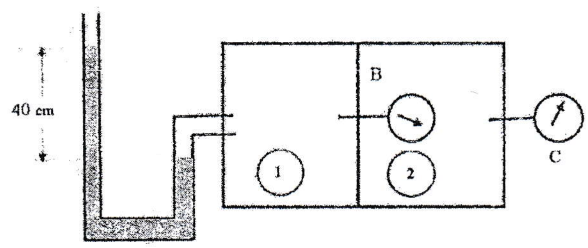
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Baishakh

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

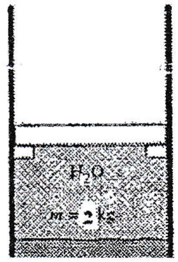
Subject: - Fundamental of Thermodynamics and Heat transfer (*ME 402*)

- ✓ 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. Define thermodynamic process. Sketch P-V, T-V and P-T diagrams for an ideal gas undergoing expansion in the piston-cylinder arrangement without any stops, until the final volume is doubled of the initial volume. [4]
2. Define work transfer. Derive the expression for heat and work for adiabatic process. [4]
3. What is an equation of state? Derive an expression for equation of state of an ideal gas. [4]
4. Write down the statement of first law of thermodynamics for an isolated system. Derive the expressions for mass flow rates at the inlet and outlet of a control volume. [6]
5. Define isentropic process. Derive isentropic relations for an ideal gas. [6]
6. Sketch an air standard diesel cycle on P – V and T – S diagrams and derive an expression for its efficiency in terms of compression ratio and cut-off ratio. [6]
7. Derive an expression with appropriate diagram for conduction heat transfer through a composite cylinder consisting of three layers of different materials. [6]
8. A large chamber is separated into two compartments which are maintained at different pressures, as shown in figure below. The local barometer reads 740 mm of Hg and pressure gauge B reads 30 kPa vacuum pressures. The U-tube manometer connected to compartment 1 contains mercury and its reading is 40 cm of Hg. Determine the absolute pressure in each compartment and reading of pressure gauge C. [Take $\rho_{Hg} = 13600$ kg/m^3, $g = 9.81$ m/s^2] [6]



9. A piston cylinder device shown in figure below contains 2 kg of water with an initial temperature and volume of 80°C and 0.05m^3. It requires a pressure of 400 kPa to lift the piston from the stops. The system is heated until its temperature reaches 250°C. Sketch the process on P-v diagram and determine the total work transfer. [8]



10. An ideal gas undergoes a thermodynamic cycle consisting of the following three processing in series. [8]

Process 1-2: constant volume, $V_1 = 0.1\ m^3$, $P_1 = 100$ kPa, $U_2 - U_1 = 150$ kJ
Process 2-3: expansion with PV = constant
Process 3-1: constant pressure, $W_{31} = -60$kJ

a) Sketch the process on P-V and T-V diagram.
b) Calculate network for the cycle.
c) Calculate net heat for the cycle.
d) Calculate the heat transfer for the process 1-2.
e) Calculate heat transfer for the process 2-3.
f) Calculate the heat transfer for the process 3-1.
g) Is this power cycle or a refrigerator cycle?

11. It is desired to maintain an auditorium hall at 25°C throughout the year. For this it is planned to use a reversible air conditioning unit which can be used as a refrigerator in summer and a heat pump in winter. The outside temperature in summer is 45°C and winter it falls down to 3°C. The heat loss through walls, roof, windows and doors is estimated as 50 kW. Determine minimum theoretical power required to operate the air conditioning until in summer and in winter. [8]

12. An ideal Brayton cycle has a pressure ratio of 8. The air temperatures at the compressor and turbine inlets are 300 K and 1300 K respectively. Determine:

a) The air temperatures at the exits of the compressor and turbine,
b) The back work ratio, and
c) The thermal efficiency of the cycle.

[Take $\gamma = 1.4$ and cp = 1005 kJ/kgK]

13. The hot combustion gas of a furnace is separated from the ambient air by a brick wall of 0.2 m thick with thermal a conductivity of 1.5 W/mK and surface emissivity of 0.85. Under steady states conditions, an inner surface temperature of brick wall is measured to be 850°C. The ambient air temperature is 20°C and the convention heat transfer coefficient between the surface and air is 20 W/m^2K. What is the brick outside surface temperature? [$\sigma = 5.67\times10^{-8}\ W/m^2K^4$] [6]

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