Course : Applied Thermal Engineering (UMT303)

Batch: B.E. Mechatronics (2nd yr.) **Faculty: Dr. Sayan Sadhu**

Tutorial No. 01 **Topic: General Energy Analysis**

Q1. A gas in a piston–cylinder assembly undergoes an expansion process for which the relationship between pressure and volume is given by pV^n =constant. The initial pressure is 3 bar, the initial volume is 0.1 m^3, and the final volume is 0.2 m^3. Determine the work for the process, in kJ, if (a) n = 1.5, (b) n = 1.0, and (c) n = 0. **[Ans. 17.6kJ, 20.79kJ, 30kJ]**

Q2. The rate of heat transfer between a certain electric motor and its surroundings varies with time as $\dot{Q} = -0.2[1 - e^{(-0.05t)}]$, where t is in seconds and Q is in kW. The shaft of the motor rotates at a constant speed of ω = 100 rad/s (about 955 revolutions per minute, or RPM) and applies a constant torque of T= 18 N m to an external load. The motor draws a constant electric power input equal to 2.0 kW. For the motor, plot Q and W, each in kW, and the change in energy ΔE, in kJ, as functions of time from t = 0 to t = 120 s. Discuss.

Q3. An average car consumes about 5 L of gasoline a day, and the capacity of the fuel tank of a car is about 50 L. The density of gasoline ranges from 0.68 to 0.78 kg/L, and its lower heating value is about 44,000 kJ/kg. Suppose all the problems associated with the radioactivity and waste disposal of nuclear fuels are resolved, and a car is to be powered by U-235. If a new car comes equipped with 0.1-kg of the nuclear fuel U-235, determine if this car will ever need refueling under average driving conditions. **[Ans. 40790 days]**

Q4. The efficiency of cooking appliances affects the internal heat gain from them since an inefficient appliance consumes a greater amount of energy for the same task, and the excess energy consumed shows up as heat in the living space. The efficiency of open burners is determined to be 73% for electric units and 38% for gas units. Consider a 2-kW electric burner at a location where the unit costs of electricity and natural gas are $0.09/kWh and $0.55/therm, respectively. Determine the rate of energy consumption by the burner and the unit cost of utilized energy for both electric and gas burners.

[Ans. 1.46kW, 0.123USD/kWh, 3.84kW, 0.049USd/kWh]

Q5. The water in a large lake is to be used to generate electricity by the installation of a hydraulic turbine–generator at a location where the depth of the water is 50 m . Water is to be supplied at a rate of 5000 kg/s. If the electric power generated is measured to be 1862 kW and the generator efficiency is 95%., determine (a) the overall efficiency of the turbine–generator, (b) the mechanical efficiency of the turbine, and (c) the shaft power supplied by the turbine to the generator **[Ans. 76%, 80%, 1964kW]**