INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

End Semester Examinations- June-July 2019

Semester – IV

B.Tech (Marine Engineering)

Marine Heat Engines and Air Conditioning (UG11T3406)

Date: 05-07-2019 Maximum Marks: 100

Time: 3 Hrs Pass Marks: 50

PART – A

(Question 1 is compulsory, 3X10 = 30 Marks)

(1)

(a) Explain what happens when a can containing saturated liquid of R134a at room temperature under pressure is punctured and the contents are exposed to atmospheric pressure.

(b) Provide a simple schematic sketch to show the energy interactions of a absorption refrigeration cycle. Label the components clearly.

(c) Summarize how regeneration with reheat modifications to an ideal Brayton cycle improves its efficiency as a heat engine.

(d) List some advantages of Gas Turbine Engines over Diesel Engines

(e) Enumerate various energy losses in a Marine Boiler operation.

(f) What is the difference between humidity ratio and relative humidity ?

(g) Indicate using a free hand sketch on Psychometric Chart a simple humidification process by steam and by water addition.

(h) What is a inlet nozzle angle, relative angle of inlet and relative angle of exit in a simple impulse turbine designed for shock-less entry ?

(i) Why does the blade height change from High Pressure end to Low Pressure end in a Marine Steam Turbine ?

(j) What is sub-cooling in a vapour compression system and state why it is provided for in the design ?

PART – B

(Answer any 5 questions from question no. 2 to 8)

(5X14 =70 Marks)

(2)

(a) Single row impulse turbine has blade speed of 175 m/s and steam leaves nozzle at 400 m/s. Steam flows at the rate of 163.2 kg/min and leaves turbine axially. Considering blade velocity coefficient of 0.9 determine nozzle angle, blade angles at inlet and exit, axial thrust, energy loss at exit, energy loss in blades and diagram efficiency if turbine produces 180 kW output.

7 Marks

(b) Derive the expression for Efficiency of a 50% reaction turbine. Use standard nomenclature for the velocities and angles – Blade speed = u; Inlet velocity = v1; Inlet angle = α1; Relative inlet velocity = vr1; Relative inlet angle = β1; Relative exit velocity = vr2; Relative exit angle = β2; exit velocity = v2; Exit angle = α2;

7 Marks

(3)

(a) A reaction turbine is supplied with steam at 60 bar and 600 deg. C. The condenser pressure is 0.07 bar. If the reheat factor can be assumed to be 1.04 and the stage efficiency is constant throughout at 80%, calculate the steam flow required for a diagram power of 25 MW.

7 Marks

(b) Derive the expression for maximum efficiency of a 50% reaction turbine. Use standard notation and list the assumptions clearly.

7 Marks

(4)

(a) What steps would you take to improve the thermal efficiency of a boiler ?

7 Marks

(b) A boiler produces 1,700 kg of dry saturated steam per hour at a pressure of 10 bar. The feed water is heated by an exhaust gas economiser to a temperature of 120 deg.C. The feed water is being maintained at a temperature of 80 deg.C in the hot well. Assuming steady flow conditions total heat transfer at the heat transfer surfaces, if 250 kg of HFO of a calorific value 41.7 MJ/kg are fired per hour, and it is ascertained that 8 per cent of the HFO is unburnt, calculate :

(a) the thermal efficiency of the boiler alone

(b) The improvement in thermal efficiency of the steam plant with boiler and economizer combined.

Take specific heat of water as 4.187 kJ/kg K.

7 Marks

(5) A gas turbine cycle has two stages of compression, with an intercooler between the stages. Air enters the first stage at 100 kPa, 300 K. The pressure ratio across each compressor stage is 5 to 1, and each stage has an isentropic efficiency of 82%. Air exits the intercooler at 330 K. The maximum cycle temperature is 1500 K, and the cycle has a single turbine stage with an isentropic efficiency of 86%. The cycle also includes a regenerator with effectiveness of 80%. Calculate the

(a) temperature at the exit of each compressor stage,

(b) the cycle thermal efficiency.

(6)

A large refrigeration plant is to be maintained at -15°C, and it requires refrigeration at a rate of 100 kW. The condenser of the plant is to be cooled by liquid water, which experiences a temperature rise of 8°C as it flows over the coils of the condenser. Assuming the plant operates on the ideal vapor-compression cycle using refrigerant-134a between the pressure limits of 120 and 700 kPa, determine

(a) the mass flow rate of the refrigerant

(b) the power input to the compressor, and

(c) the mass flow rate of the cooling water.

Assume specific heat of water to be constant = 4.187 kJ/kg.

(7)

(a) Sketch and describe a simple ideal vapor-compression refrigeration cycle on T-S & P-h diagram and provide a schematic process diagram identifying components and equipments. Label the states correctly corresponding to both the diagrams and the process schematic diagram.

(b) Sketch a Gas Turbine cycle with following modifications -

- (a) Two stage compression with inter-cooling
- (b) Two stage turbine with reheat
- (c) With regenerator.
- (d) Efficiency of each compressor and Turbine = η
- (e) Diagrams should include the process schematic with correct corresponding labeling with thermodynamic cycle being drawn.

(8)

A stream consisting of 142 m3/min of moist air at a temperature of 5 deg.C and a humidity ratio of 0.002 kg(vapor)/kg(dry air) is mixed adiabatically with a second stream consisting of 425 m3/min of moist air at 24 deg.C and 50% relative humidity. The pressure is constant throughout at 1 bar. Determine

(a) The humidity ratio

(b) The temperature of the exiting mixed stream, in deg.C.