We will cover the following concepts,

- Internal Energy
- Energy by Heat Transfer
- Heat Transfer Modes
- Energy Balance for a Closed System

Internal Energy: Summation of Any other forms of energy stored in a system is called Internal Energy



$\Delta E = \Delta KE + \Delta PE + \Delta U$ = $(KE_2 - KE_1) + (PE_2 - PE_1) + (U_2 - U_1)$





Q > 0: heat transfer *to* the system Q < 0: heat transfer *from* the system

Energy by Heat Transfer

Rate Of Energy Transfer By Heat

$$\dot{Q} = \frac{Heat}{Time} = \frac{dQ}{dt}$$
$$Q = \int_{t_1}^{t_2} \dot{Q} dt$$

Heat Transfer Modes:

- Conduction: Energy Transfer between the Particles of a Substance
- Radiation: Change in Electronic Configuration of the Molecules
- Convection: Energy Transfer when Contacting Solid-Fluid or Fluid-Fluid



- Linear Variation

$$\dot{Q}_x = -kA\frac{T_2 - T_1}{L}$$

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Boltzmann's Law:

$$\dot{Q}_e = \varepsilon \sigma A T_b^4$$

 ϵ emissivity is a property of the surface that shows how effectively the surface radiates.

 σ is called Boltzmann's constant.

Newton's Law of Cooling

$$\dot{Q}_c = hA(T_b - T_f)$$

 T_b is solid surface temperature T_f is moving fluid temperature *h* heat transfer coefficient A is the surface area



Change in Total Energy = Net Heat Transfer In – Net Work Out

$$E_2 - E_1 = \Delta KE + \Delta PE + \Delta U = Q - W$$

 or

$$dE = \delta Q - \delta W$$

W > 0: work done *by* the system W < 0: work done *on* the system Q > 0: heat transfer *to* the system Q < 0: heat tranfer *from* the system Time Rate of Change of Total Energy = Net Rate of Heat Transfer *In* – Net Rate of Work *Out*

$$E_{2} - E_{1} = \Delta KE + \Delta PE + \Delta U = Q - W$$

or
$$\frac{dE}{dt} = \frac{dKE}{dt} + \frac{dPE}{dt} + \frac{dU}{dt} = \dot{Q} - \dot{W}$$

- Specific Properties

$$e = \frac{E}{m}, u = \frac{U}{m}$$

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First Law of Thermodynamics

