Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – June 2023

Programme Name: B Tech (ME)

Semester: IV

Subject Code: UG11T3406

Subject Name: MARINE HEAT ENGINE AND AIR CONDITIONING

Date: 30.05.2023	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Options, if any, are specified in respective section.
(iii) Use of Steam Table with Mollier diagram and Refrigeration tables with charts is permitted.
(iv) Assume suitable data if required and state it clearly.

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

Q1. The temperature of air recorded by a thermometer, when it is not affected by the moisture present in the air, is called

(A) Wet bulb temperature
(B) Dry bulb temperature
(C) Dew point temperature
(D) Critical temperature

Q2. The mass of water vapour present in 1 kg of dry air, and is generally expressed in terms of grams per kg of dry air is called _____.

(A) absolute humidity
(B) degree of saturation
(C) relative humidity
(D) humidity ratio

Q3. Which of the following is the result of a reduction in operating pressure in the Air refrigeration cycle?

(A) decrease in C.O.P.
(B) always decreases
(C) increase in C.O.P.
(D) no change in C.O.P.

Q4. If the Coefficient of performance of a heat pump is 5, then what is the value of the Coefficient of performance of the refrigerator operating under the same conditions?

(A) 0.2
(B) 3
(C) 4
(D) 6

Q5. Steady flow energy equation for steam turbine is;
(A) $W = h_1 - h_2$
(B) $W = h_2 - h_1$
(C) $W = h_2 + h_1$
(D) None of these

Q6. Which among these is the main component of a gas turbine plant?

(A) Condenser

(B) Compressor

(C) Boiler

(D) Both Compressor & Boiler

Q7. The values of enthalpies at the stator inlet and rotor outlet of a hydraulic turbomachine stage are h_1 and h_3 respectively. The enthalpy at the stator outlet (or, rotor inlet) is h_2. The condition $(h_2 - h_1) = (h_3 - h_2)$ indicates that the degree of reaction of this stage is

(A) 75%
(B) 100%
(C) 50%
(D) 0%

Q8. Which one of the following modifications of the simple ideal Rankine cycle increases the thermal efficiency and reduces the moisture content of the steam at the turbine outlet?

(A) Increasing the boiler pressure.
(B) Decreasing the boiler pressure.
(C) Increasing the turbine inlet temperature.
(D) Decreasing the condenser pressure.

Q9. In a Rankine cycle, the enthalpies at turbine entry and outlet are 3159 kJ/kg and 2187 kJ/kg, respectively. If the specific pump work is 2 kJ/kg, the specific steam consumption (in kg/kW-h) of the cycle based on net output is

(A) 3.711 kg/kWh
(B) 9.236 kg/kWh
(C) 8.265 kg/kWh
(D) 5.362 kg/kWh

Q10. Gas turbine performance majorly depends on

(A) compressor efficiency
(B) calorific value of fuel used
(C) nozzle efficiency
(D) None of these

Section B

Five Questions of 02 Marks each

Q11. What are the advantages of Dry compression over wet compression?

Q12. Define Specific humidity and relative humidity.

Q13. Define work ratio and back work ratio.

Q14. Define Boiler Efficiency.

Q15. What are the differences (any 2 points) between Impulse and reaction turbines?

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered.

Q16. A cold storage plant is required to store 20 tonnes of fish. The fish is supplied at a temperature of 30°C. The specific heat of fish above freezing point is 2.93 kJ/kg K. The specific heat of fish below freezing point is 1.26 kJ/kg K. The fish is stored in cold storage which is maintained at – 8°C. The freezing point of fish is – 4°C. The latent heat of fish is 235 kJ/kg. If the plant requires 75 kW to drive it, find

(a) The capacity of the plant, and

(b) Time taken to achieve cooling.

Assume actual C.O.P. of the plant as 0.3 of the Carnot C.O.P. (5+5) Marks

Q17. The humidity ratio of atmospheric air at 28°C dry bulb temperature and 760 mm of mercury is 0.016 kg/kg of dry air. Determine

1. Partial pressure of water vapour
2. Relative humidity
3. Dew point temperature
4. Specific enthalpy

(2+2+3+3) Marks

Q18. Consider an air standard cycle in which the air enters the compressor at 1.0 bar and 20°C. The pressure of air leaving the compressor is 3.5bar and the temperature at turbine inlet is 600°C. Determine per kg of air:

(i) Efficiency of the cycle, (2 Marks)

(ii) Heat supplied to air (2 Marks)

(iii) Work available at the shaft, (2 Marks)

(iv) Heat rejected in the cooler (2 Marks)

(v) Temperature of air leaving the turbine. (2 Marks)

For air ratio of specific heats(□) = 1.4 and Cp = 1.005 kJ/kg K.

Q19. Derive optimum intermediate pressure for intercooling in a gas turbine cycle. (10 Marks)

Q20. (a) What are the requirements of a good boiler? (5 Marks)

(b) Explain equivalent evaporation. (5 Marks)

Q21. The velocity of steam entering a simple impulse turbine is 1000 m/s, and the nozzle angle is 20°. The mean peripheral velocity of blades is 400 m/s and the blades are symmetrical.

(a) If the steam is to enter the blades without shock, what will be the blade angles?

(b) Neglecting the friction effects on the blades, calculate the tangential force on the blades and the diagram power for a mass flow of 0.75 kg/s. Estimate also the axial thrust and diagram efficiency.

(c) If the relative velocity at exit is reduced by friction to 80% of that at inlet, estimate the axial thrust, diagram power and diagram efficiency. (3+3+4) Marks

Q22. Prove that the maximum blade efficiency for a reaction turbine is given by,

$$(\eta_b)_{max} = \frac{2\cos^2 \alpha_1}{1 + \cos^2 \alpha_1}$$ (10 Marks)