CHAPTER 2. ENERGY; ENERGY TRANSFER; GENERAL ENERGY ANALYSES

1) What forms of energy involved during
   a) Heating of water on an electrical heater?
   b) Heating of lead (Pb) on an electrical heater from room temperature to 400°C? (Tm= 327°C)
      Also determine the type of energy transformations that take place.

2) Determine type of interactions take place between surroundings and the following stationary systems
   a) A gas in a piston–cylinder device is compressed, and as a result its temperature rises.
   b) A well-insulated room heated by candles inside and by an electric resistance.

3) Consider a river flowing toward a lake at an average velocity of 3 m/s at a rate of 500 m³/s at a location 90 m above the lake surface. Determine the total mechanical energy of the river water per unit mass and the power generation potential of the entire river at that location. (assume that there is no loss)

4) The engine of a 1500-kg automobile has a power rating of 75 kW. Determine the time required to accelerate this car from rest to a speed of 100 km/h at full power on a level road. Is your answer realistic?

5) A vertical piston–cylinder device contains water and is being heated on top of a range. During the process, 65 Btu of heat is transferred to the water, and heat losses from the side walls amount to 8 Btu. The piston rises as a result of evaporation, and 5 Btu of work is done by the vapor. Determine the change in the energy of the water for this process.

6) A fan is to accelerate quiescent air to a velocity of 10 m/s at a rate of 4 m³/s. Determine the minimum power that must be supplied to the fan. Take the density of air to be 1.18 kg/m³. (no loss due to frictional effects)

7) The driving force for fluid flow is the pressure difference, and a pump operates by raising the pressure of a fluid (by converting the mechanical shaft work to flow energy). A gasoline pump is measured to consume 5.2 kW of electric power when operating. If the pressure differential between the outlet and inlet of the pump is measured to be 5 kPa and the changes in velocity and elevation are negligible, determine the maximum possible volume flow rate of gasoline. (No frictional loss)
8) A glycerin pump is powered by a 5 kW electric motor. The pressure differential between the outlet and the inlet of the pump at full load is measured to be 211 kPa. What is the overall efficiency of the pump if the flow rate through the pump is 18 \text{lt/s} and the changes in elevation and the flow velocity across the pump are negligible?

9) Water is pumped from a lake to a storage tank 20 m above at a rate of 70 \text{lt/s} while consuming 20.4 kW of electric power. Disregarding any frictional losses in the pipes and any changes in kinetic energy, determine (a) the overall efficiency of the pump–motor unit and (b) the pressure difference between the inlet and the exit of the pump.

10) An oil pump is drawing 35 kW of electric power while pumping oil (\rho_{oil}=860 \text{ kg/m}^3) with at a rate of 0.1 \text{ m}^3/\text{s}. The inlet and outlet diameters of the pipe are 8 cm and 12 cm, respectively. If the pressure rise of oil in the pump is measured to be 400 kPa and the motor efficiency is 90 percent, determine the mechanical efficiency of the pump.

11) Electric power is to be generated by installing a hydraulic turbine–generator at a site 70 m below the free surface of a large water reservoir that can supply water at a rate of 1500 kg/s steadily. If the mechanical power output of the turbine is 800 kW and the electric power generation is 750 kW. Determine the turbine efficiency and the combined turbine–generator efficiency of this plant. (Neglect losses in the pipes)