國立臺灣大學101學年度碩士班招生考試試題

1. (26%) A steam power plant operates on the reheat Rankine cycle. Steam enters the high-pressure turbine at 10MPa and 550°C and leaves at 2.5MPa. Steam is then reheated at constant pressure to 450°C before it expands in the low-pressure turbine to 10kPa. The isentropic efficiencies of the turbines and the pump are 85 percent and 90 percent, respectively. Steam leaves the condenser as a saturated liquid. Determine (a) the quality of the steam when it leaves the low-pressure turbine, (b) the net power output, and (c) the thermal efficiency.

Saturated water table (f: saturated liquid, g: saturated vapor)

P, kPa	v_f, m^3/kg	v_g, m^3/kg	h_f, kJ/kg	h_{fg}, kJ/kg	s_f, kJ/kg.K	s_{fg}, kJ/kg.K
10	0.001010	14.670	191.81	2392.1	0.6492	7.4996

Superheated water table

P, MPa	T, °C	h, kJ/kg	s, kJ/kg.K
10	550	3502.0	6.7585
2.5	300	3009.6	6.6459
2.5	350	3127.0	6.8424
2.5	450	3351.6	7.1768

2. (24%) Answer the following questions clearly but briefly.

(i) What are point and path functions? Give one example for each.

(ii) A system undergoes a process between two fixed states first in a reversible manner and then in an irreversible manner. For which case is the entropy change of the system greater? Explain.

(iii) The entropy of a hot baked potato decreases by an amount of 2kJ/K as it cools. Is the entropy increment of the surrounding air greater than, less than, or equal to 2kJ/K? Explain.

(iv) How does the excess CO_2 gas in the atmosphere cause the green house effect?

(v) Somebody claims to have developed a new refrigerator that can remove 12.5kWh of energy from the 4°C-refrigerated space in a 27°C-environment for each 1kWh of electricity it consumes. Is this a violation of the first law of thermodynamics? Explain.

(vi) Re-consider the refrigerator discussed in (iv). Is it a violation of the second law of thermodynamics? Explain.

3. (20%) A fluid flows at a rate **m** between parallel plates spaced a distance **w** apart. There is a uniform heat flux $\mathbf{q_o}$ from the top plate into the fluid, and the bottom plate is adiabatic. There are two flow conditions that differ only by flow regime.

A. Laminar flow B.Turbulent flow

(a) Please write the definition of the mean temperature ($\mathbf{T_m}$).

(b) Please **sketch** the mean temperature ($\mathbf{T_m}$) and upper wall temperature ($\mathbf{T_o}$) as a function of distance and label clearly $\mathbf{T_m}$ and $\mathbf{T_o}$ for laminar flow (A) and turbulent flow (B). Assume $\mathbf{T_e}$ is the entrance fluid flow temperature.

(c) **Sketch** carefully the temperature profiles at x =L and label clearly which is A and B.

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4. (30%) In a circular hot tube shown in the following Figure.,

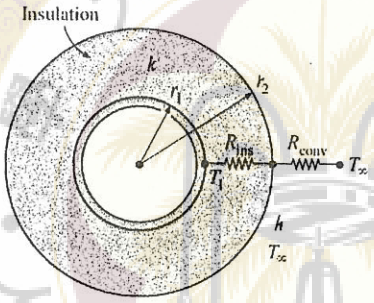
(a) Please write down heat transfer equation (with the expression of total thermal resistance) from the insulated pipe to the surrounding air. Assume k (pipe) > k (insulation)

(b) If only increase k (insulation), what are the effects on **h** (outside), **Gr** (Grashof number) and **q** (heat loss to surroundings)?

(c) If only increase ambient air temperature, what are the effects on **h** (outside), **Gr** (Grashof number) and **q** (heat loss to surroundings)?

(d) When only increase k (pipe), what are the effects on **h** (outside), **Gr** (Grashof number) and **q** (heat loss to surroundings)?

(e) If the inner tube surfaces are roughened or corrugated,what is the effect on **h** (inside)?



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