(一)解釋名詞

1. Define kinematic viscosity and write down its units in the SI system. (5%)
2. Define vena contracta. (5%)
3. What is meant by the term "Leidenfrost point". (5%)
4. What is meant by the term "plait point". (5%)

(二)單選題每一小題 5 分

1. 已知某牛頓流體(Newtonian fluid)在水平長圓形管中以層流(laminar flow)穩定流動。假設該流體與圓形管壁接觸點無滑動現象(no slip condition)，下列敘述何者是<u>錯誤</u> (5%)
   (A) Fanning Friction factor 是 16/Re (Re, Reynolds number)
   (B) 在管中心的剪應力(shear stress)是 0
   (C) 在管中心的黏度比在管壁小
   (D) 在管中心的速度最大

2. 已知某牛頓流體(Newtonian fluid)在水平長圓形管中以完全發展層流(laminar flow)穩定流動。假設該流體的速度分部為 $u(r)= 4(1-r^2/R^2)$，R 是圓形管的半徑，r 是流體到圓形管中心的距離。假設圓形管的半徑是 2 公分，試問距離管中心多遠的距離最接近平均速度 (5%)
   (A) 0.5 公分
   (B) 0.75 公分
   (C) 1.11 公分
   (D) 1.41 公分

3. 已知機油在 300K 時之普蘭特數(Prandtl number)為 6400，若在此溫度下以層流流經一平板，該平板溫度維持在 373K，則在平板附近某固定流動位置會形成速度邊界厚度(velocity boundary layer thickness)δ_m和熱量邊界厚度(thermal boundary layer thickness)δ_t ，以下何者<u>正確</u> (5%)
   (A) $\delta_m > \delta_t$
   (B) $\delta_m = \delta_t$
   (C) $\delta_m < \delta_t$
   (D) 不一定

4.在套管熱交換器，如 $h_i = 4000\frac{W}{m^2 \cdot {}^oC}$，$h_o = 500\frac{W}{m^2 \cdot {}^oC}$，假設管壁很薄，內外表面積大小相近，且管壁熱阻可忽略，求總傳熱係數約為多少 $\frac{W}{m^2 \cdot {}^oC}$ (5%)

(A) 2404
(B) 1544
(C) 804
(D) 444

(三). A horizontal annulus is 50 ft long. The inner pipe is 1 inch schedule 40 and the outer is 2 inch schedule 40. The fluid density is 60 lb/ft^3 and its viscosity is 0.04 lb/(ft s). The fluid is pumped through the annulus with a mass flow rate of 6 lb/s.

(a) Calculate the hydraulic mean diameter (inch) (5%)
(b) Calculate the hydraulic radius (inch) (5%)
(c) What is the average linear velocity for the fluid in the annulus (ft/s) (5%)
(d) Estimate the Reynolds number (5%)

Representative Pipe Sizes for Schedule 40

Nominal Size (inch)	Outside Diameter (inch)	Inside Diameter (inch)
1	1.315	1.049
2	2.375	2.067

(四). A binary mixture of 72 mol% n-hexane and 28 mol% n-octane at $1452\,mmHg$, 225^oF is fed to a flash distiller. The vapor pressure data for the n-hexane and n-octane at 225^oF are 2130 mmHg and 434 mmHg, respectively. If the distiller operate at constant temperature 225^oF.

(a) Calculate the composition of the liquid leaving the distiller. (5%)
(b) Calculate the composition of the vapor leaving the distiller. (5%)
(c) Calculate the fraction of the vaporization, f ? (5%)
(d) Calculate the relative volatility, $\alpha_{octane-hexane}$? (5%)

(五). An organic fluid flowing in the inner pipe of a double-pipe exchanger is cooled with water flowing in the jacket. The inner pipe is made from the steel with ID = 7.5 mm, OD = 10.3 mm and the outer pipe with ID = 17.5 mm, OD = 120.3 mm. The thermal conductivity of the steel is $58.6\frac{KJ}{m\cdot hr\cdot^oC}$. The individual properties are the following:

	Organic fluid	Water
ρ $(\frac{Kg}{m^3})$	989.3	994.3
μ $(\frac{Kg}{m\cdot \sec})$	0.581×10^{-3}	0.743×10^{-3}
Cp $(\frac{KJ}{Kg\cdot^oC})$	4.180	4.176
K $(\frac{KJ}{hr\cdot m\cdot^oC})$	2.289	2.226

	Organic fluid	Water
Inlet temperature	53^oC	24^oC
Outlet temperature	40^oC	45^oC

The flow rate of the organic fluid and the water are $1\times10^3\frac{cm^3}{\min}$ and $0.2\times10^3\frac{cm^3}{\min}$, respectively. If the configurations are counterflow and L = 400 mm long. An empirical equation describing the forced convection specified: For $\mathrm{Re}<4000$, $Nu=2\left(\frac{\dot{m}C_P}{KL}\right)^{\frac{1}{3}}$. For $\mathrm{Re}\geq4000$, $Nu=0.023(\mathrm{Re})^{0.8}(\mathrm{Pr})^{\frac{1}{3}}$. Determine

(a) The logarithmic-mean temperature difference. (5%)

(b) The heat-transfer coefficient on the organic fluid side, h_i $(\frac{W}{m^2K})$. (5%)

(c) The heat-transfer coefficient on the water side, h_o $(\frac{W}{m^2K})$. (5%)

(d) The overall coefficient, based on the outside area of the inner pipe, U_o $(\frac{W}{m^2K})$? (5%)