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EME401

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 140402

Roll No.

B. Tech.

(SEM. IV) THEORY EXAMINATION, 2014-15

APPLIED THERMODYNAMICS

Time : 3 Hours] [Total Marks : 100

Note:
(i) Attempt all questions very carefully.
(ii) All questions carry equal marks.
(iii) Use of Steam Table/Mollier chart and Calculator is allowed.
(iv) Be precise in your answer.

1 Attempt **any two** parts of the following: 10×2=20

(a) What is the physical significance of thermodynamic relations? Prove all Maxwell relations using equations based on thermodynamics laws.

(b) Over a certain range of pressures and temperatures, the equation of state of a certain gas is prescribed by the relation

$v = (RT/p) - (C/T^3)$ where C is a constant.

Set up expressions for a change in enthalpy and entropy of the gas. Consider the change to occur under isothermal conditions.

(c) The following data pertains to the test run made in the laboratory to determine the calorific value of a gaseous fuel by Junker's gas calorimeter:

Gas burnt in the calorimeter = 10 liters

Gas temperature and pressure at inlet = 20°C and 50mm of water above atmospheric

Cooling water passing through the calorimeter = 8 liters
Inlet and outlet temperature of water = 15°C and 25°C
Steam condensed during test run = 10cc

Determine the higher and lower calorific value of fuel sample. You may take barometric pressure as 750mm of mercury and latent heat of vaporization of water as 2465KJ/kg.

2 Attempt **any two** parts of the following: **10×2=20**

(a) List the differences in between fire tube and water tube boiler. Explain working and construction of Locomotive boiler with a neat sketch.

(b) Define equivalent evaporation.

The following data are obtained in a boiler trial:

Mass and temperature of feed water: 680 kg/hr and 20°C Steam pressure and its temperature: 15 bar and 300°C

Coal used and its calorific value: 98 kg/hr and 26500 KJ/kg Flue gas formed and its temperature at chimney: 18 kg/kg of coal supplied and 300°C

Ash and unburnt coal in ash-pit: 44 kg/hr with 2200 KJ/kg calorific value

Mean specific heat of flue gases and feed water: 1 KJ/kg K and 4.187 KJ/kg K

If the ambient temperature in the boiler room is 28°C. Determine:

(i) Boiler efficiency

(ii) Equivalent evaporation from and at 100°C

(iii) Percentage heat unaccounted for

(iv) Draught produced in mm of water column if the height of chimney is 50 m.

(c) The following observations are recorded during a test on a steam condenser:

Recorded condenser vacuum = 71 cm. of Hg, Barometric reading = 76.5 cm of Hg, Mean condenser temperature = 34°C, Temperature of hot well = 28.5°C, Condensate collected = 1800 kg/hour, Flow rate of cooling water = 57500 kg/hour, Inlet temperature of cooling water = 8.5°C, Outlet temperature of cooling water = 26°C. Determine:

(i) Vacuum efficiency

(ii) Condenser efficiency

(iii) Dryness fraction of steam entering the condenser

(iv) Mass of air leakage per m^3 of the condenser volume.

3 Attempt **any two** parts of the following: **10×2=20**

(a) A steam engine of 30 cm diameter and 50 cm stroke length is supplied steam at 10 bar and 300°C. The steam expands adiabatically to 0.7 bar and then release occurs at constant volume to a condenser at 0.3 bar. Represent the cycle on P-V and T-S plots and compare it with the corresponding diagram for the complete Rankine cycle. Determine:

(i) The modified Rankine cycle efficiency

(ii) The Rankine efficiency corresponding to complete expansion.

(b) A supersonic nozzle is to be designed for air flow with Mach number 3 at the exit section which is 250 mm in diameter. The pressure and temperature of air at the nozzle exit are 8.5 kN/m^2 and 215 K. Make calculations for:

(a) Reservoir pressure and temperature

(b) Throat area.

(c) Prove expression for mass flow rate per unit area of steam in a nozzle. Also give condition for maximum discharge.

4 Attempt **any two** parts of the following: **10×2=20**

(a) (i) What are effects of pressure and temperature on Rankine cycle efficiency and output? Explain showing in cycle.

(ii) Compare impulse and reaction turbine.

(b) In a regenerative feed heating cycle, the steam enters the turbine at 25 bar and 250°C. The condenser pressure is 0.05 bar. The steam is bled off for feed water heating for a closed heater at 3.5 bar and for an open heater at 0.7 bar. The condensate of the closed heater is discharged into

the low pressure open heater. Calculate the thermal efficiency of the cycle. Neglect the pump work. Also determine the corresponding Rankine cycle efficiency.

(c) In a Parson's reaction turbine the rotor of 1 m diameter runs at 3000 rpm. Determine the isentropic enthalpy drop in the stage considering stage efficiency of 0.80, ratio of linear velocity of blade to absolute velocity at inlet of moving blade=0.7, blade outlet angle = 20°.

5 Attempt **any two** parts of the following: **10×2=20**

(a) Classify Gas turbines. Explain the cycle on which Gas turbine works? Also, explain it with reheat and regeneration showing its effects when used simultaneously in a single cycle.

(b) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar pressure and 300 K temperature. The pressure ratio is 5 and the maximum cycle temperature is limited to 1075 K. If the compressor and turbine efficiencies are 80% and 85% respectively. Make calculations for the net work output, cycle efficiency and the work ratio.

(c) Compare Jet engine and Propeller engine. Explain working and construction of turbojet engine.
