航空太空研究所（甲）

國立成功大學 79 學年度碩士班考試（熱力學　試題）共 2 頁 第 1 頁

每題 20分，計五題共 100分

1. 請依熱力學的觀點來回答下列兩個問題.

i) 一般重油燃料中所含水分極少（在 0.1% 以下），現有某人宣稱在重油中加入微量的乳化添加劑後，可溶入 10%（重量百分比）的水分，同時所混合過後重油中每單位重量所能產生的燃燒熱值和燃燒純重油一樣．經查其所使用的添加劑之熱值極低（相對於重油）且一般燃燒炉之燃燒效率皆在 97% 以上，試評論此項報導之正確性．(8分)

ii) 國內在夏季時之用電量，白天（尖峯期間）和晚上（離峯期間）差異極大。為求達到能源節約之目的，今有下列三种方案來選擇：

a) 利用離峯期間之電力，將低水位的水打回高水位（蓄水灘）儲存，在尖峯期間時再以水力發電方式放出．

b) 利用離峯期間之電力將水電解成氫及氧氣，再以火力發電方式（燃燒氫氣）在尖峯期間加入營運．

c) 在離峯期間將多餘的電力貯存於電池中，然後在尖峯期間釋出．

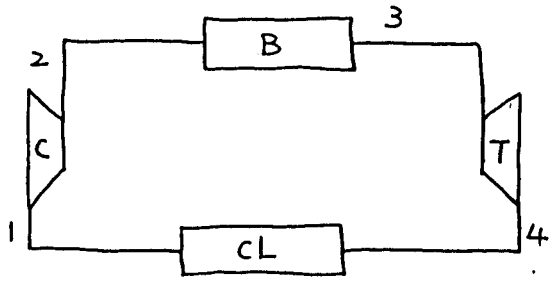
試以純粹能源使用效率的觀點（不考慮所需的設備及操作成本）來評論這三种方案之優劣．(12分)

2. A Carnot heat engine is used to drive a Carnot refrigerator. The heat engine receives Q_1 at T_1 and rejects Q_2 at T_2. The refrigerator removes a quantity of heat Q_3 from a source at T_3 and rejects a quantity of heat Q_4 at T_4. 1) Please determine Q_3/Q_1 in terms of the various temperatures of the heat reservoirs. 2) Can we use part of the heat rejected by the refrigerator to heat the heat engine? If yes, please show how you can achieve this purpose naturally without external heat and work (You may add heat engines and refrigerators in between. But in overall you should not add heat and work to achieve this purpose). If not, explain your reason.

3. Air from environment at 14.7 psia and 80°F is compressed isothermally in a steady flow process to $P_2 = 147$ psia. The amount of heat transfer

from the compressor is 90 Btu/lbm. Please determine: 1) the minimum work required, 2) the maximum work can be produced from the heat rejected by the compressor, 3) the irreversibility of the process.
(for air $C_p = 0.24$ Btu/lbm°R, $C_v = 0.17$ Btu/lbm°R, $R = 0.0686$ Btu/lbm°R)

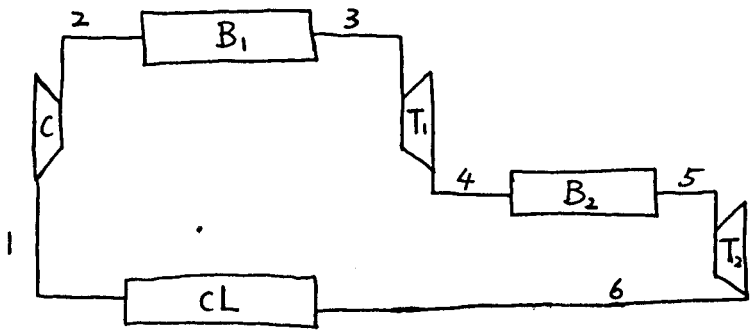
4. 簡化後之飛機引擎熱力循環被稱為布萊頓循環（Brayton Cycle），其典型之元件組合為



C: Compressor
B: Burner
T: Turbine
CL: Cooler

a) 請畫出上述理想化循環之T-S圖（溫度－熵圖）。（5分）

b) 為增加引擎推力，一般戰机後方常加上一組加力後燃燒室（after-burner），並增加第二組燃燒室及渦輪機，其元件組合如下：



在理想情況下，請畫出其T-S圖。（7分）

c) 請問(b)中之循環輸出功是否較(a)增加？其熱效率是否增加？（8分）

5. A mixture of 59.39% CO_2 and 40.61% CH_4 (mole basis) is maintained at 310.94°K, 86.19 bar, at which condition the specific volume measured is 0.2205 m^3/Kmole. Please calculate the percent deviation if the specific volume has been calculated by a) ideal gas law b) van der Waals' equation of state. For the van der Waal's eqn. $P = \frac{RT}{V-b} - \frac{a}{V^2}$, the two pure substance constants a and b are combined according to $a_m = (\sum_i y_i a_i^{\frac{1}{2}})^2$, $b_m = \sum y_i b_i$ and y_i is mole fraction of component i.
($a_{CO_2} = 365.185 \frac{KPa\,m^6}{Kmole^2}$, $b = 0.04278 \frac{m^3}{Kmole}$, $a_{CH_4} = 229.532 \frac{KPa\,m^6}{Kmole^2}$, $b_{CH_4} = 0.0428 \frac{m^3}{Kmole}$)