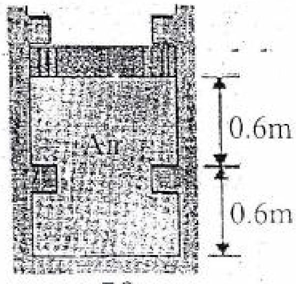
21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2067 Ashadh

Exam.		Regular/Back	
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat

- ✓ 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. List out and explain the three types of thermodynamic system. Derive an expression for work done during an isothermal process. [6]
2. Write down steady flow energy equation (SFEE) with necessary assumptions. Reduce it for nozzle, adiabatic pump and throttling valve. [4]
3. Define entropy. Derive the expressions for change of entropy for an ideal gas by combining first and second laws of thermodynamics. [6]
4. What are the major two differences between Otto cycle and Diesel cycle? Draw P-v and T-s diagrams for the Dual cycle. Write down the expression for an efficiency of Dual cycle and conditions when Dual cycle tends to Diesel cycle and Otto cycle. [6]
5. Derive an expression for radial heat flow through three layer composite cylinders. [6]
6. What is brake nozzle? Differentiate between impulse turbine and reaction turbine. [6]
7. Write short notes: (any four) [2×4]
   a) Surface tension
   b) Buoyant force
   c) Path line
   d) Statement and assumptions of Bernoulli's equation
   e) Lift force and drag force
8. Air is contained in a vertical cylinder fitted with a frictionless piston and a set of stops as shown in figure below. The cross-sectional area of the piston is $0.05 m^2$. At initial condition, piston is in upper stops with pressure and temperature inside the cylinder are 0.3 MPa and 731°C respectively. Air is cooled as a result of heat transfer to the surroundings. The piston starts to move down at pressure 0.21 MPa. The cooling process continues until the temperature reaches 70°C. [8]
   a) Draw P-V diagram for the process.
   b) Find the temperature of the air inside the cylinder when the piston reaches the lower stops.
   c) Calculate the heat transfer during the process. (For air R = 287 J/kg K, Cp = 1004 J/kg K, Cv = 717 J/kg K)



9. A rigid container with a volume of $0.170 m^3$ is initially filled with steam at 200 kPa and 350°C. It is cooled to 90°C. [7]

   a) At what temperature does a phase change starts to occur?
   b) What is the final pressure?
   c) What mass fraction of the water is liquid in the final state?

   Also sketch the process on P-v and T-v diagrams. [Refer the attached table for properties of steam]

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 $100 mm^2$. At the exit, the area is $860 mm^2$, and the exit velocity is 20m/s. Determine the exit temperature and pressure of the air. [Take C_p = 1005 J/kg K, R = 287J/kg K]. [8]

11. Steam at 700kPa with a quality of 0.96, is throttled down to 350kpa. Calculate the change of entropy per unit mass of steam. [Refer the attached table for properties of steam.] [6]

12. Air enters the compressor of an ideal air standard Brayton cycle at 100kpa, 300k, with a volumetric flow rate of $5 m^3/s$. The compressor pressure ratio is 10. The turbine inlet temperature is 1400k. Determine: [8]

   a) The thermal efficiency of the cycle
   b) The net power developed, in kW. [Take R = 287J/kg K, cp = 1005J/kg K, γ = 1.4]

13. The inside surface of an insulating layer is at 270°C, and the outside surface is dissipating heat by convention in to air at 20°C. The insulation layer is 4 cm thick and has thermal conductivity of 1.2W/m.K. What is the minimum value of the heat transfer coefficient at the outside surface if the outside temperature is not to exceed 70°C? [6]

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