

**Department:** Mining Engineering

**Division:** Mining Exploitation and Rock Mechanics

**Level and Major:** BSc, Mining Exploitation and Rock Mechanics

---

**Course Title:** Thermodynamics

**Number of Credits:** 3

**Prerequisite:** Mathematics2+Physics2+General Chemistry1

**Lecturer:** Dr. Amir Reza Azadmehr

---

### **Course Goals and Objectives**

Introduction to fundamental of thermodynamic

### **Course Topics**

- Colligative properties, elevation of boiling point, depression of freezing, osmotic pressure, van't Hoff equation.
- Phase diagrams, indicator diagram, temperature composition diagram, Ellingham classification, Debye-Hückel, partially miscible, steam distillation.
- Chemical equilibrium, relation of equilibrium with pressure, relation of equilibrium with temperature.
- Introduction to electrochemical thermodynamic
- Introduction thermodynamic: system, environmental, universal, isothermal, isobar, isolated system, open system, closed system, adiabatic, homogenous, heterogenous, perfect gas, real gas
- The first law of thermodynamic: The conservation of energy, work, Pressure–volume work, The measurement of work, work and heat, the measurement of heat, Internal energy and application
- Enthalpies of composition, standard enthalpies of formation, the variation of enthalpy with temperature
- The first law of thermodynamic: exact differential, function, internal energy, internal pressure, equation of state.
- The first law of thermodynamic: expansion coefficient and application, , internal energy change, isothermal joule- Thomson, inversion temperature
- The second law of thermodynamic: entropy and application, residual entropy, third law entropy, Clausius. Carnot cycle.
- Intrinsic molar entropy, Gibbs energy, standard Gibbs energy of reaction
- Maxwell relation, thermodynamic equation state, Helmholtz function, relation of Gibbs energy with pressure

- Phase diagram, phase transition, energy levels, Clausius–Clapeyron equation, Ehrenfest classification, Thomson- James.
- Partial molar volume, partial molar Gibbs energy, partial molar energy, molar property, thermodynamic equation state, entropy of mixing,
- Ideal solution, ideal- dilute solution, Raoul's law, partially miscible, regular solution.

### **Reading Resources**

- Peter Atkins, Julio de Paula, physical chemistry, oxford, 2007
- Ladislav Cemic, Thermodynamics in Mineral sciences, Springer, 2005
- Introduction to thermodynamic of materials