所　別：機械工程技術研究所　　組別：熱流組　　科目：熱力學
學程別：

1. An exterior wall of a house may be approximated by a 4-in layer of common brick (k=0.7 W/m-℃) followed by a 1.5-in layer of gypsum plaster (k=0.48 W/m-℃). What thickness of lossely packed rock -wool insulation (k=0.065W/m-℃) should be added to reduce the heat loss (or gain) through the wall by 80 percent ?

(18 %)

2. Air at 27 ℃ and 1atm flows over a flat plate at a speed of 2m/s , and the plate is heated over its entire length to a temperature of 60 ℃ . Calculate the amount of heat transferred in (a) the first 20 cm of the plate ,and (b) the first 40 cm of the plate .The properties of air at atmospheric pressure are shown in the following table.

T(K)	C_p(kJ/kg-℃)	$\nu \times 10^6$ (m^2/s)	k(W/m-℃)	Pr
300	1.0057	15.68	0.02624	0.708
350	1.0090	20.76	0.03003	0.691

where T is temperature, C_p is specific heat at constant pressure,ν is kinematic viscosity, k is thermal conductivity, and Pr is Prandtl number.

(22 %)

3. A certain ideal gas with molar mass M=30 kg/kmol, and isentropic index k= C_p/C_v =1.4, is contained in a piston-cylinder device at 0.5MPa and 200 ℃, with a volume of 0.5m^3. If the gas expands according to the process $PV^{1.3}$=C to a final pressure of 100 kPa, and the surrounding atmosphere is at a temperature of 27 ℃, determine

(a) the total amount of work and heat transfer of the process,

(b) the entropy change of the gas, and

(c) the process is reversible, irreversible, or impossible.

The universal gas constant is 8.3144 kJ/kmol-K.

(20 %)

4. Atmospheric air at 100 kPa and 27 ℃ enters a centrifugal compressor steadily, compressed polytropically with n=1.35 and exits at 300kPa. For air, R=0.287kJ/kg-K, C_p=1.0035kJ/kg-K, and C_v=0.7165kJ/kg-K. Determine, for 1-kg of mass flow of air,

(a) the amount of work and heat transfer of the process,

(b) the entropy change of air between inlet and exit, and

(c) the process is reversible, irreversible, or impossible

(18 %)

5. Steam enters a nozzle steadily at 400kPa and 200 ℃ with negligible velocity, expands adiabatically and exits at 100 kPa through an area of 20 cm^2. If the isentropic efficiency of the nozzle is 70 %, draw the corresponding T-s diagram, and determine

(a) the temperature and velocity of exit steam ,and

(b) the mass flow rate of steam through the nozzle.

Properties of steam are partly listed in the following tables.

(22 %)

Saturated Water

p	v_f	v_g	u_f	u_{fg}	u_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
(kPa)	(m^3/kg)		(kJ/kg)			(kJ/kg)			(kJ/kg-K)		
75	0.001037	2.2170	384.29	2112.4	2496.7	384.36	2278.6	2663.0	1.2129	6.2434	7.4563
100	0.001043	1.6940	417.33	2088.7	2506.1	417.44	2258.0	2675.5	1.3025	6.0568	7.3593
125	0.001048	1.3749	444.16	2069.3	2513.5	444.30	2241.1	2685.3	1.3739	5.9104	7.2843

Superheated Water Vapor

T	P=100kPa				P=400kPa			
(℃)	v	u	h	s	v	u	h	s
100	1.6958	2506.6	2676.2	7.3641				
150	1.9364	2582.7	2776.4	7.6133	0.47084	2564.5	2752.8	6..9299
200	2.1723	2658.0	2875.3	7.8342	0.53422	2646.8	2860.5	7.1706