MEEG 2013 Quiz #3.m16

A. (3 pts) Describe the **potential energy** of a body.

B. (4 pts) Using the first law of thermodynamics for a closed system, derive the **principle of work and kinetic energy**:

$$T_1 + U_{1\to 2} = T_2$$

C. (3 pts) Using the above **principle of work and kinetic energy**, derive the **principle of conservation of mechanical energy**:

$$T_1 + V_1 = T_2 + V_2$$

A. The **potential energy** of a body in its current position with respect to a reference datum in a conservative force field is defined as the amount of work done by the conservative force on the body if the body travels from its current position to the reference datum.

B. The **first law of thermodynamics** states that the net energy transfer to a system from its surroundings is equal to the net increase in the total energy of the system. For a closed system, we have

$$Q_{\text{net}} + W_{\text{net}} = \Delta U + \Delta \text{KE} + \Delta \text{PE} \qquad Q_{\text{net}} = 0 \qquad W_{\text{net}} = U^N_{1\to 2} \qquad \Delta U = 0$$

$$\Delta \text{KE} = T_2 - T_1 \qquad \Delta \text{PE} = V_2 - V_1 = U^C_{2\to RD} - \left(U^C_{1\to 2} + U^C_{2\to RD}\right) = -U^C_{1\to 2}$$

$$0 + U^N_{1\to 2} = 0 + (T_2 - T_1) - U^C_{1\to 2} \qquad T_1 + \left(U^N_{1\to 2} + U^C_{1\to 2}\right) = T_2$$

$$U_{1\to 2} = U^N_{1\to 2} + U^C_{1\to 2} \qquad \therefore \quad T_1 + U_{1\to 2} = T_2$$

C. $$U_{1\to 2} = U^C_{1\to 2} = U^C_{1\to RD} + U^C_{RD\to 2} = U^C_{1\to RD} - U^C_{2\to RD} = V_1 - V_2$$

$$T_1 + (V_1 - V_2) = T_2 \qquad \therefore \quad T_1 + V_1 = T_2 + V_2$$