**MECHANICAL ENGINEERING PhD 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](#EN35) | 7.5 | 3+0 | 3 | **C** | Turkish |
| 503712608 | [NUMERICAL SOLUTION OF ENGINEERING PROBLEMS](#EN32) | 7.5 | 3+0 | 3 | **C** | Turkish |
|  | Elective Course-1 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Elective Course-2 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Total of I. Semester  | 30 |  | 12 |  |  |
| **II. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
|  | Elective Course-3 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Elective Course-4 | 7.5 | 3+0 | 3 | E | Turkish |
|  | Elective Course-5 | 7.5 | 3+0 | 3 | E | Turkish |
| 503712001 | PhD Seminar | 7.5 | 0+1 | - | **C** | Turkish |
|  | Total of II. Semester  | 30 |  | 9 |  |  |
|  | TOTAL OF FIRST YEAR | 60 |  | 21 |  |  |

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| **Second Year** |
| **III. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 503711801 | PhD PROFICIENCY | 30 | 0+1 | **-** | **C** | Turkish |
|  | Total of III. Semester | 30 |  |  |  |  |
| **IV. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 501011102 | THESIS PROPOSAL | 30 | 0+1 | **-** | **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 |
| 503711802 | PhD THESIS STUDY | 25 | 0+1 | **-** | **C** | Turkish |
| 503711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0 | **-** | **C** | Turkish |
|  | Total of V. Semester | 30 |  |  |  |  |
| **VI. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 503711802 | PhD THESIS STUDY | 25 | 0+1 | **-** | **C** | Turkish |
| 503711803 | SPECIALIZATION FIELD COURSE | 5 | 3+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 |
| 503711802 | PhD THESIS STUDY | 25 | 0+1 | **-** | **C** | Turkish |
| 503711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0 | **-** | **C** | Turkish |
|  | Total of VII. Semester | 30 |  |  |  |  |
| **VIII. Semester** |
| Code | Course Title | ECTS | T+P | Credit | C/E | Language |
| 503711802 | PhD THESIS STUDY | 25 | 0+1 | **-** | **C** | Turkish |
| 503711803 | SPECIALIZATION FIELD COURSE | 5 | 3+0 | - | **C** | Turkish |
|  | 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 |
| 503711610 | [ADVANCED ENGINEERING DYNAMICS](#EN14) | 7.5 | 3+0 | 3 | E | Turkish |
| 503712601 | [ADVANCED ENGINEERING THERMODYNAMICS](#EN15) | 7.5 | 3+0 | 3 | E | Turkish |
| 503711611 | [BOUNDARY LAYER THEORY](#EN28) | 7.5 | 3+0 | 3 | E | Turkish |
| 503712605 | [ENERGY AND MOMENTUM TRANSFER](#EN16) | 7.5 | 3+0 | 3 | E | Turkish |
| 503711605 | [EXERGY ANALYSIS OF THERMAL SYSTEMS](#EN3) | 7.5 | 3+0 | 3 | E | Turkish |
| 503711612 | [HYDRAULIC AND PNEUMATIC TRANSPORT](#EN19) | 7.5 | 3+0 | 3 | E | Turkish |
| 503712602 | [MATERIALS AND SURFACE ENGINEERING IN TRIBOLOGY](#EN24) | 7.5 | 3+0 | 3 | E | Turkish |
| 503711606 | [PART PROGRAMMING IN CNC MACHINES](#EN17) | 7.5 | 3+0 | 3 | E | Turkish |
| 503711607 | [SURFACE MODIFICATION](#EN29) | 7.5 | 3+0 | 3 | E | Turkish |
| 503712606 | [VIBRATION ANALYSIS & CONTROL IN MECHANICAL SYSTEMS](#EN4) | 7.5 | 3+0 | 3 | E | Turkish |

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**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503701605 | **TITLE** |  EXERGY ANALYSIS OF THERMAL SYSTEMS |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | -  | -  | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( X ) | Turkish |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework |   |    |
| Project | 2 | 30 |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  The laws and fundamental concepts of thermodynamics; Gouy-Stodola thoremi; Entropy production; Concept of Exergy; Exergy Analysis of steady-State systems; Non-flow Systems; Entropy production via heat Transfer; Local Entropy Production during Convective Heat transfer; Entropy Analysis of Heat Exchangers; Exergy Analysis of Energy and Power Systems. |
| **COURSE OBJECTIVES** |  To supply necessary knowledge for the engineering problems including energy to get better systems by teaching the fundamental aspects of energy and exergy losses |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Providing the ability to analysis of all engineering systems in terms of exergy and to design new efficient termal systems |
| **LEARNING OUTCOMES OF THE COURSE** |  Providing the ability to analysis of all engineering systems in terms of exergy and to design new efficient termal systems |
| **TEXTBOOK** |  Adrian Bejan, Entropy generation through heat and fluid flow, Wiley int. Ed. 2nd Ed. 1994. VAN WYLEN, Gordon J. And SONNTAG, Richard E., “Fundamentals of Classical Thermodynamics”, 2nd Ed., John Wiley & Sons, Inc, 1978  |
| **OTHER REFERENCES** |  ÇENGEL, Yunus A. and TURNER Robert H., “Fundamentals of Thermal-Fluid Sciences" 1. Ed., McGraw-Hill Book Comp., 2001  |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Concepts and Laws of Thermodynamics |
| 2 |  Gouy-Stodola teorem |
| 3 |  Entropy Generation |
| 4 |  Concept of Exergy |
| 5 |  Exergy Analysis of Steady-flow Systems |
| 6 | Midterm Examination 1 |
| 7 |  No-flow Systems |
| 8 |  No-flow Systems |
| 9 |  Entropy Generation through Heat Transfer |
| 10 |  Entropy Generation through Heat Transfer |
| 11 | Midterm Examination 2 |
| 12 |  Local Entropy Generation during Convective Heat Transfer      |
| 13 |  Entropy Analysis of Heat Exchangers |
| 14 |  Entropy Analysis of Energy and Power Generation Systems      |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Prof. Dr.L. Berrin ERBAY | **Date:** |        |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503711601 | **TITLE** |  SPECIAL TOPICS IN HEAT TRANSFER |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | -  | -  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | Turkish |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework |   |    |
| Project | 2 | 30 |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Heat transfer problems carrying special interest: Heat Transfer at Extended Surfaces, Extended Surfaces with Relative Motion and Internal Heat Generation, Approximate Methods, Semi - Infinite Solid Model, Concentrated Sources and Sinks, Heat Conduction Through Fibrous Materials, Convection through Porous Media, Curved Duct Flow, Annular Channel Flow, Two-Phase Flow Heat Transfer, Melting and Solidification, Melting and Solidification |
| **COURSE OBJECTIVES** |  Providing the ability to analze, solve and examine the whole heat btransfer problems faced in the engineering systems |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Solving the governing equations of the special heat transfer subjects by using computer softwares with numerical analysis |
| **LEARNING OUTCOMES OF THE COURSE** |  Solving the governing equations of the special heat transfer subjects by using computer softwares with numerical analysis |
| **TEXTBOOK** |  Kakaç, S. and Yener, Y. Convective Heat Transfer, CRC Press, 2nd ed. (ISBN 0-8493-9939-4) 1995. |
| **OTHER REFERENCES** |        |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction |
| 2 |  Heat Transfer at Extended Surfaces |
| 3 |  Extended Surfaces with Relative Motion and Internal Heat Generation |
| 4 |  Approximate Methods, Semi - Infinite Solid Model |
| 5 |  Concentrated Sources and Sinks |
| 6 | Midterm Examination 1 |
| 7 |  Heat Conduction Through Fibrious Materials |
| 8 |  Convection through Porous Media |
| 9 |  Curved Duct Flow |
| 10 |  Annular Channel Flow |
| 11 | Midterm Examination 2 |
| 12 |  Two-Phase Flow Heat Transfer |
| 13 |  Melting and Solidification |
| 14 |  General Discussion |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Prof. Dr. L. Berrin ERBAY | **Date:** |        |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503711602 | **TITLE** |  THERMOHYDRAULIC DESIGN I |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | -  | -  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | Turkish |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework |   |    |
| Project | 2 | 30 |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Basic Considerations in Design, Modeling of Thermal Systems, Numerical Modeling and Simulation, Softwares, Acceptable Design of a Thermal System, Syntesis of Different Design Steps, Problem Formulation for Optimization, Lagrange Multipliers |
| **COURSE OBJECTIVES** |  Teaching the combination of subjects given in the courses of heat transfer, thermodynamics, fluid mechanics and numerical analysis in the context of designing a thermal system |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Designing a new thermal system and analyzing conventional systems for obtaining optimum designs |
| **LEARNING OUTCOMES OF THE COURSE** |  Designing a new thermal system and analyzing conventional systems for obtaining optimum designs |
| **TEXTBOOK** |  Yogesh Jaluria, Design and Optimization of Thermal systems, McGraw-Hill, Inc., 1998 |
| **OTHER REFERENCES** |  W.F. Stocker, Design of Thermal systems, McGraw-Hill, Inc., 1989. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction |
| 2 |  Basic Considerations in Design  |
| 3 |  Basic Considerations in Design: Examples  |
| 4 |  Modeling of Thermal Systems and Complex Systems |
| 5 |  Numerical Modeling and Simulation and Softwares |
| 6 | Midterm Examination 1 |
| 7 |  Acceptable Design of a Thermal System: Introduction |
| 8 |  Acceptable Design of a Thermal System  |
| 9 |  Syntesis of Different Design Steps |
| 10 |  Problem Formulation for Optimization Introduction and Complex Enerji Systems |
| 11 | Midterm Examination 2 |
| 12 |  Lagrange Multipliers: Introduction |
| 13 |  Lagrange Multipliers: Thermohydroulic systems |
| 14 |  Lagrange Multipliers: Power Plants |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Prof. Dr. L. Berrin ERBAY | **Date:** |        |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503701609 | **TITLE** |  ADVANCED ENGINEERING DYNAMICS |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 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 |   |    |
| Quiz |   |    |
| Homework | 1 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Kinematics, Generalized Speed & Forces, Mass Center & Moment of Inertia, Inertia Matrix, Various (Newton-Euler, Lagrange & Kane) Formulations of Motion, Energy Functions |
| **COURSE OBJECTIVES** |  Comprehensive analysis of the tools in analytical mechanics |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  The course aims to teach how to develop mathematical models that describe the dynamics of systems of rigid bodies and continuous systems, and to address the formulation of equations of motion for complicated mechanical systems and the methods for solving these equations. |
| **LEARNING OUTCOMES OF THE COURSE** |  By the end of this module students will be able to:1) describe position, velocity and acceleration in diffrent Coordinate Systems, 2) comprehend the value of the terms such as force/torque, work/energy, impulse/ momentum etc. in three dimensional dynamic system modeling,3) apply common modelling techniques to multi-body 3D dynamic systems, 4) evaluate the dynamics of a complex 3D enginering system and perform synthesis towards optimization.  |
| **TEXTBOOK** |  Dynamics: Theory And Applications, T. R. Kane and D. A. Levinson, Mcgraw Hill, New York, 1985. |
| **OTHER REFERENCES** |  Lecture Notes |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction |
| 2 |  Vectors and Their Differentiation  |
| 3 |  Kinematics: Velocity & Acceleration |
| 4 |  Generalized Coordinates, Generalized and Partial Speeds |
| 5 |  Constraints, Mass Center, Inertia |
| 6 | Midterm Examination 1 |
| 7 |  Inertia Matrix and Dyadic, Parallel Axis Theorem |
| 8 |  Principal/Maximum/Minimum Moment of Inertia |
| 9 |  Generalized Active & Inertia Forces, Friction |
| 10 |  Energy Functions |
| 11 | Midterm Examination 2 |
| 12 |  Newton-Euler, Lagrange Formulation |
| 13 |  Kane Formulation |
| 14 |  Applications |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Assoc. Prof. Dr. Naci Zafer | **Date:** |  15 May 2015 |

**Signature**:

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**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503712601 | **TITLE** |  ADVANCED ENGINEERING THERMODYNAMICS |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | -  | -  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | Turkish |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework |   |    |
| Project | 2 | 30 |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  First and Second Laws of thermodynamics and their applications to closed and open systems; Steady-State, Steady-Flow Processes, Uniform-state uniform-flow processes and continuity equation; The concept of irreversibility;; Single and two-phase systems; Power generation; Cooling; Thermodynamic Design |
| **COURSE OBJECTIVES** |  Teaching the importance and application of thermodynamics at all energy conversion systems and applications in engineering To teach thermodynamic laws for the design purposes considering energy efficient and sustainable future needs. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  After the course, students will be able to have fundamental information of the thermodynamic laws; explain the ways for enhancing energetic efficiency of energy conversion systems;; analyse a new system. |
| **LEARNING OUTCOMES OF THE COURSE** |  After the course, students will be able to analyse an engineering system in terms of thermodynamics; explain the ways for enhancing the energetic efficiency of energy conversion systems; explain the reasons for energy and exergy loses; analyse a new system. |
| **TEXTBOOK** |  BEJAN Adrian, Advanced Engineering Thermodynamics, John Wiley & Sons, Inc. ISBN0-471-61747-4, 1988. |
| **OTHER REFERENCES** |  ÇENGEL, Yunus A. ve BOLES, Michael A., Thermodynamics with Engineering Approach, McGraw-Hill, 1996. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  First and Second Laws of Thermodynamics |
| 2 |  Application of First and Second Laws of Thermodynamics to Closed Systems |
| 3 |  Application of First and Second Laws of Thermodynamics to Control Volume |
| 4 |  Steady-State Steady-Flow and Uniform-State Uniform-Flow Processes |
| 5 |  Continuity and Energy Conservation |
| 6 | Midterm Examination 1 |
| 7 |  Irreversiblitiy Concepts |
| 8 |  Irreversiblitiy Concepts |
| 9 |  Definition of Entropy |
| 10 |  Definition of Entropy |
| 11 | Midterm Examination 2 |
| 12 |  Anaylysis of Exergy and Exergy Loss |
| 13 |  Single-Phase Systems |
| 14 |  Multi-Phase Systems |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Prof. Dr. L. Berrin ERBAY  | **Date:** |        |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503712605 | **TITLE** |  ENERGY AND MOMENTUM TRANSFER |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | -  | -  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | Turkish |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
| T | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework |   |    |
| Project | 2 | 30 |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 40 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Viscosity  , Thermal Conductivity k, Formulation Technique, Shell Momentum Balances, Velocity Profiles, Average Velocity, Momentum flux, Shell Energy Balances, Temperature Profiles, (isothermal - non isothermal), Multi Dimensional Transport Phenomena, Momentum and Energy Transport with two independent variables, Laminar Forced Convection in Pipes and Ducts, Unsteady Forced convection in Ducts |
| **COURSE OBJECTIVES** |  Teaching the fundamentals of energy and momentum transport to supply the solution of the engineering problems including energy and momentum transport |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Providing the ability of investigation and examining the whole engineering systems in terms of energy and momentum transfer |
| **LEARNING OUTCOMES OF THE COURSE** |  Analyzing all of the engineering systems from the aspects of the energy and momentum transport and designing new thermal systems |
| **TEXTBOOK** |  R.Byron Bird-Warren E. Stewart- Edwin N. Lightfoot ,Transport Phenomena, John Wiley & Sons, Inc. 1960.  |
| **OTHER REFERENCES** |  Adrian Bejan, Convection Heat Transfer, Wiley int. Ed. 2nd Ed. 1995. Sadık Kakaç-Yaman Yener, Convective Heat Transfer, 2nd Ed.,CRC Publ. 1995. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Viscosity  , Newton’s Law of Viscosity, Temperature and Pressure Dependence of , Kinetic Theory of  |
| 2 |  Thermal Conductivity k, Fourier’ s Law of Heat Conduction, Temperature and Pressure Dependence of k, Kinetic Theory of k |
| 3 |  Formulation Technique, Five Steps of Formulation |
| 4 |  Shell Momentum Balances, Velocity Profiles, Average Velocity, Momentum flux at Surfaces |
| 5 |  Shell Energy Balances, Temperature Profiles, Average Temperature, Energy flux at surfaces |
| 6 | Midterm Examination 1 |
| 7 |  Equations of Change (isothermal) |
| 8 |  Equations of Change (non isothermal) |
| 9 |  Multi Dimensional Transport Phenomena |
| 10 |  Momentum Transport with two independent variables, Energy Transport with two independent variables |
| 11 | Midterm Examination 2 |
| 12 |  Laminar Forced Convection in Pipes - Formulation |
| 13 |  Laminar Forced Convection in Ducts- Formulation |
| 14 |  Unsteady Transport Phenomena |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |
| **Prepared by :**  |  Prof. Dr. L. Berrin ERBAY | **Date:** |        |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503711606 | **TITLE** |  Part Programming in CNC Machines |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  |    |    | 3  | 7,5 | COMPULSORY(   ) | ELECTIVE( x ) | Turkish |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | x |  3  |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework | 2 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Part programming techniques and terms, part programming, Selection of Machine, Feed values, Computer aided part programming, CAD/CAM Systems, Planning of Operations steps, Analysing of part programming |
| **COURSE OBJECTIVES** |  The purpose of the course is to teach using CNC Machine Tools |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Comprehension of part programming techniques and terms, Comprehension of part programming, Understanding of the selection of Machine, Understanding how to use feed values, Using of Computer aided part programming, understanding CAD/CAM Systems, Understanding CAPP Systems, Comprehension of Analysing of part programming.  |
| **LEARNING OUTCOMES OF THE COURSE** |  Description of NC Control, Introduce to CNC Machine Tools, Understand the tool control and repeatability, Saving the part programming and the terms, preparing of the part programmes and comments, list and derive G and M functions, Use and practise part programmes, test and simulate programmes, Evaluate of the part programmes. |
| **TEXTBOOK** |  1. Malkoç Ali, Özel Takım Tezgahları Ders Notları, 1999 2. FANUC Operator's Manual, 1988  |
| **OTHER REFERENCES** |  Gibbs David, (Çeviren: Malkoç Cengiz) CNC Parça Programlama, 1999 AKKURT Mustafa, CNC Takım Tezgahlarının Programlanması ve CAD-CAM Sistemleri, Birsen Yayınevi, 2010 |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Description of NC Control |
| 2 |  Slide motions, Spindle motion |
| 3 |  Spindle control, tool control |
| 4 |  Jig and fixtures |
| 5 |  Part programming and the terms |
| 6 | Midterm Examination 1 |
| 7 |  Feeds and Spindle speeds |
| 8 |  Part programming techniques |
| 9 |  G Functions |
| 10 |  M Functions |
| 11 | Midterm Examination 2 |
| 12 |  Part programming at the EMCO5 Educational CNC Lathe |
| 13 |  Part programming at FANUC Lathe |
| 14 |  Practice |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[ ]**  | **[x]**  |

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| **Prepared by :**  |  Öğr.Gör.Dr. Ahmet Nafi PEKÖZCAN | **Date:** |  5.5.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503702502 | **TITLE** |  Pneumatics |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  |    |    | 3  |     | 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 |   |    |
| Quiz |   |    |
| Homework | 1 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Description of theoretical and practical industrial system in which compressed air is used.  |
| **COURSE OBJECTIVES** |  Compressed air theory, project implementation and utilization in the industrial field of a pneumatic circuit . |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Evaluation of the position in the compressed air production and for the completion of the mechanical engineering in industrail formation . |
| **LEARNING OUTCOMES OF THE COURSE** |  Utilization and definition of compressed air as the act of preparing a practical project work , analysis and evaluation |
| **TEXTBOOK** |  1. Hydraulics and Pneumatics, Andrew A. Parr, Elsevier, 1999.2. Pnömatik, Peter Patient, Ray Pickup, Norman Powell, Çeviren: Prof. Dr. Yaşar PANCAR, Eskişehir, M.E.B. Yayını, 1994.3. Hidrolik ve Pnömatik, İsmail KARACAN, Ankara, 1989. |
| **OTHER REFERENCES** |  Handbook of Pneumatic Conveying Engineering, David Mills, Mark G. Jones, Vijay K. Agarwal, 2004. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Compressed Air Theory |
| 2 |  Production of Compressed Air and Methods Used |
| 3 |  Compressed Air Applications |
| 4 |  Pneumatic Circuits and Components  |
| 5 |  Production Components in Compressed Air Systems  |
| 6 | Midterm Examination 1 |
| 7 |  Pneumatic Valves, Cylinders and Other Circuit Components |
| 8 |  Laminar and Turbulent Flow Regime in the Flow Definition |
| 9 |  Flow Types |
| 10 |  Newton's Laws in Compressed Air Applications |
| 11 | Midterm Examination 2 |
| 12 |  Application Project |
| 13 |  Application Project |
| 14 |  Application Project |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Prof. Dr. Yaşar PANCAR | **Date:** |  09.10.2015 |

**Signature**:

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**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503711612 | **TITLE** |  Hydraulic and Pneumatic Transport |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  |    |    | 3  |     | 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 |   |    |
| Quiz |   |    |
| Homework | 1 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Theoretical and practical definition of material handling by fluid and compressed air.  |
| **COURSE OBJECTIVES** |  Theory of hydraulic and pneumatic transport, project of application and industrial implementation. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  In order to complete the mechanical engineering formation, assessment of material conveying in ındustry by hydraulic and pneumatic transport. |
| **LEARNING OUTCOMES OF THE COURSE** |  Understanding the two phase flow, preparing a study of project application in conveying material with fluid and compressed air using analysis and assessment. |
| **TEXTBOOK** |  Handbook of Pneumatic Conveying Engineering, David Mills, Mark G. Jones, Vijay K. Agarwal, 2004. |
| **OTHER REFERENCES** |  1.Pneumatic Conveying Design, David Mills, Elsevier, October 2003. 2. Pneumatic Conveying of Solids, Marcus R. D., 1990. 3.Hazırlanmış Ders Notları. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Hydraulic Transport Theory |
| 2 |  Hydraulic Transport Applications |
| 3 |  Hydraulic Transport Applications |
| 4 |  Pneumatic Transport Applications  |
| 5 |  Pneumatic Transport Applications  |
| 6 | Midterm Examination 1 |
| 7 |  Flow Regimes |
| 8 |  Transport by Laminer and transport by Laminer and Turbulence  |
| 9 |  Flow Types |
| 10 |  Newton Rules on Hydraulic and Pneumatic Transport |
| 11 | Midterm Examination 2 |
| 12 |  Application Project |
| 13 |  Application Project |
| 14 |  Application Project |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Assist. Prof. Dr. H. Sevil ERGÜR | **Date:** |  26.08.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503712602 | **TITLE** |  Materials and Surface Engineering in Tribology |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  |    |    | 3  |     | 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 |   |    |
| Quiz |   |    |
| Homework | 2 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Importance of tribology, theories of tribology and wear mechanisms, contact surfaces and its interaction, friction and wear of elements, methodology and technique of tribological testing, selection of materials for tribology, surface design for tribology. |
| **COURSE OBJECTIVES** |  Introduction of materials and surface engineering in tribology.Understand the experimental approaches and theories used in the tribology.Material selection and surface design according to the needs of different tribological systems. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Students gain skills about the tribological system solution and design subjects. |
| **LEARNING OUTCOMES OF THE COURSE** |  After completing the course students should obtain the knowledge of theoretical fundamentals and practical methods for decisions making according tribological problems in design and maintenance of machines and develop the ability to apply them to practical situations: • have a clear overall picture about the basics of tribology and related sciences, theoretical background about processes in tribological system, mechanisms and forms of interaction of friction surfaces; • have enough knowledge about the surface and materials applied for different tribological systems; • understand the principles and know the methodology of performing the tribological testing; • have good knowledge about the technologies and methods to increase the tribological reliability of machinery elements and friction joints. |
| **TEXTBOOK** |  Materials and Surface Engineering in Tribology, Jamal Takadoum, Wiley, 2008  |
| **OTHER REFERENCES** |  Friction, wear, lubrication : a textbook in tribology, K.C Ludema, CRC Press,1996Wear –Materials,Mechanism and Practice, Gwidon W. Stachowiak, Wiley, 2005. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction of Tribology |
| 2 |  Introduction of tribological applications |
| 3 |  Materials and surface treatments |
| 4 |  Tribological properties of coatings |
| 5 |  Tribological properties of coatings |
| 6 | Midterm Examination 1 |
| 7 |  Coating characterization and evaluation |
| 8 |  Coating selection |
| 9 |  Tribological applications and coatings |
| 10 |  Tribological applications and coatings |
| 11 | Midterm Examination 2 |
| 12 |  Tribological system design–coating selection |
| 13 |  Tribological system design–coating selection |
| 14 |  Tribological system design–coating selection |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Assist.Prof.Dr. Mustafa Ulutan | **Date:** |  07.05.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503702511 | **TITLE** |  COGENERATION SYSTEMS |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( x ) | TURKISH |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 30 |
| Quiz |   |    |
| Homework | 1 | 20 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |  ------ |
| **SHORT COURSE CONTENT** |  The definition of cogeneration, cogeneration systems, cogeneration system type selection criteria and thermodynamic cycles used in cogeneration systems, trigeneration applications, Energy and exergy analysis of cogeneration and trigeneration systems |
| **COURSE OBJECTIVES** |  Nowadays, efficient use of energy is very important. For these reason, cogeneration and trigeneration system to use more energy efficient techniques to gain knowledge and skills required for the project to be analyzed. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  The ability to set up and operation of cogeneration facility |
| **LEARNING OUTCOMES OF THE COURSE** |  Have knowledge about cogeneration and trigeneration systems, Ability to design elements of cogeneration system, Gain ability and knowledge to make energy and exergy analysis of cogeneration and trigeneration systems  |
| **TEXTBOOK** |  N.V. Khartchenko, Advanced Energy Systems, Taylor and Francis, 1998. |
| **OTHER REFERENCES** |  Acıkkalp E., Balli Ö., Yamik H., Aras H., Energy and Exergy Analysis of a Trigeneration Facility with Natural Gas Engine., Progress in Sustainable Energy Technologies Vol II, CHAPTER 41.p:621-635, Springer 2014. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction to cogeneration |
| 2 |  Cogeneration systems |
| 3 |  Selection criteria of cogeneration system type |
| 4 |  Classification of Cogeneration Systems |
| 5 |  Factors Influencing Cogeneration Choice |
| 6 | Midterm Examination 1 |
| 7 |  Thermodynamics cycles which used in cogeneration systems |
| 8 |  Energy and exergy analysis of cogeneration and trigeneration systems  |
| 9 |  Energy and exergy analysis of cogeneration and trigeneration systems  |
| 10 |  Applications |
| 11 | Midterm Examination 2 |
| 12 |  Topping and Bottoming cycles |
| 13 |  Investment models for Cogeneration |
| 14 |  Investment models for Cogeneration |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[x]**  | **[ ]**  | **[ ]**  |

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| **Prepared by :**  |  Prof.Dr.Haydar ARAS | **Date:** |  26.08.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503701608 | **TITLE** |  MODELLING OF SOLAR RADIATION CALCULATION |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  | 0  | 0  | 3  | 7.5 | COMPULSORY(   ) | ELECTIVE( X ) | TURKISH |
| **CREDIT DISTRIBUTION** |
| **Basic Science** | **Basic Engineering** | **Knowledge in the discipline****[if it contains considerable design content, mark with (√)]** |
|   | X |      |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm | 1 | 30 |
| Quiz |   |    |
| Homework | 1 | 20 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |  ------- |
| **SHORT COURSE CONTENT** |  Basic concepts and definitions, Solar angles, angles inclined surface, radiation coming from the atmosphere. Radiation from the earth's surface measurements of solar radiation, all solar radiation, direct and diffuse solar radiation, solar radiation on inclined surface, solar radiation in the open air. Provinces selected for the modeling studies based on geographic region in our country |
| **COURSE OBJECTIVES** |  The design of solar energy systems, the accuracy of solar radiation is extremely important. From the existing studies in the literature that measures the solar radiation and sunshine duration expensive due to the establishment and maintenance of the systems, the region closest to the measured values of the selected region using empirical formulas are developed for the region is work to be done. The best known and widely used of these formulas Angstrom formula. Instant from the earth, hourly and daily solar radiation values measured by meteorological stations with solar radiation measuring devices or it can be calculated with the aid of empirical or atmospheric correlations developed for the area.In this course, in our country, all of the daily solar radiation per unit area of the horizontal plane equations used to calculate and analysis of the results obtained from these relations will be discussed. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Be able to MODELLING OF SOLAR RADIATION CALCULATION  |
| **LEARNING OUTCOMES OF THE COURSE** |  PlHaving information about the Renewable Energy Resources Solar Energy Basics,Learning knowledge and skills to calculate solar radiation,To-date information about literature on the subjectThe model developed to understand the results to be obtained to access the Knowledge Levelease write minimum four learning outcomes for the course. |
| **TEXTBOOK** |  1) Güneş Enerjisi, Abdurrahman KILIÇ, Aksel ÖZTÜRK, Kipaş Dağıtımcılık, İstanbul, 1983.  |
| **OTHER REFERENCES** |  2) Güneş Enerjisi ve Uygulamaları, Ali Yücel UYAREL, Etem Sait ÖZ, Emel Matbaacılık Ankara, 1987. 3) Güneş Enerjili Su Isıtma Sistemler TÜBİTAK MAM, Kocaeli, 1997.  |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Basic Concepts and Definitions |
| 2 |  Solar Angles |
| 3 |  Angular Surface Angles |
| 4 |  Extraterrestirial Radiation |
| 5 |        |
| 6 | Midterm Examination 1 |
| 7 |  Global Solar Radiation |
| 8 |  Direct and Diffuse Solar Radiation |
| 9 |  Angular Plane Incoming Solar Radiation |
| 10 |  Introduction the Modelling |
| 11 | Midterm Examination 2 |
| 12 |  Model Studies for Different Provincies in Turkey |
| 13 |  Model Studies for Different Provincies in Turkey |
| 14 |  Model Studies for Different Provincies in Turkey |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[x]**  | **[ ]**  | **[ ]**  |

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| **Prepared by :**  |  Prof.Dr.Haydar ARAS | **Date:** |  26.08.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503711605 | **TITLE** |  Boundary Layer Theory |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  |    |    | 3  |     | 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 |   | 30 |
| Quiz |   |    |
| Homework | 2 | 20 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Conservation of mass, momentum, energy equations, kinematics, viscous flow, unsteady parallel flow, Stokes problems, similarity solution, aproximate methods for the solution of two dimensional steady boundary layer equations, stability of steady flows. |
| **COURSE OBJECTIVES** |  Derivation of mass, momentumand energy equations, application of these equations to parallel flow and boundary layer flows  |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Student gain the skills to apply the basic equations about the boundary layer to real, complex flows. |
| **LEARNING OUTCOMES OF THE COURSE** |  Apply Navier Sokes equations to sove the flow broblems such as parallel flow, flow betwee two cocentric cylindersapply the basic equations to boundary layer flows Analyse the boundary layer flows  |
| **TEXTBOOK** |  Schlichting, H. Boundary-Layer Theory, McGraw-Hill Book Company, 1979, USA |
| **OTHER REFERENCES** |  White, M. W. Viscous Fluid Flow, McGraw-Hill, Inc. 1991, SingapureRosenhad, L. Laminar Boundary Layers, Dover Publications 1988, USA |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Kinematic |
| 2 |  Conservation of mass, momentum, energy equations |
| 3 |  Conservation of mass, momentum, energy equations |
| 4 |  Exact solution of Navier Stokes equations, unsteady paralel flows  |
| 5 |  Very slow motion, Stokes problems  |
| 6 | Midterm Examination 1 |
| 7 |  Laminar boundary layer |
| 8 |  Laminar boundary layer |
| 9 |  Similarity solution |
| 10 |  Approximate methods for the solution of two dimensional steady boundary layer equations |
| 11 | Midterm Examination 2 |
| 12 |  Approximate methods for the solution of two dimensional steady boundary layer equations |
| 13 |  Stability of steady flows |
| 14 |  Stability of steady flows |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[x]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Assoc.Prof.Dr. Necati MAHİR | **Date:** |  07.05.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503711607 | **TITLE** |  Surface Modification |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 3  |    |    | 3  |     | 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 |   |    |
| Quiz |   |    |
| Homework | 2 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Surface modification techniques of metals. General and special processes. Diffusion techniques, chemical and physical vapour deposition techniques, and thermally assisted coatings. Surface properties that improved by these techniques. |
| **COURSE OBJECTIVES** |  Introduction of surface modification techniques of metal materials.Understand the importance of different properties and applications of the surface modification.Introduction of some advanced techniques of surface treatment of metals.Developing and decision-making according to needs of surface properties of manufactured parts. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Student gain the skills to advanced design and selection of the surface properties of different work materials. |
| **LEARNING OUTCOMES OF THE COURSE** |  Design a system, component, or process to meet desired needs.Get a recognition of the need for, and an ability to engage in life-long learning.Gain a knowledge of contemporary issues. Identify, formulate, and solve engineering problems.Improving knowledge about material selection for industrial applications. |
| **TEXTBOOK** |        |
| **OTHER REFERENCES** |  1. ASM Handbook Volume 5, “Surface Modification”2. Coating Materials and Surface Coating, Arthur A. Tracton.3. Advanced Thermally Assisted Surface Engineering Processess, Ramnarayan Chattopadhyay 4. Modern Surface Technology, Friedrich-Wilhelm Bach, Andreas  |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Surfaces |
| 2 |  Surface energy |
| 3 |  Tribological properties of surfaces |
| 4 |  Mechanical state of surfaces |
| 5 |  Mechanical state of surfaces |
| 6 | Midterm Examination 1 |
| 7 |  Chemical state of surfaces  |
| 8 |  Chemical state of surfaces |
| 9 |  Surface treatments and coatings |
| 10 |  Surface treatments and coatings |
| 11 | Midterm Examination 2 |
| 12 |  Selection and design of surface modification |
| 13 |  Selection and design of surface modification |
| 14 |  Selection and design of surface modification |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[x]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[x]**  | **[ ]**  |

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| **Prepared by :**  |  Assist.Prof.Dr. Mustafa ULUTAN | **Date:** |  07.05.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503712608 | **TITLE** |  Numerical Solution of Engineering Problems |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
|  **PhD** | 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 (√)]** |
|   | x |  3  |
| **ASSESSMENT CRITERIA** |
| **SEMESTER ACTIVITIES** | **Evaluation Type** | **Number** | **Contribution** **( % )** |
| Midterm |   |    |
| Quiz |   |    |
| Homework | 2 | 50 |
| Project |   |    |
| Report |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  Introduction, Initial and boundary value problems, Classification of partial differential equations, Finite difference formulations, Parabolic equations: Explicit and implicit methods, Elliptic equations, Hyperbolic equations. |
| **COURSE OBJECTIVES** |  Provide graduate students with sound knowledge of numerical methods for thermo-fluid systems, use this knowledge in the numerical solution of thermo-fluids problems. |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Give an ability to apply knowledge of numerical engineering problems |
| **LEARNING OUTCOMES OF THE COURSE** |  1. Ability to solve initial and boundary value problems employing various numerical techniques2. Make a distinction among elliptic, parabolic and hyperbolic equations and understand the corresponding physical phenomena3. Ability to solve parabolic equations using explicit and implicit methods4. Ability to solve elliptic equations using iterative method. |
| **TEXTBOOK** |  Joe D. Hoffman, “Numerical Methods for Engineers and Scientists"Marcel Dekker, 2001  |
| **OTHER REFERENCES** |  J.C. Tannehill, D.A. Anderson, R.H. Pletcher, “Computational FluidMechanics and Heat Transfer”, Washington, DC, Taylor and Francis,1997. |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction  |
| 2 |  Numerical solution of initial and boundary value problems |
| 3 |  Classification of partial differential equations: Elliptic, Parabolic and Hyperbolic equationsand related initial and boundary conditions. |
| 4 |  Numerical solution of parabolic partial differential equations |
| 5 |  Numerical solution of parabolic partial differential equations |
| 6 | Midterm Examination 1 |
| 7 |  Numerical solution of parabolic partial differential equations |
| 8 |  Numerical solution of elliptic partial differential equations |
| 9 |  Numerical solution of elliptic partial differential equations |
| 10 |  Numerical solution of elliptic partial differential equations |
| 11 | Midterm Examination 2 |
| 12 |  Numerical solution of hyperbolic partial differential equations |
| 13 |  Numerical solution of hyperbolic partial differential equations |
| 14 |  Numerical solution of hyperbolic partial differential equations |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[ ]**  | **[ ]**  |

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| **Prepared by :**  |  Assoc. Prof. Dr. Mesut TEKKALMAZ | **Date:** |  15.05.2015 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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

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

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

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE INSTITUTE’S GRADUATE PROGRAMME’S LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (M.Sc.-Ph.D.)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Having the scientific and vocational ethics’ understanding and being able to defend this understanding in every medium. | **[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:** |  14.06.2016 |

**Signature**:

**T.R.**

**ESKISEHIR OSMANGAZI UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**

**COURSE INFORMATION FORM**

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

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| **COURSE** |
| **CODE** |  503712606 | **TITLE** |  VIBRATION ANALYSIS & CONTROL IN MECHANICAL SYSTEMS |

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| **LEVEL** | **HOUR/WEEK** | **Credit** | **ECTS** | **TYPE** | **LANGUAGE** |
| **Theory** | **Practice** | **Laboratory** |
| **PhD** | 3  | 0  | 0  | 3  | 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 |   |    |
| Quiz |   |    |
| Homework | 1 | 50 |
| Project |   |    |
| Report |   |    |
| Seminar |   |    |
| Other (     ) |   |    |
| **Final Examination** | 50 |
| **PREREQUISITE(S)** |        |
| **SHORT COURSE CONTENT** |  The course aims to teach modeling, detection, elimination and control of noise & vibrations in machines. It provides comprehensive analysis of the tools in vibrational analysis, modeling/measurement and control. The specific topics addressed are: dynamic modeling & analysis, isolation techniques, vibration sources, vibration measurement and data analysis, vibration transducers, modal analysis, FFT, filtering, windowing, control of vibrations. |
| **COURSE OBJECTIVES** |  1) to provide practical knowledge on mechanical vibrations, 2) to teach how to analyze vibration behavior characteristics, 3) to study approches used in preventing and controlling vibrations |
| **COURSE CONTRIBUTION TO THE PROFESSIONAL EDUCATION** |  Students learn, by taking this course, how to model, eliminate and control machine vibrations. The course also aims to make them understand in detail the techniques of elimination and control of noise and vibrations. |
| **LEARNING OUTCOMES OF THE COURSE** |  By the end of this module students will be able to:1) model and analyze vibrations in machinery,2) learn how to determine vibration and noise sources,3) gain insight into vibration isolation and elimination techniques,4) learn practical aspects of vibration analysis & control techniques,5) understand the importance of condition monitoring. |
| **TEXTBOOK** |  Vibration of Discrete and Continuous Systems, A.A. Shabana, Springer |
| **OTHER REFERENCES** |  Lecture Notes |

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| **COURSE SCHEDULE (Weekly)** |
| **WEEK** | **TOPICS** |
| 1 |  Introduction: Mechanical Vibrations Review  |
| 2 |  Vibration Sources, Directions, Detection, Effects, Isolation and Prevention; Noise  |
| 3 |  Vibration Analysis: Spectrum: FFT, Interpretation, Periodic Measurements |
| 4 |  Vibration Analysis: Data Collection and Processing, Test Conditions , Vib Pattern, Waveform (RMS, Peak-to-Peak), Vib Standards, Demodulation; Practical Applications |
| 5 |  Waveform Analysis: Signal Conditioning, Modulation, Beating, Clipped Vibs etc.; Commonly Faced Issues (Impacting, Unbalance, Misalignment, Looseness, Damaged Parts, Cavities etc.)  |
| 6 | Midterm Examination 1 |
| 7 |  Frequency Domain Analysis (Fourier Transform & FFT) |
| 8 |  Matlab: Signals and FFT, Convolution, Sampling  |
| 9 |  Matlab: Signals with Noise, Filtering (Bandpass) |
| 10 |  Nyquist-Shannon theorem, Anti-Aliasing filter, Frequency leakage |
| 11 | Midterm Examination 2 |
| 12 |  Filter Types (Butterworth, Chebyshev, Bessel, Elliptical), Frequency Responses |
| 13 |  Signal Parameters for a Random Signal, Windowing (Hanning and Rectangular) |
| 14 |  Control of Vibrations (Passive, Semi-Active & Active) |
| 15,16 | Final Examination |

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| **CONTRIBUTION OF THE COURSE LEARNING OUTCOMES TO THE MECHANICAL ENGINEERING PhD PROGRAM LEARNING OUTCOMES** | **CONTRIBUTION LEVEL** |
| **NO** | **LEARNING OUTCOMES (PhD)**  | **3**High | **2**Mid | **1**Low |
| **LO 1** | Sufficient knowledge of mechanical engineering subjects related with science and own branch; an ability to apply theoretical and practical knowledge on solving and modeling of engineering problems. | **[x]**  | **[ ]**  | **[ ]**  |
| **LO 2** | Ability to determine, define, formulate and solve complex mechanical engineering problems; for that purpose an ability to select and use convenient analytical and experimental methods. | **[ ]**  | **[x]**  | **[ ]**  |
| **LO 3** | Ability to design a complex system, a component and/or an engineering process under real life constrains or conditions, defined by environmental, economical and political problems; for that purpose an ability to apply modern design methods. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 4** | Ability to develop, select and use modern methods and tools required for mechanical engineering applications; ability to effective use of information technologies. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 5** | In order to investigate mechanical engineering problems; ability to set up and conduct experiments and ability to analyze and interpretation of experimental results. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 6** | Ability to work effectively in inner or multi-disciplinary teams; proficiency of interdependence. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 7** | Ability to communicate in written and oral forms in Turkish/English; proficiency at least one foreign language. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 8** | Awareness of life-long learning; ability to reach information; follow developments in science and technology and continuous self-improvement. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 9** | Understanding of professional and ethical issues and taking responsibility | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 10** | Awareness of project, risk and change management; awareness of entrepreneurship, innovativeness and sustainable development. | **[ ]**  | **[ ]**  | **[ ]**  |
| **LO 11** | Knowledge of actual problems and effects of mechanical engineering applications on health, environment and security in global and social scale; an awareness of juridical results of engineering solutions. | **[ ]**  | **[ ]**  | **[ ]**  |

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| **Prepared by :**  |  Assoc. Prof. Dr. Naci Zafer | **Date:** |  15 May 2015 |

**Signature**: