**University/Academy**: Benha university

**Faculty/Institute:** Benha Faculty of Eengineering

**Department:** Mechanical Engineering

**Form no. (12)**

**Course Specification**

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| **1- Course Data** | | | |
| **Course Code:**  M1431 | **Course Title:**  Combustion technology | | **Academic Year/Level:**  4th year |
| **Specialization:**  Mechanical Power Engineering | **No. of Instructional Units:**  ...... | **Lecture** 3 **Practical** 2/2 | |

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| **2- Course Aim** | By the end of the course the students will be able to:  1. Demonstrate knowledge of different fuel types and systems for different combustible systems  2. Able to select fuel type for different combustion systems at different operating conditions.  3. Define and solve problems related to thermo-chemistry and chemical equilibrium for chemical reactions of combustion processes  4. Know different flame types, and their own characteristics  5. Define minimum ignition energy, flame speed, and quenching distance  6. Predict necessary design and operating parameters enhancing the performance, economy and environmental requirements of combustion systems. |
| **3- Intended Learning Outcome**  ...... | |
| **a- Knowledge and Understanding** | a.1 Define chemical reaction, thermal properties of exhaust gases, pollution level of exhaust out of furnaces and differentiate between premixed and non-premixed flames, flame stability, ignition phenomenon.  a2 - Derive the governing equations of chemical equilibrium, energy equation involving combustion, droplet vaporization time.  a3 - Define the terms of flame ignition, propagation and extinction.  a4 - Describe and explain the fuel structure and properties for different combustion systems  a5 - Explain the variation in flame speed with various parameters, and study the behavior of Bunsen flame.  a6- Define the terms of heat losses from fuel combustion in boiler and furnaces |

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| **b- Intellectual Skills** | b1 - Analyze thermal problems including combustion process, conclude solutions and demonstrate creative thinking.  b.2 diffrentiate between burners and predict their flame behavior.  b.3 Demonstrate creative thinking about thermal blamce across burning devices |
| **c- Professional Skills** | c.1 Use appropriate flame sensing probes in the lab.  c2 - Design and perform experiments in the lab and field within proper technical, safety and ethical framework.  c3 – Measured and perform exhaust gases analysis of boiler and furnaces in the lab. |
| **d- General Skills** | d.1 Write reports in accordance with the standard scientific guidelines.  d.2 Present reports, discuss results and defend personal ideas.  d.3 Work coherently and successfully as a part of a team in assignments |

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| **4- Course Content** | Topic No. of Hours Lectur Tutorial/Practical  Chemical Reactions: Chemical reaction equations, thermal properties of fuels, the enthalpy of formation, application of the first law on systems involving chemical reactions, the adiabatic flame temperature, the heat of reaction 14 6 8  The Second Law Analysis: Application of the second law on chemically reacting systems, Gibbs and Hulems functions, entropy calculation at stander state, thermal balance for heat generation in boiler.  14 6 8  Chemical Kinetics and chemical equilibrium: Chemical kinetic bases, Chemical equilibrium bases, the model of an overall reaction, calculation of reaction rates, combustion process calculations, the chemical equilibrium constant. 14 6 8  Flames: Definitions, types of flames, a simplified model, the mathematical equations and solutions, factors influencing the flame properties and flame propagation, flame ignition and extinction, the flammability limits, flame stability.  14 6 8  Fuels: fuel structure, physical properties, thermal properties of fuel, liquid fuel properties, gaseous fuel properties, solid fuel properties.  14 6 8  Gas turbine combustion: Definitions, types of gas turbine combustors, flame zones, mixing process, flame temperature, secondary air, primary air, turbine inlet temperature control, premixed gas turbine combustor, exhaust temperature, a simplified gas turbine combustion models, factors influencing the combustion in gas turbine combustors.  14 6 8  Combustion models. Diffusion combustion model, the rates of evaporation, the time of vaporization, the factors influencing the complete time of evaporation, premixed combustion model, mixing process, comparisons between diffusion and premixed models. 14 6 6  Envrironmental aspects of combustion process: emissions from combustion, emission formation.  7 3 4  Total 105 45 60 |
| **5- Teaching and Learning Methods** | 1- Lectures  2- Laboratory  3- Tutorials and discussion sessions |
| **6- Teaching and Learning Methods for Students with Special Needs** | ...... |
| **7- Student Assessment:** | Written exams : To assess the understanding of the scientific background  Oral Discussions : To assess the skills of analysis and discussion  Class work : Reports discussion and assignments to assess the solidity of conjunction between theories in one side and mathematical problems and real cases from the other side |
| **a- Procedures used:** | ...... |

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| **b- Schedule:** | Mid-term exam Week 7  Quizzes Random  Oral exam. Week 15  Final exam According to Faculty exam plan |
| **c- Weighing of Assessment:** | Assignments 10 %  Mid-term Exam. 20 %  Reports & Oral Exam. 10 %  Final Exam. 60 %  Total 100 % |
| **8- List of Textbooks and References:** | ...... |
| **a- Course Notes** | • Notes by instructor distributed in class |
| **b- Required Books (Textbooks)** | • Turns, S. R., "An introduction to Combustion: concepts and applications", 2nd ed., McGraw-Hill Inc., 2000 |
| **c- Recommended Books** | 1- Glassman, I., Yetter, R.A., "Combustion", 4th ed., Elsevier, 2008.  2- Kuo, K.K., "Principle of Combustion", 2nd ed., John Wiley and Sons Inc.,2005.  3- McAllister, S., Chen, J.-Y., Fernandez-Pello, A.C., "Fundamentals of Combustion Processes", Springer, 2011.  3- 4- Law, C.K., "Combustion Physics", Cambridge University Press, 2006.  4- Al-Mahallawy, F., Habik, S.D., "Fundamentals and technology of combustion", Elsevier, 2002 |
| **d- Periodicals, Web Sites, ..., etc.** | 1. Combustion and Flame  2. Progress in Energy and Combustion Science  3. ASME Trans. - Journal of Power and Energy |

**Course Instructor:** Dr. Ali Mahmoud Ali Attia  **Head of Department:** Prof. Ahmad Al-Assal

**Date:** 21/09/2013