**ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES 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](#D1) | 7.5 | 3+0+0 | 3 | **C** | Turkish |
| 507101501 | [ELECTROCHEMICAL BASICS](#D2) | 7.5 | 3+0+0 | 3 | **C** | Turkish |
|  | Elective Course-1 | 7.5 | 3+0+0 | 3 | E | Turkish |
|  | Elective Course-2 | 7.5 | 3+0+0 | 3 | E | Turkish |
|  | Total of I. Semester | 30 |  | 12 |  |  |
| **II. Semester** | | | | | | |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 507101501 | [ELECTROCHEMICAL METHODS](#D3) | 7.5 | 3+0+0 | 3 | **C** | Turkish |
|  | Elective Course-3 | 7.5 | 3+0+0 | 3 | E | Turkish |
|  | Elective Course-4 | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102001 | Seminar | 7.5 | 0+1+0 | - | **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 |
| 507101702 | MSc THESIS STUDY | | 25 | 0+1+0 | - | **C** | Turkish |
| 507101703 | SPECIALIZATION FIELD COURSE | | 5 | 3+0+0 | - | **C** | Turkish |
|  | | Total of III. Semester | 30 |  |  |  |  |
| **IV. Semester** | | | | | | | |
| Code | | Course Title | ECTS | T+P | Credit | C/E | Language |
| 507101702 | | MSc THESIS STUDY | 25 | 0+1+0 | - | **C** | Turkish |
| 507101703 | | SPECIALIZATION FIELD COURSE | 5 | 3+0+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 |
| 507102507 | [BATTERIES](#D18) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507101504 | [CONDUCTING POLYMERS AND APPLICATIONS](#D16) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102504 | [CORROSION AND CORROSION TESTS](#D10) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102502 | [ELECTROCHEMICAL SENSORS](#D12) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102506 | [ELECTROCHEMICAL TREATMENT TECHNICS](#D19) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102503 | [ELECTROPOLYMERIC SURFACE COATINGS](#D11) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507101502 | [ENERGY STORAGE SYSTEMS](#D4) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507101505 | [FUEL CELLS](#D15) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102505 | [FUNDAMENTALS OF ELECTROCHEMICAL ENGINEERING](#D13) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507101503 | [HYDROGEN ENERGY AND TECHNOLOGIES](#D17) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507102501 | [PROTON EXCHANGE MEMBRANE FUEL CELLS](#D9) | 7.5 | 3+0+0 | 3 | E | Turkish |
| 507101506 | [SEMICONDUCTOR COATING AND CHARACTERIZATION](#D14) | 7.5 | 3+0+0 | 3 | E | Turkish |

**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** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | ELECTROCHEMICAL BASICS |

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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 (√)]** | | | | | | |
| 0 | |  | | | |  | | | | | | |
| **ASSESSMENT CRITERIA** | | | | | | | | | | | | |
| **SEMESTER ACTIVITIES** | | | | | **Evaluation Type** | | | | | **Number** | | **Contribution**  **( % )** |
| Midterm | | | | | 1 | | 50 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | | No | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Electrochemical terms and concepts, ionic conductivity of the electrolyte balance, ionic equilibrium and Donnan equilibrium, thermodynamics of electrolytic solution to the electrochemical cell and the Nernst equation, electrode types, electrochemical battery types, Thermodynamics of electrochemical cells, electrolysis, corrosion basics | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The aim of the course; students can learn basic concepts and equations of electrochemistry | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Understand the fundamentals of electrochemical processes and gain the ability to follow and evaluate industrial applications and current studies. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1) Electrochemical terms and the relationship between them.  2) Explain the conductivity, resistance and current properties of electrolyte solutions.  3) Explain the equilibrium and thermodynamics of the electrolyte solutions.  4) Electrolytic, galvanic cells and electrodes used in these cells is known.  5) Describes electrochemical battery types and thermodynamics.  6) Understands electrolysis and corrosion events. | | | | | | | |
| **TEXTBOOK** | | | | | 1) B.E. Conway, J.O’M. Bockris, R.E. White, Modern Aspects of Electrochemistry No:32, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow, ISBN 0-306-46916-2 (2002). 2) P.H. Riger, Electrochemistry, This edition published by Chapman & Hall One Penn Plaza New York, NY 10119, ISBN 0-412-04391-2 (1994) | | | | | | | |
| **OTHER REFERENCES** | | | | | 1) A. R. Berkem, "Elektrokimya", İstanbul Ünivesitesi Yayınları, 1993 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Electrochemical terms and concepts |
| 2 | Ionic conductivity, ionic equilibrium and Donnan equilibrium |
| 3 | Electrolyte balances |
| 4 | Thermodynamics of electrolytic solutions |
| 5 | Electrochemical cells and Nerst equation |
| 6 | Midterm Examination 1 |
| 7 | Electrode types |
| 8 | Electrochemical battery types |
| 9 | Thermodynamics of electrochemical batteries |
| 10 | Thermodynamics of electrochemical batteries |
| 11 | Midterm Examination 2 |
| 12 | Electrolysis and electrolysis laws |
| 13 | Electrolysis |
| 14 | Corrosion basics |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Prof.Dr.Evrim HÜR **Date:**      

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | ELECTROCHEMICAL METHODS |

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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 | | 50 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Electrochemical and electroanalytical methods; electrolysis and galvanic cells, electrode voltages and cell thermodynamics, potentiometric, voltammetric, amperometric and coulometric methods | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The aim of the course; to understand the electrochemical and electroanalytical measurement techniques which are very common in industrial applications and to have professional competence related to the basic information on this subject, to monitor current issues and to gain research skills. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Electrochemical measurement techniques which are very common in industrial applications and basic knowledge on this subject will be able to analyze the data to the students and to evaluate it by associating it with the subject. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1) By learning electrolysis and galvanic cells, they can find the reactions and cell thermodynamics in these cells.  2) Explains the electroanalytical methods and applications.  3) Interpret electrochemical data. | | | | | | | |
| **TEXTBOOK** | | | | | 1)Instrumental Methods\_in\_Electrochemistry, R.Greef, R.Peat, L.M.Peter, D.Pletcher, J.Robinson,Ellis Horword Ltd., England, 1993. 2)Electrochemical\_Methods (Second Edıtıon), A.J.Bard&L.R.Faulkner, John Wıley & Sons, Inc., 2001. | | | | | | | |
| **OTHER REFERENCES** | | | | | Enstrümantal Analiz Yöntemleri, Atilla Yıldız, Ömer Genç, Sema Bektaş, Hacettepe Üni. Yayını, 1997 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Electrolysis cells |
| 2 | Galvanic cells |
| 3 | Electrode voltages |
| 4 | Cell thermodynamics |
| 5 | Introduction to electroanalytical methods |
| 6 | Midterm Examination 1 |
| 7 | Potentiometry |
| 8 | Voltammetry |
| 9 | Amperometry |
| 10 | Coulometry |
| 11 | Midterm Examination 2 |
| 12 | Industrial applications of electroanalytical methods |
| 13 | Interpretation of electrochemical data and problem solving |
| 14 | Interpretation of electrochemical data and problem solving |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium |  |  |  |

**Prepared by:**       **Date:**      

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **Electrochemistry and Electrochemical Technologies (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | Energy Storage Systems |

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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 | | | | | 2 | | 50 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 20 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 30 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Students study the equivalent circuits, thermodynamics, reaction kinetics, transport phenomena, electrostatic, porous media and phase transformations. In addition, this course includes batteries, fuel cells, supercapacitors, and electrokinetic applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | This course aims to introduce the principles and mathematical models of electrochemical energy conversion and storage. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Energy storage systems are discussed from the perspective of science and engineering. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. To recognize energy storage systems.  2. To learn the importance of energy storage technology.  3. To apply basic science and engineering knowledge on energy storage systems.  4. To recognize the methods applied in energy storage. | | | | | | | |
| **TEXTBOOK** | | | | | Alfred Rufer, "Energy Storage Systems and Components", CRC Press Taylor & Francis, 2018. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Robert A. Huggins, "Energy Storage: Fundamentals, Materials and Applications", 2nd Edition, Springer, 2016.2. David Elliott, "Energy Storage Systems", IOP Publishing, 2017. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | General Terms |
| 2 | Energy Storage Materials |
| 3 | Energy Conversion Materials |
| 4 | Electrochemical Energy Storage |
| 5 | Equivalent Circuits in Energy Storage Systems |
| 6 | Midterm Examination 1 |
| 7 | Batteries |
| 8 | Supercapacitors |
| 9 | Fuel Cells |
| 10 | Solar Cells |
| 11 | Midterm Examination 2 |
| 12 | Hydrogen Energy Storage |
| 13 | Other Energy Storage Systems-Thermal, Wind and Hydroelectric |
| 14 | Student Presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE** **Electrochemistry and Electrochemical Technologies MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Asistant Prof. Dr. Salim Erol **Date:** 30.04.2018 **Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | HYDROGEN ENERGY AND TECHNOLOGIES |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | What are energy and technology?; Use of energy from the past to date, exhaustible and inexhaustible sources of energy perspective; What is hydrogen?; production, storage, transportation, environmental effects, safety and usage areas of hydrogen; the situation in the world and in Turkey and international Hydrogen Energy Technologies Center (ICHET). | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To recognize energy and technology. To understand the use of energy types from the past to date. To introduce the hydrogen energy and technology by processing the properties of hydrogen, production, storage, safety, transportation, usage area and environmental effects. The situation of hydrogen in the world and Turkey in Istanbul to grasp the International Center for Hydrogen Energy Technologies. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis in the field of hydrogen energy and technologies. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To be able to recognize the hydrogen energy and its technologies. To understand the properties of hydrogen and the situation in the world. | | | | | | | |
| **TEXTBOOK** | | | | | \* Prof.Dr.Durmuş KAYA, Prof.Dr.H.Hüseyin ÖZTÜRK, Doç.Dr.Muhammet KAYFECİ. (2017). Hidrojen ve Yakıt Pili Teknolojisi. Umuttepe Yayınları. | | | | | | | |
| **OTHER REFERENCES** | | | | | \* Hülya Erdener, Serdar Erkan, Ela Eroğlu, Nadiye Gür, Erce Şengül, Nurcan Baç. (2007). Sürdürülebilir Enerji ve Hidrojen. ODTU Yayıncılık. \* Yrd.Doç.Dr.İsmet AKOVA. (2008). Yenilenebilir Enerji Kaynakları. Nobel Yayın Dağıtım. \* Prof.Dr.Beycan İbrahimoğlu. (2008). Hidrojenli Enerji Üreteçleri. Nobel Yayın Dağıtım. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | What is Energy and Technology? |
| 2 | Use of energy from the past to date. |
| 3 | A look at the energy sources that can be consumed and not consumed. |
| 4 | What is hydrogen? |
| 5 | Hydrogen sources. |
| 6 | Midterm Examination 1 |
| 7 | Hydrogen production. |
| 8 | Hydrogen storage. |
| 9 | Hydrogen transport. |
| 10 | Environmental effects of hydrogen. |
| 11 | Midterm Examination 2 |
| 12 | Hydrogen safety. |
| 13 | Areas of hydrogen use. |
| 14 | The situation of hydrogen in Turkey and in the world - International Center for Hydrogen Energy Technologies. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND TECHNOLOGY MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |
| **LO 12** |  |  |  |  |

**Prepared by:** Murat KELLEGÖZ, Ph.D. **Date:** 13/04/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | CONDUCTING POLYMERS AND APPLICATIONS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Definition of conducting polymers, conductivity theory of conducting polymers, synthesis methods and characterization of conducting polymers, polymerization mechanisms of conducting polymers, conducting polymers and applications of conducting polymers | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Understanding basic information about conductive polymers and their application areas | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis for conducting polymers and application areas | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To know conducting polymers  To understand conductivity theory of conducting polymers  To understand conducting polymer synthesis techniques  To evaluate the application areas of conducting polymer | | | | | | | |
| **TEXTBOOK** | | | | | S. Cosnier, A. Karyakin, Electropolymerization, Consepts, Materials and Applications, Wiley-VCH, 2010. | | | | | | | |
| **OTHER REFERENCES** | | | | | A. Eftekhari, Nanostructured Conductive Polymers, Wiley-VCH, 2010.T.A. Skotheim, J.R. Reynolds, Congugated Polymers, Theory, Synthesis, Properties and Characterization, CRC Press, 2007. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Definition and history of conducting polymers |
| 2 | Examples of conducting polymers |
| 3 | Conductivity theory |
| 4 | Synthesis methods of conducting polymers |
| 5 | Polymerization mechanisms of conducting polymers |
| 6 | Midterm Examination 1 |
| 7 | Characterization of conducting polymers |
| 8 | Composite conducting polymers |
| 9 | Corrosion applications of conducting polymers |
| 10 | Capacitor applications of conducting polymers |
| 11 | Midterm Examination 2 |
| 12 | Electrochromic applications of conducting polymers |
| 13 | Sensor applications of conducting polymers |
| 14 | Biomaterial applications of conducting polymers |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Assoc. Prof. Dr. Berrin DURAN **Date:** 16/04/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | FUEL CELLS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Historical development, components, working principle, electrochemistry, thermodynamics, efficiency, application areas, advantages and disadvantages of fuel cell. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To understand the structure, thermodynamics, electrochemistry and usage areas of fuel cells, which are of great importance in studies for a healthier environment and sustainable technological development. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis in the field of fuel cells. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To be able to recognize the fuel cells, to understand the structure and working principle, to understand the electrochemistry and thermodynamics. | | | | | | | |
| **TEXTBOOK** | | | | | \* EG and G Services. (2000). Fuel Cell Handbook (Fifth Edition). Parsons Inc., Science Applications International Corporations. | | | | | | | |
| **OTHER REFERENCES** | | | | | \* Frano Barbir.(2000) Fuel Cell Handbook. EG and G Servicesademic Press. \* Prof.Dr.Durmuş KAYA, Prof.Dr.H.Hüseyin ÖZTÜRK, Doç.Dr.Muhammet KAYFECİ. (2017). Hidrojen ve Yakıt Pili Teknolojisi. Umuttepe Yayınları. \* Yrd.Doç.Dr.İsmet AKOVA. (2008). Yenilenebilir Enerji Kaynakları. Nobel Yayın Dağıtım. \* Prof.Dr.Beycan İbrahimoğlu. (2008). Hidrojenli Enerji Üreteçleri. Nobel Yayın Dağıtım. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Historical development of fuel cell. |
| 2 | Fuel cell types. |
| 3 | Fuel cell types. (continued) |
| 4 | Fuel cell components. |
| 5 | Fuel cell components. (continued) |
| 6 | Midterm Examination 1 |
| 7 | Fuel cell electrochemical. |
| 8 | Fuel cell electrochemical. (continued) |
| 9 | Fuel cell thermodynamics. |
| 10 | Fuel cell thermodynamics. (continued) |
| 11 | Midterm Examination 2 |
| 12 | Fuel cell efficiency. |
| 13 | Advantages and disadvantages of fuel cell types compared to each other. |
| 14 | Application areas of fuel cells. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Murat KELLEGÖZ, Ph.D. **Date:** 13/04/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | SEMICONDUCTOR COATING AND CHARACTERIZATION |

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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 | | | | |  | |  |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | | 1 | | 25 |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Thin film concept and historical view, vacuum science and technology, Thin film growth mechanisms, physical vapour deposition, chemical vapour deposition, Classification of thin film characterization techniques, x-ray diffraction, optical characterization and spectroscopic ellipsometry, scannimg probe microscopy, electron microscopy, electrical characterization, laboratory applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To coach equipped students for thin film technology and thin film production.To coach equipped students for thin film characterization techniques such as structural, surface, optical and electrical properties, for the devices used in this field and for commenting results. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To learn thin film coating technologies and concepts on this field, to realize the importance of thin film technology, to gain knowledge. To learn and apply thin film characterization technologies, to use the devices related to this field and to make comments on the results. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Apply knowledge of natural sciences (Mathematics, Physics, Chemistry)  Identify and solve field related problems  Design experiments as well as to analyze and interpret data  Interdisciplinary knowledge association  Direct correlation of gained knowledge with technology and industry  Gain a knowledge of contemporary issues | | | | | | | |
| **TEXTBOOK** | | | | | Milton OHRING, The Material Science of Thin Films.E.M.MURT and W.L.GULDNER, Physical Measurement and Analysis of Thin Films | | | | | | | |
| **OTHER REFERENCES** | | | | | L. B. Freund, S. Suresh, Thin Film Materials,K. L. Chopra, S. R. Das, Thin Film Solar Cells, E.M.MURT and W.L.GULDNER, Physical Measurement and Analysis of Thin Films, John P. McKelvey, Solid State and Semiconductor Physics, O. S. HEAVENS, Thin Film Physics. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Thin film concept and historical view |
| 2 | Vacuum science and technology |
| 3 | Thin film growth mechanisms |
| 4 | Physical vapour deposition |
| 5 | Chemical vapour deposition |
| 6 | Midterm Examination 1 |
| 7 | Laboratory Application |
| 8 | Introduction and Classification of thin film characterization techniques |
| 9 | Structural Properties |
| 10 | Surface Properties |
| 11 | Midterm Examination 2 |
| 12 | Optical Properties |
| 13 | Electrical Properties |
| 14 | Laboratory Application |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** PROF. DR. İDRİS AKYÜZ **Date:** 04.16.2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

|  |  |  |  |
| --- | --- | --- | --- |
| **DEPARTMENT** | **Electrochemistry and Electrochemical Technologies (MSc)** | **SEMESTER** |  |

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| --- | --- | --- | --- |
| **COURSE** | | | |
| **CODE** |  | **TITLE** | Energy Storage Systems |

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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 | | | | | 2 | | 50 |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 20 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 30 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Students study the equivalent circuits, thermodynamics, reaction kinetics, transport phenomena, electrostatic, porous media and phase transformations. In addition, this course includes batteries, fuel cells, supercapacitors, and electrokinetic applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | This course aims to introduce the principles and mathematical models of electrochemical energy conversion and storage. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Energy storage systems are discussed from the perspective of science and engineering. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. To recognize energy storage systems.  2. To learn the importance of energy storage technology.  3. To apply basic science and engineering knowledge on energy storage systems.  4. To recognize the methods applied in energy storage. | | | | | | | |
| **TEXTBOOK** | | | | | Alfred Rufer, "Energy Storage Systems and Components", CRC Press Taylor & Francis, 2018. | | | | | | | |
| **OTHER REFERENCES** | | | | | 1. Robert A. Huggins, "Energy Storage: Fundamentals, Materials and Applications", 2nd Edition, Springer, 2016.2. David Elliott, "Energy Storage Systems", IOP Publishing, 2017. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | General Terms |
| 2 | Energy Storage Materials |
| 3 | Energy Conversion Materials |
| 4 | Electrochemical Energy Storage |
| 5 | Equivalent Circuits in Energy Storage Systems |
| 6 | Midterm Examination 1 |
| 7 | Batteries |
| 8 | Supercapacitors |
| 9 | Fuel Cells |
| 10 | Solar Cells |
| 11 | Midterm Examination 2 |
| 12 | Hydrogen Energy Storage |
| 13 | Other Energy Storage Systems-Thermal, Wind and Hydroelectric |
| 14 | Student Presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE Electrochemistry and Electrochemical Technologies MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Asistant Prof. Dr. Salim Erol **Date:** 30.04.2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **ELECTROCHEMISTRY AND TECHNOLOGY (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | HYDROGEN ENERGY AND TECHNOLOGIES |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | What are energy and technology?; Use of energy from the past to date, exhaustible and inexhaustible sources of energy perspective; What is hydrogen?; production, storage, transportation, environmental effects, safety and usage areas of hydrogen; the situation in the world and in Turkey and international Hydrogen Energy Technologies Center (ICHET). | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To recognize energy and technology. To understand the use of energy types from the past to date. To introduce the hydrogen energy and technology by processing the properties of hydrogen, production, storage, safety, transportation, usage area and environmental effects. The situation of hydrogen in the world and Turkey in Istanbul to grasp the International Center for Hydrogen Energy Technologies. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis in the field of hydrogen energy and technologies. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To be able to recognize the hydrogen energy and its technologies. To understand the properties of hydrogen and the situation in the world. | | | | | | | |
| **TEXTBOOK** | | | | | \* Prof.Dr.Durmuş KAYA, Prof.Dr.H.Hüseyin ÖZTÜRK, Doç.Dr.Muhammet KAYFECİ. (2017). Hidrojen ve Yakıt Pili Teknolojisi. Umuttepe Yayınları. | | | | | | | |
| **OTHER REFERENCES** | | | | | \* Hülya Erdener, Serdar Erkan, Ela Eroğlu, Nadiye Gür, Erce Şengül, Nurcan Baç. (2007). Sürdürülebilir Enerji ve Hidrojen. ODTU Yayıncılık. \* Yrd.Doç.Dr.İsmet AKOVA. (2008). Yenilenebilir Enerji Kaynakları. Nobel Yayın Dağıtım. \* Prof.Dr.Beycan İbrahimoğlu. (2008). Hidrojenli Enerji Üreteçleri. Nobel Yayın Dağıtım. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | What is Energy and Technology? |
| 2 | Use of energy from the past to date. |
| 3 | A look at the energy sources that can be consumed and not consumed. |
| 4 | What is hydrogen? |
| 5 | Hydrogen sources. |
| 6 | Midterm Examination 1 |
| 7 | Hydrogen production. |
| 8 | Hydrogen storage. |
| 9 | Hydrogen transport. |
| 10 | Environmental effects of hydrogen. |
| 11 | Midterm Examination 2 |
| 12 | Hydrogen safety. |
| 13 | Areas of hydrogen use. |
| 14 | The situation of hydrogen in Turkey and in the world - International Center for Hydrogen Energy Technologies. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND TECHNOLOGY MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |
| **LO 12** |  |  |  |  |

**Prepared by:** Murat KELLEGÖZ, Ph.D. **Date:** 13/04/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | CONDUCTING POLYMERS AND APPLICATIONS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Definition of conducting polymers, conductivity theory of conducting polymers, synthesis methods and characterization of conducting polymers, polymerization mechanisms of conducting polymers, conducting polymers and applications of conducting polymers | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Understanding basic information about conductive polymers and their application areas | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis for conducting polymers and application areas | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To know conducting polymers  To understand conductivity theory of conducting polymers  To understand conducting polymer synthesis techniques  To evaluate the application areas of conducting polymer | | | | | | | |
| **TEXTBOOK** | | | | | S. Cosnier, A. Karyakin, Electropolymerization, Consepts, Materials and Applications, Wiley-VCH, 2010. | | | | | | | |
| **OTHER REFERENCES** | | | | | A. Eftekhari, Nanostructured Conductive Polymers, Wiley-VCH, 2010.T.A. Skotheim, J.R. Reynolds, Congugated Polymers, Theory, Synthesis, Properties and Characterization, CRC Press, 2007. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Definition and history of conducting polymers |
| 2 | Examples of conducting polymers |
| 3 | Conductivity theory |
| 4 | Synthesis methods of conducting polymers |
| 5 | Polymerization mechanisms of conducting polymers |
| 6 | Midterm Examination 1 |
| 7 | Characterization of conducting polymers |
| 8 | Composite conducting polymers |
| 9 | Corrosion applications of conducting polymers |
| 10 | Capacitor applications of conducting polymers |
| 11 | Midterm Examination 2 |
| 12 | Electrochromic applications of conducting polymers |
| 13 | Sensor applications of conducting polymers |
| 14 | Biomaterial applications of conducting polymers |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Assoc. Prof. Dr. Berrin DURAN **Date:** 16/04/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | FUEL CELLS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Historical development, components, working principle, electrochemistry, thermodynamics, efficiency, application areas, advantages and disadvantages of fuel cell. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To understand the structure, thermodynamics, electrochemistry and usage areas of fuel cells, which are of great importance in studies for a healthier environment and sustainable technological development. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis in the field of fuel cells. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To be able to recognize the fuel cells, to understand the structure and working principle, to understand the electrochemistry and thermodynamics. | | | | | | | |
| **TEXTBOOK** | | | | | \* EG and G Services. (2000). Fuel Cell Handbook (Fifth Edition). Parsons Inc., Science Applications International Corporations. | | | | | | | |
| **OTHER REFERENCES** | | | | | \* Frano Barbir.(2000) Fuel Cell Handbook. EG and G Servicesademic Press. \* Prof.Dr.Durmuş KAYA, Prof.Dr.H.Hüseyin ÖZTÜRK, Doç.Dr.Muhammet KAYFECİ. (2017). Hidrojen ve Yakıt Pili Teknolojisi. Umuttepe Yayınları. \* Yrd.Doç.Dr.İsmet AKOVA. (2008). Yenilenebilir Enerji Kaynakları. Nobel Yayın Dağıtım. \* Prof.Dr.Beycan İbrahimoğlu. (2008). Hidrojenli Enerji Üreteçleri. Nobel Yayın Dağıtım. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Historical development of fuel cell. |
| 2 | Fuel cell types. |
| 3 | Fuel cell types. (continued) |
| 4 | Fuel cell components. |
| 5 | Fuel cell components. (continued) |
| 6 | Midterm Examination 1 |
| 7 | Fuel cell electrochemical. |
| 8 | Fuel cell electrochemical. (continued) |
| 9 | Fuel cell thermodynamics. |
| 10 | Fuel cell thermodynamics. (continued) |
| 11 | Midterm Examination 2 |
| 12 | Fuel cell efficiency. |
| 13 | Advantages and disadvantages of fuel cell types compared to each other. |
| 14 | Application areas of fuel cells. |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Murat KELLEGÖZ, Ph.D. **Date:** 13/04/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | SEMICONDUCTOR COATING AND CHARACTERIZATION |

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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 | | | | |  | |  |
| Quiz | | | | |  | |  |
| Homework | | | | | 1 | | 25 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | | 1 | | 25 |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 50 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Thin film concept and historical view, vacuum science and technology, Thin film growth mechanisms, physical vapour deposition, chemical vapour deposition, Classification of thin film characterization techniques, x-ray diffraction, optical characterization and spectroscopic ellipsometry, scannimg probe microscopy, electron microscopy, electrical characterization, laboratory applications. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To coach equipped students for thin film technology and thin film production.To coach equipped students for thin film characterization techniques such as structural, surface, optical and electrical properties, for the devices used in this field and for commenting results. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To learn thin film coating technologies and concepts on this field, to realize the importance of thin film technology, to gain knowledge. To learn and apply thin film characterization technologies, to use the devices related to this field and to make comments on the results. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | Apply knowledge of natural sciences (Mathematics, Physics, Chemistry)  Identify and solve field related problems  Design experiments as well as to analyze and interpret data  Interdisciplinary knowledge association  Direct correlation of gained knowledge with technology and industry  Gain a knowledge of contemporary issues | | | | | | | |
| **TEXTBOOK** | | | | | Milton OHRING, The Material Science of Thin Films.E.M.MURT and W.L.GULDNER, Physical Measurement and Analysis of Thin Films | | | | | | | |
| **OTHER REFERENCES** | | | | | L. B. Freund, S. Suresh, Thin Film Materials,K. L. Chopra, S. R. Das, Thin Film Solar Cells, E.M.MURT and W.L.GULDNER, Physical Measurement and Analysis of Thin Films, John P. McKelvey, Solid State and Semiconductor Physics, O. S. HEAVENS, Thin Film Physics. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Thin film concept and historical view |
| 2 | Vacuum science and technology |
| 3 | Thin film growth mechanisms |
| 4 | Physical vapour deposition |
| 5 | Chemical vapour deposition |
| 6 | Midterm Examination 1 |
| 7 | Laboratory Application |
| 8 | Introduction and Classification of thin film characterization techniques |
| 9 | Structural Properties |
| 10 | Surface Properties |
| 11 | Midterm Examination 2 |
| 12 | Optical Properties |
| 13 | Electrical Properties |
| 14 | Laboratory Application |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** PROF. DR. İDRİS AKYÜZ **Date:** 04.16.2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| --- | --- | --- | --- |
| **DEPARTMENT** | **Electrochemistry and Electrochemical Technology (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | Fundamentals of Electrochemical 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 | | | | | 2 | | 60 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | A. Fundamentals: Thermodynamics, electrode kinetics, interfacial phenomena, and transport processes as applied to electrochemical systems. This section will encompass as well the influence of coupled kinetic, interfacial, and transport phenomena on current and potential distributions in a variety of electrochemical systems.  B. Applications of Electrochemical Principles: The emphasis will be on applying a fundamental understanding to electrochemical topics of current interest. The list of subjects will include: fundamentals of electrochemical measurements and applications of electrokinetic phenomena. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | This course aims to introduce electrochemical engineering as an extension to the fields of transport phenomena, thermodynamics, reaction and design that encompass engineering basics. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Electrochemical phenomena and processes are covered from an engineering perspective. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. To Recognize electrochemical engineering.  2. To solve electrochemical process problems.  3. To Apply knowledge of mathematics in electrochemical processes.  4. To Recognize the methods applied in electrochemical processes. | | | | | | | |
| **TEXTBOOK** | | | | | John Newman and Karen Thomas-Alyea, Electrochemical Systems, 3rd edition, John Wiley & Sons, New York, 2004. | | | | | | | |
| **OTHER REFERENCES** | | | | | G. A. Prentice, Electrochemical Engineering Principles, Prentice Hall, 1990. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | The Electric Potential |
| 2 | Structure of the Electric Double Layer |
| 3 | Electrodes |
| 4 | Electrode Kinetics |
| 5 | Thermodynamics in Terms of Electrochemical Potentials |
| 6 | Midterm Examination 1 |
| 7 | Fluid Mechanics in Electrochemical Systems |
| 8 | Convective-Transport Problems in Electrochemical Systems |
| 9 | Applications of Potential Theory |
| 10 | Limiting Current |
| 11 | Midterm Examination 2 |
| 12 | Electrokinetic Phenomena |
| 13 | Electrocapillary Phenomena |
| 14 | Electrochemical Measurement Techniques |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE Electrochemistry and Electrochemical Technology MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |
| **LO 12** |  |  |  |  |

**Prepared by:** Asistant Prof. Dr. Salim Erol **Date:** 06.11.2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **Electrochemistry and Electrochemical Technology (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | Electrochemical Sensors |

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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 | | | | | 2 | | 60 |
| Quiz | | | | |  | |  |
| Homework | | | | |  | |  |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Application of electrochemical methods about electrochemical sensors developed for the purpose of determination of certain chemical or molecular classes and wide knowledge of electrochemistry foundations, interpretation of mechanisms and electrochemical results of reduction-oxidation reactions, basic design steps of electrochemical sensors, essential components for electrochemical sensors. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | This course aims to characterization of the properties of electrochemical sensor systems by using different electrochemical methods. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Electrochemical phenomena and processes are covered from an interdisciplinary engineering perspective. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1.To describe the principles of electrochemical sensors.  2.To describe the properties of sensors and their applications in science.  3.To explain the electrochemical results of sensors for a process.  4.Have a fundamental knowledge about the instrumentation for sensing. | | | | | | | |
| **TEXTBOOK** | | | | | Zhang, X., Ju, H., & Wang, J. (Eds.). (2011). Electrochemical sensors, biosensors and their biomedical applications. Academic Press. | | | | | | | |
| **OTHER REFERENCES** | | | | | Raluca-Ioana Stefan, Electrochemical Sensors in Bioanalysis, CRC Press, 2001. Gabor Harsanyi, Sensors in Biomedical Applications - Fundamentals, Technology and Applications, CRC Press, 2000. Brian R. Eggins, Chemical Sensors and Biosensors, Analytical Techniques in the Sciences (ANTS), 2nd Edition, Wiley, 2002.Wang, Joseph, Analytical Electrochemistry, 3th edition, John Wiley & Sons, New Jersy, 2006.Advances in Biosensors, B.D. Malhotra, A.P.F.Turner, Elsevier JAI, 2003.Tokar, J. M., & Dickey, T. D. (2000). | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Fundamental Concepts of Electrochemistry |
| 2 | Sensors and Sensor Types |
| 3 | Electrochemical Sensors and Their Characteristics |
| 4 | Redox Process, Oxidation Potentials and Reduction Potentials |
| 5 | Electrochemical Methods for Electrochemical Sensors |
| 6 | Midterm Examination 1 |
| 7 | Facilitating Parameters of Redox Process |
| 8 | Roles of Electrochemical Electrodes |
| 9 | Performance Parameters of Electrochemical Sensors |
| 10 | Performance Parameters of Electrochemical Sensors |
| 11 | Midterm Examination 2 |
| 12 | Instrumentation Used for Electrochemical Sensing |
| 13 | Applications for Food Safety |
| 14 | Applications for Biomedical Diagnosis |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE Electrochemistry and Electrochemical Technology MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Dr. Uğur Moralı **Date:**      

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND TECHNOLOGY (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | ELECTROPOLYMERIC SURFACE COATINGS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Basic principles of electrochemical methods, definition and importance of electropolymerization, electropolymerization-chemical polymerization difference, components in the electropolymerization process, surface pretreatments, oxidation reactions of monomers, electropolymerization by cyclic voltammetry, electropolymerization by chronoamperometry, electropolymerization by chronopotentiometry, spectroscopic, microscopic and physical characterization of electropolymeric coatings | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Understanding basic information about electropolymeric surface coatings | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To provide a scientific basis for surface coating techniques by electropolymerization and characterization of these coatings | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To know electropolymerization  To understand electrode processes and surface pretreatments  To understand electropolymerization techniques  To evaluate the characterization methods of electropolymeric coatings | | | | | | | |
| **TEXTBOOK** | | | | | Yıldız A., Genç Ö., Bektaş S., Enstrümental Analiz Yöntemleri, Hacettepe Üniv. Yayınları, 1997. | | | | | | | |
| **OTHER REFERENCES** | | | | | Cosnier S., Karyakin A., Electropolymerization Consepts Materials and Applications, Wiley, 2010. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Basic principles of electrochemical methods |
| 2 | Definition, importance and advantages of electropolymerization |
| 3 | Comparison of electropolymerization and chemical polymerization |
| 4 | Components of the electropolymerization process |
| 5 | Surface pretreatments before electropolymerization |
| 6 | Midterm Examination 1 |
| 7 | Oxidation reactions of monomers |
| 8 | Electropolymerization by cyclic voltammetry (CV) |
| 9 | Electropolymerization by chronoamperometry (CA) |
| 10 | Electropolymerization by chronopotentiometry (CP) |
| 11 | Midterm Examination 2 |
| 12 | Spectroscopic characterization of electropolymeric coatings (FTIR, UV) |
| 13 | Microscopic characterization of electropolymeric coatings (SEM, AFM) |
| 14 | Physical characterization of electropolymeric coatings (thickness, conductivity measurements) |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE       MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Assoc. Prof. Dr. Berrin DURAN **Date:** 22/10/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND TECHNOLOGY (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | CORROSION AND CORROSION TESTS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | | None | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Definition and importance of corrosion, thermodynamic and kinetic approach to corrosion, corrosion types, electrochemical technics for determination of corrosion rate (electrochemical impedance, polarization resistance, potentiodynamic polarization, dynamic impedance, harmonic analyis), corrosion prevention methods | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Understanding basic information about the technics used for the determination of rate of corrosion | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis about corrosion and corrosion test technics | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To know corrosion  To understand corrosion types  To evaluate the techniques used for determination of corrosion rate  To understand the methods used for corrosion prevention | | | | | | | |
| **TEXTBOOK** | | | | | Üneri S. Korozyon ve Önlenmesi, 2011, Poyraz Ofset. | | | | | | | |
| **OTHER REFERENCES** | | | | | Erbil M. Korozyon (İlkeler-Önlemler), 2012, Poyraz Ofset. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Definition and importance of corrosion |
| 2 | Thermodynamic approach to corrosion |
| 3 | Kinetic approach to corrosion |
| 4 | Corrosion types |
| 5 | Corrosion types |
| 6 | Midterm Examination 1 |
| 7 | Non-electrochemical techniques for determination of corrosion rate |
| 8 | Electrochemical techniques for determination of corrosion rate |
| 9 | Electrochemical impedance spectroscopy (theory, application and evaluation) |
| 10 | Polarization resistance (theory, application and evaluation) |
| 11 | Midterm Examination 2 |
| 12 | Potentiodynamic polarization (theory, application and evaluation) |
| 13 | Harmonic analysis and dynamic impedance (theory, application and evaluation) |
| 14 | Corrosion prevention methods |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE       MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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. |  |  |  |
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| **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 personal ethics and defend this approach in any medium. |  |  |  |
| **LO 12** |  |  |  |  |

**Prepared by:** Assoc. Prof. Dr. Berrin DURAN **Date:** 22/10/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND TECHNOLOGY (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | PROTON EXCHANGE MEMBRANE FUEL CELLS |

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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 | | 30 |
| Project | | | | |  | |  |
| Report | | | | |  | |  |
| Seminar | | | | |  | |  |
| Other (………) | | | | |  | |  |
| **Final Examination** | | | | | | | 40 |
| **PREREQUISITE(S)** | | | | |  | | | | | | | |
| **SHORT COURSE CONTENT** | | | | | Historical development, components, working principle, electrochemistry, thermodynamics, efficiency, application areas of proton exchange membrane fuel cells, advantages and disadvantages according to other type of fuel cells, production in laboratory conditions, electrical analysis of the proton exchange membrane fuel cells. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | To understand the structure, thermodynamics, electrochemistry, applications and production of proton-exchange membrane fuel cells for a healthier environment and sustainable technological development. Production and analysis of proton exchange membrane fuel cells in laboratory. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | To establish a scientific basis in the field of proton exchange membrane fuel cells. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | To be able to recognize proton exchange membrane fuel cells, to understand structure and working principle, to understand electrochemistry and thermodynamics, to be able to produce a proton exchange membrane fuel cell under laboratory conditions and to make electrical analysis. | | | | | | | |
| **TEXTBOOK** | | | | | \* Frano Barbir. (2005) PEM Fuel Cells: Theory and Practise. Elsevier Akademic Press. | | | | | | | |
| **OTHER REFERENCES** | | | | | \* Prof.Dr.Durmuş KAYA, Prof.Dr.H.Hüseyin ÖZTÜRK, Doç.Dr.Muhammet KAYFECİ. (2017). Hidrojen ve Yakıt Pili Teknolojisi. Umuttepe Yayınları. \* Prof.Dr.Beycan İbrahimoğlu. (2008). Hidrojenli Enerji Üreteçleri. Nobel Yayın Dağıtım. | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Historical development of proton exchange membrane fuel cell. |
| 2 | Proton exchange membrane fuel cell components. |
| 3 | Proton exchange membrane fuel cell operating principle. |
| 4 | Proton exchange membrane fuel cell efficiency. |
| 5 | Advantages and disadvantages of proton exchange membrane fuel cells compared to other fuel cells. |
| 6 | Midterm Examination 1 |
| 7 | Application areas of proton exchange membrane fuel cell. |
| 8 | Production of proton exchange membrane fuel cells under laboratory conditions. |
| 9 | Production of proton exchange membrane fuel cells under laboratory conditions (continued). |
| 10 | Production of proton exchange membrane fuel cells under laboratory conditions (continued). |
| 11 | Midterm Examination 2 |
| 12 | Electrical analysis of proton exchange membrane fuel cell. |
| 13 | Electrical analysis of proton exchange membrane fuel cell (continued). |
| 14 | Electrical analysis of proton exchange membrane fuel cell (continued). |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND TECHNOLOGY MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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 Electrochemistry 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 personal ethics and defend this approach in any medium. |  |  |  |
| **LO 12** |  |  |  |  |

**Prepared by:** Murat KELLEGÖZ, Ph.D. **Date:** 07/11/2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | Electrochemical Treatment Technics |

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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 (√)]** | | | | | | |
| 2 | | 1 | | | |  | | | | | | |
| **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** | | | | | Itroduction to Electrochemical Treatment, electrochemical Reactors, Design Parameters, Electrochemical Treatment Process(Electrooxidation, Electrocoagulation, Electroflotation, Electrodialysis..) Application examples. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | Comprehend the principles of electrochemical purification; to introduce the electrochemical methods and application areas used in water and wastewater treatment | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | Students will have knowledge about principles, application areas and advantages of electrochemical treatment techniques. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. Comprehends the general principles of electrochemical treatment techniques.  2. Explains electrochemical treatment methods and different aspects from chemical methods.  3. Recognize the basic and new application areas of electrochemical treatment.  4. Recognize the environmental effects of electrochemical treatment techniques. | | | | | | | |
| **TEXTBOOK** | | | | | Electrochemical Water Treatment Methods: Fundamentals, Methods and Full Scale Applications, 2017, 1st Edition, M. Sillanpää and M. Shestakova, Imprint: Butterworth-Heinemann, ISBN: 9780128114629, 310 p. | | | | | | | |
| **OTHER REFERENCES** | | | | | Electrochemical Water and Wastewater Treatment, 2018, Edited by:C. A. Martínez-Huitle, M. A. Rodrigo and O. Scialdone, Imprint: Butterworth-Heinemann, ISBN: 978-0-12-813160-2, 556 p.Articles about the topics in the course | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction to Electrochemical Treatment |
| 2 | Fundamentals of Electrochemical Processes in Water and Wastewater Treatment |
| 3 | Equipment for Electrochemical Water Treatment, Electrochemical Reactors |
| 4 | Reactor types, electrodes |
| 5 | Electroreduction |
| 6 | Midterm Examination 1 |
| 7 | Electrooxidation |
| 8 | Electrocogulation, Electroflotation |
| 9 | Electro-Fenton, Peroxi-coagulation, Photoelectrocatalysis, Sonoelectrocatalysis |
| 10 | Electrodialysis, Reverse Electrodialysis |
| 11 | Midterm Examination 2 |
| 12 | Electrodeionization, Capacitive Deionization |
| 13 | Microbial Fuel Cells, Industrial applications of electrochemical treatment |
| 14 | Homework presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
| **LO 1** | Learning to use knowledges which have been gained by undergraduate education in the postgraduate areas. |  |  |  |
| **LO 2** | To have a research qualificaiton with professional responsibility. |  |  |  |
| **LO 3** | Self-developing by following and being aware of the importance of innovation and Electrochemistry 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. |  |  |  |
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| **LO 6** | To follow closely the developments of Electrochemistry in both national and international levels. |  |  |  |
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| **LO 10** | Using the ability to take initiative by acting independently. |  |  |  |
| **LO 11** | To have a scientific and personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Assoc.Prof.Dr. Belgin Karabacakoğlu **Date:** 12.11.2018

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** | **ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES (MSc)** | **SEMESTER** |  |

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| **COURSE** | | | |
| **CODE** |  | **TITLE** | BATTERIES |

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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 (√)]** | | | | | | |
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| **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** | | | | | Importance of energy storage and introduction to battery technology, working principles of batteries, investigation of various battery technologies/chemistries, fabrication, characterization and applications of advanced batteries. | | | | | | | |
| **COURSE OBJECTIVES** | | | | | The aim of the course is to investigate the working principles and properties of the batteries and their components under the light of fundamental science and also to have information about their fabrication, characterization and applications. | | | | | | | |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** | | | | | The course will contribute to become familiar with the advanced batteries, which are the energy storage systems that we are encountering more and more frequently in our daily lives. This course will help to ones working on the batteries to learn their working principles, to know the materials used in them, to have knowledge about their fabrication, and characterization methods, and also to gain skills to develop new products by identifying common and specific application areas. | | | | | | | |
| **LEARNING OUTCOMES OF THE COURSE** | | | | | 1. To gain knowledge about the propoerties of the batteries and their components.  2. To design new batteries by using the physical and chemical properties of various battery technologies.  3. Be capable to produce new batteries, to characterize them and to develop new application areas.  4. Be able to develop novel research and application areas for various battery technologies with similar characteristics. | | | | | | | |
| **TEXTBOOK** | | | | | Robert A. Huggins, Advanced Batteries, Springer, ISBN 978-0-387-76424-5 | | | | | | | |
| **OTHER REFERENCES** | | | | | Robert A. Huggins, Energy Storage, Springer, ISBN 978-1-4419-1023-3 | | | | | | | |

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| **COURSE SCHEDULE (Weekly)** | |
| **WEEK** | **TOPICS** |
| 1 | Introduction to Energy Storage |
| 2 | Basic characteristics of the batteries |
| 3 | Battery components |
| 4 | Lithium ion batteries |
| 5 | Lithium sulfur batteries |
| 6 | Midterm Examination 1 |
| 7 | Sodium ion batteries and Potassium ion batteries |
| 8 | Aluminium ion batteries |
| 9 | Calcium ion and Magnesium ion batteries |
| 10 | Zinc ion batteries |
| 11 | Midterm Examination 2 |
| 12 | Aqueous batteries |
| 13 | Air batteries |
| 14 | Redox flow batteries |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTROCHEMISTRY AND ELECTROCHEMICAL TECHNOLOGIES MSc PROGRAM LEARNING OUTCOMES** | | **CONTRIBUTION LEVEL** | | |
| **NO** | **LEARNING OUTCOMES (MSc)** | **3**  High | **2**  Mid | **1**  Low |
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| **LO 10** | Using the ability to take initiative by acting independently. |  |  |  |
| **LO 11** | To have a scientific and personal ethics and defend this approach in any medium. |  |  |  |

**Prepared by:** Assistant Professor Recep Yuksel **Date:** 15.11.2021

**Signature**: