國立中正大學
112學年度碩士班招生考試
試 題

［第1節］

科目名稱	熱力學
系所組別	機械工程學系-丙組

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。

3. 入場後於考試開始40分鐘內不得離場。

4. 全部答題均須在試卷（答案卷）作答區內完成。

5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。

6. 試題須隨試卷繳還。

1. (35%) A stationary piston-cylinder device contains 2 kg of air at 27°C and 100 kPa. The air is now compressed to a pressure of 500 kPa according to the relation $PV^{1.4}$ = constant. P and V are the pressure and the volume, respectively. Determine the following:
   (a) the initial volume of air. (7%)
   (b) the final volume of air. (7%)
   (c) the work input during the process. (7%)
   (d) the change in total internal energy of the system (ΔU). (7%)
   (e) the amount of heat transfer (Q) during the process. (7%)

Gas constant of air, $R = 0.287$ kJ/kgK ; Idea gas properties of air are given:

Temperature -T- (K)	Enthalpy -h- (kJ/kg)	Relative Pressure -p_r-	Internal Energy -u- (kJ/kg)
250	250	0.733	178
300	300	1.39	214
350	350	2.38	250
400	401	3.81	286
450	452	5.76	323
500	503	8.41	359
550	555	11.9	397
600	607	16.3	435
650	660	21.9	473

2. (15%) Consider two piston-cylinder devices shown below. In system A, heat is added, the piston is free to move, and it is found that the magnitude of work done is more than the magnitude of heat added. In system B, heat is added when the piston is resting against a set of stops; therefore, the piston cannot move. Assume that changes in kinetic and potential energy are negligible. You must provide justification with appropriate equation(s) to receive full credit.

   (a) What happens to internal energy when heat is added in system A? (increases; decreases; or remains the same?) (8%)
   (b) What happens to internal energy when heat is added in system B? (increases; decreases; or remains the same?) (7%)

System A　　　　　　　**System B**
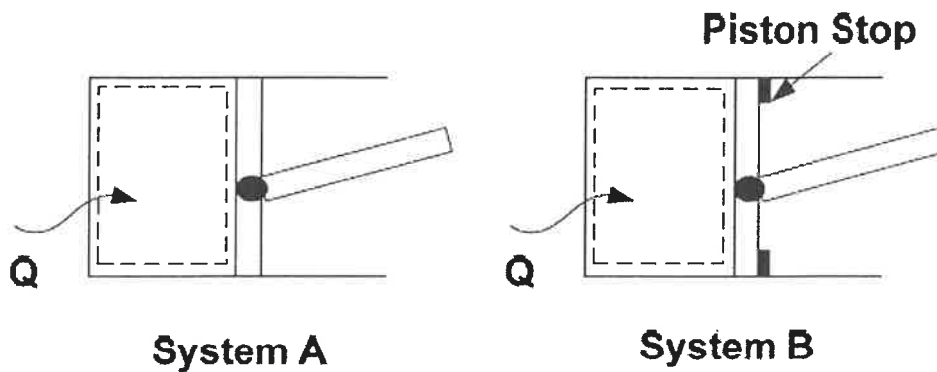
3. (30%) Consider an ideal Stirling engine which thermal cycle includes two isothermal processes and two isochoric processes. The maximum volume V_{max} and minimum volume V_{min} of the working space is 500 cm³ and 300 cm³, respectively. The engine is heated with a heating temperature of T_h = 800 °C and a room temperature of T_c = 27 °C. Suppose that the working space of the engine is charged with 10 bar air at room temperature T_c and minimum volume V_{min}. (Hints: 1 bar = 100000 Pa, Gas constant R = 8.314 m³·Pa·K⁻¹·mol⁻¹)
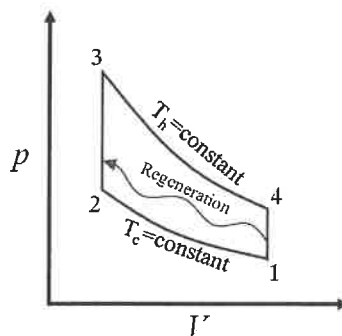
   (a) Calculate the thermal efficiency. (10 %)
   (b) Calculate the indicated work. (10 %)
   (c) Suppose the engine is operated at 1200 rpm, calculate the indicated power. (10 %)

4. (20%) A heat source at 800 °C loses 2000 kJ of heat to a sink at 500 °C and loses 2000 kJ of heat to a sink at 600 °C.
   (a) Calculate the entropy generation during these processes (10 %)
   (b) Determine which heat transfer process is more irreversible. (10 %)