**Engineering Thermodynamics**

**Tutorial – 1**

1. A bucket of concrete of total mass 200 kg is raised by a crane with an acceleration of 2 m/s2 relative to the ground at a location where the local gravitational acceleration is 9.5 m/s2. Find the required force. 2300 N
2. A piston/cylinder with cross sectional area of 0.01 m2 has a piston mass of 100 kg resting on the stops. With an outside atmospheric pressure of 100 kPa, what should the water pressure be to lift the piston? 198.1 kN
3. A disk-shaped flywheel, of uniform density ρ, outer radius *R*, and thickness *t*, rotates with an angular velocity ω, in rad/s. Show that the moment of inertia, *I=∫ρr2dV,* can be expressed as *I = πρωR*4/2 and the kinetic energy can be expressed as KE =*Iω2*/2.
4. One fourth kg of a gas contained within a piston-cylinder arrangement undergoes a constant pressure process at 5 bar beginning at v1=0.2 m3/kg. For the gas as the system, the work is -15 kJ. Determine the final volume of the gas. 0.02 m3.
5. A gas is compressed from 0.3 m3, 1 bar to 0.1 m3 and 3 bar. Pressure and volume are related linearly during the process. For the gas, find the work. -40 kJ
6. Warm air is contained in a horizontal piston-cylinder arrangement. The air cools slowly from an initial volume of 0.003 m3 to a final volume of 0.002 m3. During the process, the spring exerts a force that varies linearly from an initial value of 900N to a final value of zero. The atmospheric pressure is 100 kPa, and the area of the piston face is 0.018 m2. Friction between the piston and cylinder wall can be neglected. For the air, determine the initial and final pressures, and the work. 150, 100 kPa, -0.125 kJ.
7. A 5-kg piston in a cylinder with diameter of 100 mm is loaded with a linear spring and the outside atmospheric pressure of 100 kPa. The spring exerts no force on the piston when it is at the bottom of the cylinder and for the state shown, the pressure is 400 kPa with volume 0.4 L. The valve is opened to let some air in, causing the piston to rise 2 cm. Find the new pressure.
8. Unit mass of a certain fluid is contained in a cylinder at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law pV2=Constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position; heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m3. 25 kN
9. A personal computer is to be examined from a thermodynamic perspective. Determine the direction of the work and heat transfers (in or out) when the (*a*) keyboard, (*b*) monitor, (*c*) processing unit, and (*d*) all of these are taken as the system.
10. A spring whose spring constant is 3.5 kN/cm has an initial force of 0.45 kN acting on it. Determine the work, in kJ, required to compress it another 1 cm.