34 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

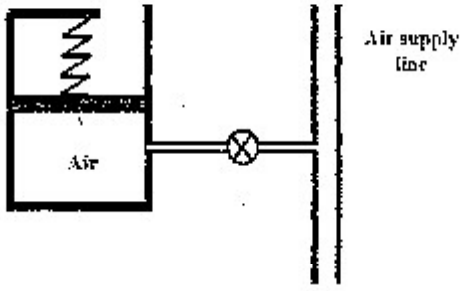
2071 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME452)*

- ✓ 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 atmospheric pressure, gauge pressure and absolute pressure. Also write down the relationship between them. [4]
2. Differentiate between heat transfer and work transfer. [4]
3. Explain saturation curve of two-phase mixture on T-V diagram. [4]
4. Write down general mass conservation and energy conservation equations for a control volume. Also reduce them for a control volume operating under unsteady state condition. [6]
5. Define entropy. Derive expressions for changes in entropy for reversible heat transfer and reversible work transfer processes. [6]
6. Sketch an ideal Brayton cycle on P-v and T-s diagrams. Also derive an expression for its efficiency in terms of pressure ratio. [6]
7. Derive for thermal resistance of composite wall using electric analogy. [6]
8. A 15 kg piston in a cylinder with diameter of 0.15 m is loaded with a linear spring and the outside atmospheric pressure of 100 kPa, as shown in figure below. The spring exerts no force on the piston when it is at the lower position of the cylinder and for the state shown, the pressure is 300 kPa with volume of 0.02 m^3. The valve is opened to let some air in, causing the piston to rise 5 cm. Find the new pressure. [Take g = 9.81 m/s^2] [6]



9. A piston cylinder device shown in figure below contains 2 kg of H_2O with an initial temperature and volume of 80°C and 0.05 m^3 respectively. 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 and T-v diagrams and determine the total work transfer. [Refer attached table for the properties of steam] [8]

10. Air expands through an adiabatic turbine from 1000 kPa, 1000 K to 100 kPa, 400 K. The inlet velocity is 10 m/s whereas exit velocity is 100 m/s. The power output of the turbine is 3600 kW. Determine the mass flow rate of air and the inlet and exit diameters. [Take R = 287 J/kgK and C_p = 1005 J/kgK]. [8]

11. An air conditioning unit with a power input of 1.5 kW. It has a COP of 3 while working as a cooling unit in summer and 4 while working as heating unit in winter. It maintains a hall at 22°C year around, which exchanges heat at a rate of 0.8 kW per degree temperature difference with the surroundings. Determine the maximum and the minimum outside temperature for which this unit is sufficient. [8]

12. A Rankine cycle has a boiler working at a pressure of 2 MPa. The maximum and minimum temperatures during the cycle are 400°C and 50°C respectively. Determine the efficiency of the cycle and compare it with that of the Carnot cycle operating between the same temperature limits. [Refer attached table for the properties of steam] [8]

13. A 2.5 cm thick plate (k = 50 W/mK) 50 cm by 75 cm is maintained at 300°C. Heat is lost from the plate surface by convection and radiation to the ambient air at 20°C. If the emissivity of the surface is 0.9 and the convection heat transfer coefficient is 20 W/m^2K, determine the inside plate temperature. [$\sigma = 5.67 \times 10^{-8}$ W/m^2K^4] [6]

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34 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

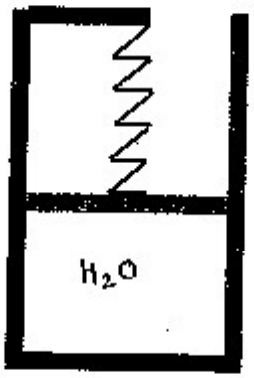
2070 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agri.	Pass Marks	32
Year / Part	I/II	Time	3 hrs.

Subject: - Fundamental of Thermodynamics & Heat Transfer ***(ME452)***

- ✓ 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. Differentiate between intensive and extensive property. State whether the following properties are intensive or extensive volume, specific volume, temperature and pressure. [4]
2. Differentiate between heat transfer and work transfer. [4]
3. Define pure substance. Explain with illustration. [4]
4. Derive the general energy equation for control volume. [6]
5. Derive the expression for change of entropy for reversible heat reservoirs and reversible work reservoirs. [6]
6. Differentiate between gas and vapor cycles. Also derive an expression for the air standard efficiency of Otto cycle in terms of compression ratio. [6]
7. Derive the expression for combined conduction and convection heat transfer through hollow cylinder covered with two layers of insulation. [6]
8. A gas is contained in a piston cylinder device initially at a pressure of 150 kPa and a volume of 0.04 m^3. Calculate the work done by the gas when it undergoes the following processes to a final volume of 0.1 m^3, (i) Constant-Pressure (ii) Constant temperature (iii) $PV^{1.35}$ – constant. [6]
9. A piston cylinder device with a linear spring initially contains water at a pressure of 4 MPa and 500°C with an initial volume being 0.1m^3, as shown in figure. 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: [8]



a) The mass of water

b) The final temperature and volume and

c) The total work transfer

[Refer the attached tables for properties of steam]

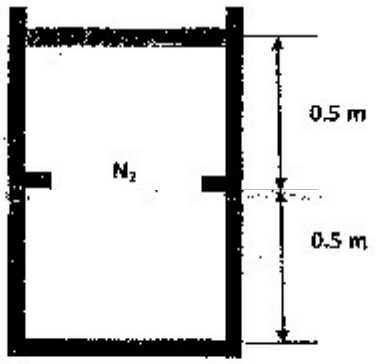
10. Air flows at a rate of 1.5 kg/s through a turbine, entering at 500 kPa, 150° and with a velocity of 120 m/s and leaving at 100 kPa, 25°C and with a velocity of 60 m/s. Power produced by the turbine is 180MW. Determine: [8]

a) Heat loss form the turbine and

b) Diameters of inlet and exhaust pipe

[Take R = 287 J/kgk, C_p = 1005 J/kgk]

11. A piston cylinder device shown in figure below contains 1 kg of Nitrogen initially at a pressure of 250 kPa and a temperature of 500°C. Heat is lost from the system till its temperature reaches 40°C. Sketch the pressure on P-V and T-V diagrams and determine the energy generation. Assume that surrounding is at 20°C. Take P = 297 J/kgk, C_v = 743 J/kgk.



12. In an air standard Brayton cycle the air enters the compressor at 0.18 MPa, 34°C. The pressure leaving the compressor is 2.3 MPa, and the maximum temperature in the cycle is 2350°C. Determine: [8]

a) The pressure and temperature at each point cycle

b) The compressor work, turbine work, and cycle efficiency

[Take Cp = 1005 J/kgk, γ= 1.4]

13. A steam main of 8 cm inside diameter and 9.5 cm outside diameter is lagged with two successive layers of insulation. The layer in contact with pipe is 3.75 cm asbestos with thermal conductivity 0.11 W/m°K and the asbestos layer is covered with 1.5 cm thick magnesia insulation with thermal conductivity of 0.067W/m°K. The inside film heat transfer co-efficient is 290 W/m^{2}K and the outside film heat transfer co-efficient is 7.0 W/m^{2}K. Conductivity of pipe material is 45 W/m°K. Calculate the inside and outside overall heat transfer co-efficient for 50 m length if the steam is passing is at 350°C and the ambient temperature is 30°C. [6]

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34 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2070 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEI, BEX, BCT, BIE, B.Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Fundamental of Thermodynamic & Heat Transfer *(ME452)*

- ✓ 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 equilibrium. Explain with illustrations. [4]
2. Explain the concept of thermodynamic work and differentiate it with mechanical work. [4]
3. Sketch the saturation curve on P-v and T-v diagram with all important points, lines and regions. [4]
4. Derive and explain first law of thermodynamics for a control mass. Also reduce it for a cylic progress. [6]
5. Define entropy. Derive isentropic relations for an ideal gas and an incompressible [6]
6. Explain the working of simple vapor compression refrigeration cycle with corresponding processes in p-h and T-s diagrams. [6]
7. Derive expressions for inside and outside overall heat transfer co-efficient for a hollow cylinder subjected to convection medium on both sides. [6]
8. 4 kg of air contained in a piston cylinder arrangement at an initial pressure of 2500 kpa and initial volume of 0.25 m^3 is allowed to expand according to pressure volume relation of PV^3= constant until its volume equals to 0.65 m^3. The air is then cooled at constant pressure until the piston comes to its initial position. Then heat is supplied to the air as the piston is locked with a screw until the pressure rises to its initial pressure. Determine the total work transfer. [6]
9. A vessel contains 2 kg of saturated liquid water and saturated water vapor mixture at a temperature of 150°C. One third of the volume is saturated liquid and two third is saturated vapor. Determine the pressure, quality volume internal energy and enthalpy of the mixture. [8]
10. Steam at 4 Mpa, 450°C enters a nozzle operating at steady state with a velocity of 50 m/s. Steam leaves the nozzle at 2 Mpa and 300°C. The inlet area of the nozzle is 80 cm^2 and heat loss from the nozzle surface occurs at the rate of 100 KW. Determine: [8]
    i) The mass flow rate of steam
    ii) The exit velocity of the steam and
    iii) The exit area of the nozzle
    [Refer the attached table for the properties of steam]
11. A control mass system consists of ice and water 12 kg of water, at 37°C is mixed with 8 kg of ice at -27°C. Assuming the process of mixing is adiabatic, find the change of entropy. Latent heat of ice = 336kJ/kg, C_p for water = 4.2 kJ/kg k. [8]
12. A compression ratio of an air standard otto cycle is 8. At the beginning of the compression process, the pressure and temperature of air are 100 kpa and 20°C respectively. The heat added per kg of air during the cycle is 2000 KJ/kg determine: [8]
    a) The pressure and temperature at the end of each process of the cycle
    b) The thermal efficiency. [Take C_v=718 J/kg.k, γ=1.4]
13. An exterior wall of a residential building of 25 cm thick brick [k=0.7 W/m.°C] followed by layers of 2cm thick cement plaster [k=0.48 W/m.°C] on both sides. What thickness of extruded polystyrene insulation [k=0.035 W/m.°C] should be added to reduce the heat loss (or gain) through the wall by 55 percent? [6]

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TABLE 1 Properties of SATURATED WATER – Temperature Table

T	P	v_f	v_{fg}	v_g	u_f	u_{fg}	u_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
°C	kPa	m³/kg	m³/kg	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K	kJ/kg.K
155	542.99	0.001096	0.3427	0.3438	657.75	1910.7	2564.0	662.55	2098.1	2752.5	1.8977	4.9010	6.7987
160	617.66	0.001102	0.3060	0.3071	674.97	1895.3	2568.3	679.65	2082.8	2758.0	1.9429	4.8074	6.7502

TABLE 2 Properties of SATURATED WATER – Pressure Table

P	T	v_f	v_{fg}	v_g	u_f	u_{fg}	u_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
kPa	°C	m³/kg	m³/kg	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K	kJ/kg.K
3250	238.37	0.001206	0.06027	0.06150	1025.5	1577.7	2603.2	1029.5	1773.6	2803.1	2.6865	3.4672	6.1538
3500	242.60	0.001235	0.05582	0.05705	1045.3	1557.6	2602.9	1049.6	1753.9	2803.6	2.7251	3.3989	6.1240

TABLE 3 Properties of SUPERHEATED STEAM

P	T	v	u	h	s
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg.K
2000	(212.42)	(0.001059)	(2599.5)	(2798.7)	(6.3396)
	250	0.1114	2678.8	2901.6	6.5438
	300	0.1254	2771.8	3022.7	6.7651
	350	0.1386	2859.4	3136.6	6.9556
	400	0.1512	2945.1	3247.5	7.1269

P	T	v	u	h	s
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg.K
4000	(250.39)	(0.04977)	(2601.5)	(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	3213.9	6.7688
	450	0.08002	3010.3	3330.4	6.9364

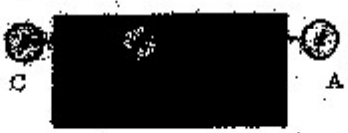
24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B. Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

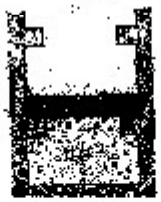
Subject: - Fundamentals of Thermodynamics and Heat Transfer *(ME 452)*

- ✓ 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. Differentiate between closed system and open system with suitable examples. [5]
2. Define total energy of a system. And differentiate between the stored energy and transient energy with examples. [4]
3. Sketch saturation curve of water in T-v with the help of isobar lines. Show all important points, lines and region. Also define saturation temperature and quality. [6]
4. Write down general expressions for mass and energy conversion for a control volume. Reduce these equations for an adiabatic nozzle and condenser. [6]
5. Derive expression of entropy generation for a control mass. [6]
6. Write the assumptions of an air standard analysis. Sketch an ideal diesel cycle on P-v and T-s diagrams. Also compare Otto and diesel cycle. [6]
7. Derive an expression for steady state radial heat conduction through a hollow cylinder. Also derive expression for its thermal resistance. [4]
8. A vessel shown has two compartments as shown in figure below at different pressures. The pressure gauge A reads 4 bar and B reads 2 bar. The barometer reads 760mm of Hg. Calculate the reading of gauge C. [Take $\rho = 13600 kg/m^3$ and $g = 9.81 m/s^2$] [5]



9. A one liter closed vessel contains water at its critical conditions. This vessel is cooled until its pressure drops to 1 MPa. Calculate the mass of water in the vessel, the final dryness fraction and final temperature. Also show the process on P-v at T-v diagrams. [6]
10. Consider the piston/cylinder arrangement as shown figure below. When the piston rests on the lower stops, the enclosed volume is 400L. When the piston reaches the upper stops, the volume is 600L. the cylinder initially contains water at 100kPa, 20% quality. It is heated until the water eventually exists as saturated vapor. It takes a pressure of 300kPa to lift the piston. Sketch P-v and T-v diagrams and determine the work transfer and heat transfer for the overall process. [8]



11. The conditions of steam at entrance and exit of a turbine are: h_1 = 3456.5kJ/kg, S_1=7.2338kJ/kgK, V_1 = 150m/s; and h_2 = 2792.8kJ/kg, S_2 = 7.4665 kJ/kgK, V_2 = 100m/s respectively. The work output per kg of steam flow is 600kJ. Heat transfer between of 500K. Determine the entropy generation per kg steam flow. [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. [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 = 0.5W/mK). What thickness of rock wool insulation (k = 0.065W/mK) should be added to reduce the heat transfer through the wall by 50%? [8]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2068 Bhadra

Exam.		Regular	
Level	BE	Full Marks	80
Programme	BEI, BEX, BCT, BIE, B.Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat Transfer

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

1. Differentiate between microscopic and macroscopic view point of thermodynamics. [4]
2. Write down the similarities and differences between heat transfer and work transfer. [4]
3. Define pure substance. State and explain 'State Postulate'. [4]
4. Write down general mass conservation and energy conservation equations for a control volume. Also derive mass and energy conservation equations for a gas filling process in a gas station. [6]
5. Write down classical statements of second law of thermodynamics. Derive the equivalence between Kelvin Plank's and Clausius's statement of 2nd law of thermodynamics. [6]
6. What is air standard cycle? Differentiate between diesel cycle and otto cycle. [6]
7. Derive the heat transfer for composite plane wall. State the electrical analogy for thermal resistance. [6]
8. A piston cylinder device loaded with a linear spring with a spring constant of k = 100kN/m contains a gas initially at a pressure of P_{abs} = 100 kPa and a volume of 0.05m^3, as shown in figure below. The mass and cross sectional area of the piston are 50 kg and 0.01m^2 respectively. Heat is supplied to the system until its volume doubles, determine the final pressure. [Take g = 9.81 m/s^2] [6]

9. A rigid vessel having a volume of 0.02m^3, initially contains water at its critical state. The vessel is cooled until its pressure drops to 2000kPa. Sketch the process on P-V and T-V diagrams and determine: [6]
   a) The mass of H_2O present in the vessel
   b) The quality at final state
   c) The mass of saturated liquid water and saturated water vapour at the final state. [Refer attached table for the properties of steam].

10. Argon (100g) is in the piston-cylinder device shown in the figure below. The initial pressure is 6.0 MPa and temperature is 200C. There is a heat transfer to the argon, causing the piston to rise until it hits the stops. There is an additional heat transfer until the final pressure is 8.0 MPa and temperature is 800°C. [8]

a) Draw the process on P-V and T-V diagrams
b) Find the total work done in the process [Take $c_v = 208 J/kg.K$].

11. A heat pump having a coefficient of 50% of the theoretical maximum maintains a house at a temperature of 20°C. The heat leakage from the house occurs at a rate of 0.8kW per degree temperature difference. For a maximum power input of 1.5kW, determine the minimum surroundings temperature for which the heat pump will be sufficient? [8]

12. A steam power plant operates on a simple Rankine cycle between the pressure limits of 2 MPa and 20 kPa. The temperature of the steam at the turbine inlet is 400°C, and the mass flow rate of steam is 50kg/s. Determine: [8]

a). The thermal efficiency of the cycle
b) The net power output of the plant [Refer attached table for the properties of steam]

13. The inside surface of an insulating layer is at 300°C and the outside surface is dissipating heat by convection into air at 25°C. The insulating layer has a thickness of 5cm and thermal conductivity of 0.8W/mK. What is the minimum heat transfer coefficient at the outside surface if the outside surface temperature should not exceed 100°C? [8]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

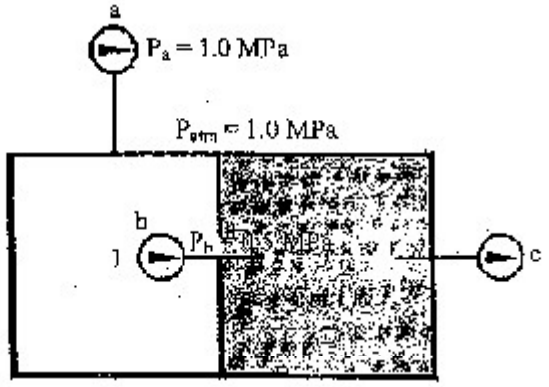
2067 Mangsir

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat Transfer

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

1. Define thermodynamic process. Sketch P-v, T-v and P-T diagram for an ideal gas undergoing isothermal expansion. [5]
2. Define work transfer and heat transfer. Also mention their sign conventions used in the analysis of thermodynamic problems. [4]
3. Define: saturation temperature, saturated vapor, quality, subcooled liquid and critical point. [5]
4. Define steady and unsteady state system. Derive the expression of conservation of mass and conservation of energy for control volume having steady and unsteady flow. [6]
5. Define reversible heat transfer reservoir and reversible work transfer reservoir. Derive expressions for change in entropy for reversible heat transfer reservoir and reversible work transfer reservoir. [8]
6. Differentiate between power cycle and refrigeration cycle. Sketch components, P-v and T-s diagrams for Rankine cycle. [6]
7. Define thermal resistance. Write down expressions of thermal resistance for plane wall, hollow cylinder and convection heat transfer. Derive an expression of heat transfer for a composite plane wall consisting of three layers using thermal resistance, inside and outside wall temperature. [6]
8. Attached to the containers shown in figure below are three pressure gauges. Determine the absolute pressure in compartment 2 and reading of pressure gauge c. [5]



9. A rigid container with a volume of 0.170m^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 100mm^2. At the exit, the area is 860mm^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 5m^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, c_p = 1005J/kg K, Y = 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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34 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2067 Shrawan

Exam.		Back	
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - 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. Define quality of a two-phase mixture. Water at atmospheric condition is heated to superheated vapor state under constant pressure condition. Sketch the heating process on P-v, T-v and T-s diagrams. [5]
2. Prove that "*There exists a property of a closed system such that a change in its value is equal to the difference between the heat supplied and the work done during any change of state.*" [6]
3. Write down classical statements of second law of thermodynamics. [3]
4. Sketch P-V and T-S diagrams for air standard Otto and air standard Diesel cycle. List the differences between Otto and Diesel cycle. [5]
5. Define thermal resistance. Write down expressions for thermal resistances for plane wall, hollow cylinder and convection heat transfer. Derive an expression for a composite plane wall consisting of three layers using thermal resistance. [6]
6. Define viscosity. Explain the effect of temperature and pressure on viscosity. [4]
7. Differentiate between Laminar and turbulent flow. Also define Reynolds Number. [5]
8. Define turbine. How turbines are classified according to head? [4]
9. Air (2 kg) is contained in a vertical frictionless piston-cylinder device shown in *Figure P.9*. The mass of the piston is such that the air has a pressure and temperature of 10.0 MPa and 75.5°C. There is a heat transfer to the cylinder until the piston reaches some stops, at which point the total volume is 0.04 m^3. There is an additional heat transfer to the air until the pressure is 15.0 MPa. Determine the total heat transfer and the total work, and show the process on P-v and T-v diagrams. [R = 287 J/kg.K, c_v = 718 J/kg.K] [10]

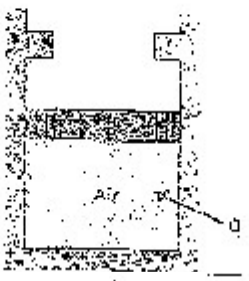

Figure P.9

10. Steam at 800 kPa and 300°C is flowing with a velocity of 45 m/s reversibly and adiabatically through a nozzle and leaves the nozzle at 100 kPa. Determine the exit velocity of the steam. [Refer the attached table for properties of steam] [8]

11. An air-standard Diesel cycle has a compression ratio of 16, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process the pressure is 0.1 MPa and the temperature is 15°C. Determine:
    (a) The pressure and temperature at each point in the cycle.
    (b) The thermal efficiency.
    (c) The mean effective pressure.
    [*Take* $c_p = 1.005$ *kJ/kg and* $c_v = 0.718$ *kJ/kg*]. [10]

12. An insulated steam pipe passes through a room in which the air and walls are at 25°C. The outside diameter of the pipe is 70 mm, and its surface temperature and emissivity are 200°C and 0.8 respectively. If the coefficient associated with free convection heat transfer from the surface to the air is 15 W/m²K, what is the rate of heat loss from the surface per unit length of the pipe? [$\sigma = 5.67 \times 10^{-8}$ *W/m²K⁴*] [7]

13. Water is flowing at the rate of 40 liters/s through a tapering pipe. The diameters at the bottom and upper ends are 300 mm and 200 mm respectively. If the pressure at the bottom and upper ends are 250 kPa and 100 kPa respectively determine the difference in datum head. [$\rho = 1000$ *kg/m³*, $g = 9.81$ *m/s²*] [7]

TABLE 1 Properties of SATURATED WATER – Pressure Table

P kPa	T °C	v_f m³/kg	v_{fg} m³/kg	v_g m³/kg	u_f kJ/kg	u_{fg} kJ/kg	u_g kJ/kg	h_f kJ/kg	h_{fg} kJ/kg	h_g kJ/kg	s_f kJ/kg.K	s_{fg} kJ/kg.K	s_g kJ/kg
90	96.713	0.001041	1.8688	1.8698	405.11	2097.1	2502.2	405.20	2265.3	2670.5	1.2696	6.1047	7.374
100	99.632	0.001043	1.6933	1.6943	417.41	2088.3	2505.7	417.51	2257.6	2675.1	1.3027	6.0552	7.357
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	7.354

TABLE 2 Properties of SUPERHEATED STEAM

P kPa	T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg.K
800	(170.44)	(0.2404)	(2576.6)	(2768.9)	(6.6625)
	200	0.2607	2630.2	2838.8	6.8151
	250	0.2931	2714.8	2949.3	7.0573
	300	0.3241	2796.6	3058.9	7.2819
	350	0.3544	2877.9	3168.4	7.4884

34 TRIBHUVAN UNIVERSITY
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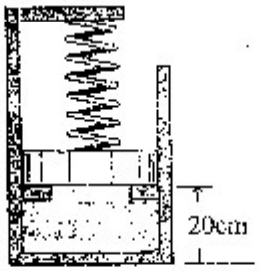
Examination Control Division
2066 Magh

Exam.		Regular/Back	
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - 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. Sketch the following process on P-v, T-v and T-s diagrams: [5]
   a) Water at compressed liquid state is heated to super heated vapor state in a cylinder with a freely moving cylinder.
   b) Water at two phase mixture (saturated liquid and saturated vapor) state is heated to super heated vapor state in a rigid vessel.
2. Define total energy of a system. Also differentiate between the stored energy and transient energy. [5]
3. Define steady state work applications. Write down the steady state energy equation and reduce it for an adiabatic turbine. Explain which properties are significant for a gas turbine. [5]
4. 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 an isothermal process. [5]
5. Air (m = 0.1 kg) is contained in piston/cylinder assembly as shown in figure. Initially, the piston rests on the stops and is in contact with the spring, which is in its unstretched position. The spring constant is 100 kN/m. The piston weighs 30 kN and atmospheric pressure is 101 kPa. The air is initially at 300K and 200 kPa. Heat transfer occurs until the air temperature reaches the surrounding temperature, 700K. [10]
   a) Find the final pressure and volume
   b) Find the process work
   c) Find the heat transfer
   d) Draw the P-V diagram of the process. [Take R = 287 J/kgK, C_v = 718 J/kg K]



6. Steam enters a nozzle at 400°C and 800 kPa with a velocity of 10 m/s, and leaves at 300°C and 200 kPa while losing heat at a rate of 25 kW. For an inlet area of 800cm^2, determine the velocity and the volume flow rate of the steam at the nozzle exit. [Refer the attached table for properties of steam] [8]

7. State Clausius Inequality [illegible] reversible [illegible] and refrigerators. [5]

8. The pressure and temperature at the beginning of compression of an air-standard diesel cycle are 95 kPa and 300K, respectively. At the end of the heat addition, the pressure is 7.2 MPa and the temperature is 2150K. Determine: [10]

   a) the compression ratio
   b) the cutoff ratio
   c) the thermal efficiency of the cycle. [R = 287 J/kg, C_V = 718 J/kg K]

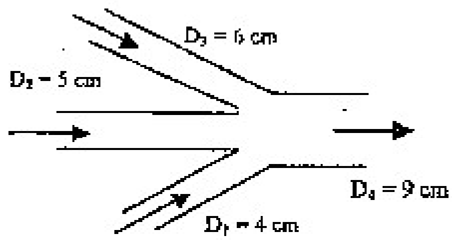
9. Derive an expression for an overall heat transfer coefficient for a composite cylinder consisting of three cylindrical layers subjected to convection on both sides. [5]

10. The roof of an electrically heated home is 8m long, 6m wide, and 0.25m thick, and is made of a flat layer of concrete whose thermal conductivity is k = 0.8 W/m.K. The temperatures of the inner and the outer surfaces of the roof on night are measured to be 15°C and 4°C, respectively, for a period of 10 hours. Determine: [6]

    a) the rate of heat loss through the roof for that night, and
    b) the cost of that heat loss to the home owner if the cost of electricity is Rs. 10/kWh.

11. Define: Cohesive force, Pressure head, Stream line and Coefficient of Lift. [5]

12. Three pipes steadily deliver water to a large exit pipe shown in figure. For velocity V_2 = 5 m/s, and the exit flow rate Q_4 = 120 m^3/h, find (a) V_1; (b) V_3 and (c) V_4 if it is known that increasing Q_3 by 20% would increase Q_4 by 10%. [6]



13. Define turbomachine and hydraulic machine. Differentiate between turbine and pump. [5]

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34 TRIBHUVAN UNIVERSITY
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Exam.		Back	
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - 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**.*
- ✓ *Assume suitable data if necessary.*

1. Explain the laws of thermodynamics. Define the entropy as a function of state. [5]
2. a) Write down the general steady flow energy equation. Derive the simplified forms when used for the centrifugal pump and table fan. [5]
   b) Water is in a piston/cylinder maintaining constant pressure at 700 KPa, quality 90% with a volume of $0.1m^3$. A heater is turned on, heating the water with 2.5 KW. How long does it take to vaporize all the liquid? [8]
3. a) Define heat engine, refrigerator and heat pump. Explain why the performance of heat engine is measured in terms of efficiency but that of refrigerator and heat pump is in terms of COP? Why does the expression for COP differ for refrigerator and heat pump? [5]
   b) A Carnot engine operates between two reservoirs at temperature T_L and T_H. The work output of the engine is 0.6 times the heat rejected. The difference in temperatures between the source and the sink is 200°c. Calculate the thermal efficiency, the source temperature and the sink temperature. [5]
4. a) Using T-S and P-V diagram, prove that, for the same quantity of heat added, increase of compression ratio increases the thermal efficiency of an Otto-Cycle. [8]
   b) Consider a steam power plant operating on the simple ideal Rankine Cycle. The steam enters the turbine at 3 Mpa and 350°c and is condensed in the condenser at a pressure 80 Kpa. Determine the thermal efficiency of the cycle. [8]
5. a) Derive an expression for the heat loss and overall heat transfer coefficient through a composite wall of layers considering the convective heat transfer coefficient. [8]
   b) Air at 27°c and 1 atm flows over a flat plate at a temperature of 60°c with a speed of 2 m/s. Calculate the heat transferred in the first 20cm of the plate and 40cm of the plate. (Properties at the film temperature 43.5°c are $\upsilon = 17.36\times10^{-6}m^2/s$, K = 0.02749 w/m°c, Pr = 0.7, Cp = 1.006 Kj/Kgk) [8]
6. a) Explain the characteristics of laminar and turbulent boundary layer. [5]
   b) The diameter of a pipe changes from 200mm at a section of 5m above datum to 50mm at a section 3m above datum. The pressure of water at first section is 500 Kpa. If the velocity of flow at the first section is 1m/s, determine the pressure at the second section. [8]
7. Describe the working principles of impulse and reaction turbine. [6]

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04 TRIBHUVAN UNIVERSITY
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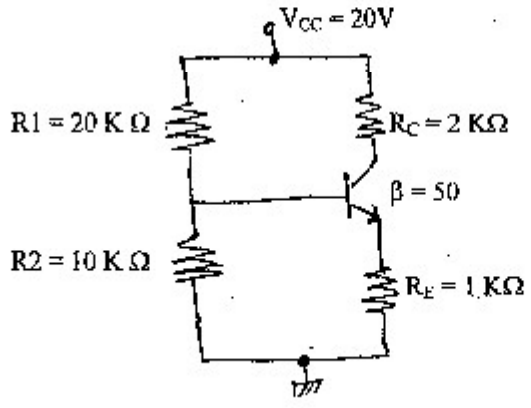
Examination Control Division
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B. Arch)	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Basic Electronics Engineering *(EX451)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you mean by filter? Explain the operation of RC high pass filter. [1+3]
   b) Define dependent voltage source and transconductance with diagrams. [2+2]
2. A silicon junction PN junction diode with n = 1 has voltage drop 0.7 V at current of 1 mA. Find the voltage drop at current equal to 0.1 mA. [3]
3. Draw full wave bridge rectifier circuit and explain its operation. Express its equivalent average dc voltage output. [5+1]
4. Draw symbol for tunnel diode and its IV-characteristic graph. [1+2]
5. Find the values of I_{CQ} and V_{CEQ} for the given circuit. Given data are:
   V_{CC} = +20V, β = 50. [5]



6. Draw circuit diagram to study the dc output IV-characteristics of Enhancement type MOSFET and explain its output IV-characteristic graph. [5]
7. Explain the concept of virtual short in ideal operational amplifier. [2]
8. Deduce the output voltage for integrating amplifier and non inverting amplifier. [4]
9. State Barkhausen criteria. Draw Wien bridge oscillator circuit and express its frequency of oscillation. [1+3]
10. What is wireless communication? Draw block diagram of communication system and explain each block. [2+5]
11. What is electromagnetic wave (EMW)? Explain EMW propagation. [3]

12. Explain the operation of D-flipflop with preset and reset facilities with necessary diagram and truth table. [5]
13. Subtract $(15)_{10}$ from $(10)_{10}$ using 2's complement method. [2]
14. What is counter? Explain with diagram the 3-bit asynchronous counter. [5]
15. Draw block diagram of digital voltmeter. And explain how it measures dc voltage. [5]
16. Describe active and passive transducers [4]
17. Write short notes on: (any three) [3×3]
    i) Photo diode
    ii) BJT as switch
    iii) Differential amplifier
    iv) Duality Theorem

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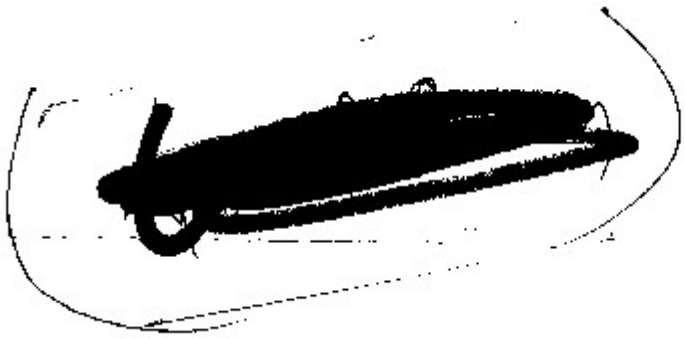

02 TRIBHUVAN UNIVERSITY
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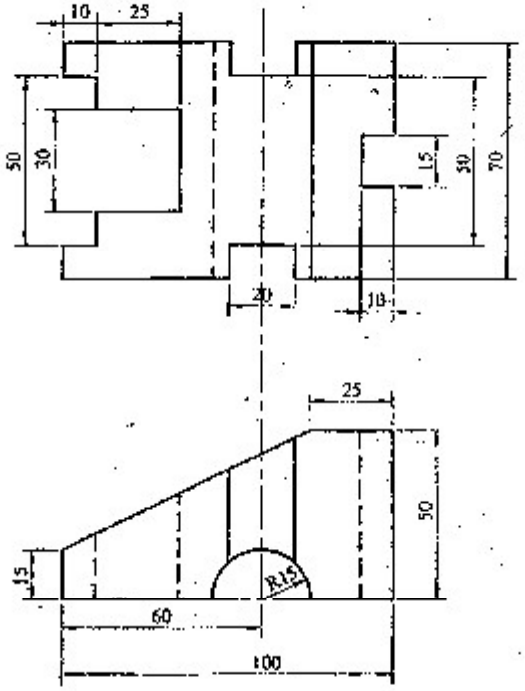
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	40
Programme	All (Except B. Arch)	Pass Marks	16
Year / Part	I / II	Time	3 hrs.

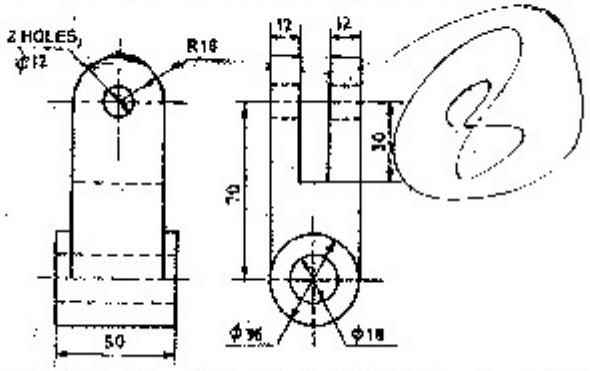
Subject: - Engineering Drawing II *(ME451)*

- ✓ 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**.*
- ✓ *Assume suitable data if necessary.*

1. Orthographic views of an object is shown in figure below. Draw its Isometric view. [10]



2. Draw oblique view of an object from given orthographic views in figure below. [6]

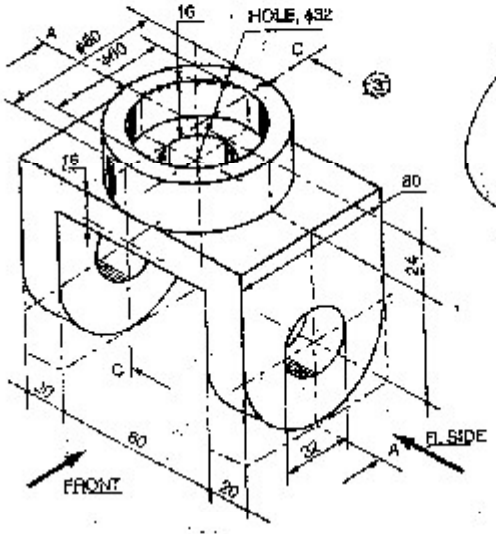


3. Draw the top view and sectional front view of double riveted chain type lap joint for basic diameter of hole is 24 mm. [5]

OR

Determine the maximum and minimum materiel conditions, allowance and type of fit for hole and shaft designated by H7/s6 for the basic size of 50 mm. Assuming fundamental deviation for H and s are 0 mm and 0.040 mm respectively and values of international tolerance grades for 7 and 6 are 0.025 mm and 0.016 mm respectively.

4. Draw sectional front view (section at A-A) from the components as shown in figure below. [5]

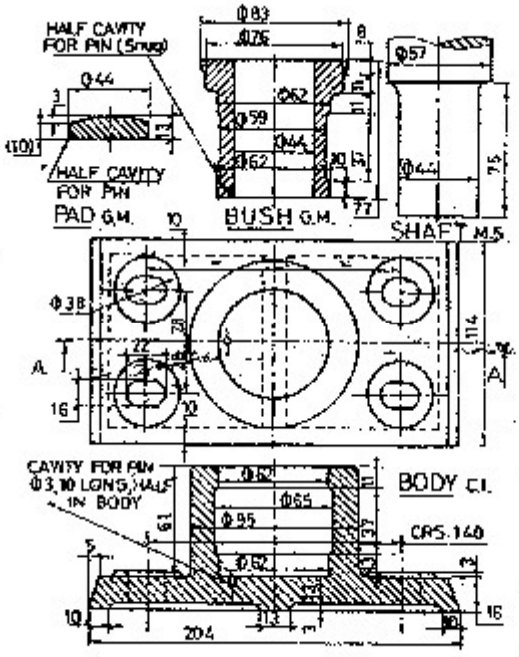


OR

Sketch the symbols for the following

a) Spot weld
b) Crossover
c) Three phase motor
d) Embankment
e) Nipple
f) Circuit breaker
g) Public addressing system
h) Surface finish with X roughness
i) Amplifier
j) Hill contour

5. Assemble the parts shown in figure below of foot-step bearing and draw half-section front view of assembled product. Dimension as the requirement. [14]



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33 TRIBHUVAN UNIVERSITY
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Examination Control Division
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B. Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Engineering Chemistry *(SH453)*

- ✓ 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.*
- ✓ *Assume suitable data if necessary.*

1. What is meant by standard hydrogen electrode? Explain briefly with diagram. Calculate the emf of the following cell at 25°C Mg/Mg^{++} (0.1M)//Ag^{+}(1M)/Ag. Given $E°Mg^{++}/Mg$ = -2.37 V $E°Ag^{+}/Ag$ = +0.80V [3+2]
2. a) What is meant by buffer capacity of a buffer solution? How does a solution containing a mixture of benzoic acid and sodium benzoate maintain its constant pH value even on the addition of small amount of strong acid or alkali? Explain. [3]
   b) Derive Henderson's equation for basic buffer solution. [2]
3. Show your acquaintance to homogenous and heterogeneous catalysis. Describe the intermediate compound formation theory of catalysis. [2+3]
4. a) What are the main sources of water pollution? Write the various impacts of water pollution. [3]
   b) What are the causes of soil pollution? How it can be controlled? [2]
5. What are air pollutants? Give a brief account about the adverse effects of air pollutants on human beings and their possible remedies. [2+1.5+1.5]
6. What do you meant by cross linked polymer? What are the general characteristics of inorganic polymer? What are the engineering application of chalcogenide polymer? [1+2+2]
7. a) What are fiber reinforced polymers? Write their application in the field of engineering. [3]
   b) What are non-biodegradable polymers? What are the demerits of using them? [2]
8. a) Are all d-block elements called transition elements? Justify your answer with reason. Why do transition elements called so? [2]
   b) Why do transition elements show variable oxidation state? Point out the industrial applications of 3d-series elements. [3]
9. Explain why: [2.5×2]
   a) Compounds of Titanium in +3 oxidation state are coloured but those in +4 oxidation state are colourless.
   b) Transition elements formed significant number of complexes.
10. How would you account for the difference in structures and magnetic properties between $[Ni(Cl_4)]^{2-}$ and $[Ni(CN)_4]^{2-}$? [2.5×2]

9

31 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B. Agri.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME452)*

- ✓ 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. Differentiate between Microscopic and Macroscopic viewpoint with examples. [4]
2. Derive expressions for displacement work transfer for the following process: [4]
   a) Constant- Pressure Process
   b) Constant temperature process and
   c) Polytrophic process
3. Explain how saturation curve is formed on T-v diagram. [4]
4. State first law of thermodynamics for a control mass undergoing cyclic process. Write the mass and energy equations for a control volume and reduce them for steady state process. [6]
5. Define isentropic process. Derive isentropic relations for an ideal gas and incompressible substances. [6]
6. Sketch an ideal Brayton cycle on P-v and T-s diagrams; also derive an expression for its efficiency. [6]
7. Derive an expression for conduction heat transfer through a composite cylinder. [6]
8. A mercury manometer is used to measure the pressure in stream pipe. The level of the mercury in the manometer is 97.5 mm. Find the absolute pressure of stream inside the pipe. If the reading of the manometer drops to 80 mm, what is the new pressure of steam? [6]

   [Take sp.gr. of Hg = 13.6, P_{atm} = 760 mm of Hg and g = 9.81 m/s^2]
9. A rigid container with a volume of 0.170 m^3 is initially filled with stream at 200 kPa, 300°C. It is cooled to 90°C. (Steam tables are attached here with) [8]
   a) At what temperature does a phase change start to occur?
   b) What is the final pressure?
   c) What mass fraction of the water is liquid in the final state?
10. A gas turbine develops 60 MW of power output, Mass flow rate of gas is found to be 80 kg/s. Properties of gas at inlet and exit of the turbine are as follows: [8]

Properties	Inlet	Outlet
Pressure	8 MPa	0.1 MPa
Temperature	500°C	50°C
Velocity	50 m/s	150 m/s
Elevation above the reference level	10 m	5 m

   a) Determine the rate at which heat is lost from the turbine surface.
   b) Determine the inlet and outlet areas. [Take R = 287 J/kg.k C_p = 1005 J/kgk)