Reg. No. | | | | | | | | | |

B.E. / B.TECH. DEGREE EXAMINATIONS, MAY 2017

SECOND SEMESTER

MR16201 – MARINE ENGINEERING THERMODYNAMICS

(Marine Engineering)

(Regulation 2016)

Q. Code: 857310

Use of Steam Table Permitted

Time: Three Hours **Maximum : 100 Marks**

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

1. Define path function and point function.
2. Is it possible to execute a quasi-static process? Justify your answer.
3. State Clausius statement of the second law of thermodynamics.
4. Show that the COP of the heat pump is always higher than that of the refrigerator by '1', when both are operated under the same temperature limits.
5. Define degree of super heat.
6. Why is reducing the condenser pressure not advisable beyond certain limit?
7. Distinguish between ideal and real gases.
8. What are the various components of heat balance chart of an internal combustion engine?
9. What are the applications of Clausius–Clapeyron equation?
10. Define equivalence air fuel ratio.

PART B - (5 X16 = 80 Marks)

11. (a) (i) A system of volume, V contains a mass, m of gas at pressure, p and temperature, T. The macroscopic properties of the system obey the following relationship: $(p + a/V^2)(V - b) = mRT$, where a, b, and R are constants. Obtain an expression for the displacement work done by the system during a constant-temperature expansion from volume V_1 to volume V_2. Calculate the work done by a system which contains 10 kg of this gas expanding from 1 m^3 to 10 m^3 at a temperature of 293 K. Use the values $a = 15.7 \times 10$ N m^4, $b = 1.07 \times 10^{-2}$ m^3 and R = 0.278 kJ/kg K. **(12)**

(ii) A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which pv = constant. The initial density of air is 1.16 kg/m^3. Find the work done by the piston to compress the air. **(4)**

(OR)

(b) Gas flows steadily through an adiabatic rotary compressor. The gas enters the compressor at a temperature of 16°C, a pressure of 100 kPa, and an enthalpy of 391.2 kJ/kg. The gas leaves the compressor at a temperature of 245°C, a pressure of 0.6 MPa, and an enthalpy of 534.5 kJ/kg. (a) Evaluate the external work done per unit mass of gas assuming the gas velocities at entry and exit to be negligible. (b) Evaluate the external work done per unit mass of gas when the gas velocity at entry is 80 m/s and that at exit is 160 m/s. **(16)**

12. (a) (i) A reversible heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 20°C. Heat transfer through the walls and roof is estimated to be 0.525 kJ/s per degree temperature difference between the inside and outside. If the outside temperature in winter is 5°C, what is the minimum power required to drive the heat pump? **(8)**

(ii) Establish the inequality of Clausius. **(8)**

(OR)

(b) One kg of ice at -5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. A) Determine the entropy increase of the universe. B) What is the minimum amount of work necessary to convert the water back into ice at -5°C? Cp of ice is 2.093 kJ/kg K and the latent heat of fusion is 333.3 kJ/kg. **(16)**

13. (a) Explain constant pressure heating and formation of steam with the help of suitable property diagrams. **(16)**

(OR)

(b) In a reheat cycle, the initial steam pressure and the maximum temperature are 150 bar and 550°C respectively. If the condenser pressure is 0.1 bar and the moisture at the condenser inlet is 5%, and assuming ideal processes, determine (a) the reheat **(16)**

pressure, (b) the cycle efficiency, and (c) the steam rate.

14. (a) In an air standard Diesel cycle, the compression ratio is 16 and the initial pressure and temperature are 1 bar and 15°C respectively. Heat is added such that the temperature at the end of the isobaric process reaches to 1480°C. Determine a) the cut-off ratio, b) the specific heat supplied, c) the air standard efficiency and d) the mean effective pressure of the cycle. **(16)**

(OR)

(b) In a gas turbine plant working on the Reversible Brayton cycle the air at the inlet is at 27°C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800°C. Find (a) the compressor work per kg of air, (b) the turbine work per kg of air, (c) the heat supplied per kg of air, (d) the cycle efficiency, and (e) the turbine exhaust temperature. **(16)**

15. (a) (i) What is Joule-Thomson coefficient? Prove that it is zero for an ideal gas. **(6)**

(ii) Derive the Maxwell relations. **(10)**

(OR)

(b) (i) Estimate the amount of theoretical air required for the complete combustion of 1 kg of acetylene (C_2H_2) to CO_2 and H_2O. **(12)**

(ii) What do you understand by excess air? What is the need of it? **(4)**