國立臺北科技大學 101 學年度碩士班招生考試

系所組別：3510 化學工程研究所甲組

第二節　化工熱力學與反應工程　試題

注意事項：

1. 本試題共六題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、 An irreversible reaction A+B→AB has been studied kinetically and one of possible mechanism for this reaction was supposed as follow.

$$B+B \xrightarrow{k_1} B_2^* \qquad A+B_2^* \xrightarrow{k_2} AB+B \qquad AB+B \xrightarrow{k_3} A+B_2^*$$

Let the k values refer to the components disappearing. Please derive the rate (r_{AB}) equation from the mechanism. (10%)

二、 1. Please derive the performance equation for a second order kinetics ($2A \rightarrow P$, $-r_A = kC_A^2$) with varied volume (with any constant ε_A) in a plug flow reactor with initial concentration C_{A0}. That is, derive the space time (τ) in the function of conversion (X_A) and ε_A. (10%)

2. 1 liter/s of a 20% ozone-80% air mixture at 1.5 atm and 93°C passes through a plug flow reactor. Under these conditions ozone decomposes by homogeneous reaction

$$2O_3 \longrightarrow 3O_2,\ -r_{ozone} = kC_{ozone},\ k = 0.05\ \frac{\text{liter}}{\text{mol. sec}}$$

What size reactor is needed for 50% decomposition of ozone? Note: gas constant R=0.08206 L·atm/(K·mol) (10%)

三、 We wish to explore various reactor setups for the transformation of A into R. The feed contains 99% A, 1% R; the desired product is to consist of 10% A and 90% R. The transformation takes place by means of the elementary reaction, A+R→R+R, with rate constant k=1 liter·/(mol·min). The concentration of active materials is $C_{A0}+C_{R0} = C_A+C_R = C_0 = 1$ mol/liter throughout.

What reactor holding time will yield a product in which $C_R = 0.9$ mol/liter (a) in a plug flow reactor, (5%) (b) in a mixed flow reactor, (5%) and (c) in a minimum-size setup without recycle? (10%)

四、 Calculate the internal-energy and enthalpy changes that occur when air is changed from an initial state of 40 °F and 10 atm, where its molar volume is 36.49 ft^3/(lb·mol), to a final state of 140 °F and 1 atm. Assume for air that PV/T is a constant and that $C_v = 5$ and $C_p = 7$ Btu·(lb·mol)$^{-1}$·°F^{-1}. (15%) Note: (i) the relation between the Fahrenheit and Rankine scales: t(°F)=T(R)-459.67. (ii) 1atm·ft^3=2.7195 Btu

五、 1. An ideal gas undergoes the following sequence of mechanically reversible processes in a closed system:

(a) From an initial state of 70 °C and 1 bar, it is compressed adiabatically to 150 °C. (b) It is then cooled from 150 to 70 °C at constant pressure. (c) Finally, it is expanded isothermally to its original state.

Calculate *W*, *Q*, ΔU, and ΔH for each of the three processes and for the entire cycle. Take $C_v = (3/2)R$ and $C_p = (5/2)R$.

2. If these processes are carried out irreversible but so as to accomplish exactly the same changes of state (i.e., the same changes in P, T, U, and H). Calculate *W*, *Q*, ΔU, and ΔH for each of the three processes and for the entire cycle, if each step is carried out with an efficiency of 80%. (30%)

Please summarize your answers in a Table.

	Mechanically reversible				Mechanically irreversible			
	ΔU	ΔH	*Q*	*W*	ΔU	ΔH	*Q*	*W*
(a)								
(b)								
(c)								
Sum								

六、 For refrigeration at a temperature level of 5°C in a surrounding at 30 °C, what is the coefficient of performance for a Carnot refrigerator? (5%)