Indian Maritime University

(A Central University, Government of India)

June/July 2019 End Semester Examinations

B.Tech. (Marine Engineering)

Semester- II

Applied Thermodynamics-I (UG11T1203/ UG11T2203)

Date:29.06.2019 Maximum marks: 100

Time: 3 Hrs Pass Marks: 50

Note: Scientific calculator & steam table are allowed in examination hall. Consider Specific gas constant R for air to be 0.287 kJ/kg.K.

Part - A

(All questions are compulsory)

Marks: 10 x 3 = 30

Q1.

a. State Kelvin-Planck statement for Second Law of Thermodynamics.
b. State Carnot Principles.
c. What do you mean by 'Quality' of steam?
d. Draw T-s diagram of an ideal Rankine cycle with superheated steam.
e. Define Diagram Factor for a steam engine.
f. Define Mechanical efficiency & Thermal efficiency for a steam engine.
g. Describe Isothermal Efficiency & Indicated Power for reciprocating compressor?
h. What do you mean by single acting & double acting reciprocating compressor?
i. State 'Gibbs-Dalton law' as applicable to gas mixtures.
j. What do you mean by Saturated air and Dew point?

Part – B

(Answer any 5 of the following 7 questions)

Marks: 5 x 14 = 70

Q2.

(a) What is Entropy? Explain. (6)
(b) A cyclic Carnot heat engine operates between a source temperature of 800^0C and a sink temperature of 30^0C. What is the least rate of heat rejection per kW net output of the engine? (8)

Q3.

(a) What do you mean by Ideal Reheat Rankine Cycle? Draw plant schematic & T-s diagram for this cycle & derive expression for its thermal efficiency. (6)

(b) A simple steam power cycle uses solar energy for heat input. Water in the cycle enters the pump as saturated liquid at 40deg C and is pumped to 2 bar. It then evaporates in the boiler at this pressure and enters the turbine as saturated vapour. At the turbine exhaust, the conditions are 40degC and 10% moisture. The water flowrate is 150 kg/hr. Determine (a) turbine isentropic efficiency & (b) net work output
(8)

Q4.

(a). What do you mean by compound steam engines? Write its advantages. (7)

(b). During a test on a single acting non-condensing, single cylinder steam engine, the following observations were recorded:

Bore= 225 mm, stroke = 600 mm, speed = 100 rpm, effective brake dia= 2.75 m, net load on the brake = 1650 N, area of indicator diagram= 2500 mm^2, Length of indicator diagram =100 mm, spring strength= 530 bar/m. Determine 1. Indicated power, 2. Brake power and 3. Mechanical efficiency. (7)

Q5.

(a). What is free air delivery & displacement? Why free air delivered is always less than displacement of a reciprocating compressor? (6)

(b). A single acting reciprocating compressor with cylinder of 15cm diameter and 18cm stroke has a clearance volume of 4% of swept volume. It takes air at 1 bar, 25^0C and delivers at 8 bar while running at 1200 rpm. The actual power input is 18kW & air mass flow rate is 4 kg/min. Calculate the power required to drive the unit & (b) the mechanical efficiency

(8)

Q6.

(a). Define Dry bulb temperature, Wet bulb temperature, Specific humidity and Relative humidity.

(6)

(b). Consider a gas mixture that consists of 3 kg of O_2, 5 kg of N_2 and 12 kg of CH_4. Determine (a) the mass fraction of each component, (b) the mole fraction of each component, and (c) the average molar mass and gas constant of the mixture. Consider molar mass of $O_2 = 32\ kg/kmol$, $N_2 = 28kg/kmol$ and C$H_4 = 16\ kg/kmol.$

(8)

Q7.

(a). What is 'Compressed air motor'? Describe & draw its p-v diagram. (7)

(b). A single stage reciprocating compressor takes $1m^3$ of air per minute at 1.013 bar and 15^0C and delivers it at 7 bar. Assuming that the law of compression is p$V^{1.35}$=constant, and clearance is negligible, calculate the indicated power. (7)

Q8.

(a). What is Volumetric Efficiency of a Reciprocating Compressor? Derive expression for it. (8)

(b). Describe Dalton's Law of partial pressure & Amagat's Law of partial volume for a gas mixture. (6)