熱　流　學　(I)

共 5 題，每題 20%。

QUESTION 1　(20%)
About the first law of thermodynamics:
(a) What does the first law of thermodynamics say about ?　(5%)
(b) Derive the general equation for an open system under transient operation condition. (5%)
(c) What is a simple steam-power-plant cycle ?　Please draw the cycle path on the P-v and T-s diagrams.　(5%)
(d) What is a simple vapor-compression refrigeration cycle ?　Please draw the cycle path on the P-v and T-s diagrams. (5%)

QUESTION 2　(20%)
About the second law of thermodynamics:
(a) What is "entropy" ?　(5%)
(b) Prove that "entropy" is a property.　(5%)
(c) Use the increase-in-entropy principle to show that the direction of heat transfer should be from a higher-temperature body to a body at a lower temperature.　(5%)
(d) What are "irreversibility" and "availability" ?　Are they properties ? Why ?　(5%)

QUESTION 3　(20%)
About thermodynamic cycles:
(a) Use P-v and T-s diagrams to describe the Carnot Cycle.　(5%)
(b) What is the efficiency of the Carnot Cycle?　How to promote this cycle efficiency to almost 100 % in practice ? (5%)
(c) Design additional three different cycles which have exactly the same cycle efficiency as the Carnot cycle. (5%)
(d) Prove that the above cycles are all totally reversible. (5%)

QUESTION 4   (20%)

Consider a velocity field defined by $\vec{V} = 10(4y - y^2)\vec{i}$.

(a) Is this an irrotational velocity field?   If not, determine the vorticity vector.   (5%)

(b) Also, determine the rate-of-strain tensor.   (5%)

(c) How rapidly would a particle be rotating at the point $(x, y) = (4,3)$?   (5%)

(d) Why is it that we do not have a primary interest in principal strain rates and principal directions, as was the case in your study of solids?   (5%)

QUESTION 5   (20%)

The flow around a model of a turbine blade is investigated.   The model is five times larger than the prototype.   A maximum pressure of $30\ KPa$ is measured at the leading edge, a maximum velocity of $10\ m/sec$ is measured near the top of the blade cross-section and a small device attached to the surface measures a shearing stress of $0.15\ KPa$ at a particular location.   Determine the associated quantities to be expected on the prototype.   Water is the fluid for both model and prototype.