04

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING

Examination Control Division

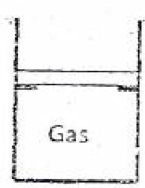
2071 Shawan

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

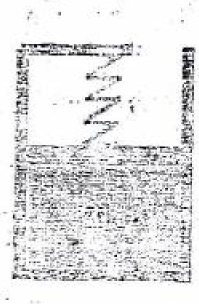
Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME402)*

- ✓ 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 figures are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. Differentiate between the microscopic and macroscopic view point in thermodynamics with example. [4]
2. Define energy and power. Differentiate between stored and transient energy with examples. [4]
3. Define moisture content and critical point. Derive an expression for specific volume of a two phase (liquid and vapor) mixture in terms of quality. [4]
4. Differentiate between steady state work application and steady state flow application. Write down mass and energy conservation equation of steady state process. Reduce them for a nozzle and a condenser. [6]
5. Explain entropy. Derive the relations for entropy for an ideal gas and an incompressible substance. [6]
6. Sketch Rankine cycle on P-v and T-s diagram using dry saturated stream and obtain an expression for the Rankine cycle efficiency, [6]
7. Define thermal resistance. Derive an expression for heat transfer through composite plane wall of three different layers of different materials using electric analogues approach. [6]
8. A piston cylinder arrangement shown in figure below has cross sectional area of 0.01 m2 and a piston mass of 80 kg. If the atmospheric pressure is 1 bar, what should be the gas pressure to lift the piston? If 50 kg mass is added above the piston, what would be the new pressure? [6]



9. A piston cylinder device with a linear spring initially contains water at a pressure of 4 MPa and 500°C with the initial volume being 0.1 m3, as shown in figure below. The system now cools until the pressure reaches 1000 kPa. If the piston is at the bottom, the system pressure is 300 kPa. Sketch the process on P-v diagram and determine the mass of H_2O, the final temperature and volume and the total work transfer. [Refer the attached table for properties of steam] [8]



10. A perfect gas flows through a nozzel where it expands in a reversible adiabatic manner. The inlet conditions are 22 bar, 500°C and 38m/s at the exit the pressure is 2 bar. Determine the exit velocity and exit area if the flow rate is 4 kg/s. Take R=190 J/Kg K and Υ = 1.35. [[illegible]]

11. A house is to be maintained at 25°C in summer as well as winter. For this purpose, it is proposed to use a reversible device as a refrigerator in summer and a heat pump in winter. The ambient temperature is 40°c in summer and 3°c in winter. The energy losses as heat from the roof and the walls are estimated as 5 kw per degree Celsius temperature between the room and the ambient conditions. Calculate the power required to operate the device in summer and winter. [8]

12. At the beginning of a compression stoke of an air standard Diesel cycle having a compression ratio of 16 the temperature is 300 K and the pressure is 1000 kpa, if the cut off ratio for the cycle is 2 Determine: [8]

a) The pressure and temperature at the end of each process of the cycle.

b) The thermal efficiency and

c) The mean effective pressure

[Take R =287 J/kg.k and Υ = 1.4]

13. A gas turbine blade is modeled as a flat plate. the thermal conductivity of the blade material is 15W/mk and its thickness is 1.5 mm. The upper surface of the blade is exposed to hot gases at 1000°C and the lower surface is cooled by air bled of the compressor. The heat transfer coefficients at upper and lower surfaces of the blade are 2500 W/m^{2}K and 1500 W/m^{2}K respectively. Under steady state conditions, the temperature at upper surface of the blade is measured as 850°C, determine the temperature of the coolant air. [6]

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TABLE 1 Properties of SATURATED WATER – Pressure Table

P kPa	T °C	v_f m^3/kg	v_{fg} m^3/kg	v_g m^3/kg	u_f kJ/kg	u_{fg} kJ/kg	u_g kJ/kg
90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
125	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
900	175.39	0.001121	0.2138	0.2149	741.92	1838.3	2580.2
950	177.70	0.001124	0.2030	0.2041	752.03	1829.8	2581.8
1000	179.92	0.001127	0.1933	0.1944	761.75	1821.6	2583.3
1100	184.10	0.001133	0.1764	0.1775	780.14	1805.9	2586.0
1200	188.00	0.001138	0.1622	0.1633	797.31	1791.1	2588.4

TABLE 2 Properties of SUPERHEATED STEAM

P kPa	T °C	v m^3/kg	u kJ/kg	H kJ/kg	s kJ/kg.K
4000	(250.39)	(0.04977)	(2601.3)	(2800.6)	(6.0689)
	300	0.05882	2724.4	2959.7	6.3598
	350	0.06644	2826.1	3091.8	6.5811
	400	0.07340	2919.8	3213.4	6.7688
	450	0.08002	3010.3	3330.4	6.9364
	500	[illegible]	[illegible]	[illegible]	[illegible]
	550	[illegible]	[illegible]	[illegible]	[illegible]
	600	[illegible]	[illegible]	[illegible]	[illegible]
	650	[illegible]	[illegible]	[illegible]	[illegible]