國立臺北科技大學九十五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

填 准 考 證 號 碼

注意事項：

1. 本試題共七題，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、Explain the first, second and third laws of thermodynamics. (15%)

二、A central power plant, rated at 800000 kW, generates steam at 585 K and discards heat to a river at 295 K. If the thermal efficiency of the plant is 70% of the maximum possible, how much heat is discarded to the river at rated power? (10%)

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

(a) From an initial state of 343.15K (70℃) and 1 bar, it is compressed adiabatically to 423.15K (150℃).

(b) It is then cooled from 423.15 to 343.15K (150 to 70℃).

(c) Finally, it is expanded isothermally to its original state.

1. **Calculate** W, Q, $\triangle U$, and $\triangle H$ for each of the three processes and for the entire cycle. Take Cv=(3/2)R and Cp=(5/2)R (15%)
2. If these processes are carried out irreversibly but so as to accomplish exactly the same changes of state (i.e. the same changes in P, T, U, and H), then different values of Q and W result. Calculate Q and W if each step is carried out with an efficincy of 80%. (10%)

四、If the mechanism of the reaction $H_2 + Br_2 \rightarrow 2HBr$ is as follow, then what is the rate of reaction (production of HBr) ? (15%)

$$Br_2 \leftrightarrow 2Br\bullet$$

$$Br\bullet + H_2 \leftrightarrow HBr + H\bullet$$

$$H\bullet + Br_2 \rightarrow HBr + Br\bullet$$

五、Consider a municipal water treatment plant for a small community. Waste water, 32000 m^3/day, flows through the treatment plant with a mean residence time of 8 hr, air is bubbled through the tanks, and microbes in the tank attack and break down the organic material,

(organic waste) + $O_2 \xrightarrow{\text{microbes}} CO_2 + H_2O$

A typical entering feed has a BOD (biological oxygen demand) of 200 mg O_2/liter, while the effluent has a negligible BOD. Find the rate of reaction, or decrease in BOD in the treatment tanks. (10%)

六、The conversion of an elementary liquid phase second order reaction $2A \rightarrow 2R$ is 2/3 when operated in an isothermal plug flow reactor with a recycle ratio of unity. What will be the conversion if the recycle stream is shut off? (10%)

七、A liquid phase, first order reaction was carried out isothermal in three CSTR reactors. It was known that the second reactor was as large as the first reactor, and the third reactor was x times larger than the first one. It was also assumed that the density was constant throughout the system. If 20% conversion was achieved in the first reactor, what should the x be in order to achieve a total conversion of 80%? (15%)