TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

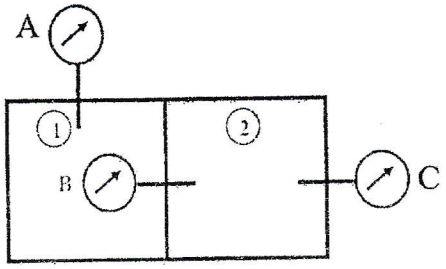
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME 402)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. State and explain equality of temperature. [4]
2. Derive a general expression for the displacement work transfer for a piston cylinder device. Also reduce it for an ideal gas undergoing isothermal process. [4]
3. Define quality and write why it is necessary. Derive an expression for specific volume of a two phase mixture in terms of quality. [4]
4. Write the general mass and energy equation for a control volume operating under unsteady state condition. Derive the mass conservation and energy conservation equation for a process in which gas is supplied to piston cylinder device through a valve and it can produce some work by displacing the piston. [6]
5. Define an isentropic process. Also derive isentropic relations for an ideal gas. [6]
6. Sketch an ideal Otto cycle on P-V and T-S diagrams. Also derive an expression for its efficiency in terms of compression ratio. [6]
7. Derive an expression for steady state heat transfer through a composite cylinder consisting of three layers. [6]
8. Three pressure gauges are connected to a container consisting of two compartments as shown in figure below. If the local barometer reads 760mm of Hg and pressure gauges A and B read 250kPa and 150kPa respectively, determine the absolute pressure in each compartment and reading of pressure gauge C. [Take ρ=13600 kg/m^3 and g=9.81m/s^2]. [6]



9. A closed rigid container of volume 0.5m^3 is placed on a plate. Initially the container holds two phase mixture of saturated liquid water and saturated water vapor at initial pressure P_1=100 kPa with a quality of 50%. After heating, the pressure in the container is P_2=150 kPa. Draw the P-V and T-V diagrams of the heating process and determine:
   a) the temperature at each state.
   b) the mass of the vapor present at each state. [8]

   [Refer the attached table for properties of water]

10. An adiabatic diffuser has air entering at 100kPa, 300K with a velocity of 200m/s. The inlet cross sectional area of the diffuser is 100mm^2. At the exit, the area is 860 mm^2 and velocity is 20m/s. Determine the exit temperature and pressure of the air. [Take c_p=1005 J/kgK, R=287 J/kgK] [8]

11. 2 kg of water at 100°C is mixed with 4kg of water at 20°C in an isolated system. Calculate the neat change in entropy due to the mixing process. [Take specific heat of water, c=4.18 kJ/K] [8]

12. Air is used as the working fluid in a simple ideal Brayton cycle that has a pressure ratio of 12, a compressor inlet temperature of 300K, and a turbine inlet temperature of 1000K. Determine the required mass flow rate of air for a net power output of 90MW. Also calculate thermal efficiency of the cycle. [Take c_p=1005 J/kgK, R=287 J/kgK, γ=1.4] [8]

13. An exterior wall of a house consists of 10cm of common brick (K=0.8W/mK) followed by a 4cm layer of gypsum plaster K=0.5 W/mK). What thickness of rock wool insulation (k=0.065 W/mK) should be added to reduce the heat transfer though the wall by 50%? [6]

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Properties of Saturated Water-Pressure Table

P	T	v_l	v_{lg}	v_g	u_l	u_{lg}	u_g	h_l	h_{lg}	h_g	s_l	s_{lg}	s_g
kPa	°C	m^3/kg	m^3/kg	m^3/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K	kJ/kg.K
100	99.632	0.001043	1.6933	1.6943	417.41	2088.3	2505.7	417.51	2257.6	2675.1	1.3027	6.0562	7.3589
101.32	100.00	0.001043	1.6727	1.6737	418.96	2087.1	2506.1	419.06	2256.6	2675.7	1.3069	6.0476	7.3545
125	105.99	0.001048	1.3742	1.3752	444.25	2068.9	2513.2	444.38	2240.7	2685.1	1.3741	5.9100	7.2841
150	111.38	0.001053	1.1584	1.1595	467.02	2052.4	2519.4	467.18	2226.2	2693.4	1.4338	5.7894	7.2232
175	116.07	0.001057	1.0027	1.0038	486.89	2037.8	2524.7	487.08	2213.3	2700.4	1.4851	5.6866	7.1717
200	120.24	0.001060	0.8848	0.8859	504.59	2024.8	2529.4	504.80	2201.7	2706.5	1.5304	5.5968	7.1272