

系所別: 機械工程學系 丙組 科目:

熱力學 (含熱傳)

1. A computer cooled by a fan contains six PCBs, each dissipate 12 W power. The height of the PCBs is 20 cm and the length is 12 cm. The cooling air is supplied by a 10 W fan mounted at the inlet. If the temperature rise of air as it flows through the case of the computer is not to exceed 20 °C, determine (a) the rate of the air that the fan needs to deliver and (b) the fraction of the temperature rise of air that is due to the heat generated by the fan and its motor? (15%)
2. An inventor claim to have developed a refrigeration system that removes heat from the closed region at -5 °C and transfers it to the surrounding air at 25 °C while maintaining a COP of 6.5. Is this claim reasonable? Why? (15%)
3. Answer the following questions (15 %).
  - (a) 請說明氫氧燃料電池 (Hydrogen-Oxygen Fuel Cell) 之工作原理。
  - (b) 在金屬冶鍊的過程中溫度是極為重要的參數之一。古時鐵匠或鑄劍師並無現今之精密溫度計以量測冶鍊過程中之溫度變化，故多依賴加熱過程中金屬顏色的變化來判斷其約略溫度。請你簡述當鐵匠觀察金屬由室溫被加熱時，其顏色的變化情形，並解釋其原因。
  - (c) 夏天的台灣吹南風時空氣極為潮濕，早晨開車出門時車窗極易結霧，請問此時應開暖氣或是冷氣對著車窗玻璃吹，較易除霧？為甚麼？
4. Air at 7°C enters a turbojet engine at a rate of 20 kg/s and at a velocity of 300 m/s (relative to the engine). Air is heated in the combustion chamber at a rate 20,000 kJ/s and it leaves the engine at 427°C. Determine the thrust produced by this turbojet engine. (15 %)
5. An electric current is used to heat a tube through which a suitable cooling fluid flow. The outside of the tube is covered with insulation to minimize heat loss to the surroundings, and thermocouples are attached to the outer surface of the tube to measure the temperature. Assuming uniform heat generation in the tube, derive an expression for the convection heat transfer coefficient on the inside of the tube in terms of the measured variables: Voltage E, current I, outside tube wall temperature  $T_o$ , inside and outside radii  $r_i$  and  $r_o$ , tube length L, and fluid temperature  $T_f$ . (20%)
6. Consider fully developed flow in a circular tube with constant heat rate per unit length. The mean flow velocity is 3 m/s, and the tube inside diameter is 10 mm. Please evaluate the convective heat transfer coefficient for air and water at temperature of 300K respectively and discuss the reason for the difference. (20%)

The properties of air and water at 300K and 1 atm are listed below.

	$\rho$ (kg/m <sup>3</sup> )	$\mu$ (N·s/m <sup>2</sup> )	k (W/m·K)	Pr
Air	1.16	$185 \times 10^{-7}$	0.0263	0.707
Water	997.0	$855 \times 10^{-6}$	0.613	5.83

參考用