizzes	Weeks 5, 8, 9 and 14	10 %
2	Two mid-term exams	Weeks 6 and 12	20 %
3	Mostly eight assignments (in-class/out-class) and homework. This number may increases according to the instructor view.	Weeks 3, 5, 7, 9, 11, 12, and 14	16 %
4	Attendance	All weeks	4 %
5	Final Exam	Week 16	50%

5- Student Support:

- Providing electronic library of textbooks and scientific periodicals.
- Providing the necessary computer applications for the course.

6- Learning Resources

i) Essential Books (References):
- *Applied combustion, by Eugene L. Keating*, Environmental Kinetics, Ltd, Arnold, Maryland, CRC Press, Taylor & Francis Group, 2007. ISBN‑13: 978‑1‑57444‑640‑1 (alk. paper)

ii) Course Notes:
-NA

iii) Recommended Books:
- Internal Combustion Engines Fundamentals, by John B. Heywood, McGraw-Hill Book company, ISBN 0-07-100449-8

iv) Electronic Books & Web Sites:
- Scientific journals and forums.
-Instructor's instruction.

v) Periodicals:
- Journal of Combustion and Flame
- http://www.sciencedirect.com/science/journal/00102180

7- Course Evaluation and Improvement Processes:

i) Strategies for Obtaining Student Feedback on Effectiveness of Teaching:

- Students' questioners.
- Students' evaluation of course and instructor.

ii) Other Strategies for Evaluation of Teaching by the Instructor or by the Department:

- Public faculty seminars.
- Assessment by external evaluators of students achievements.

iii) Processes for Improvement of Teaching:

- Assessment of students' work by external examiners.
- Analysis of students' evaluation of course and instructor.
- Seminars by industry professionals.

iv) Processes for verifying standards of student achievement:

- Check marking by an independent faculty member of a sample of student work.

v) Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement: .

- A continuous improvement process through adopting a closed loop assessment/improvement. The process depends on assessment by all stake holders for the M.Sc. program educational outcomes ending with proposing the necessary improvements.