

國立臺灣科技大學

115學年度碩士班招生

試題

系所組別：0330機械工程系碩士班丙組

科 目：熱力與流力

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(總分為100分;所有試題務必於答案卷內頁依序作答)

NTUST Entrance Examination

Date: 01/12/2026

1. (10%) Multiple choice questions:

- (a) Which one of the following is NOT a mechanism of heat transfer? (1) Conduction (2) Convection (3) Diffusion (4) Radiation.
- (b) Which one of the following is NOT considered as a pure substance in thermodynamics? (1) air (2) a mixture of ice and liquid water (3) a mixture of liquid air and gaseous air (4) none of the above.
- (c) Which one of the following gases is a greenhouse gas? (1) methane (CH_4) (2) water vapor (H_2O) (3) nitrous oxide (N_2O) (4) Carbon dioxide (CO_2) (5) all of the above.
- (d) Under which one of the following conditions, real gases will behave like an ideal gas? (1) high temperature, high pressure (2) high temperature, low pressure (3) low temperature, high pressure (4) low temperature, low pressure.
- (e) In Joule's free expansion experiment of an ideal gas, which one of the following statements is false? (1) Temperature of the ideal gas remains constant. (2) The process is irreversible. (3) No heat is added or removed, thus the entropy of the ideal gas does NOT change. (4) Enthalpy of the ideal gas remains constant.
- (f) If a system undergoes a process between two fixed equilibrium states, one in a reversible manner and the other in an irreversible manner, which one will have a greater entropy change? (1) reversible (2) irreversible (3) two are the same (4) insufficient condition to determine.
- (g) Which one of the following can NOT be an isentropic device theoretically? (1) Turbine (2) Compressor (3) Nozzle (4) Diffuser (5) Throttling valve.
- (h) Which one the following is the thermodynamic cycle for a steam power plant? (1) Otto cycle (2) Diesel cycle (3) Bryaton cycle (4) Rankine cycle.
- (i) For a heat pump running between two heat reservoirs with high temperature T_H and low temperature T_L , what will be the highest coefficient of performance: (1) $1 - \frac{T_L}{T_H}$ (2) $\frac{T_L}{T_H - T_L}$ (3) $\frac{T_H}{T_H - T_L}$ (4) $\frac{T_H - T_L}{T_L}$.



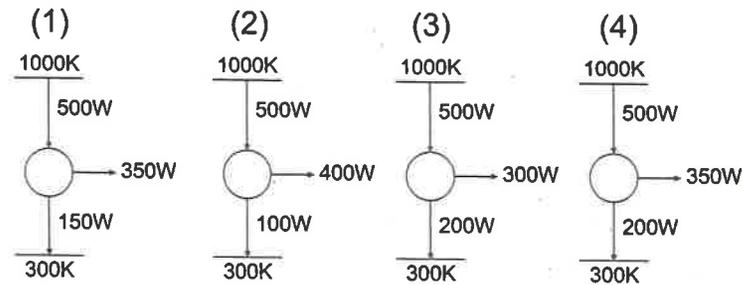
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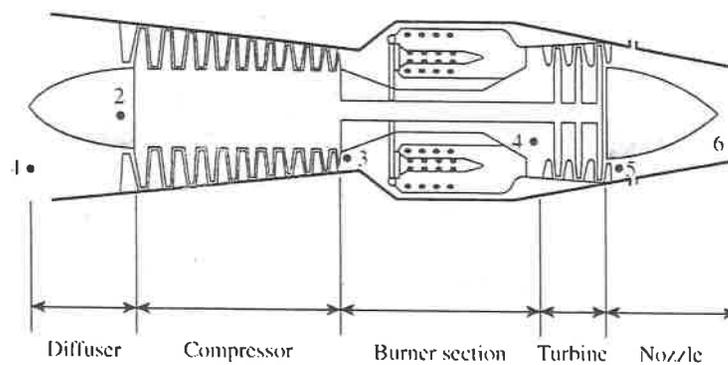
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- (j) Which one of the following schematics represents the operation of a real heat engines



2. (20%) In a steady-flow device, the pressure of argon is reduced from 300 kPa to 100 kPa through a throttling valve, determine the entropy change per unit mass due to throttling. The specific heat (C_v) and gas constant (R) of argon are 0.3122 kJ/kg-K and 0.2081 kJ/kg-K, respectively. You must give detailed and professional explanation to justify your calculation to get full credits.
3. (20%) A turbojet aircraft flies with a velocity of 250 m/s at an altitude where the air is at -30°C and 41 kPa. The compressor has a pressure ratio of 9, and the gas temperature at the turbine inlet is 1200°C . Air enters the compressor at a rate of 45 kg/s. Assume all devices except burner are adiabatic and reversible. Utilizing the cold-air-standard assumptions and using constant air properties $C_p = 1.005$ kJ/kg $^\circ\text{C}$ and $R = 0.287$ kJ/kg $^\circ\text{C}$, please answer the following questions:
- Determine the temperature and pressure of the gasses at the turbine exit. (5%)
 - Calculate the velocity of the gases at the nozzle exit. (5%)
 - Calculate the propulsive efficiency of the cycle. (5%)
 - Plot the $T - s$ diagram of the jet engine's ideal thermodynamic cycle. Mark the points 1-6 in the following figure on your $T - s$ diagram. (5%)



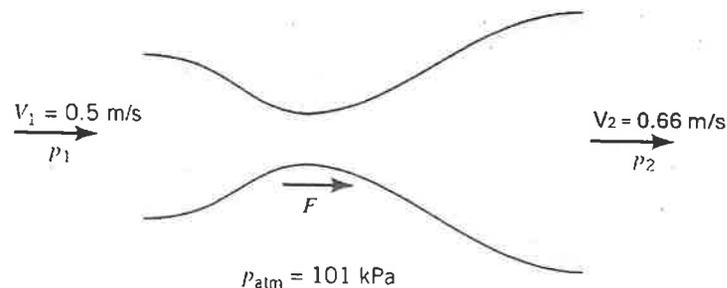
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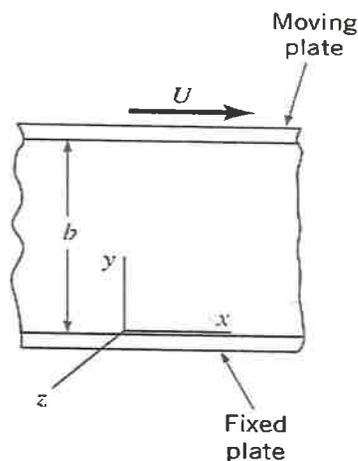
4. (10%) Air at $p_1 = 303$ kPa (abs), and $V_1 = 0.5$ m/s with a density of $\rho_1 = 3.52$ kg/m³ enters the Venturi as shown in the figure below. The air leaves at $p_2 = 101$ kPa (abs) and at a speed of $V_2 = 0.66$ m/s. The cross-sectional areas at the inlet and outlet are $A_1 = 0.6$ m² and $A_2 = 1.0$ m², respectively. Calculate the horizontal force required to hold the Venturi stationary.



5. (20%) Consider steady, incompressible flow of a Newtonian fluid between two large, parallel plates separated by a distance b . The lower plate is fixed, while the upper plate moves in the positive x -direction with constant velocity U , as shown in the figure below. The coordinate y is measured normal to the plates from the lower plate. A constant pressure gradient $\frac{\partial p}{\partial x}$ exists along the x -direction, and body forces in that direction may be neglected. Starting from the Navier-Stokes equation in the x -direction, simplify the governing equation under the assumptions that the flow is steady, fully developed, one-dimensional, and that no-slip boundary conditions are valid at both plates. Integrate the resulting equation to obtain the velocity profile $u(y)$.

Navier-Stokes equation in the x -direction:

$$\rho \left(\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right) = -\frac{\partial p}{\partial x} + \rho g_x + \mu \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right)$$



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6. (20%) Water flows through a horizontal plastic pipe (smooth) with a diameter of 0.2 m and a length of 1 m at a velocity of 10 cm/s. Determine the pressure drop per meter of pipe. The density and dynamic viscosity of water are 999 kg/m^3 and $1.12 \times 10^{-3} \text{ N} \cdot \text{s/m}^2$, respectively. The equivalent roughness of a plastic pipe is $\varepsilon = 0.0 \text{ mm}$, and the Haaland formula for the friction factor is:

$$\frac{1}{\sqrt{f}} = -1.8 \log \left[\left(\frac{\varepsilon/D}{3.7} \right)^{1.11} + \frac{6.9}{Re} \right]$$

