科目：输送现象与单元操作
考试时间：100 分钟

系所：化学工程及材料工程学系
（甲组）
本科原始成绩：100 分

是否使用计算机：是

1. (40 pts) Please answer the following questions:

(a) Determine the **drag force** on a gas bubble moving in a liquid at large Reynolds number. (6 pts)

(b) Please derive the **heat transfer** in a parallel-flow double-pipe heat exchanger and then explain the usage of **mean, average and logarithmic mean temperature differences**. (10 pts)

(c) Please find the dimensionless numbers in **mass transfer** by **Buckingham method** under **forced** and **natural** convection. (10 pts)

(d) What are the physical meanings of **number of transfer units** (NTU) in heat exchanger and gas absorption? (8 pts)

(e) Please explain three types of **plate efficiency** can be employed in **distillation** and their applications. (6 pts)

2. (15 pts) Consider the motion of a fluid between two in finite coaxial cylinders with radii R_1, R_2 ($R_2 > R_1$), rotating about their axis with angular velocities Ω_1, Ω_2. Please find the **velocity distribution, pressure distribution** and the moment of **frictional forces** acting on the cylinders and also list **the assumptions**.

3. (15 pts) Please derive **the fin efficiencies of (a) straight rectangular fins; (b) straight triangular fins; (c) pin fins of rectangular profile** and **list your assumptions.**

4. (10 pts) A person feels very comfortable in light clothing when the thermostat is set at 22°C and the average temperature of the surrounding surface is also 22°C. During a cold front, the average mean radiation temperature drops to 13.6^{o}C in **Kaohsiung**. What will **the indoor air temperature** be raised to maintain the same level of comfort in the same clothing? (*Hint:* The emissivity of the person is 0.93. The convection heat transfer coefficient from the body is $h_{conv} = 3.2$ W/m$^2\cdot^{o}$C.)

5. (10 pts) A drop of water, jetting from a standard 20 μm orifice, at a velocity of 230 cm/s through dry, still air at 1 atm pressure without internal circulation. The vapor pressure at room temperature is 0.0247 atm. Please estimate the instantaneous **rate of evaporation** from the drop, **the diameter decrease** and **the distance the drop evaporates completely**. (*Hint:* $Nu_m=2+0.6Re^{\frac{1}{2}}Pr^{\frac{1}{3}}$)

6. (10 pts) A natural phenol is to be extracted from a dilute aqueous solution using a oil with a distribution coefficient of 5.3. Please **design an extractor** to achieve **the highest recovery**, **lowest oil flow rate** and **ideal stages required**.