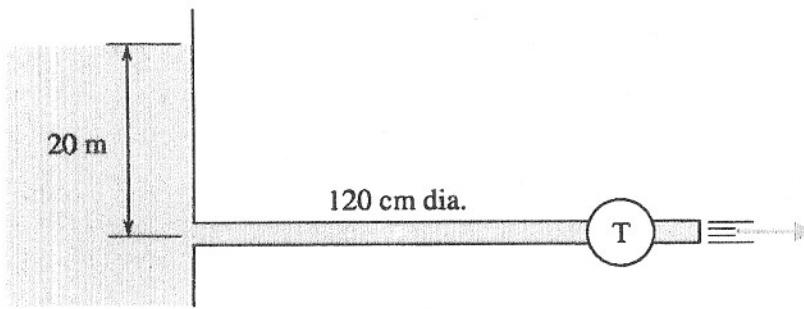


96 學年度 動力機械工程學 系(所) 甲組(熱流組) 碩士班入學考試

科目 熱流學(二) 科目代碼 1001 共二頁第一頁 *請在【答案卷卡】內作答

1. A 1:60 scale model of a ship is used in a water tank to simulate a ship speed of 10 m/s. What should be the model speed? If a towing force of 10 N is measured on the model, what force is expected on the prototype? Neglect viscous effects. (10%)
2. A small river with a flow rate of $15 \text{ m}^3/\text{s}$ feeds the reservoir shown in the figure below. Calculate the energy that is available continuously if the turbine is 80% efficient. The loss coefficient for the overall piping system is $K = 4.5$. (12%)



3. Products of combustion enter the nozzle of a gas turbine at the design conditions of 400 kPa, 1000 K, and 200 m/s, and they exit at a pressure of 270 kPa at a rate of 3 kg/s. Assuming isentropic flow, determine whether the nozzle is converging or converging-diverging. Also, find the exit velocity and the exit area. Take $k = 1.34$ and $C_p = 1.16 \text{ kJ}/(\text{kg} \cdot \text{K})$ for the combustion products. (12 points)
4. Heat Conduction Problems (35 points)
 - (a) What is the general heat conduction equation in three-dimensional, unsteady form with a heat source? (5%)
 - (b) Please define the thermal diffusivity (α) of a substance and explain its physical meaning and unit. (5%)
 - (c) What is the definition of the Prandtl number (Pr)? Please explain its physical meaning. (5%)
 - (d) Please solve the steady state heat conduction within a 1-D slab with constant thickness of L , the heat transfer is from the heat source to both side walls at the temperature of T_w . Please show the temperature distribution diagram between two side walls of this slab ($T = T(x)$). (5%) What is the similarity between this temperature distribution and the velocity distribution of a laminar flow across a 1-D channel? (5%)
 - (e) What are the definition of the Biot number (Bi) and the Nusselt number (Nu)? (5%) Please explain the differences of the physical meaning between two numbers. (5%)

國立清華大學命題紙

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科目 熱流學(二) 科目代碼 1001 共 二 頁第 二 頁 *請在【答案卷卡】內作答

5. What are the differences between surface radiation and gas radiation? (4%) Based on the radiation phenomena explain why CO₂ emission affects the temperature of the earth? (4%)
6. Consider flow in a circular tube. Within the test section length a constant heat flux q_x'' is maintained.
- (a) For the two cases identified, sketch, qualitatively, the surface temperature $T_s(x)$ and the fluid mean temperature $T_m(x)$ as a function of distance along the test section x . In case A flow is hydrodynamically and thermally fully developed. In case B flow is not developed. (10%)
- (b) Assuming that the surface flux q_s'' and the inlet temperature $T_{m,i}$ are identical for both cases, will the exit mean temperature $T_{m,o}$ for case A be greater than equal to, or less than $T_{m,o}$ for case B? You must briefly explain why, otherwise you will not earn any point from this problem. (5%)
7. Please derive the governing equations (momentum and energy) for the cold fluid flowing upward over a vertical hot plate. Begin from the given equations and list the necessary assumptions. Note that this problem is a free convection problem. (8%)

$$\rho \left(u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} \right) = - \frac{\partial p}{\partial x} + \mu \frac{\partial}{\partial y} \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right) + X$$

$$\rho \left(u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} \right) = - \frac{\partial p}{\partial y} + \mu \frac{\partial}{\partial x} \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right) + Y$$

$$\rho c_p \left(u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} \right) = k \frac{\partial}{\partial x} \left(\frac{\partial T}{\partial x} \right) + k \frac{\partial}{\partial y} \left(\frac{\partial T}{\partial y} \right)$$