Indian Maritime University

June 2022 End Semester Examinations

B Tech (ME)

UG11T3406

Marine Heat Engine and Air Conditioning

Date – 09.06.2022

Duration – 03 Hours

Max Marks - 70 Marks

Pass Marks - 35

Part A –Q.No.1; 10 MCQs (10 X 01 Mark)

i. What is the air standard cycle for a Gas-Turbine called?
   a) Reheat cycle
   b) Rankine cycle
   c) Brayton cycle
   d) Diesel cycle

ii. A Gas Turbine is which type of combustion plant?
   a) external
   b) open
   c) internal
   d) cannot say

iii. What is the perfect condition for dehumidification of air?
   a. air is heated above its dew point temperature
   b. air is cooled up to its dew point temperature
   c. air is heated below its dew point temperature
   d. air is cooled below its dew point temperature

iv. The dew point temperature is less than the wet bulb temperature for
   a.saturated air
   b. unsaturated air
   c. both saturated and unsaturated air
   d. none of the above

v. Which of the following is a type of turbine classified based on the fuel that supplies the driving force?
   a) Steam Turbine
   b) Gas Turbine
   c) Wind Turbine
   d) All of the mentioned

vi. In which of the following Cross compound steam turbines was once used?
a) marine ships
b) automobiles
c) generation of electricity
d) none of the mentioned

vii. In a refrigeration system, the expansion device is connected between the

a) Compressor and condenser

b) Condenser and receiver

c) Receiver and evaporator

d) Evaporator and compressor

viii. A human body feels comfortable when the heat produced by the metabolism of human body is equal to the

a) Heat dissipated to the surroundings

b) Heat stored in the human body

c) Sum of (A) and (B)

d) Difference of (A) and (B)

ix. Which of the following is a fixed factor on which boiler efficiency depends?

a) Actual firing rate

b) Humidity of combustion air

c) Condition of heat absorbing surfaces

d) Properties of the fuel burnt

x. Boiler efficiency doesn't depend on _____

a) calorific value of fuel fired
b) specific heat of steam generated
c) boiler design
d) operation time

Part B – Q.No.2;5 Short Questions (05 X 02 Marks)

i. What is "degree of reaction"?

ii. What is the difference between impulse turbine and reaction turbine?

iii. What is relative humidity and specific humidity?

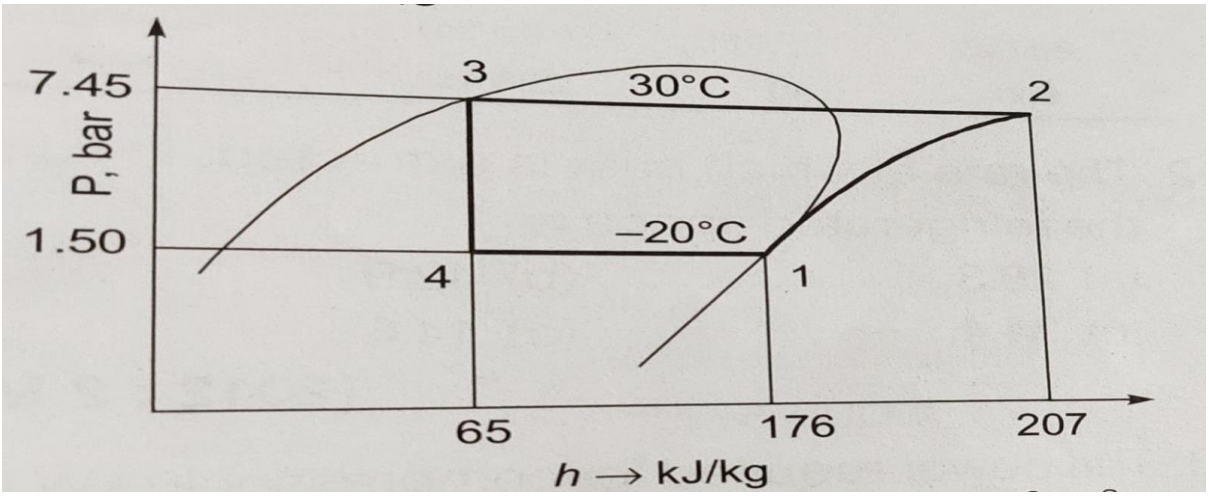
iv. Draw P-V and T-S diagram for ideal gas turbine cycle.

v. what are the different types of heat losses occur in a boiler?

Part C – 7 Long Questions-Answer Any 5 (05 X 10 Marks)

3.In a simple Brayton cycle, the pressure ratio is 8 and temperature at the entrance of compressor and turbine are 300 K and 1400 K, respectively. Both compressor and gas turbine have isentropic efficiencies equal to 0.8. For the gas. assume a constant value of Cp (specific heat at constant pressure) equal to 1 kJ/kgK and ratio of specific heats as 1.4. Neglect changes in kinetic and potential energies. What is the power required by the compressor in kW/kg of gas flow? What is the thermal efficiency of the cycle in percentage?

4.A R-12 refrigerant reciprocating compressor operates between the condensing temperature of 30^0Cand evaporator temperature -20^0C. The clearance volume ratio of the compressor is 0.03. Specific heat ratio of the vapour is 1.15 and the specific volume at the suction is 0.1089 m^3/kg. Other properties at various states are given in the figure. To realize 2 tons of refrigeration, what is the actual volume displacement rate considering the effect of clearance?

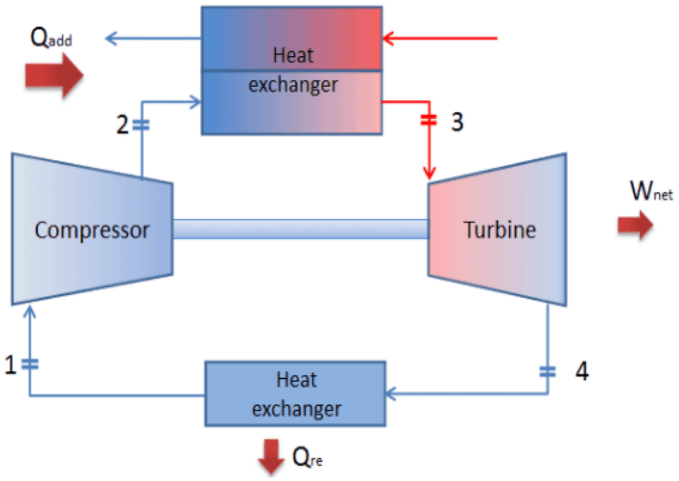


5. An ideal Brayton cycle, operating between the pressure limits of 1 bar and 6 bar, has minimum and maximum temperatures of 300 K and 1500 K. The ratio of specific heats of the working fluid is 1.4. What are the approximate final temperature in Kelvin at the end of the compression and expansion processes?

6. At a particular stage of a reaction turbine, the mean blade speed is 60 m/sec and the steam pressure is 3.5 bar with a temperature of 175°C. The identical fixed and moving blades have inlet angles 30° and outlet angle of 20°. Determine (i) The blade height if it is 1/10 of the blade ring diameter for a flow rate of 13.5 kg/sec. (ii) The power developed by a pair (iii) the specific enthalpy drop if the stage efficiency is 85%.

7. In this turbine, the high-pressure stage receives gas (point 3 at the figure) from a heat exchanger:

- p_3 = 6.7 MPa;
- T_3 = 1190 K (917°C))
- the isentropic turbine efficiency is η_T = 0.91 (91%)



and exhaust it to another heat exchanger, where the outlet pressure is (point 4):

- p_4 = 2.78 MPa
- $T_{4,is}$ = ?

Thus, the compressor pressure ratio is equal to PR = 2.41. Moreover, we know that the compressor receives gas (point 1) at the figure:

- p_1 = 2.78 MPa;
- T_1 = 299 K (26°C)
- the isentropic compressor efficiency η_K = 0.87 (87%).

The heat capacity ratio for helium, is equal to $=c_p/c_v=1.66$

Calculate:

1. the heat added by the heat exchanger (between 2 → 3)
2. the compressor outlet temperature of the gas (T2, is)
3. the real work done on this compressor when the isentropic compressor efficiency is η_K = 0.87 (87%)

8. A sling psychrometer gives reading of 250c dry bulb temperature 1 5^0C wet bulb temperature. The barometer indicates 760 mm of hg assuming partial pressure of the vapour as 10 mm of Hg. Determine
    1. Specific humidity
    2. Saturation ratio.

9. A boiler produces 1000 kg/hr steam with rise in enthalpy of steam of 2500 kJ/Kg. The calorific value of coal used is 30000 kJ/Kg and its consumption is 100 kg/hr. what would be the boiler efficiency?