**CHEMICAL ENGINEERING MSc PROGRAMME**

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| **First Year** | | | | | | |
| **I. Semester** | | | | | | |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 501011101 | [THE SCIENTIFIC RESEARCH METHODS AND ITS ETHICS](#EN22) | 7.5 | 3+0 | 3 | **C** | Turkish |
| 503501501 | [TRANSPORT PHENOMENA](#EN1) | 7.5 | 3+0 | 3 | **C** | Turkish |
|  | Elective Course-1 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Elective Course-2 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Total of I. Semester | 30 |  | 12 |  |  |
| **II. Semester** | | | | | | |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
|  | Elective Course-3 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Elective Course-4 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Elective Course-5 | 7.5 | 3+0 | 3 | E | Turkish |
| 503502001 | Seminar | 7.5 | 0+1 | - | **C** | Turkish |
|  | Total of II. Semester | 30 |  | 9 |  |  |
|  | TOTAL OF FIRST YEAR | 60 |  | 21 |  |  |

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| **Second Year** | | | | | | | | |
| **III. Semester** | | | | | | | | | |
| Code | Course Title | | ECTS | | T+P | Credit | C/E | Language |
| 503501702 | MSc THESIS STUDY | | 25 | | 0+1 | - | **C** | Turkish |
| 503501703 | SPECIALIZATION FIELD COURSE | | 5 | | 3+0 | - | **C** | Turkish |
|  | | Total of III. Semester | 30 |  | |  |  |  | |
| **IV. Semester** | | | | | | | | | |
| Code | | Course Title | ECTS | T+P | | Credit | C/E | Language | |
| 503501702 | | MSc THESIS STUDY | 25 | 0+1 | | - | **C** | Turkish | |
| 503501703 | | SPECIALIZATION FIELD COURSE | 5 | 3+0 | | - | **C** | Turkish | |
|  | | Total of IV. Semester | 30 |  | |  |  |  | |
|  | | TOTAL OF SECOND YEAR | 60 |  | |  |  |  | |

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| **Elective Courses** | | | | | | | |
| Code | Course Title | | ECTS | T+P | Credit | C/E | Language |
| 503502512 | | [ADSORPTION AND SURFACE CHARACTERIZATION OF SOLIDS](#EN2) | 7.5 | 3+0 | 3 | E | Turkish |
| 503502510 | [ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS](#EN12) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503501505 | [ADVANCED CHEMICAL PROCESS CALCULATIONS](#EN15) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503501506 | [ADVANCED CHEMICAL REACTION ENGINEERING](#EN11) | | 7.5 | 3+0 | 3 | E | TR-EN |
| 503501509 | [ADVANCED ENGINEERING MATHEMATICS](#EN23) | | 7.5 | 3+0 | 3 | E | TR-EN |
| 503502501 | [ADVANCED MASS TRANSFER](#EN13) | | 7.5 | 3+0 | 3 | E | TR-EN |
| 503501510 | [Advanced Technologies and Developments in Chemical Engineering](#EN26) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503501504 | [BIOTECHNOLOGY ENGINEERING](#EN3) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503501502 | [ENERGY SOURCES](#EN6) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503501512 | [Fuel Cell Catalysis](#EN25) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503501507 | [HYDROMETALLURGY](#EN9) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503502502 | [INDUSTRIAL WASTEWATER TREATMENT](#EN5) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503502513 | [MEMBRANE PROCESSES](#EN19) | | 7.5 | 3+0 | 3 | E | TR-EN |
| 503501511 | [NANOCOMPOSITES WITH CELLULOSE ORIGIN](#EN24) | | 7.5 | 3+0 | 3 | E | Turkish |
| 503502505 | [PRACTICE OF GAS CHROMATOGRAPHY](#EN7) | | 7.5 | 3+0 | 3 | E | Turkish |

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503501501 | **TITLE** | Transport Phenomena |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  ( x ) | | ELECTIVE  (   ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| 1 | |  | | | | 2 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 5 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Theory of viscosity, heat conductivity and diffusivity of gases and liquids; the equations of change; potential flow, streamfunction, potential flow of heat; boundary-layer theory and applications to momentum, heat, and mass transfer; film andpenetration, theories of mass transfer; macroscopic momentum, energy, and mass balances and some applications; homework presentations. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main objective of this course is to understand of transport phenomena (momentum, heat, and mass transfer) in the systems, which fluids are stationary or flowing laminar or turbulent manner. Teaching the advanced subjects that notinvolved in the junior courses as Fluid Mechanics, Heat and Mass Transfer Operations, Separation Operations; forms a basis  to the scientific research. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Students learned the basis of the Transport Phenomena, will be able to understand processes based on transport phenomena better; learn differences and analogies between Transport Phenomena, get the experience of incorporating in a team work and individual study by doing homework; in addition to these; they will be able to engage in life-long learning and get application skills. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | By the end of this module students will be able to:  1. Apply knowledge of mathematics, science, and engineering.  2. Identify, formulate, and solve engineering problems  3. Grasp analogies between momentum, heat, and mass transfer.  4. Comprehend some mass transfer models.  5. Strengthen chemical engineering applications via solving numerous problems.  6. Get recognition of the need for, and an ability to engage in life-long learning.  7. Gain experience on teamwork and presentation via term project. | | | | | | | |
| **TEXTBOOK** | | | | | Bird, R. B. , Stewart, W. E. , and Lightfoot, E. N., “Transport Phenomena”, 2nd edition, John Wiley, New York, 2002. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1.S. Peker, Ş. Helvacı (2003) Akışkanlar Mekaniği: Kavramlar, Problemler, Uygulamalar, Literatür Yayıncılık, İstanbul.2. F. P. Incropera, D. P. DeWitt (Çev. Bir gurup) (2001) Isı ve Kütle Geçişinin Temelleri, 4. basımdan çeviri, LiteratürYayıncılık, İstanbul.3. A number of books and periodicals on the subject. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction, The subject of Transport Phenomena |
| 2 | Theory of gas and liquid viscosity |
| 3 | Theory of gas and liquid thermal conductivity, Theory of diffusion in gases and binary liquids |
| 4 | The equations of change and applications |
| 5 | The general equations of change and applications |
| 6 | Midterm Examination 1 |
| 7 | Solving flow problems using a stream function, Creeping flow around a sphere. |
| 8 | Flow of inviscid fluids by use of the velocity potential, Potential flow around a cylinder, Flow into a rectangular channel |
| 9 | Flow near solid surfaces by boundary-layer theory, Laminar flow around the flat plate, |
| 10 | Steady potential flow of heat in solids |
| 11 | Midterm Examination 2 |
| 12 | Thermal boundary layer theory |
| 13 | Steady-state transport in binary boundary layers |
| 14 | Film and penetration theory, Macroscopic balances and applications |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Prof.Dr.Neşe Öztürk | **Date:** | | 20.4.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502512 | **TITLE** | Adsorption and Surface Characterization of Solids |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | |  | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | General definitions and terminology, types of adsorption, equations of adsorption isotherms, kinetics of adsorption, thermodynamics of adsorption, adsorbents and characterization of adsorbents, applications of adsorption. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | In this course, it is intended to introduce the place and importance of adsorption in chemical engineering, to give the principal knowledge related to adsorption, and to reach the scientific and technical literature on adsorption. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Understand the place and importance of adsorption in chemical engineering | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Identify, formulate and solve problems related to adsorption.  2. Reach, evaluate and discuss the literature related to adsorption.  3. Use and apply the knowledge related to adsorption for characterization of solids.  4. Analysis and evaluate the results obtained from characterization. | | | | | | | |
| **TEXTBOOK** | | | | | Gregg, S.J. and Sing, K.S.W., Adsorption, Surface Area and Porosity, Academic Pres, London, 1982. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Rouquerol, F., Rouquerol, J. and Sing, K., Adsorption by Powders and Porous Solids, Academic Press, London, 1999.2. Ruthven, D.M., Principles of Adsorption and Adsorption Processes, Wiley-Interscience Publication, New York, 1984.3. Crittenden, B. And Thomas, W.J., Adsorption Technology and Design, Butterworth-Heinemann, Oxford, 1998. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | General definitions and terminology |
| 2 | Types of adsorption |
| 3 | Adsorption isotherms |
| 4 | Equations of adsorption isotherms |
| 5 | Kinetics of adsorption |
| 6 | Midterm Examination 1 |
| 7 | Thermodynamics of adsorption |
| 8 | Adsorbents |
| 9 | Characterization of porous solids |
| 10 | Properties of particles |
| 11 | Midterm Examination 2 |
| 12 | Presentation of homework |
| 13 | Presentation of homework |
| 14 | Presentation of homework |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Doç. Dr. Fatma Tümsek | **Date:** | | 20.4.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503501504 | **TITLE** | Biotechnology Engineering |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 2 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | no | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Fermentation Technology, Primary and secodary Metabolites, Bio-convertion, Products of organic acids and antibiotics by fermentation technique, some unit operation techniques used in biotechnology, Bioreactors and continuous cultivation, Cell transfer, oxygen transfer, mixture and sterilization, Otomatic control of bioreactor, Properties of waste water, Treatment methods, microorganisms Used in waste water treatment and aerobic and anaerobic treatment methods, Meaning of BOD and COD, biogas production by anaerobic fermentation methods, Etil alcohol production by fermentation, Biogas production by anaerobic fermentation, Kinetics of substrate utilization, product formation and biomass production in cell culture, Design of biological reactors, Instrumentation and control, Bioprocess economics and its advantages over other processes. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | During this course given general information about the fermentation process, bioreactor kinetics, design of biological reactors, instrumentation/control and economics of bioreactor and its advantages over the other processes. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Provide information about biological and chemical production, enzymatic kinetics knowledge, separation and purification processes. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Providing knowledge about biotechnology and biological processes and products, learning the microorganisms and enzymes are useing in the process also learning technical purification and seperation of biological products. | | | | | | | |
| **TEXTBOOK** | | | | | Türker M., Biyoreaksiyon Mühendisliği, Su vakfı yayınları , 2005.Kargı F., Çevre Mühendisliğinde biyoprosesler, D.E.Ü. Müh. Fak. Basım Ünitesi,izmir,19953.. | | | | | | | |
| **OTHER REFERENCES** | | | | | Bailey J. E. And Ollis D. F. , Biochemical Engineering Fundamentals., McGraw-Hill, Edition, New York, 1986. .Pekin B., Biyokimya Mühendisliği, Ege Üni. İzmir,1983 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Fermentation Technology, |
| 2 | Primary and secodary Metabolites, Bio-convertion, |
| 3 | Products of organic acids and antibiotics by fermentation technique, |
| 4 | some unit operation techniques used in biotechnology |
| 5 | Bioreactors and continuous cultivation, Cell transfer, oxygen transfer, mixture and sterilization, Otomatic control of bioreactor, Properties of waste water |
| 6 | Midterm Examination 1 |
| 7 | Treatment methods, microorganisms Used in waste water treatment and aerobic and anaerobic treatment methods |
| 8 | Meaning of BOD and COD, biogas production by anaerobic fermentation methods, Etil alcohol production by fermentation |
| 9 | Biogas production by anaerobic fermentation, |
| 10 | Kinetics of substrate utilization |
| 11 | Midterm Examination 2 |
| 12 | product formation and biomass production in cell culture, |
| 13 | Design of biological reactors, Instrumentation and control |
| 14 | Bioprocess economics and its advantages over other processes. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Asistant Prof. Dr. Macid Nurbaş | **Date:** | | 15/04/2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503512602 | **TITLE** | Exergy Analysis |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | |  |  | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 40 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 10 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | | - | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Basic Thermodynamic Concepts; Thermomechanical Exergy; Second Law Efficiency; Exergy Property Relations; Chemical Exergy; Some Applications of Exergy Analysis Method. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main aim of the course is to introduce the exergy concept and to highlighting the importance of exergy analysis in engineering. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | The course gains to students the concept of the more efficient use of energy and the ways of the more efficient use of energy by exergy analysis in the chemical engineering operations. . | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | By the end of this course students will be able to:  1. have an awareness of the importance of exergy in engineering  2..explain the exergy concept.  3. explain and discuss the second law efficiency.  4. formulate the exergy balance for open and closed systems.  5. perform exergy balance for open and closed systems | | | | | | | |
| **TEXTBOOK** | | | | | Moran, M.J., Availability Analysis: A Guide to Efficient Energy Use, Prentice-Hall, Inc., 1982. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Szargut, J., Morris, D.R., Steward, F.R., Exergy Analysis of Thermal, Chemical, and Metallurgical Processes, Hemisphere Publishing Corparation, 1988.2. Ahern, J.E., The Exergy Method of Energy Systems Analysis, John Wiley & Sons, 1980.3. Çengel, Y., Boles, M.A., Thermodynamics:An Engineering Approach, 7.baskı, McGraw Hill, 2011. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction and Basic Thermodynamic Concepts |
| 2 | Thermomechanical Exergy |
| 3 | Thermomechanical Exergy |
| 4 | Thermomechanical Exergy |
| 5 | Thermomechanical Exergy |
| 6 | Midterm Examination 1 |
| 7 | Second Law Efficiencies |
| 8 | Exergy Property Relations |
| 9 | Exergy Property Relations |
| 10 | Chemical Exergy |
| 11 | Midterm Examination 2 |
| 12 | Chemical Exergy |
| 13 | Applications of Exergy Analysis |
| 14 | Applications of Exergy Analysis |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Prof. Dr. Hürriyet ERŞAHAN | **Date:** | 16/04/2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502502 | **TITLE** | Industrial Wastewater Treatment |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| x | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Sources of industrial wastewaters, Properties of industrial wastewaters, Control and remediation process of industrial wastewater, Control and standardizations of industrial wastewater, Presentations of homework | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main objective of this course is learning the management and treatment of industrial waste waters. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Gaining the experience to analyze and solve a waste water engineering problem | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1 to arouse and to improve the environmental consciousness.  2. to understand some related basic concepts and technologies.  3. to understand the impact of engineering solutions in a global and societal context  4. to bring forward a proposal with treatment by researching a industrial wastewater treatment plant.  5. to gain experience presentation via term project.Please write minimum four learning outcomes for the course. | | | | | | | |
| **TEXTBOOK** | | | | | 1. F.Şengül (1991) Endüstriyel atıksuların özellikleri arıtılması, 2. Baskı, D.E.Ü. Mühedislik-Mimarlık Fakültesi Basım Ünitesi, İzmir. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. H.F.Lund (Editor) (1971) Industrial Pollution Control Handbook, McGraw-Hill, Newyork.2.A. Tanyolaç ve S. S. Çelebi (Editörler) (1992) Endüstriyel Atık SuArıtımı,TMMOB Kimya Mühendisleri Odası, Ankara Şubesi Ankara | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Characterization of Wastewaters |
| 2 | Measurement of Wastewater Flows |
| 3 | Physical Treatment |
| 4 | Physical Treatment |
| 5 | Biological Treatment |
| 6 | Midterm Examination 1 |
| 7 | Biological Treatment |
| 8 | Anaerobic Treatment |
| 9 | Treatment and Removal of Sludge |
| 10 | Treatment and Removal of Sludge |
| 11 | Midterm Examination 2 |
| 12 | Control of Industrial Pollution |
| 13 | Presentations of Homework |
| 14 | Presentations of Homework |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Asistant Professor Yeliz Aşçı | **Date:** | | 20/04/2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503501502 | **TITLE** | Energy Sources |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | |  |  | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | | 1 | | 30 |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Energy; energy sources in the World and Turkey,energy production and consumption, primary energy sources, renewable energy sources | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The aim of this course is to introduce the energy sources and energy technologies | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Have a clear and unambiguous scientific grounding on what constitutes energy sources and Technolog | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Explain the production and consumption of the energy sources in the world and Turkey,  2. Explain and discuss the primary energy sources,  3. Recognize the significance of the coal, petroleum and natural gas,  4. Say the nuclear, geothermal, biomass, solar and hydroelectric energy sources | | | | | | | |
| **TEXTBOOK** | | | | | 1. Klass, D. L., ‘’Biomass for renewable energy, fuels and chemicals’’Academic Press, 1998 | | | | | | | |
| **OTHER REFERENCES** | | | | | 2. TÜSİAD-T/98-12/239 "Türkiye'nin enerji Stratejisinin değerlendirilmesi", Lebib Yalkım Yayımları ve Basım, 1998 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Energy; energy sources in the World and Turkey: production and consumption |
| 2 | Primary energy sources |
| 3 | Coal |
| 4 | Petroleum |
| 5 | Natural gas |
| 6 | Midterm Examination 1 |
| 7 | Nuclear energy |
| 8 | Geotehermal energy |
| 9 | Biomass |
| 10 | Solar energy |
| 11 | Midterm Examination 2 |
| 12 | Hyroelectri |
| 13 | Presantation of the projects |
| 14 | Presantation of the projects |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Prof. Dr. Sevgi Şensöz | **Date:** | | 15.4.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502505 | **TITLE** | Practice of Gas Chromatography |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| X | |  | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 25 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | | 1 | | 40 |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 35 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Introduction to chromatography, theory of gas chromatography, instrument overview, basic concepts and terms, properties of carrier gas, column parameters, injection and detector types, sample reaching methods, qualitative and quantitative analysis, gas chromatographic applications and practice | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Teaching chromatography, chromatographic techniques and basic terms  To be familiar operating principles gas chromatography  To do practice on instrument.  To give knowledge about application areas of gas chromatography | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Learn methods of analysis by gas chromatography  Gain knowledge about gas chromatography | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Learn chromatography, chromatographic techniques and basic terms  Acknowledgegas chromatography and understand operate principles by practical.  Obtain knowledge about application areas of gas chromatography  Learn methodsof analysis by gas chromatography | | | | | | | |
| **TEXTBOOK** | | | | | Modern Practice of gas Chromatography, 1995, Grob R. L.(Ed.), John Wiley &Sons, NY | | | | | | | |
| **OTHER REFERENCES** | | | | | Basic Gas Chromatography, Techniques in Analytical Chemistry, 1998, Mc. Nair H. M., Miller J. M., Wiley-Interscience.Gas Chromatography, 1995, Fowlis I. A. , John Wiley &Sons, | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction to chromatography, theory of gas chromatography, instrument overview, determination of project subjects |
| 2 | Chromatographic techniquies |
| 3 | Basic concepts and terms |
| 4 | Basic concepts and terms |
| 5 | Properties of carrier gas, column parameters |
| 6 | Midterm Examination 1 |
| 7 | Columns |
| 8 | Injection and detector types |
| 9 | Temperature control, sample reaching methods |
| 10 | Qualitative and quantitative analysis |
| 11 | Midterm Examination 2 |
| 12 | Hyphenated methods |
| 13 | Presantation of gas chromatograpy application areas projects |
| 14 | Presantation of gas chromatograpy application areas projects |
| 15,16 | Final Examination |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Prof. Dr. Ayşegül Aşkın | **Date:** | | 17.4.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMISTRY (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503511601 | **TITLE** | Heterogeneous Catalysis |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | |  | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Catalysts; steps in a catalytic reaction; synthesizing a rate low, mechanism, and rate -limiting step; heterogeneous data analysis for reactor design; catalyst deactivation; packed-bed reactors; moving-bed reactors; industrial applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To teach the kinetics of heterogeneous catalytic reactions, the design of heterogeneous catalytic reactor and the industrial applications. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Ability to define, formulate and solve heterogeneous catalysis problems. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Know the base concepts of heterogeneous catalysis.  2. Know the steps of heterogeneous catalytic reactions.  3. Analyse the rate equations of heterogeneous catalytic reactions.  4. Analyse the performance equations of heterogeneous catalytic reactors.  5. Know the industrial applications of heterogeneous catalysis. | | | | | | | |
| **TEXTBOOK** | | | | | Fogler, H.S., Elements of Chemical Reaction Engineering, Pearson, 2005. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Levenspiel, O., Chemical Reaction Engineering, John Wiley, 1999.2. Satterfield, C.N., Heterogeneous Catalysis in Practice, McGraw-Hill, 1980. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction to Heterogeneous Catalysis |
| 2 | Catalysts |
| 3 | Steps In A Catalytic Reaction |
| 4 | Synthesizing A Rate Low, Mechanism, and Rate Limiting Step |
| 5 | Heterogeneous Data Analysis for Reactor Design |
| 6 | Midterm Examination 1 |
| 7 | Catalyst Deactivation |
| 8 | Packed-Bed Reactors |
| 9 | Moving Bed Reactors |
| 10 | Industrial Applications |
| 11 | Midterm Examination 2 |
| 12 | Homework Presentation |
| 13 | Homework Presentation |
| 14 | Homework Presentation |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMISTRY PhD PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use the knowledges which have been gained by undergraduate and graduate education in the postgraduate areas. | | |  | |  |  |
| **LO 2** | To have a research qualification with professional responsibility. | | |  | |  |  |
| **LO 3** | Self - developing by following and being aware of the importance of innovation and Chemistry in the development of science and technology. | | |  | |  |  |
| **LO 4** | By using individual working abilities, to be capable of sharing studies and opinions in various communication media such as seminars, symposiums, congress or workshops. | | |  | |  |  |
| **LO 5** | To be capable of preparing scientific publications by using their acquired knowledge and experience in undergraduate and graduate study | | |  | |  |  |
| **LO 6** | To follow closely the developments of Chemistry in both national and international levels. | | |  | |  |  |
| **LO 7** | To design and apply theoretical, experimental and modelling studies and to examine and solving complex problems encountered in these processes. | | |  | |  |  |
| **LO 8** | To be capable of making disciplinary and inter-disciplinary studies. | | |  | |  |  |
| **LO 9** | Ability to make literature survey, presentation, designing and performing experiments and interpretation of relevant results. | | |  | |  |  |
| **LO 10** | Using the ability to take initiative by acting independently. | | |  | |  |  |
| **LO 11** | To have a scientific and professional ethics and defend this approach in any medium. | | |  | |  |  |
| **Prepared by :** | | | Professor Dr. Mine Özdemir | **Date:** | | 17.04.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMISTRY (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503501507 | **TITLE** | Hydrometallurgy |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | |  | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Introduction of metal production processes; calcination; roasting; leaching; leaching methods; leaching kinetics; recovery of metal from leaching solution, and refining; industrial applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To teach the base concepts of hydrometallurgy and the industrial applications. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Ability to define, formulate and solve hydrometallurgy problems. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Know the benefication of ore by physical methods.  2. Know the heat operations such as roasting and calcination.  3. Know the leaching and leaching methods.  4. Analyse the rate equations of leaching reactions.  5. Investigate the methods of recovery of metal from leaching solutions and the methods of rafining.  6. Know the industrial applications. | | | | | | | |
| **TEXTBOOK** | | | | | Gupta, C.K., Mukherjee, T.K., Hydrometallurgy in Extraction Process,CRC Press, 1990. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Levenspiel, O., Chemical Reaction Engineering, John Wiley, 1999.2. Habashi, F., Principles of Extractive Metallurgy, Gordon&Breach, 1980. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction to Metal Production Processes |
| 2 | Calcination, Roasting |
| 3 | Leaching, Leaching Methods |
| 4 | Leaching Kinetics |
| 5 | Recovery of Metal from Leaching Solution, and Refining |
| 6 | Midterm Examination 1 |
| 7 | Industrial Applications |
| 8 | Industrial Applications |
| 9 | Industrial Applications |
| 10 | Industrial Applications |
| 11 | Midterm Examination 2 |
| 12 | Homework Presentation |
| 13 | Homework Presentation |
| 14 | Homework Presentation |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMISTRY MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use the knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualification with professional responsibility. |  |  |  |
| **LO 3** | Self - developing by following and being aware of the importance of innovation and Chemistry in the development of science and technology |  |  |  |
| **LO 4** | By using individual working abilities, to be capable of sharing studies and opinions in various communication media such as seminars, symposiums, congress or workshops. |  |  |  |
| **LO 5** | To be capable of preparing scientific publications by using their acquired knowledge and experience in undergraduate and graduate study |  |  |  |
| **LO 6** | To follow closely the developments of Chemistry in both national and international levels. |  |  |  |
| **LO 7** | To design and apply theoretical, experimental and modelling studies and to examine and solving complex problems encountered in these processes. |  |  |  |
| **LO 8** | To be capable of making disciplinary and inter-disciplinary studies. |  |  |  |
| **LO 9** | Ability to make literature survey, presentation, designing and performing experiments and interpretation of relevant results. |  |  |  |
| **LO 10** | Using the ability to take initiative by acting independently. |  |  |  |
| **LO 11** | To have a scientific and professional ethics and defend this approach in any medium. |  |  |  |

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| **Prepared by :** | Professor Dr. Mine Özdemir | **Date:** | 17.04.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503512601 | **TITLE** | Advanced wastewater treatment |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| 1 | | 2 | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | Introduction, wastewater treatment requirement, classic technologies for wastewater treatment , advanced treatment technologies for wastewater treatment , homework presentations. | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | The basic objectives of the course; arouse students environmental awareness and to impose the idea that advanced techniques of waste water treatment to avoid issues such as eutrophication as well as environmental pollution is necessary ; In addition, analyzing and solving a related waste water engineering problem to learn advanced waste water treatment and gain the experience. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | 1.To awaken environmental awareness and development.  2. Understanding some of the basic concepts and technologies related to the subject  3. Following up-to-date issues , understanding The importance tracking lifelong learning, and its application  4.Understand the national and global impact of engineering solutions.  5. Exploring and examining A waste water treatment facility and bringing up new recommendations on treatment. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | 1.To awaken environmental awareness and development.  2. Understanding some of the basic concepts and technologies related to the subject  3. Following up-to-date issues , understanding The importance tracking lifelong learning, and its application  4.Understand the national and global impact of engineering solutions.  5. Exploring and examining a waste water treatment facility and bringing up new recommendations on treatment. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1.Application of information about Basic Sciences (mathematics, physics, chemistry)  2.Data analysis and evaluation.  3. Bring environmental awareness  4.Gain presentation experience | | | | | | | |
| **TEXTBOOK** | | | | | 1.G. Tchobanoglous (1979) Wastewater Engineering: Treatment, Disposal, Reuse, Second Edition, Tata McGraw-Hill, New Delhi.2. F. Şengül (1991) Endüstriyel Atıksuların Özellikleri ve Arıtılması, 2. Baskı, D.E.Ü. Mühendislik-Mimarlık Fakültesi Basım Ünitesi, İzmir.3. H. F. Lund (Editor) (1971) Industrial Pollution Control Handbook, McGraw-Hill, New York. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. A. Tanyolaç ve S. S. Çelebi (Editörler) (1992) Endüstriyel Atık Su Arıtımı,TMMOB Kimya Mühendisleri Odası Ankara Şubesi, Ankara. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction , telling the purpose and Content of the course , Giving the Exam Percentages applied for the course |
| 2 | Need for advanced wastewater treatment, introduction to advanced treatment technologies for wastewater treatment |
| 3 | Nitrification process, nitrogen and phosphorus removal |
| 4 | Membrane systems |
| 5 | Adsorption |
| 6 | Midterm Examination 1 |
| 7 | İon exchange |
| 8 | Chemical oxidation |
| 9 | Elektro-coagulation |
| 10 | Design and operation of treatment plants |
| 11 | Midterm Examination 2 |
| 12 | Design and operation of treatment plants |
| 13 | Oral presentation and discussion |
| 14 | Oral presentation and discussion |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Associate professor Duygu KAVAK | **Date:** | 17.04.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMISTRY (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502510 | **TITLE** | Advanced Chemical Reaction Engineering |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  ( x ) | | ELECTIVE  (   ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | |  | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Distributions of residence times for chemical reactors, heterogeneous reaction systems, models for heterogeneous reaction systems, fluid-solid systems (non-catalytic heterogeneous systems), biochemical reaction systems. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To give knowledge about the catalytic and non-catalytic heterogeneous systems which are widely used in Chemical Engineering | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Learn about advanced level chemical reaction engineering.  Get knowledge of synthesis and characterization of solid catalysis.  Develop reaction rate expression for non-catalytic heterogeneous systems.  Derive the residence time distribution functions, E(t) and F(t), for a plug-flow reactor (PFR) and for a CSTR. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Analyse heterogeneous reaction rate equations.  Apply the non-linear rate equations by using numerical methods.  Analyse rate equations of non-catalytic heterogeneous reactions.  Analyse the rate controlling step in heterogeneous reaction systems. | | | | | | | |
| **TEXTBOOK** | | | | | Levenspiel, O., Chemical Reaction Engineering, 3th Ed., Wiley, 1999. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Lee, H. H., Heterogeneous Reactor Design, Butterworth Publishers, 1985.2. Fogler, H. S., Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2006.3. Vannice, M.A., Kinetics of catalytic reactions, New York: Springer, 2005 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Non-ideal flow models, the age distribution of fluid |
| 2 | Heterogeneous reactions-introduction |
| 3 | Solid catalyzed reactions-models |
| 4 | The packed bed catalytic reactor |
| 5 | Deactivating catalysts |
| 6 | Midterm Examination 1 |
| 7 | Non-catalytic systems-kinetics |
| 8 | Non-catalytic systems-kinetics |
| 9 | Non-catalytic systems-reactor design |
| 10 | Non-catalytic systems-reactor design |
| 11 | Midterm Examination 2 |
| 12 | Homework presentation |
| 13 | Homework presentation |
| 14 | Homework presentation |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMISTRY MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use the knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualification with professional responsibility. |  |  |  |
| **LO 3** | Self - developing by following and being aware of the importance of innovation and Chemistry in the development of science and technology |  |  |  |
| **LO 4** | By using individual working abilities, to be capable of sharing studies and opinions in various communication media such as seminars, symposiums, congress or workshops. |  |  |  |
| **LO 5** | To be capable of preparing scientific publications by using their acquired knowledge and experience in undergraduate and graduate study |  |  |  |
| **LO 6** | To follow closely the developments of Chemistry in both national and international levels. |  |  |  |
| **LO 7** | To design and apply theoretical, experimental and modelling studies and to examine and solving complex problems encountered in these processes. |  |  |  |
| **LO 8** | To be capable of making disciplinary and inter-disciplinary studies. |  |  |  |
| **LO 9** | Ability to make literature survey, presentation, designing and performing experiments and interpretation of relevant results. |  |  |  |
| **LO 10** | Using the ability to take initiative by acting independently. |  |  |  |
| **LO 11** | To have a scientific and professional ethics and defend this approach in any medium. |  |  |  |

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| **Prepared by :** | Professor Dr. Mine Özdemir | **Date:** | 17.04.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503501506 | **TITLE** | Advanced Chemical Engineering Thermodynamics |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | |  |  | | | 3 | 7,5 | COMPULSORY  ( x ) | | ELECTIVE  (   ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 40 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 10 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | | - | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Introduction and Basic Concepts; Thermodynamic Property Relations for Fluids; Phase Equilibria; Vapor-Liquid Equilibria; Solution Thermodynamics and Applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main aims of the course are to introduce the relations between thermodynamic properties for fluids, to the phase equilibria and to the principles and applications of solution thermodynamics. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | At the end of the course, students will be able to evaluate the engineering phenomena from the thermodynamic viewpoint; to use the principles of solution thermodynamics in related chemical engineering operations. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. An awareness of the necessity of thermodynamics from the chemical engineering viewpoint.  2. An awareness of the necessity of solution thermodynamics in the chemical engineering.  3. To explain and application of phase equilibria.  4. To explain and application the principles of solution thermodynamic | | | | | | | |
| **TEXTBOOK** | | | | | Smith, J.M., Van Ness, H.C., Abbott, M.M., Introduction to Chemical Engineering Thermodynamics, McGraw-Hill Book Co., 6.baskı, 2001. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Gürüz K., Kimya Mühendisliği Termodinamiği Ankara Üniv. Yay. Ankara 1986.2. Çengel, Y., Boles, M.A., Thermodynamics:An Engineering Approach, 7.baskı, McGraw Hill, 2011. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction and Basic Concepts |
| 2 | Thermodynamic Property Relations for Fluids |
| 3 | Thermodynamic Property Relations for Fluids |
| 4 | Thermodynamic Property Relations for Fluids |
| 5 | Phase Equilibria |
| 6 | Midterm Examination 1 |
| 7 | Phase Equilibria |
| 8 | Vapor-Liquid Equilibria |
| 9 | Vapor-Liquid Equilibria |
| 10 | Solution Thermodynamics and Applications |
| 11 | Midterm Examination 2 |
| 12 | Solution Thermodynamics and Applications |
| 13 | Solution Thermodynamics and Applications |
| 14 | Solution Thermodynamics and Applications |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Prof. Dr. Hürriyet ERŞAHAN | **Date:** | | 16/04/2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502501 | **TITLE** | Advanced Mass Transfer |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| x | |  | | | | x | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 2 | | 20 |
| Project | | | | |  | |  |
| Report | | | | | 1 | | 50 |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | |  |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Diffusion and mass transfer, Molecular diffusion in fluids, Mass transfer coefficients in turbulent flow, Diffusion in solids, Interphase mass transfer, Examples for gas-liquid operations, Examples for liquid-liquid operations, Examples for solid-fluid operations. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Explaining the advanced level mass transfer theories in order to do contributions to the basic concepts of mass transfer acquired at undergraduate program, modeling the complex systems and examining the mass transfer applications. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Students will be able to understand better the mass transfer operations in complicated systems, get the experience of modeling the complicated systems by doing homeworks and project, in addition to these; they will be able to engage in life-long learning and get application skills. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1.Student can explain the mass transfer and diffusion and can use the mechanisms of transfer.  2.Student can model the mass transfer in turbulent flow, explain the diffusion in solids and can model the system.  3.Student can solve the mass transfer problems for the examples of different interphases and discuss it.  4.Student examines, describes, collects data and solves while preparing the homeworks and the project and defends them. | | | | | | | |
| **TEXTBOOK** | | | | | Bird, R. B. , Stewart, W. E. , and Lightfoot, E. N., “Transport Phenomena”, 2nd edition, John Wiley, New York, 2002. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Treybal, R.E., “Mass-Transfer Operations”, 3rd edition, McGraw-Hill, Tokyo,1981.2. Incropera, F. P., DeWitt, D. P. (Çeviri: Bir gurup) “Isı ve Kütle Geçişinin Temelleri”, 4. basımdan çeviri, Literatür, İstanbul, 2001. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Diffusion and mass transfer, molecular diffusion in fluids |
| 2 | Mass transfer coefficients in turbulent flow,transfer coefficients at high net mass transfer rates |
| 3 | Diffusion in solids, transport in boundary layers |
| 4 | Interphase mass transfer, boundary layer mass transport with complex interfacial motion |
| 5 | Mass transfer and chemical reactions |
| 6 | Midterm Examination 1 |
| 7 | Enhancement of mass transfer by a first-order reaction in turbulent flow |
| 8 | Turbulent mixing and turbulentflow with second-order reaction |
| 9 | Combined heat and mass transferby free convection |
| 10 | Effects of interfacial forces on heat and mass transfer |
| 11 | Midterm Examination 2 |
| 12 | Macroscopic levelbalances for multicomponent systems |
| 13 | Use of the macroscopic balances tosolve unsteady-state problems |
| 14 | Other mechanisms for mass transport |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Assoc. Prof. Dr. Demet Topaloğlu Yazıcı | **Date:** | | 16.4.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502503 | **TITLE** | Advanced polymeric materials |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 2 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Polymerization, Polymerization Processes, Catalysis, Additive Materials, Characteristics of Polymers, Sensitive Polymers, Biopolymers, Composite Polymers, identification of advanced polymers. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | polymer knowledge and production techniques | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Polymer concept, knowledge about the production and application of polymers | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1-Describes and explains the basic concepts of polymers.  2-Can be define the raw materials and classification of polymers,  3-Specifies the properties of polymers and production mechanism..  4- May be deciding the polymer production process, and used the catalyst, initiator and other additives kinds.  5-Knows the processes of industrial applications of polymers and have an idea about the processing of polymers and additives. | | | | | | | |
| **TEXTBOOK** | | | | | 1. Erhan Pişkin, Polimer teknolojisine giriş, Anka ofset A.Ş. İstanbul, 1987Mutafa Akay, Introduction to Polymer Science and Technology,Ventus publishing Aps,2012ISBN: 978-87-403-0087-1 | | | | | | | |
| **OTHER REFERENCES** | | | | | All polymers books | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Polymeric substances presentation and classification |
| 2 | Raw Materials |
| 3 | Physical and chemical properties, bonds |
| 4 | Molecular weight and its distribution |
| 5 | Solution of the polymer gel |
| 6 | Midterm Examination 1 |
| 7 | Polymer synthesis, |
| 8 | Observes manufacturing processes |
| 9 | Investigation of the properties of polymers |
| 10 | Polymer processing agents and additives |
| 11 | Midterm Examination 2 |
| 12 | Composite materials |
| 13 | Smart polymers |
| 14 | Biopolymers |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Asistant Prof. Dr. Macid Nurbaş | **Date:** | 25/04/2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503501505 | **TITLE** | Advanced chemical process calculations |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 0 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | |  | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | - | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Definition of a chemical process, drawing the flow diagram of the process, , writing and solving mass and energy balances | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Definition of a chemical process, drawing the flow diagram of the process, to obtain physical and chemical data and the equations about the process, writig the mass and energy balance on the total system or on a specifi unit | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To gain the skill of drawing a flowchart of a process , To gain the skill of writing and solving themass and energy balance on a system . To obtain necessary data for designing and solving the process | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1.Defines a chemical process and draws the flowchart  2.Obtain the required data fort he process  3.Write the mass and energy balances, and solve them  4.Comments the obtained results. | | | | | | | |
| **TEXTBOOK** | | | | | Felder, R. M., Rousseau, R. W., 1986, Elementary principles of chemical Processes., wiley series in chemical engineering.2. Himmelblau, D.,1974, Basic principles and calculations in chemical engineering, PrinticHall ınc. | | | | | | | |
| **OTHER REFERENCES** | | | | |  | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Definition of a chemical process |
| 2 | Definition of a chemical process |
| 3 | Drawing flowchart of the process |
| 4 | To obtain the required data for the process |
| 5 | To obtain the required data for the process |
| 6 | Midterm Examination 1 |
| 7 | Mass and energy balances |
| 8 | Mass and energy balances |
| 9 | Mass and energy balances |
| 10 | Mass and energy balances |
| 11 | Midterm Examination 2 |
| 12 | Mass and energy balances |
| 13 | Discussion of the results |
| 14 | Discussion of the results |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. | | |  | |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. | | |  | |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. | | |  | |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. | | |  | |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. | | |  | |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. | | |  | |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. | | |  | |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. | | |  | |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. | | |  | |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. | | |  | |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. | | |  | |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. | | |  | |  |  |
| **Prepared by :** | | Assoc. Prof. Dr. Hakan Demiral | **Date:** | | 22.04.2015 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503511604 | **TITLE** | Staged Separation Processes |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | |  | | | | 3 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 35 |
| Quiz | | | | |  | |  |
| Homework | | | | | 5 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | A brief discussion of the basic rules of matrix algebra, staged process; overall material balance; computer solution of the overall material balance equation; the component material balance; a computer program for solving component material balances; phase equilibrium; computer programs for equilibrium ratios and component vapor pressures; constant equilibrium ratio extraction; a program for constant equilibrium ratio extractions; constant flow rate distillation; bubble and dew point calculation; equilibrium flash calculations; The bubble point correction method for constant flow distillation. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To teach deriving and usage of mathematical models used for design of separation equipment. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Deriving and usage of mathematical models used for design of separation equipment. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | By the end of this module students will be able to:  1.To learn calculation methods for staged process (not graphical methods).  2.To remember main knowledge about matrix algebra.  3.To solve simultaneous nonlinear equations sets for staged processes by manually and by use of computer and programming in MATLAB | | | | | | | |
| **TEXTBOOK** | | | | | Tierney, J.W., Notes for Staged Separations, Chemical and Petroleum Engineering Department, University of Pittsburgh, 1974. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1.Doğan, İ., A’dan Z’ye MATLAB ile çalışmak, Bileşim yayınevi, İstanbul, 2004.2.Constantinides, A., Mostoufi, N., Numerical Methods for Chemical Engineers with MATLAB Applications, Prentice Hall, 1999. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction |
| 2 | A brief discussion of the basic rules of matrix algebra, Introduction to Matlab, Basic knowledges |
| 3 | Matrix in Matlab, Matrix operations |
| 4 | Staged process; overall material balance |
| 5 | Computer solution of the overall material balance equation; the component material balance |
| 6 | Midterm Examination 1 |
| 7 | A computer program for solving component material balances; phase equilibrium |
| 8 | Computer programs for equilibrium ratios and component vapor pressures |
| 9 | Constant equilibrium ratio extraction; a program for constant equilibrium ratio extractions |
| 10 | Constant flow rate distillation |
| 11 | Midterm Examination 2 |
| 12 | Bubble and dew point calculation |
| 13 | Equilibrium flash calculations |
| 14 | The bubble point correction method for constant flow distillation. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Prof.Dr.Neşe Öztürk | **Date:** | 20.4.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502511 | **TITLE** | Synthesis and Characterization of Catalyst |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  ( x ) | | ELECTIVE  (   ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| 1 | |  | | | | 2 | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 2 | | 40 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 30 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Introduction, Bulk and supported catalysts, Support materials, Fundamentals of catalyst preparation, Precipitation method, Impregnation method, Catalyst supports, Physical characterization and Examination, Supported metal catalysts; homework presentations. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main aims of this course are to give knowledge about the synthesis and characterization of solid catalysts which are widely used in Chemical Engineering. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Students learn about bulk and supported catalysts, get knowledge of synthesis and characterization of catalysts, find out support materials and its properties, get the experience of incorporating in a team work and individual study by doing homework; in addition to these; they will be able to engage in life-long learning and get application skills. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | By the end of this module students will be able to:  1. Apply knowledge of mathematics, science, and engineering.  2. Identify, formulate, and solve engineering problems  3. Grasp analogies between momentum, heat, and mass transfer.  4. Comprehend some mass transfer models.  5. Strengthen chemical engineering applications via solving numerous problems.  6. Get recognition of the need for, and an ability to engage in life-long learning.  7. Gain experience on teamwork and presentation via term project. | | | | | | | |
| **TEXTBOOK** | | | | | Charles N. Satterfield, Heterogeneous Catalysis in Practice, McGraw-Hill Book Company 1980. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Ertl, G., Knozinger, H., Weitkamp,J., Preparation of Solid Catalysts,Wiley, 1999.2. Regalbuto, J., Catalyst Preparation: Science and Engineering, Taylor & Francis, 2006.3. Haw, J.W., In-situ Spectroscopy in Heterogeneous Catalysis, Wiley-VCH Verlag GmbH, 2007.4. Charles N. Satterfield, Heterogeneous Catalysis in Practice, McGraw-Hill Book Company 1980.5. Krijn P. de Jong, Synthesis of Solid Catalysts, John Wiley & Sons, 2009. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction, Bulk and supported catalysts |
| 2 | Fundamentals of catalyst preparation |
| 3 | Precipitation method, Calcination, Reduction tok the metal, Impregnation method |
| 4 | Precipitation method, Calcination, Reduction tok the metal, Impregnation method |
| 5 | Physical characterization and Examination |
| 6 | Midterm Examination 1 |
| 7 | Measurement of surface area, Pore volume, Pore-size distrubution |
| 8 | Mechanical properties |
| 9 | Instrumental methods |
| 10 | Supported metal catalysts |
| 11 | Midterm Examination 2 |
| 12 | Metal dispersion, Alloy catalysts |
| 13 | Properties and Characteristics of Industrial Catalysts |
| 14 | Homework presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. |  |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. |  |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. |  |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. |  |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. |  |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. |  |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. |  |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. |  |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. |  |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. |  |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. |  |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. |  |  |  |

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| **Prepared by :** | Yrd. Doç. Dr. Alime ÇITAK | **Date:** | 17.04.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503512605 | **TITLE** | Modeling of the chemical processes |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 2 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Chemical Processes, Mathematical Modeling, Steady State and Non steady State Conditions, Mass Balance, Energy Balance, Momentum Balance, Batch and Continuous Sistems, Examples for Steady State and Non steady State Conditions, Stagewise Extraction and Efficiency, Distilled Water Production Process, Distillation and effeiciency, Examples for Heat transfer. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | introduce of processes that Used in the field of chemical engineering. Modeling, mass and energy balances, and problem solutions | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Modeling of processes; teamwork ability; identification, formulate and solve the problems in the related field, use the modern methods such as computer software, techniques, | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Providing knowledge about the modeling of chemical processes, establishing  the mass and energy balances and solution of the problems | | | | | | | |
| **TEXTBOOK** | | | | | McCabe L. And Smith C., Unit Operations of Chemical Engineering, McGraw Hill. | | | | | | | |
| **OTHER REFERENCES** | | | | | Chemical engineering undergraduate lecture notes | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Chemical Processes |
| 2 | Mathematical Modeling, |
| 3 | Steady State |
| 4 | Non steady State Conditions |
| 5 | Non steady State Conditions |
| 6 | Midterm Examination 1 |
| 7 | Energy Balance Momentum Balance, |
| 8 | Batch and Continuous Sistems |
| 9 | Examples for Steady State and Non steady State Conditions, |
| 10 | Stagewise Extraction and Efficiency, |
| 11 | Midterm Examination 2 |
| 12 | Distilled Water Production Process, |
| 13 | Distillation and effeiciency, |
| 14 | Examples for Heat transfer. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Asistant Prof. Dr. Macid Nurbaş | **Date:** | 25/04/2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503502513 | **TITLE** | MEMBRANE PROCESSES |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| 1 | | 2 | | | | X | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Overview of membrane science and technology; membranes and modules; membrane transport mechanism; concentration polarization and membrane fouling;advantages and disadvantages of membrane processes; classification of membrane processes, application areas of membrane separation processes. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main of the course is to define the membrane procecess and to give subject about the industrial applications. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | The students learn subjects about the membranes, their kinds and preparation. The students learn about the application areas of the membrane processes according todriving force(pressure, concentration, temperature and electricity). | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Obtain fundamental understanding of the theory and applications of membrane processes.  2. Describe the advantages and disadvantages of membrane processes.  3. Compare the conventional separation processes and membrane processes. Compare the conventional separation processes and membrane processes | | | | | | | |
| **TEXTBOOK** | | | | | Mulder, M ., Basic Principles of Tecnology,Kluwer Academic Publishers, 1998. | | | | | | | |
| **OTHER REFERENCES** | | | | | Advanced Membrane Technology And Applications, Edited By Norman N. Li, Anthony G. Fane, W. S. Winston Ho, and T. Matsuura John Wiley& Sons,Ltd, 2008R.W.Baker., Membrane Tecnology and Application, John Wiley& Sons,Ltd, 2004 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction to Membrane Processes, Types of Membranes, Membrane Separation Mechanism |
| 2 | Membrane modules, concentration polarization and fouling |
| 3 | Membrane separation mechanism, transport mechanism |
| 4 | Advantages and disadvantages of membrane processes, classification of membrane processes |
| 5 | Pressure-driven membrane processes |
| 6 | Midterm Examination 1 |
| 7 | Pressure-driven membrane processes |
| 8 | Membrane processes driven by the concentration difference |
| 9 | Membrane processes driven by the concentration difference |
| 10 | Membrane processes driven by the electrical potential difference |
| 11 | Midterm Examination 2 |
| 12 | Membrane processes driven by the temperature difference |
| 13 | Assignment Presentations |
| 14 | Assignment Presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. |  |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. |  |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. |  |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. |  |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. |  |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. |  |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. |  |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. |  |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. |  |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. |  |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. |  |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. |  |  |  |

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| **Prepared by :** | Yrd. Doç.Dr. Belgin Karabacakoğlu | **Date:** | 20.4.2014 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 503511605 | **TITLE** | Polymer Production |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 2 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Introduction to polymer production, Structure of a polymer, the polymer molecular weight and molecular weight distribution, polymer solution and gel condition, Polymer Melts flow, polymer synthesis, polymerization processes, polymer processing, basic properties of the polymer. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Introdution aboult the polimers Which is widely used in our life, Synthesis of polymers, Surveys of manufacturing processes of polymers  investigation of polymer properties. Knowledge of polymer formation | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Polymer concept, knowledge about the production and application of polymers | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1-Describes and explains the basic concepts of polymers.  2-Can be define the raw materials and classification of polymers,  3-Specifies the properties of polymers and production mechanism..  4- May be deciding the polymer production process, and used the catalyst, initiator and other additives kinds.  5-Knows the processes of industrial applications of polymers and have an idea about the processing of polymers and additives. | | | | | | | |
| **TEXTBOOK** | | | | | Erhan Pişkin, Polimer Teknolojisine Giriş, Anka Ofset A.Ş. İstanbul, 1987. | | | | | | | |
| **OTHER REFERENCES** | | | | | Mutafa Akay, Introduction to Polymer Science and Technology,Ventus publishing Aps,2012ISBN: 978-87-403-0087-1 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | polymer infomation |
| 2 | the structure of the polymer |
| 3 | Polymer molecular weight and molecular weight distribution |
| 4 | Polymer solution and gel condition |
| 5 | Flow of polymer melts |
| 6 | Midterm Examination 1 |
| 7 | polymer synthesis |
| 8 | Block polymerization and solution polymerization processes |
| 9 | Suspension polymerization polymerization processes |
| 10 | Emulsion polymerization, polymerization processes |
| 11 | Midterm Examination 2 |
| 12 | Polymer processing |
| 13 | Processing of the polymer and additives |
| 14 | Basic properties of polymers |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Assistant Prof. Dr. Macid Nurbaş | **Date:** | 25/04/2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (PhD)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 5035012606 | **TITLE** | Renewable Energy Sources |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **PhD** | 3 | |  |  | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) |  |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | X | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | | 1 | | 30 |
| Report | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Biomass energy, production of liquid fuels from biomass, geothermal, nuclear, wind, solar, hydroelectric and hydrogen energy, characterization of synthetic fuels, reletionship of the energy and environment. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Determining the physical properties and amounts of alternative energy sources, their chemical compositions, designing of the energy sources, using the production units, evoluation of small scale systems and scaling up and comparing their products with those obtained from traditional sources, emphasizing their positive effects. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To discuse therelations of various diciplines with energy and determining the optimal conditions, to follow the energy technologies closely. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. State the significane renewable energy sources,  2. Define the hydrogen, bor and biomass energy,  3. Discuss the production of the liquid fuels,  4. Classify the analysis methods of the biooils,  5. Recognize the environmental effect of the energy sources. | | | | | | | |
| **TEXTBOOK** | | | | | 1. Acaroğlu, M, ‘’ Alternatif Enerji Kaynakları’’, Atlas yayın dağıtım, 2003 | | | | | | | |
| **OTHER REFERENCES** | | | | | Priodicals about energy | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Renewable energy sources |
| 2 | Hydrogen energy |
| 3 | Bor |
| 4 | Biomass |
| 5 | Thermal processes |
| 6 | Midterm Examination 1 |
| 7 | Production of liquid fuels from biomass |
| 8 | Ethanol and methanol production processes |
| 9 | Characterization of synthetic fuels |
| 10 | Chromatographic methods |
| 11 | Midterm Examination 2 |
| 12 | Spectroscopic methods |
| 13 | Energy and environmental |
| 14 | Presantation of the projects |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE CHEMICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (PhD)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to understand and apply the most advanced levels of mathematics, science and engineering knowledge in chemical engineering and other related areas |  |  |  |
| **LO 2** | Ability to design, plan, supervise, conduct, conclude and apply the original research and investigation processes for innovative scientific and technological studies, by obtaining the up-to-date knowledge, in chemical engineering and other related areas |  |  |  |
| **LO 3** | Ability to design, plan, supervise, conduct, conclude and apply the innovative multi-disciplinary studies |  |  |  |
| **LO 4** | Ability to submit and publish the outcomes of academic studies in all kinds of respectable academic media |  |  |  |
| **LO 5** | Ability of written, oral and visual communication, in advanced level, in at least one foreign language |  |  |  |
| **LO 6** | Ability to analyze, synthesize, evaluate and criticize the arisen, suggested and/or submitted ideas in the study area |  |  |  |
| **LO 7** | Ability to assess the up-to-date scientific, technological, social, cultural and environmental issues, having the awareness of ethics and responsibility in all these areas |  |  |  |

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| **Prepared by :** | Prof. Dr. Sevgi Şensöz | **Date:** | 16.4.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | Joint Course for the Institute | **SEMESTER** | Fall-Spring |

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| **COURSE** | | | |
| **CODE** | 501011101 | **TITLE** | The Scientific Research Methods and Its Ethics |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| MSc-  Ph.D | 3 | | 0 | 0 | | | 3+0 | 7,5 | COMPULSORY  ( X ) | | ELECTIVE  (   ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| 1,5 | | 1,5 | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 40 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 60 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Science, the scientific thought and other fundamental concepts, the scientific research process and its techniques, Methodology: Data Collecting-Analysis-Interpretation, Reporting the scientific research (Preparation of a thesis, oral presentation, article, project), Ethics, Ethics of scientific research and publication. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The main objectives are: To examine the foundations of scientific research and the scientific research methods, to teach the principles of both the methodology and the ethics, to realize the process on a scientific research and to evaluate the results of research, to teach reporting the results of research (on a thesis, presentation, article). | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Applying the scientific research methods and the ethical rules in their professional life. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Gaining awareness on ethical principles at basic research methods, becoming skillful at analyzing and reporting the data obtained in scientific researches, being able to have researcher qualification with occupational sense of responsibility, having the scientific and vocational ethics’ understanding and being able to defend this understanding in every medium. | | | | | | | |
| **TEXTBOOK (Turkish)** | | | | | Karasar, N. (2015). Bilimsel Araştırma Yöntemi. Nobel Akademi Yayıncılık, Ankara. | | | | | | | |
| **OTHER REFERENCES** | | | | | **1-**Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş., Demirel, F. (2012). Bilimsel Araştırma Yöntemleri. Pegem Akademi Yayınevi, Ankara.  **2-**Tanrıöğen, A. (Editör). (2014). Bilimsel Araştırma Yöntemleri. Anı Yayıncılık, Ankara.  **3-**Türkiye Bilimler Akademisi Bilim Etiği Komitesi. Bilimsel Araştırmada Etik ve Sorunları, Ankara: TÜBA Yayınları, (2002).  **4-**Ekiz, D. (2009). Bilimsel Araştırma Yöntemleri: Yaklaşım, Yöntem ve Teknikler. Anı Yayıncılık, Ankara.  **5-**Day, Robert A. (Çeviri: G. Aşkay Altay). (1996). Bilimsel Makale Nasıl Yazılır ve Nasıl Yayımlanır?, TÜBİTAK Yayınları, Ankara.  **6-**Özdamar, K. (2003). Modern Bilimsel Araştırma Yöntemleri. Kaan Kitabevi, Eskişehir.  **7-**Cebeci, S. (1997). Bilimsel Araştırma ve Yazma Teknikleri. Alfa Basım Yayım Dağıtım, İstanbul.  **8-**Wilson, E. B. (1990). An Introduction to Scientific Research. Dover Pub. Inc., New York.  **9-**Çömlekçi, N. (2001). Bilimsel Araştırma Yöntemi ve İstatistiksel Anlamlılık Sınamaları. Bilim Teknik Kitabevi, Eskişehir. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Science, scientific thought and other basic concepts (University, history of university, higher education, science, scientific thought and other related concepts) |
| 2 | Science, scientific thought and other basic concepts (University, history of university, higher education, science, scientific thought and other related concepts) |
| 3 | The scientific research and its types (Importance of the scientific research, types of science, scientific approach) |
| 4 | The scientific research process and its techniques (Access to the scientific knowledge, literature search, determining the research issue, definition of the problem, planning) |
| 5 | The scientific research process and its techniques (Access to the scientific knowledge, literature search, determining the research issue, definition of the problem, planning) |
| 6 | The scientific research process and its techniques (Access to the scientific knowledge, literature search, determining the research issue, definition of the problem, planning) |
| 7 | The method and the approach: Collecting, analysis and interpretation of the data (Data, data types, measurement and measurement tools, collecting data, organizing data, summarizing data, analysis and the interpretation of data) |
| 8 | The method and the approach: Collecting, analysis and interpretation of the data (Data, data types, measurement and measurement tools, collecting data, organizing data, summarizing data, analysis and the interpretation of data) |
| 9 | Finalizing the scientific research (Reporting, preparing the thesis, oral presentation, preparing an article and a project) |
| 10 | Finalizing the scientific research (Reporting, preparing the thesis, oral presentation, preparing an article and a project) |
| 11 | Finalizing the scientific research (Reporting, preparing the thesis, oral presentation, preparing an article and a project) |
| 12 | Ethics, scientific research and publication ethics (Ethics, rules of ethics, occupational ethics, non-ethical behaviors) |
| 13 | Ethics, scientific research and publication ethics (Ethics, rules of ethics, occupational ethics, non-ethical behaviors) |
| 14 | Ethics, scientific research and publication ethics (Ethics, rules of ethics, occupational ethics, non-ethical behaviors) |
| 15,16 | Mid-term exam, Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE INSTITUTE’S GRADUATE PROGRAMME’S LEARNING OUTCOMES** | | | | **CONTRIBUTION LEVEL** | | | |
| **NO** | **LEARNING OUTCOMES (M.Sc.-Ph.D.)** | | | **3**  High | | **2**  Mid | **1**  Low |
| **LO 1** | Having the scientific and vocational ethics’ understanding and being able to defend this understanding in every medium. | | |  | |  |  |
| **LO 2** | Being able to have researcher qualification with occupational sense of responsibility. | | |  | |  |  |
| **LO 3** | Becoming skillful at analyzing and reporting the data obtained in scientific researches. | | |  | |  |  |
| **LO 4** | Gaining awareness on ethical principles at basic research methods. | | |  | |  |  |
| **Prepared by :** | | |  | **Date:** | | 14.06.2016 | | | |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | Advanced Engineering Mathematics |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| 1 | | 2 | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 2 | | 50 |
| Quiz | | | | |  | |  |
| Homework | | | | | 2 | | 20 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 30 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Methods of linear systems, engineering applications in finite and infinite dimensional spaces, concepts of stability, application to transport phenomena | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To solve engineering problems using basic mathematical knowledge | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Achieving sufficient knowledge in mathematics, modeling and solving engineering problems | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Learning mathematical applications in engineering.  2. Modeling and solving engineering problems.  3. Gaining analytical analysis ability.  4. Gaining numerical analysis ability. | | | | | | | |
| **TEXTBOOK** | | | | | Zill, Dennis, Warren S. Wright, and Michael R. Cullen, "Advanced Engineering Mathematics", Jones & Bartlett Learning, 2011. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Michael D. Greenberg, “Advanced Engineering Mathematics”, 1998.2. O'neil, Peter V, "Advanced Engineering Mathematics", 2011.3. G. Strang “Introduction to Linear Algebra”, 1998. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Diferential equations |
| 2 | Introduction to Partial Diferential Equations |
| 3 | Separation of Variables Method |
| 4 | Solution of the Wave Equation Using the Method of Characteristics |
| 5 | Introduction to Linear Algebra |
| 6 | Midterm Examination 1 |
| 7 | Systems of Linear Equations and Gaussian Elimination |
| 8 | Linear Spaces |
| 9 | Orthogonal Bases in Finite- and Infinite-dimensional Spaces |
| 10 | Fourier and Laplace Transforms and Their Application to Solutions of Diferential Equations |
| 11 | Midterm Examination 2 |
| 12 | Eigenvectors and Eigenvalues |
| 13 | Green’s Functions and Their Application to Solution of Diferential Equations |
| 14 | Numerical Methods and Numerical Solution of Diferential Equations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. |  |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. |  |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. |  |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. |  |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. |  |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. |  |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. |  |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. |  |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. |  |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. |  |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. |  |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. |  |  |  |

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| **Prepared by :** | Assist. Prof. Dr. Salim Erol | **Date:** | 06.04.2018 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | Advanced Technologies and Developments in Chemical Engineering |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | 3 | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Advanced technologies such as pharmaceutical industry, Nanotechnology, Plastic and rubber industry, Paper industry, Biotechnology, Aviation and automotive industry, Fuel cell technology, Polymer industry, Food and Dye/pigment/ink industry. Latest developments within the scope of these technologies. Homework presentations. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To inform students about the advanced technologies that have an important place in chemical engineering and the latest developments related to these technologies. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Analysis, synthesis and evaluation of information and developments related to advanced technologies.  Development of research and communication skills. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Understand current developments and advanced technologies related to chemical engineering.  2. Ability to do research and apply by following up-to-date information about advanced technologies in chemical engineering.  3. To evaluate the national and global impact of the latest technologies and the latest developments in the field.  4. To gain communication skills by giving written and oral presentations. | | | | | | | |
| **TEXTBOOK** | | | | | Chemical Engineering in the Pharmaceutical Industry:Drug Product Design, Development, and Modeling, Mary T. am Ende, David J. am Ende, John Wiley & Sons, Second Edition, 2019.İnorganik Kimyasal Teknoloji, Biçer, A., Yalçın, H., G.Ü.V. İlke Yayınevi, Ankara, 2007. | | | | | | | |
| **OTHER REFERENCES** | | | | | Perry’s Chemical Engineers’ Handbook, Don W. Gren, Marylee Z. Southard  9th Edition 2018.  Periodicals on advanced technologies and applications | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | General information about the introduction of the course and evaluation of the course |
| 2 | Pharmaceutical industry and recent advances in this field |
| 3 | Pharmaceutical industry and recent advances in this field |
| 4 | Recent developments about nanotechnology and nanotechnological products |
| 5 | Recent developments in plastic and rubber industry products |
| 6 | Developments in pulp and paper industry |
| 7 | Biotechnology and advances in this field |
| 8 | Advances in the aviation and automotive industry |
| 9 | Fuel cell technology and latest developments |
| 10 | Polymer industry and developments in the field |
| 11 | Food industry and recent developments |
| 12 | Technological developments in dye/ pigment / ink industry branches |
| 13 | Homework presentations |
| 14 | Homework presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. |  |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. |  |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. |  |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. |  |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. |  |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. |  |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. |  |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. |  |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. |  |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. |  |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. |  |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. |  |  |  |

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| **Prepared by :** | Prof. Dr. Duygu KAVAK | **Date:** | 15.05.2020 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** | 0 | **TITLE** | Fuel Cell Catalysis |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7,5 | COMPULSORY  (   ) | | ELECTIVE  ( x ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
| x | | x | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 20 |
| Quiz | | | | | 2 | | 10 |
| Homework | | | | |  | |  |
| Project | | | | | 2 | | 30 |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | No | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | The course will focus on the historical development, basic concepts, classification, synthesis and characterization of catalysts of fuel cells. Electrochemistry and thermodynamics of fuel cells will be examined. In fuel cell catalysts, hydrogen fuel cell catalysts, direct fed fuel cell catalysts and biofuel cells will be studied. In the synthesis of fuel cell catalysts, precipitation method, impregnation method, electrochemical method, vapor phase methods, liquid phase method, spray methods will be emphasized. In the characterization of fuel cell catalysts, X-ray Diffractometry, X-ray Photoelectron Spectroscopy, Electron Microscopy, Raman Spectroscopy and density functional theory and surface calculations will be examined. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To provide students with knowledge and research about environmentally friendly fuel cells that can meet the energy deficit in Turkey. In addition, to gain competence in the characterization processes of these fuel cell catalysts. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | This course provides detailed information about the working principles of fuel cells, which is one of the alternative energy generators and the preparation and characterization of nanomaterials used in these systems, that have an important place in Chemical Engineering education | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To be informed about the basic concepts and historical development of the fuel cell. Electrochemistry and thermodynamics performance analysis of fuel cells.Fuel cell operating analysis of hydrogen fuel cell and direct fed fuel cell catalysts. learn the synthesis methods used in fuel cell catalysts.  To be informed about the characterization of fuel cell catalysts. | | | | | | | |
| **TEXTBOOK** | | | | | Yakıt Pili Katalizörleri Kitabı, Gece yayın evi, 2019, Editör: Doç. Dr. Hilal DEMİR KIVRAK | | | | | | | |
| **OTHER REFERENCES** | | | | | Direct Liquid Fuel Cells, 1st Edition, Fundamentals, Advances and Future, Editors: Ramiz Akay Ayse Bayrakceken Yurtcan | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Basic concepts, historical development and classification of fuel cells |
| 2 | Electrochemistry of Fuel Cells |
| 3 | Thermodynamics of Fuel Cells |
| 4 | Hydrogen fuel cell catalysts |
| 5 | Direct Fuel cell catalysts |
| 6 | Biofuel cell catalysts |
| 7 | Microbial fuel cells |
| 8 | Introduction to the synthesis of Fuel Cell Catalysts |
| 9 | Synthesis methods of fuel cell catalysts |
| 10 | Characterization of Fuel Cell Catalysts: X-ray Diffractometry |
| 11 | Characterization of Fuel Cell Catalysts: X-ray Photoelectron Spectroscopy |
| 12 | Characterization of Fuel Cell Catalysts: Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic force microscopy, Raman Spectroscopy |
| 13 | Characterization of Fuel Cell Catalysts: MicroRaman Spectroscopy and Chemsisorption and active site identification |
| 14 | Surface Quantum chemical calculations and surface calculations with density functional theory |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. |  |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. |  |  |  |
| **LO 3** | Ability to complete and apply the limited or insufficient data through scientific methods and ability to use together the knowledge of different disciplines. |  |  |  |
| **LO 4** | Awareness of new and improving applications in chemical engineering and the ability to learn and study on these applications. |  |  |  |
| **LO 5** | Ability to define and formulate the problems related to chemical engineering, ability to improve methods to solve these problems and ability to apply innovative methods for solutions. |  |  |  |
| **LO 6** | Ability to develop new and/or original ideas and methods, ability to design complex systems and processes and develop innovative/alternative solutions in the designs. |  |  |  |
| **LO 7** | Ability to design and apply the theoretical, experimental and modeling research activities and ability to discuss and solve the complex problems arisen in these processes. |  |  |  |
| **LO 8** | Ability to study effectively in teams for in-discipline and interdisciplinary activities, ability to lead these teams, ability to develop useful problem-solving approaches in complex situations, and ability to have responsibilities and to study independently and individually in all cases. |  |  |  |
| **LO 9** | Ability of written and oral communication using a foreign language sufficiently. |  |  |  |
| **LO 10** | Ability to present properly, clearly and systematically all processes and results of their studies oral or in written form in all kinds of national and international media. |  |  |  |
| **LO 11** | To have the knowledge of social, environmental, health, safety and legal aspects in engineering applications and the knowledge of project management and engineering activities, and awareness of all of their limitations in engineering operations. |  |  |  |
| **LO 12** | Having the social, scientific and ethical responsibilities in all stages of collecting, interpreting and presenting the related data and in all professional activities. |  |  |  |

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| **Prepared by :** | Assoc. Prof. Dr. Hilal DEMİR KIVRAK | **Date:** |  |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **CHEMICAL ENGINEERING (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | NANOCOMPOSITES WITH CELLULOSE ORIGIN |

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| **LEVEL** | **HOUR/WEEK** | | | | | | **Credit** | **ECTS** | **TYPE** | | | **LANGUAGE** |
| **Theory** | | **Practice** | **Laboratory** | | |
| **MSc** | 3 | | 0 | 0 | | | 3 | 7.5 | COMPULSORY  (   ) | | ELECTIVE  ( X ) | Turkish |
| **CREDIT DISTRIBUTION** | | | | | | | | | | | | |
| **Basic Science** | | **Basic Engineering** | | | | **Knowledge in the discipline**  **[if it contains considerable design content, mark with (√)]** | | | | | | |
|  | | X | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 30 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 20 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (     ) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | | - | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Current uses of nanotechnology, chemical structure of cellulose, properties of cellulose nanocrystals, surface modification, characterization by various characterization methods, characterizing cellulose-reinforced nanocomposites | | | | | | | |
| **COURSE OBJECTIVES** | | | | | This course gives graduate students general information about the production of cellulose-based nanocomposites and their application in the field of biomass-based products. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Learning the concept of nanotechnology, Learning the crystal structure of cellulose, Learning how to convert cellulose into nanocrystalline structure, Learning the characterization of cellulose nanocrystals, Learning the production of cellulose nanocrystalline reinforced nanocomposites | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Understanding nanotechnology properties  Understanding the crystal structure of cellulose  Understanding the conversion of cellulose to its nanocrystalline structure  Understanding the characterization of cellulose nanocrystalline  Understanding the production of cellulose nanocrystalline reinforced nanocomposites | | | | | | | |
| **TEXTBOOK** | | | | | Oksman, K., Sain, M. Cellulose Nanocomposites, Processing, Characterization and Properties. American Chemical Society, 2006. | | | | | | | |
| **OTHER REFERENCES** | | | | | Nagarajan, R. Hatton, T. A. Nanoparticles: Synthesis, Stabilization, Passivation, and Functionalization, American Chemical Society, 2008. Fernando, R. H., Sung, L. Nanotechnology Applications in Coatings. American Chemical Society, 2009. Hon, D. N.-S., Shiraishi, N. Wood and Cellulosic Chemistry, Marcel Dekker, Inc. 1991 Fengel, D., Wegener, G. Wood Chemistry, Ultrastructure, Reactions, Walter de Gruyter, 1984. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction, Definition of nanotechnology, Current application areas of nanotechnology |
| 2 | Chemical structure of cellulose |
| 3 | Methods for obtaining cellulose nanocrystalline (whiskers) |
| 4 | Obtaining nanocrystalline from different cellulose sources |
| 5 | Characterization of cellulose nanocrystalline |
| 6 | Characterization of cellulose nanocrystalline |
| 7 | Surface modification of cellulose nanocrystalline |
| 8 | Mid-Term Examination |
| 9 | Determination of crystal structures of cellulose nanocrystalline |
| 10 | Determination of crystal structures of cellulose nanocrystalline |
| 11 | Combination of Solutions and In situ Polymerization Techniques and Production of Cellulose Whiskers-Reinforced Nanocomposites |
| 12 | Characterization of cellulose nanocrystal-reinforced nanocomposites |
| 13 | Characterization of cellulose nanocrystal-reinforced nanocomposites |
| 14 | Future applications of cellulose nanocrystal-reinforced nanocomposites |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **CHEMICAL ENGINEERING MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Ability to obtain necessary knowledge deeply through scientific investigation, ability to evaluate, conclude and apply this knowledge in chemical engineering. |  |  |  |
| **LO 2** | Having comprehensive knowledge about up-to-date technologies and methods and their limitations in engineering. |  |  |  |
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| **Prepared by :** | Assoc.Prof.Dr. Ceyda BİLGİÇ | **Date:** | **30.04.2020** |

**Signature**: