1. (a) (10%)

What is known about the specific heat and internal-energy behavior for an ideal gas?

(b) (10%)

What minimum information is necessary to formulate a table of thermodynamic properties for a pure substance?

2. (15%)

Air enters a steady-flow compressor at 101 kPa and 25°C, where it undergoes an internally reversible compression to 800 kPa. Assume constant specific heats and neglect changes in kinetic and potential energy during the compression process. Calculate the work per unit mass required to compress the air and the temperature of the air as it leaves the compressor for the following:

(a) An isentropic-compression process (5%)
(b) An isothermal-compression process (5%)
(C) Draw P-V Diagram (5%)

3. (15%)

The heat transfer from a thermal-energy reservoir at a temperature of 550 K to a heat engine is 50 kJ. The heat engine produces 10 kJ of work and the heat transfer from the heat engine is to (a) a thermal-energy reservoir at 400 K and (b) the environment at 298 K.

(a) Determine the thermal efficiency of the engine. (7%)
(b) Find the 2nd law efficiency. (8%)

061

4. (25%) The wet bulb and dry bulb temperatures of a moist-air mixture at a total pressure of 1 atm (= 101. 3 Kpa) are measured with a sling psychrometer and are found to be 10 and 20 ^{o}C, respectively. Determine:

(a)the humidity ratio

(b)the relative humidity(%)

(c) the enthalpy of the mixture per unit mass of dry air(KJ/Kg)

(d) volume of the mixture per unit mass of dry air(m^3/Kg).

5. (25%)A heat pump is to be used to heat a house in the winter and then reversed to cool the house in the summer. The interior temperature is to maintained at 20 ^{o} C in the winter and 25 ^{o} C in the summer. Heat transfer through the walls and roof is estimated to be 2400 KJ per hour per degree temperature difference between the inside and outside.

(a) If the outside temperature in the winter is 0 ^{o} C, what is the minimum power (KW) required to drive the heat pump?

(b) If the power input is the same as that in part (a), what is the maximum outside summer temperature for which the inside of the house can be maintained at 25 ^{o} C?

TABLE B.1 SATURATED WATER—TEMPERATURE TABLE: SI UNITS

		Specific volume, m³/kg			Internal energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg·K		
Temp., °C, T	Press., kPa, P	Sat. liquid, v_f	Evap., v_{fg}	Sat. vapor, v_g	Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Sat. liquid, s_f	Evap., s_{fg}	Sat. vapor, s_g
0.01	0.61173	0.0010002	205.99	205.99	0.00	2374.5	2374.5	0.00	2500.5	2500.5	0.0000	9.1541	9.1541
1.00	0.65716	0.0010002	192.44	192.44	4.18	2371.7	2375.9	4.18	2498.2	2502.4	0.0153	9.1124	9.1277
5	0.87260	0.0010001	147.02	147.02	21.02	2360.4	2381.4	21.02	2488.7	2509.7	0.0763	8.9473	9.0236
10	1.2281	0.0010003	106.32	106.32	41.99	2346.3	2388.3	41.99	2476.9	2518.9	0.1510	8.7477	8.8986
15	1.7056	0.0010009	77.896	77.897	62.92	2332.3	2395.2	62.92	2465.1	2528.0	0.2242	8.5550	8.7792
20	2.3388	0.0010018	57.777	57.778	83.83	2318.2	2402.0	83.84	2453.3	2537.2	0.2962	8.3689	8.6651
25	3.1690	0.0010030	43.360	43.361	104.75	2304.1	2408.9	104.75	2441.5	2546.3	0.3670	8.1889	8.5559
30	4.2455	0.0010044	32.897	32.898	125.67	2290.0	2415.7	125.67	2429.7	2555.3	0.4365	8.0148	8.4513
35	5.6267	0.0010060	25.221	25.222	146.58	2275.9	2422.5	146.59	2417.8	2564.4	0.5050	7.8461	8.3511
40	7.3814	0.0010079	19.528	19.529	167.50	2261.7	2429.2	167.50	2405.9	2573.4	0.5723	7.6828	8.2550
45	9.5898	0.0010099	15.262	15.263	188.41	2247.5	2435.9	188.42	2393.9	2582.3	0.6385	7.5244	8.1629
50	12.344	0.0010122	12.036	12.037	209.31	2233.3	2442.6	209.33	2381.9	2591.2	0.7037	7.3708	8.0745

062