**ELECTRICAL ELECTRONICS ENGINEERING (English)PhD PROGRAMME**

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| **First Year** |
| **I. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 501011901 | [THE SCIENTIFIC RESEARCH METHODS AND ITS ETHICS](#d0) | 7.5 | 3+0+0 | 3 | **C** | English |
|  | Elective Course-1 | 7.5 | 3+0+0 | 3 | E | English |
|  | Elective Course-2 | 7.5 | 3+0+0 | 3 | E | English |
|  | Elective Course-3 | 7.5 | 3+0+0 | 3 | E | English |
|  | Total of I. Semester  | 30 |  | 12 |  |  |
| **II. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
|  | Elective Course-4 | 7.5 | 3+0+0 | 3 | E | English |
|  | Elective Course-5 | 7.5 | 3+0+0 | 3 | E | English |
|  | Elective Course-6 | 7.5 | 3+0+0 | 3 | E | English |
| 505712001 | PhD Seminar | 7.5 | 0+1+0 | - | **C** | English |
|  | 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 |
| 505711801 | PhD PROFICIENCY  | 30 | 0+1+0 | - | **C** | English |
|  | Total of III. Semester  | 30 |  |  |  |  |
| **IV. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 501011902 | THESIS PROPOSAL | 30 | 0+1+0 | **-** | **C** | Turkish |
|  | Total of IV. Semester  | 30 |  |  |  |  |
|  | TOTAL OF SECOND YEAR  | 60 |  |  |  |  |

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| **Third Year** |
| **V. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 505711802 | PhD THESIS STUDY | 25 | 0+1+0 | - | **C** | English |
| 505711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0+0 | - | **C** | English |
|  | Total of V. Semester  | 30 |  |  |  |  |
| **VI. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 505711802 | PhD THESIS STUDY | 25 | 0+1+0 | - | **C** | Turkish |
| 505711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0+0 | - | **C** | Turkish |
|  | Total of VI. Semester  | 30 |  |  |  |  |
|  | TOTAL OF THIRD YEAR  | 60 |  |  |  |  |

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| **Fourth Year** |
| **VII. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 505711802 | PhD THESIS STUDY | 25 | 0+1+0 | **-** | **C** | English |
| 505711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0+0 | **-** | **C** | English |
|  | Total of VII. Semester | 30 |  |  |  |  |
| **VIII. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 505711802 | PhD THESIS STUDY | 25 | 0+1+0 | **-** | **C** | English |
| 505711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0+0 | - | **C** | English |
|  | Total of VIII. Semester | 30 |  |  |  |  |
|  | TOTAL OF FOURTH YEAR | 60 |  |  |  |  |

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| **Elective Courses** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 505711501 | [APPLIED COMPUTER VISION FOR ROBOTICS](#d5) | 7.5 | 3+0+0 | 3 | E | English |
| 505711502 | [Introduction to Robotics](#d4) | 7.5 | 3+0+0 | 3 | E | English |
| 505711503 | [BIOMEDICAL PATTERN RECOGNITION](#d1) | 7.5 | 3+0+0 | 3 | E | English |
| 505712601 | [Robot Path Planning](#d6) | 7.5 | 3+0+0 | 3 | E | English |
| 505712602 | [Diffraction Theory](#d10) | 7.5 | 3+0+0 | 3 | E | English |
| 505712603 | [Nonlinear Programming for Engineering Sciences](#d8) | 7.5 | 3+0+0 | 3 | E | English |
| 505712604 | [Machine learning for computer vision applications](#d7) | 7.5 | 3+0+0 | 3 | E | English |
| 505712605 | [Control of Robotic Manipulators](#d3) | 7.5 | 3+0+0 | 3 | E | English |
| 505712606 | [Analytical Methods in Electromagnetic Theory](#d9) | 7.5 | 3+0+0 | 3 | E | English |
| 505712607 | [BIOMEDICAL SIGNAL PROCESSING AND MODELLING](#d2) | 7.5 | 3+0+0 | 3 | E | English |

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**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** |  501011901 | **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. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Being able to have researcher qualification with occupational sense of responsibility.  | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Becoming skillful at analyzing and reporting the data obtained in scientific researches. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Gaining awareness on ethical principles at basic research methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **Prepared by :**  |   | **Date:** |  |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  BIOMEDICAL PATTERN RECOGNITION  |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | 3 |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 30 |
| Quiz |   |    |
| Homework |   |    |
| Project | 1 | 30 |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |  None. |
| **SHORT COURSE CONTENT** |  Pattern Recognition (PR) techniques are widely used for medical applications for a long time. This course will introduce the most frequently preferred PR techniques in biomedical signal classification studies. |
| **COURSE OBJECTIVES** |  The objective of this course is first to make student familiar with general approaches such as Bayes Classification, Nearest Neighbor Rule, Principal Component Analysis and later to concentrate on more often used modern classification techniques such as Support Vector Machines and 2D subspace-based classifiers for solving biomedical problems. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  This course, in particular, will provide a different perspective to the engineers who work in the field of biomedical career. |
| **LEARNING OUTCOMES OF THE COURSE** |  To introduce the fundamental descriptions and basic concepts of pattern classification,To learn how to use MATLAB software in pattern recognition applications,To understand the basic and advanced 1-D classifiers,To be informed of classical and modern 2-D classifiers,To introduce 1-D biomedical signals (ECG, EMG, etc.) and investigate their characteristics,To introduce 2-D biomedical signals (Digital Mammography, CT images, etc.) and investigate their characteristics,To learn the operation of pattern recognition methods used in the biomedical signal classification studies. |
| **TEXTBOOK** |  Duda, R.O., Hart, P.E., and Stork D.G. (2001). Pattern Classification. John Wiley and Sons, New York, USA. |
| **OTHER REFERENCES** |  Theodoridis, S. ve Koutroumbas K. (2009). Pattern Recognition, Academic Press, Cambridge, Massachusetts, USA. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Review: Vectors and Matrices |
| 2 | Review: Probability |
| 3 | Introduction to Pattern Classification. Statistical Pattern Recognition: Bayes Decision Theory, Bayes Classifier, Minimum Distance Classifier, Naive Bayes Classifier, Special Cases. |
| 4 | Basic 1-D Classifiers: k-Nearest Neighbor Classifier (k-NN), Principal Component Analysis (PCA). |
| 5 | Basic 1-D Classifiers: Linear Discriminant Analysis (LDA).  |
| 6 | Advanced 1-D classifiers: Support Vector Machines (SVM), Kernel PCA, Direct-LDA |
| 7 | Midterm |
| 8 | Classical 2-D classifiers: 2DPCA, 2DLDA |
| 9 | Modern 2-D classifiers: 2DSVD (2D Singular Value Decomposition), Common Matrix Approach (CMA), Tensor-based Approaches (using HOSVD) |
| 10 |       |
| 11 | Introduction to 1-D Biomedical Signals (ECG, EMG, etc.). 1-D Biomedical Signal Processing and Classification. A Case Study for Raw ECG Signals |
| 12 | Introduction to 2-D Biomedical Signals (Digital Mammography, Fundus Fluorescein Angiography, etc.)  |
| 13 | 2-D Biomedical Signal Processing and Classification. A Case Study for Raw Mammogram Images. |
| 14 | Feature Selection Methods: Sequential Wrapper Algoritms: SFS, SBS, LRS, BDS, SFFS.       |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[x]**  |

**Prepared by:** Assoc. Prof. Dr. Semih ERGİN\_ **Date:** 02/02/2022

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  BIOMEDICAL SIGNAL PROCESSING AND MODELLING |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | 3 |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 30 |
| Quiz |   |    |
| Homework |   |    |
| Project | 1 | 30 |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |  None. |
| **SHORT COURSE CONTENT** |  Nowadays, one of the most common research areas is biomedical signals and the accurate analysis of these signals. In this course, various types of biomedical signals will be analyzed and modeled by signal processing techniques. |
| **COURSE OBJECTIVES** |  The first objective of this course is to introduce the students with two basic concepts of signal processing which are linear systems and probabilistic processes. In the later stages of the course, various filtering and estimation methods will be focused on several biomedical signals. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  This course, in particular, will provide a different perspective to the engineers who work in the field of biomedical career. |
| **LEARNING OUTCOMES OF THE COURSE** |  To know the general definitions and basic concepts of signal processing,To be able to comprehend the most basic subjects on linear systems in detail,To be able to analyze random variables, probabilistic processes and their use on biomedical signals,To evaluate the analysis and models of 1-D (ECG, EMG, etc.), 2-D (Digital Mammography, Ultrasonography images, etc.) and 3-D (MRI, Tomography, etc.) biomedical signals,To learn how to use MATLAB software in biomedical signal processing and modeling applications. |
| **TEXTBOOK** |  Eugene N. Bruce, (2001). Biomedical Signal Processing and Signal Modeling, John Wiley and Sons, New York, USA. |
| **OTHER REFERENCES** |  Steven Kay, (1998). Fundamentals of Statistical Signal Processing, Prentice Hall, New Jersey, USA. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Properties of biological signals: Non-stationary, non-linear, non-Gaussian. Linear shift invariant systems.  |
| 2 | Finite and infinite impulse responses. Moving average filters. |
| 3 | Discrete Fourier transform. Magnitude and phase responses. Poles and zeros. Stability and Causality.  |
| 4 | Convolution theorem. Linear versus circular convolution. |
| 5 | Discrete versus continuous time signals. Sampling theorem. Pre-filtering: Up and Down-sampling. |
| 6 | Probability distribution and density functions of 1D random variables. Conditional distribution. Normal distribution and the central limit theorem.  |
| 7 | Midterm |
| 8 | Moments and Cumulants. Characteristic functions. Gaussian and Poison distributions. |
| 9 | Multivariate distributions. Multivariate Gaussian functions.  |
| 10 | Statistical independence and factorization. Bayes theory and prior/posterior probabilities. Probabilistic prediction. Auto-Correlation. Shifts in biomedical signal frequencies and variance. |
| 11 | Linear discriminants. |
| 12 | Harmonic analysis: Estimation of heart rates from ECG signals. |
| 13 | Linear Prediction analysis: Estimation of the spectrum for 'thoughts' from EEG signals. |
| 14 | Filtering: X-ray filtering. Independent components analysis. Wavelets.  |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[x]**  |

**Prepared by:** Assoc. Prof. Dr. Semih ERGİN\_      **Date:** 02/02/2022

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Control of Robotic Manipulators |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   |   |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 35 |
| Quiz |   |    |
| Homework | 5 | 20 |
| Project |   |    |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 45 |
| **PREREQUISITE(S)** |  - |
| **SHORT COURSE CONTENT** |  Introduction and definitions. Stability theory.Structure and properties of robot dynamic equation. Cartesian and other dynamics, actuator dynamics Computed-torque control. Adaptive control of robotic manipulators.Robust Control of robotic manipulators Force control. |
| **COURSE OBJECTIVES** |  The aim of this course is to teach control techniques of robotic manipulators. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Students will be able to develop control methods for industrial robots. |
| **LEARNING OUTCOMES OF THE COURSE** |  Learning how to control a complex system. |
| **TEXTBOOK** |  Lewis F.L., C. T. Abdallah, and D. M. Dawson, Control of Robot manipulators, Macmillan, New York, 1993. |
| **OTHER REFERENCES** |  Sciavicco, L., and Siciliano, B. Modeling and Control of Robot Manipulators, Mc Graw Hill, 1996. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Introduction and definitions. |
| 2 | Stability theory. |
| 3 | Structure and properties of robot dynamic equation. |
| 4 | Cartesian and other dynamics, |
| 5 | actuator dynamics |
| 6 | Computed-torque control |
| 7 | Computed-torque like control |
| 8 | Midterm Exam |
| 9 | Adaptive control of robotic manipulators |
| 10 | Adaptive control of robotic manipulators |
| 11 | Robust control of robotic manipulators |
| 12 | Robust control of robotic manipulators |
| 13 | Force Control |
| 14 | Force Control |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[ ]**  |

**Prepared by:** Prof. Dr. Osman Parlaktuna **Date:** 16.01.2022

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Introduction to Robotics |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   |   |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 35 |
| Quiz |   |    |
| Homework | 5 | 20 |
| Project |   |    |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 45 |
| **PREREQUISITE(S)** |  - |
| **SHORT COURSE CONTENT** |  Introduction and definitions. Spatial relations: position, rotation, homogeneous transformation matrix, Euler angles.Kinematics. Relations between joints and links of a robot manipulator.Inverse kinematics. Velocities, Jacobian matrix, static forces.Dynamics: Newton-Euler and Lagrangian methods.Trajectory generation |
| **COURSE OBJECTIVES** |  1)Teaching the spatial relations between objects.2) Deriving kinematics of robotic manipulators3) Solving inverse kinematics of robotic manipulators4) Deriving dynamics equations of robotic manipulators |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Students can derive the equations of industrial robots. |
| **LEARNING OUTCOMES OF THE COURSE** |  Students will learn how to model an industrial robot. |
| **TEXTBOOK** |  Craig J. J., Introduction to Robotics: Mechanics and Control, 3rd Ed. Addison Wesley, Reading Mass., 2004.  |
| **OTHER REFERENCES** |  Sciavicco, L., and Siciliano, B. Modeling and Control of Robot Manipulators, Mc Graw Hill, 1996. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Introduction and definitions. |
| 2 | Spatial relations: position, rotation |
| 3 | Homogeneous transformation matrix, Euler angles. |
| 4 | Kinematics. |
| 5 | Kinematics. |
| 6 | Relations between joints and links of a robot manipulator. |
| 7 | Inverse kinematics. |
| 8 | Midterm Exam |
| 9 | Inverse kinematics. |
| 10 | Velocities, Jacobian matrix, static forces. |
| 11 | Dynamics |
| 12 | Newton-Euler Method |
| 13 | Lagrangian method |
| 14 | Trajectory generation |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[ ]**  |

**Prepared by:** Prof. Dr. Osman Parlaktuna **Date:** 16.01.2022

**Signature**:

**T.C.**

**ESKİŞEHİR OSMANGAZİ ÜNİVERSİTESİ**

**FEN BİLİMLERİ ENSTİTÜSÜ**

**DERS BİLGİ FORMU**

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  APPLIED COMPUTER VISION FOR ROBOTICS |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | 3 |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 20 |
| Quiz |   |    |
| Homework | 4 | 30 |
| Project | 1 | 20 |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 30 |
| **PREREQUISITE(S)** |  Introduction to Image Processing |
| **SHORT COURSE CONTENT** |  Feature Detectors and Descriptors, 3D reconstruction, Stereo reconstruction, Visual odometry, Localization, Mapping, SLAM |
| **COURSE OBJECTIVES** |  (1) understand and apply fundamental mathematical and computational techniques in computer vision (2) implement computer vision techniques to be used in robotic tasks |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Students will be able to use computer vision techniques for specific robotic applications and integrate them to robotic systems. |
| **LEARNING OUTCOMES OF THE COURSE** |  Learning advanced topics of Computer Vision for robotic applications. Ability to design vision-based components of pipelines for robotic tasks. |
| **TEXTBOOK** |  Computer Vision: Algorithms and Applications, by R. Szeliski, Springer, 2011. |
| **OTHER REFERENCES** |  Robot Vision,B. Horn, MIT Press 1986. Computer Vision: A Modern Approach, Forsyth and Ponce, Prentice Hall 2002.Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard and Dieter Fox, MIT Press, 2005. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Edge detection, Thresholding, Morphological Image Processing, Connected Components, Contour Extraction |
| 2 | Image segmentation, Region based methods, Edge based methods, K-means, Watershed Algorithm |
| 3 | Feature Detectors and Descriptors, Feature Matching and Tracking |
| 4 | RGBD Sensors, 3D Reconstruction, Depth Sensor Technologies |
| 5 | Stereo vision: Camera calibration, epi-polar geometry, fundamental matrix, pixel andfeature-based approaches for stereo matching. |
| 6 | Visual odometry: Image features, RANSAC, Optical flow analysis |
| 7 | Ego-motion estimation : Visual servoing, model matching |
| 8 | Navigation : Exploration algorithms, obstacle avoidance, landmark based navigation. |
| 9 | Localization: Kalman filters |
| 10 | Localization: Monte-Carlo methods, particle fields, distance filters. |
| 11 | Mapping: occupancy grids, topological maps  |
| 12 | Simultaneous localization and mapping (SLAM) |
| 13 | Project presentations |
| 14 | Project presentations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[x]**  |

**Prepared by:** Helin Dutağacı **Date:**

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Robot Path Planning |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **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 |   |    |
| Quiz |   |    |
| Homework | 3 | 60 |
| Project | 1 | 40 |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** |    |
| **PREREQUISITE(S)** |  - |
| **SHORT COURSE CONTENT** |  Bug Algorithms, Potential functions and collision avoidance behavior, roadmaps, path planning for coverage problem, graph theory and graph-based shortest path planning algorithms, search-based shortest path planning algorithms |
| **COURSE OBJECTIVES** |  To know behavior-based path planning algorithms such as Bug algorithms for mobile robots. To introduce collision avoidance algorithms. To be able to learn roadmap concept. To know path planning algorithms for coverage problem. To be able to use graph and grid based shortest path algorithms.  |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  In this course, students will be familiar to produce global and local path plans for mobile robots. They will also learn to develop behaviors for collision avoidance. They will learn to implement programs for robots that perform the produced paths. Then, they will learn to choose approporiate algorithms in terms of time and memory complexity for producing path plans.  |
| **LEARNING OUTCOMES OF THE COURSE** |  1) Students will learn behavior-based path planning algorithms such as Bug algorithms.2) Students will learn approaches for collision avoidance.3) Students will learn roadmap concept and they will learn approaches frequently used for producing roadmaps.4) Students will learn path planning aproaches for coverage problem.5) Students will learn graph theory and graph-based shortest path algorithms.6) Students will learn search-based shortest path algorithms.  |
| **TEXTBOOK** |  Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, Principles of Robot Motion Theory, Algorithms, and Implementations, MIT Press, 2005. |
| **OTHER REFERENCES** |  Ahuja, Ravindra; Magnanti, Thomas; Orlin, James, Network Flows: Theory, Algorithms, and Applications, Pearson, 2015.Web cites |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Introduction to path planning problem |
| 2 | Bug Algorithms 1 |
| 3 | Bug Algorithms 2 |
| 4 | ROS and GAZEBO, Robot Programming |
| 5 | Potential Functions 1 |
| 6 | Potential Functions 2 |
| 7 | State-of-the-art collision avoidance approaches |
| 8 | Roadmaps 1 |
| 9 | Roadmaps 2 |
| 10 | Path Planning for Coverage Problem 1 |
| 11 | Path Planning for Coverage Problem 2 |
| 12 | Graph Theory |
| 13 | Graph-Based Shortest Path Algorithms |
| 14 | Search-Based Shortest Path Algorithms |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[x]**  |

**Prepared by:** Asist. Prof. Burak Kaleci **Date:** 24/01/2022

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Machine learning for computer vision applications |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **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 | 30 |
| Project | 1 | 30 |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |  An "Introduction to Image Processing" or a similar lecture is recommended as a preliminary |
| **SHORT COURSE CONTENT** |  Machine learning fundamentals, image descriptors, classification, artificial neural networks, convolutional neural networks for visual computing.  |
| **COURSE OBJECTIVES** |  To introduce the basic concepts of machine learning and basic concepts of deep learning architecture that have recently achieved great achievements in computer vision applications using visual images. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Students who take this course can make various object recognition applications by using some pretrained models or they can create their own models by training a basic visual classifier. |
| **LEARNING OUTCOMES OF THE COURSE** |  -Understanding some image description definitions,-Image classification-Regression based learning,-To analyze various artificial neural network models,-To design an image recognition application by using pre-trained models. |
| **TEXTBOOK** |  -Ragav Venkatesan and Baoxin Li, "Convolutional Neural Networks in Visual Computing", ISBN: 978-1-4987-7039-2, Taylor & Francis, 2018. |
| **OTHER REFERENCES** |  -Steven W. Knox, "Machine Learning: a Concise Introduction", ISBN: 978-1-1194-3907-3, Wiley, 2018. -Simon Rogers, Mark Girolami, "A First Course in Machine Learning", ISBN: 978-1-4987-3856-9, Crc Press, 2018. -Sandro Skansi, "Introduction to deep Learning From Logical Calculus to Artificial Intelligence", ISBN: 978-3-319-73003-5, Springer, 2018. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Background: Machine Learning, Computer Vision |
| 2 | Fundamental concepts on digital image processing |
| 3 | Image features: Transform spaces, LBP, LTP, Gradients |
| 4 | Image descriptors: Histogram of Gradients (HOG) |
| 5 | Image descriptors: Scale invariant features (SIFT), Speeded-up robust features (SURF) |
| 6 | Machine learning fundamentals: probabilistic modelling, clustering. |
| 7 | Supervised Learning and Inference, Unsupervised Learning: Clustering |
| 8 | Midterm presentations |
| 9 | Subspace based classification |
| 10 | Support Vector Machine (SVM) Classification |
| 11 | Artificial Neural Networks: perceptron, backpropagation, feed forward neural networks |
| 12 | Convolutional Neural Networks: regularization, stochastic gradient descent, on-line learning |
| 13 | CNN architectures: LeNet, AlexNet |
| 14 | CNN architectures: GoogleNet, VGG-19 |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[ ]**  |

**Prepared by:** Dr. Öğr. Üyesi Hasan Serhan Yavuz **Date:** 25.03.2022

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING PhD (English)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Nonlinear Programming for Engineering Sciences |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   |   |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 20 |
| Quiz |   |    |
| Homework | 1 | 20 |
| Project | 1 | 20 |
| Report |   |    |
| Seminar |   |    |
| Other (………) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |  - |
| **SHORT COURSE CONTENT** |  Convexity; Fundamentals of Unconstrained Optimization; Trust-Region Methods; Conjugate Gradient Methods; Newton’s method; Fundamentals of Algorithms for Nonlinear Constrained Optimization. |
| **COURSE OBJECTIVES** |  Aim of this course is to teach the major topics of nonlinear programming methods with the basic mathematical tools needed for the subject. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Ability to choose and apply the necessary tools and methods to solve the problems in engineering applications related to the nonlinear programming. |
| **LEARNING OUTCOMES OF THE COURSE** |  1) Students learn basic topics of nonlinear programming.2) Students learn how to implement different techniques of nonlinear optimization.3) Students can develop algorithms for nonlinear optimization methods.4) Students learn how the nonlinear programming techniques can be applied to solve some real-world problems.  |
| **TEXTBOOK** |  E. K. P. Chong and S. H. Zak, An introduction to Optimization, Wiley & Sons, 2nd edition, 2001. |
| **OTHER REFERENCES** |  M. S. Bazaraa, H. D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Wiley & Sons, 3rd edition, 2006.S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 | Convexity |
| 2 | Fundamentals of Unconstrained Optimization |
| 3 | Fundamentals of Unconstrained Optimization |
| 4 | Line Search Methods |
| 5 | Trust-Region Methods |
| 6 | Conjugate Gradient Methods |
| 7 | Practical Newton Methods |
| 8 | Practical Newton Methods |
| 9 | Midterm Examination 1 |
| 10 | Quasi-Newton Methods |
| 11 | Fundamentals of Algorithms for Nonlinear Constrained Optimization |
| 12 | Fundamentals of Algorithms for Nonlinear Constrained Optimization |
| 13 | Presentations of student projects |
| 14 |       |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD in English PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 5** | Ability to work effectively in interdisciplinary and multidisciplinary teams, making leadership of these kind of teams. Ability to work independently and taking responsibility. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Awareness of social, environmental, health, safety, and legal issues of engineering applications and Project management. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[x]**  |

**Prepared by:** Prof. Dr. Hakan Çevikalp **Date:** 24/3/2022

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING (PhD)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Analytical Methods in Electromagnetic Theory |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | 3 |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 30 |
| Quiz |   |    |
| Homework | 2 | 40 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 30 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Partial differential equations and Fourier analysis, boundary-value problems, Strum-Liouville problems, modal analysis in electromagnetic waveguides, mode-matching technique, analysis of some step discontinuities with mode-matching technique, generalized scattering matrix method |
| **COURSE OBJECTIVES** |  Provide the ability to analyze electromagnetic problems with mathematical analysis |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Provide ability to analyze fundamental problems of RF engineering. |
| **LEARNING OUTCOMES OF THE COURSE** |  1-Understand Fourier analysis and Strum-Liouville problems2- Analyze waveguides with modal analysis3- Apply mode-matching technique to waveguide problems4- Apply generalized scattering matrix method to waveguide problems |
| **TEXTBOOK** |  R. Mittra ve S. W. Lee, Analytical Techniques in the Theory of Guided Waves, The MacMillan Company, New York, 1971. |
| **OTHER REFERENCES** |  Mithat İdemen, Lineer Sınır Değer Problemleri ve Özel Fonksiyonlar, İTÜ Vakfı Yayınları, İstanbul, 2015. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Partial differential equations |
| 2 |  Fourier analysis |
| 3 |  Fourier analysis applications to Laplace equation |
| 4 |  Boundary-value problems |
| 5 |  Applications of boundary-value problems |
| 6 |  Applications of Strum-Liouville problems |
| 7 |  Midterm Exam |
| 8 |  Modal analysis in electromagnetic waveguides |
| 9 |  Analysis of sudden area expansion with mode-matching technique |
| 10 |  Analysis of sudden area contraction with mode-matching technique |
| 11 |  Analysis of single-axis discontinuity in rectangular waveguides with mode-matching technique |
| 12 |  Analysis of double-axis discontinuity in rectangular waveguides with mode-matching technique |
| 13 |  Generalized scattering matrix method applied on sudden are expansion and contraction |
| 14 |  Generalized scattering matrix method applied on complex discontinuities |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas.  | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design, plan, manage, finalize, and implement innovative multi-disciplinary works  | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to present and publish academic studies in any academic environment | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 5** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to make critical analysis, synthesis and evaluation of ideas and developments in the area of work. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[ ]**  |

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| **Prepared by :**  |  Assoc. Prof. Dr. Özge YANAZ ÇINAR | **Date:** |  28.03.2022 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

|  |  |  |  |
| --- | --- | --- | --- |
| **DEPARTMENT** |  **ELECTRICAL ELECTRONICS ENGINEERING (PhD)** | **SEMESTER** |   |

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| **COURSE** |
| **CODE** |        | **TITLE** |  Diffraction Theory |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | English |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   |   |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 30 |
| Quiz |   |    |
| Homework | 2 | 40 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 30 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Review on electromagnetic theory, Fourier transform and Wiener-Hopf technique, half-plane problem, modified Wiener-Hopf geometries, several scattering problems along waveguides. |
| **COURSE OBJECTIVES** |  Teaching Wiener-Hopf technique for application on electromagnetic and acoustic wave diffraction |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Providing the ability of mathematical analysis for some applications related to wave scattering |
| **LEARNING OUTCOMES OF THE COURSE** |  1. Apply Wiener-Hopf technique on diffraction of electromagnetic and acoustic waves.2. Solve problems related to modified Wiener-Hopf geometries.3. Apply spectral iteration technique.4. Analyze scattering in waveguides. |
| **TEXTBOOK** |  Ben Noble, Methods Based on the Wiener-Hopf Technique, Pergamon Press, 1958 |
| **OTHER REFERENCES** |  Alinur Büyükaksoy, Gökhan Uzgören, Ali Alkumru, Dalga Kırınımında Analitik Yöntemler Cilt I – II, İTÜ Vakfı Yayınları, 2011 |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Maxwell equations, electromagnetic boundary conditions, edge and radiation conditions, Fourier transform, Wiener-Hopf technique |
| 2 |  Diffraction by a half-plane (Dirichlet problem) |
| 3 |  Diffraction by a half-plane (Neumann problem) |
| 4 |  Modified Wiener-Hopf geometry of the first kind: Diffraction by a strip |
| 5 |  Modified Wiener-Hopf geometry of the first kind: Diffraction by a strip |
| 6 |  Modified Wiener-Hopf geometry of the second kind: Diffraction by a step discontinuity |
| 7 |  Modified Wiener-Hopf geometry of the second kind: Diffraction by a step discontinuity |
| 8 |  Midterm Exam |
| 9 |  Diffraction by a step discontinuity on a parallel-plate waveguide |
| 10 |  Diffraction by a step discontinuity on a parallel-plate waveguide |
| 11 |  Diffraction by a step discontinuity on a waveguide with circular cross-section |
| 12 |  Diffraction by a step discontinuity on a waveguide with circular cross-section |
| 13 |  Analysis of successive step discontinuities with Generalized Scattering Matrices |
| 14 |  Analysis of successive step discontinuities with Generalized Scattering Matrices |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE ELECTRICAL ELECTRONICS ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Ability to apply knowledge of mathematics, basic sciences and engineering in expertise level in Electrical-Electronics Engineering and other related areas.  | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Developing new and original ideas and methods; ability to develop innovative/alternative solutions in system, component or process design. | **[x]**  | **[ ]**  | **[ ]**  |
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| **LO 4** | Ability to present and publish academic studies in any academic environment | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 5** | Ability to use a foreign language at an advanced level, ability to communicate in oral and written forms. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to make critical analysis, synthesis and evaluation of ideas and developments in the area of work. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Advanced level of Professional and ethical responsibility. | **[ ]**  | **[ ]**  | **[x]**  |

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| **Prepared by :**  |  Prof. Dr. Gökhan ÇINAR | **Date:** |  28.03.2022 |

**Signature**: