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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – December, 2017

Program/course: B.Tech PSE — **Semester – III**
Subject: Fundamentals of Thermodynamics — **Max. Marks : 100**
Code : GNEG 214 — **Duration : 3 Hrs**
No. of page/s: 2

SECTION A (5Q x 4= 20 Marks, Attempt All)

Q1. [CO1] Explain with an example the contrivance of a Quasi Static Process, in which a particular systems remains in internal equilibrium.

Q2. [CO2]Explain with a diagrammatic representation a Cyclic Refrigeration Plant, and obtain its expression for COP.

Q3. [CO3]Derive with the help of Steady Flow Energy Equation (SFEE), the expression for efficiency of Rankine Cycle.

Q4.[CO2] Explain the ideologies of Carnot's Theorem taking into consideration Two Cyclic Heat Engines operating between same source and sink.

Q5.[CO3] Explain with T-S and P-V Diagram the working of Otto- Cycle; also derive the expression for efficiency of the Otto-Cycle in terms of Heat Supplied and Heat Rejected.

SECTION B (4Q x 10= 40 Marks, Attempt All)

Q6. [CO2]A piston-cylinder device operates 1 kg of fluid at 20 atm pressure. The initial volume is 0.04 m cube. The fluid is allowed to expand reversibly following a process $p V^{1.45}$ = Constant, so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to the original position. Keeping the piston unaltered, heat is added reversibly to restore it to the initial pressure. Calculate the work done in the cycle.

Q7. [CO5] In a steam power plant, steam flows steadily through a 0.2m diameter pipeline from the boiler to the turbine. At the boiler end , the steam conditions are found to be : p(Pressure)= 4Mpa, t(temperature)= 400 Deg C, h (enthalpy)= 3213.6 KJ/Kg and v (Vol)= 0.073 m^3/Kg. At the turbine end the conditions are found to be: p(Pressure)=3.5Mpa, t(Temperature)= 392 Deg

C, h(enthalpy) =3202.6 KJ/Kg and v(Vol)= 0.084 m^3/kg. There is a heat loss of 8.5 KJ/Kg from the pipeline. Calculate the steam flow rate.

Q8. [CO4]Water flows through a turbine in which friction causes the water temperature to rise from 35 Deg C to 37 Deg C. If there is no heat transfer, how much does the entropy of the water change in passing through the turbine? (Water is incompressible and the process can be taken to be at constant volume)

Q9. [CO4]A cold Storage is to be maintained at -5 Deg C, while the surrounding is at 35 Deg C. The heat leakage from the surroundings into the cold storage is estimated to be 29 KW. The actual COP of the refrigeration plant used is one –third that of an ideal plant working between the same temperatures. Find the power required in KW to drive the plant.

SECTION C (2Q x 20= 40 Marks, Attempt All)

Q10.

(A) [CO5]A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3 m. The steam leaves the turbine at the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW?

(B) [CO2]Explain the concept of Gibb's Phase Rule with three different iterations, and comment as to how thermodynamic state remains invariant with time

Q11.

(A) [CO4]If a refrigerator is used for heating purposes in winter so that the atmosphere becomes the cold body and the room to be heated becomes the hot body, how much heat would be available for heating for each kW input to the driving motor? The COP of the refrigerator is 5, and the electromechanical efficiency of the motor is 90%. How does this compare with resistance heating?

(B) [CO3]The processes classified under second law of thermodynamics are reversibility and irreversibility. Explain their differences, and causes of irreversibility

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SECTION A (5Q x 4= 20 Marks, Attempt All)

Q1. [CO1] Explain with a graphical representation on P-V, demonstrating heat transfer a path function.

Q2. [CO2] Derive and explain the relation between the COP of Refrigeration and COP of Heat Pump, and explain by identifying their basic working difference

Q3. [CO2]Explain the theory of PMM2, and explain what happens when a Heat engine exchanges heat from only one reservoir.

Q4. [CO3] Explain the ideologies of Carnot's Theorem and its Corollary taking into consideration Two Cyclic Heat Engines.

Q5.[CO3] Explain with T-S and P-V Diagram the working of Diesel- Cycle; also derive the expression for efficiency of the Diesel-Cycle in terms of Heat Supplied and Heat Rejected.

SECTION B (4Q x 10= 40 Marks, Attempt All)

Q6. [CO4]A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 Mpa to a final state of 0.15 m^3 and 0.105 Mpa, the pressure remaining constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. How much does the internal energy of the gas change?

Q7. [CO4]A Domestic food freezer maintains a temperature of – 20 Deg C. The ambient air temperature is 40 Deg C. Heat leaks into the freezer at the continuous rate of 1.75 kJ/s what is the least power necessary to extract this heat out?

Q8. [CO5]A cyclic heat engine operates between a source temperature of 800 Deg C, and a sink temperature of 30 Deg C. Find out the least rate of heat rejection per kW net output of the engine.

Q9. [CO4]A refrigeration plant for a food store operates as a reversed Carnot heat engine cycle. The store is to be maintained at a temperature of – 5°C and the heat transfer from the store to the cycle is at the rate of 5 kW. If heat is transferred from the cycle to the atmosphere at a temperature of 25°C, calculate the power required to drive the plant.

SECTION C (2Q x 20= 40 Marks, Attempt All)

Q10

(A) [CO5]A turbo compressor delivers 2.33 m3/s at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible.

(B) [CO3]Explain the theory of PMM1, and explain how can there be no machine which can continuously consume work without producing energy.

Q11.

(A) [CO5]During one cycle the working fluid in an engine engages in two work interactions: 15 kJ to the fluid and 44 kJ from the fluid, and three heat interactions, two of which are known: 75 kJ to the fluid and 40 kJ from the fluid. Evaluate the magnitude and direction of the third heat transfer.

(B) [CO1]Explain with the theory of Zeroth Law of thermodynamics, the various phases of thermodynamic equilibrium, thereby conceptualizing Quasi Static Equilibrium.