04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Shrawan

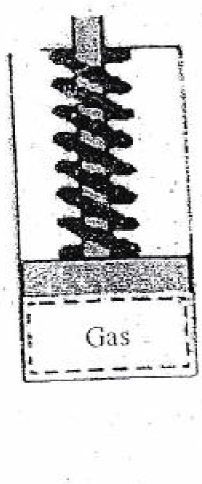
Exam.	New Back (2066 Batch & Later)		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Fundamentals of Thermodynamics and Heat Transfer

- ✓ 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. Highlight assumptions of air standard cycle. Derive the thermal efficiency of two stroke Spark Ignition (SI) Engine. [4]
2. Define a polytropic process. Sketch polytropic processes with n = 0, 1, 1.4 and ∞ on a common P-V diagram. Derive an expression for work transfer for a polytropic process. [6]
3. Draw saturation curve of water using isobar lines. Differentiate between compressed liquid and saturated liquid as well as saturated vapor and superheated vapor. [6]
4. Derive general energy equation for an open system and modify it for steady state, steady flow operation. [6]
5. Define isentropic process. Derive isentropic relations for an ideal gas. [6]
6. Derive the relationship between rate of heat transfer and thermal resistance for a composite wall having three layers. [6]
7. Derive an expression for overall heat transfer coefficient for a composite plane wall consisting of three layers with convection on both sides. [6]
8. A gas is contained in a piston cylinder device at 101.325 KPa, 200°C and 0.425m^3 as shown in figure below. At this state, a linear spring with a spring constant of 219 kN/m is touching the piston but exerts no force on it. The cross sectional area of the piston is 0.279 m^2. Heat is transferred to the gas, causing it to expand until it's volume doubles. Determine: [5]

   a) The final pressure
   b) The ratio of fraction of work done against the spring and total work done
   c) The total heat transfer during the process
   d) Also, show the process on a P-V and T-V diagrams. (Take R = 287J/kgK and C_V = 718 J/kgK)



9. The mass rate of flow into a turbine is 1.5 kg/s, and the heat transfer from the turbine is 8.5 kW. The following data are known for the steam entering and leaving the turbine. [8]

	Inlet Conditions	Exit Conditions
Pressure	2.0MPa	0.1MPa
Temperature	350°C	
Quality		100%
Velocity	50m/s	100m/s
Elevation above reference plane	6m	3m

Determine the power output of the turbine and exit area of outlet pipe. [Refer the attached table for properties of steam]

10. Two kg of water at 90°C is mixed with three kg of water at 10°C in an isolated system. Calculate the change of entropy due to the mixing process. [Cp for water = 4.18kJ/kgK]. [6]

11. Air enters the compressor of an ideal air standard Brayton cycle at 100kPa, 300K, with a volumetric flow rate of $5m^3/s$. The compressor pressure ratio is 10. The turbine inlet temperature is 1400K. Determine: [11]

    a) The thermal efficiency of the cycle.
    b) The net power developed in kW.

12. A steel pipe having an outside diameter of 2cm is to be covered with two layers of insulation, each having a thickness of 1cm. The average conductivity of one insulation is 5 times that of the other. Assuming that the inner and outer surface temperatures of the composite insulation are fixed, calculate by what percentage the heat transfer will be reduced when the better insulating material is next to the pipe than it is away from the pipe. [10]

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