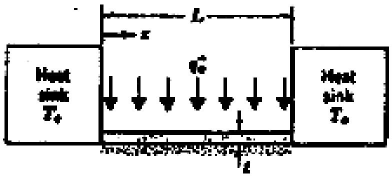
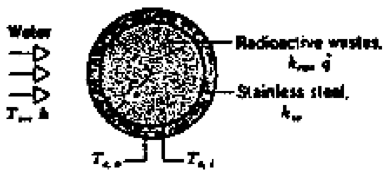
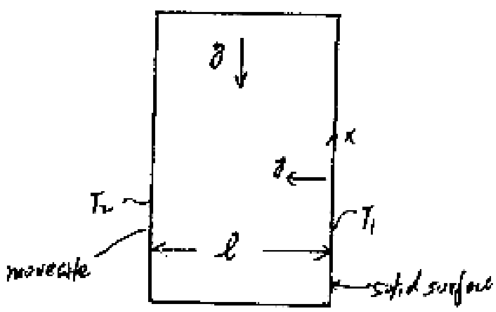
1.A thin plate of length L, thickness t, and width W >> L is thermally joined to two large heat sinks that are maintained at a temperatre $T_0$. The bottom of the plate is well insulated, while the net heat flux to the top surface of the plate is known to have a uniform value of $q_0''$. Determine the steady-state temperature distribution T(x). (15%)



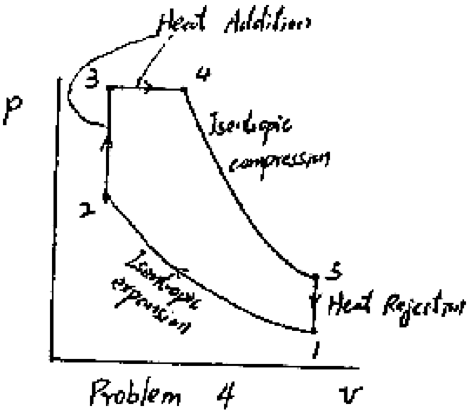

2.Radioactive wastes are stored in a cylindrical, stainless steel container of inner and outer radii equal to $r_i$ and $r_o$. Heat is generated volumetrically within the wastes at a uniform rate of $\dot{q}$, and the outer surface of the container is exposed to a water flow with convection coefficient h and temperature $T_\infty$. Determine the temperature T(r) in the radioactive waste. Express your result in terms of $r_i$, $r_o$, $T_\infty$, $k_{rw}$, $k_{ss}$, h and q. (15%)




3. We wish to examine flow in the central region of a long vertical slot. The vertical walls are at temperature $T_1$ and $T_2$. (20 %)
   (a) Neglect end effects, and find the velovity distribution in the slot when the walls are not moving. Choose an appropriate temperature to evaluate the properties. (Hint: consider the flow to be fully developed). Sketch this velocity profile.
   (b) Suppose the left wall begins to move downward with a velocity $U$. How does this change the velocity profile? Notice that your momentum equation is linear and that you can use the result from part (a). You will need to conserve some quantity.




Problem 3




Problem 4

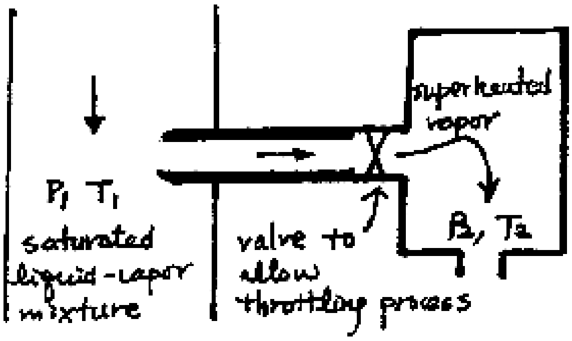
4. A diesel engine works on the dual combustion cycle (see the $P$-$v$ diagram ) and has a compression ratio of 15. Initially the air temperature at the start of compression is 17°C. In the cycle, heat is added at constant volume until the pressure has increased by 50% and then at constant pressure for 8% of the stroke. Calculate the thermal efficiency of the air standard cycle. For air assume $c_p = 1.005$ kJ/kgK; $c_v = 0.718$ kJ/kgK; the specific heat ratio $\gamma = 1.4$. (15%)

5. (15 %) Consider the following device which is used to measure the quality $x$ of a saturated liquid-vapor mixture. The device uses a probe insert into the pipe which the mixture flow inside. Between the device and the pipe, the throttling process can be assumed, i.e., $h_1 = h_2$. The throttling process also reduces the pressure from the exit of the device probe $p_2 < p_1$ and let the state becomes super-heated vapor. Suppose one can measured the following properties: $p_1, T_1, T_2, p_2$.

(a) Explain how to determine the quality of the mixture.

(b) Discuss the throttling effect on $T_2, s_2$.

(c) Plot the $p-v, T-s$ diagram of the process.

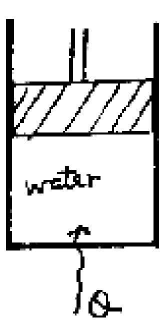



6. (20 %) Water with mass $m$ kg initially a saturated liquid at $T_{sat}$ is contained in a piston-cylinder. The water is brought to the corresponding saturated vapor state by two approaches: (1) internally reversible heating process, (2) stirring the paddle wheel in a adiabatic process. The given properties are: $v_f, v_g$=the specific volume at the saturated liquid and the saturated vapor, $s_f, s_g$=the specific volume at the saturated liquid and the saturated vapor, $u_f, u_g$=the internal energy at the saturated liquid and the saturated vapor.

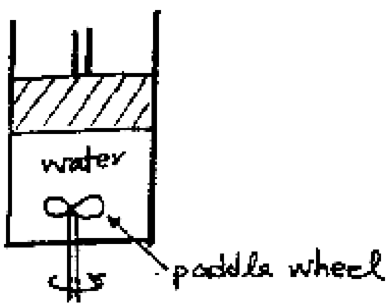
(a) Find the required amount of heat transfer, generated work of process (1).

(b) Find the work and entropy production associated process (2).

(c) Explain which process is preferred based on results from (a) and (b).




(1)




(2)