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|  **COURSE DETAILS** |
| **Course Name** | Thermodynamics of Hydrocarbon Fluids |

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| **Language of Instruction** | Turkish |

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| **Level of Instruction** | Associate | Undergraduate  | MA(X) | Ph.D. () |

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| **Education System** |
| Formal Education (X) | Distance Education () | Other |

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| **Type of Course** | **Course Area Code** | **Course Optical Code** |
| Comp () | Elective (x) |  |  |

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| **Theory** | **Practice Time** | **Total Hours** | **Semester** | **National Credit** | **ECTS Credits** |
| 3 | 0 | 3 | Fall | 3 | 6 |

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| **Course Aim** |

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|  | * To introduce the basic concepts of thermodynamics;
* Giving information about the phase behavior of pure components and hydrocarbon mixtures that make up oil and natural gas;
* Improvement of energy and mass balance for open and closed systems;
* To teach how to calculate thermodynamic quantities using state equations and correlations;
* Explaining the concepts of chemical potential, fugacity, fugacity coefficient;
* To inform the students about the processes used to model oil and gas reservoirs.
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| **Course Content** |

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|  | General phase behavior of oil and gas systems; First and second laws; Thermodynamic processes; Mass and energy balance for open systems; PVT behavior of pure components; Equivalent law; State equations; Vapor pressure, z-factor, enthalpy, entropy and heat capacity correlations for hydrocarbon gases; Basic property relations for homogeneous phases; Methods of calculating residual properties; Joule-Thomson effect; Simple models for VLE; Basic property relations for mixtures, chemical potential and phase equilibrium, partial properties; Definition of fugacity and fugacity coefficient; Ideal mixing models; modeling of vapor-liquid balance; CCE, CVD and differential evaporation processes. |

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| **Prerequisites**  | • Basic concepts of thermodynamics,• Phase behavior of pure hydrocarbons and hydrocarbon mixtures;• Energy and mass balance for thermodynamic systems;• Determination of vapor-liquid balance using chemical potential, fugacity and fugacity coefficient;• Processes encountered during the production of oil and gas fluids. |

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| **Course Instructor** | Assistant Professor Hasan SAYĞILI |

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| **Assistant Instructor** |   |

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| **Text Book / Recommended Reading** | * Ahmed, T.H. (2007). Equation of State and PVT Analysis, Gulf Publishing Company
* Edminster, W., Lee, B. I. (1984). Applied Hydrocarbon Thermodynamics, 2nd ed. Gulf Publishing Company.
* Firoozabadi, A. (1999). Thermodynamics of Hydrocarbon Reservoirs, McGraw-Hill.
* Prausnitz, J. M., Lichtenthaler, R. N., de Azevedo, E. G. (1998). Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed., Prentice Hall.
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| **Grading Evaluation System** |
| (X) Direct Conversion System |   | () Curve |
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|  | **Tools** | **Number** | **Rate** |
|  | Attendance and Participation | 15 | 5 |
|  | Research homework | 1 | 15 |
|  | Quiz | 4 | 16 |
| **Measurement and Evaluation** | Presentations | 1 | 10 |
|  | Literature | 1 | 4 |
|  | Semester Exam | 1 | 50 |
|  | **Total** |  | **100%** |

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| **Subjects by Week** |
| **Week** | **Topics** | **Teaching Methods** |
| 1 | Basic concepts of thermodynamics, general phase behavior of oil and natural gas systems, first law of thermodynamics, internal energy, enthalpy, heat capacity, second law of thermodynamics | Lecture, discussion, sampling. |
| 2 | Phase rule, constant volume and constant pressure processes, mass and energy balance for open systems | Lecture, discussion, sampling. |
| 3 | PVT behavior of pure components, critical behavior, ideal gas, ideal gas processes | Lecture, discussion, sampling. |
| 4 | Equivalent states law, virial state equation, state of cubic state equations (vdW, RK, SRK, PR), general correlations for gases and liquids | Lecture, discussion, sampling. |
| 5 | Vapor pressure, z-factor for hydrocarbon gases, enthalpy, entropy and heat capacity correlations and their applications | Lecture, discussion, sampling. |
| 6 | Basic property relationships for homogeneous phases | Lecture, discussion, sampling. |
| 7 | Calculation of residual properties for residual properties, hydrocarbon gases using state equations and z-factor correlations | Lecture, discussion, sampling. |
| 8 | Joule-Thomson expansion and inversion curve, phase rule and Duhem's theorem | Lecture, discussion, sampling. |
| 9 | Joule-Thomson expansion and inversion curve, phase rule and Duhem's theorem | Lecture, discussion, sampling. |
| 10 | Simple models for VLE (Dalton, Raoult and Henry laws, ideal K values) | Lecture, discussion, sampling. |
| 11 | Simple models for VLE (Dalton, Raoult and Henry laws, ideal K values) | Lecture, discussion, sampling. |
| 12 | Basic property relations for mixtures, chemical potential and phase equilibrium, partial properties | Lecture, discussion, sampling. |
| 13 | Basic property relations for mixtures, chemical potential and phase equilibrium, partial properties | Lecture, discussion, sampling. |
| 14.  | Calculation of fugacity and fugacity coefficient for pure hydrocarbons and hydrocarbon mixtures | Lecture, discussion, sampling. |
| 15 | Ideal mixture models and Lewis-Randall rule, excess properties, property changes caused by mixing | Lecture, discussion, sampling. |
| 16 | Ideal mixture models and Lewis-Randall rule, excess properties, property changes caused by mixing | Lecture, discussion, sampling. |
| 17 | Final  | Written exam |

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| **Program Outcomes** | 01 | 02 | 03 | 04 |
| PO 01  | Comprehend the basic concepts of thermodynamics and apply them to petroleum and natural gas systems. | 5 | 4 | 4 | 5 |
| PO 02 | Knows the phase behavior of pure hydrocarbons and hydrocarbon mixtures. | 4 | 5 | 5 | 4 |
| PO 03 | Determine chemical potential, fugacity and vapor-liquid balance using fugacity coefficient. | 5 | 4 | 4 | 5 |
| PO 04 | Knows the processes encountered during the production of petroleum and natural gas fluids. | 5 | 5 | 5 | 5 |
| PO 05 | Determine energy and mass balance for thermodynamic systems. | 5 | 5 | 5 | 5 |

\* 1: Very Low 2: Low 3: Medium 4: High 5: Very high

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| **Student workload / ECTS account**  |
| **Activities** | **Number** | **Preparation** | **Duration of Activity** | **Total Workload** |
| Theoretical Course | 14 | - | 3 | 42 |
| Scientific homework  | 14 | - | 2 | 28 |
| The library search | 2 | - | 10 | 20 |
| Presentation | 2 | - | 15 | 30 |
| Quiz | 1 | - | 30 | 30 |
| Semester Exam | 1 | - | 40 | 40 |
| Total Workload (Hour) | 34 |  |  | 190 |
| Roll [Total Workload (hours) / week work load (30)] = ECTS Credit | 190/30=6,33 |