Total No. of printed pages = 2

ME 181702

Roll No. of candidate

23/12/22 2021

B.Tech. 7th Semester End-Term Examination

ME

APPLIED THERMODYNAMICS - II

(New Regulation w.e.f. 2017-18 & New Syllabus w.e.f. 2018-19)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

1. Answer any four of the following : $(4 \times 8 = 32)$

(a) 'There are certain disadvantages of increasing the delivery pressure to a high value in reciprocating air compressors' – elaborate the statement with the help of suitable diagrams.

(b) Obtain a mathematical relationship for optimum pressure ratio in a gas turbine plant for fixed values of inlet temperatures of the compressor and the turbine of the plant.

(c) The criterion for the thermodynamic efficiency of a reciprocating compressor is isothermal compression, while for rotary compressor it is isentropic compression. Discuss the reasons for this.

(d) Design a jet engine that alternately accelerates a contained mass of air rearward and then breathes in a fresh mass of air to replace it. The engine can be made with few or no moving parts.

(e) A refrigerant is superheated at the end of compression and under-cooled before throttling in a vapour compression refrigeration cycle. Represent the cycle of operation in T-s and p-h diagrams. Also find the theoretical COP of the cycle from the diagrams.

(f) Processes applied for summer and winter air-conditioning are different – elaborate the statement with suitable diagrams.

[Turn over

2. Answer any two of the following: $(2 \times 9 = 18)$

(a) The following observations are recorded during a trial on a two-stage single-acting reciprocating air compressor. The free air delivered is 6 m^3/min. Atmospheric pressure and temperature are 1 bar and 27°C respectively. Delivery pressure is 40 bar. Speed of compressor is 400 rpm. The intermediate pressure is 6 bar. Temperature at the inlet to the second stage is 27°C. The law of compression is $pv^{1.3} = C$. The mechanical efficiency is 80%. Stroke of LP compressor = Diameter of LP Compressor = Stroke of HP compressor. Find the power required and diameters of the cylinders.

(b) In an ideal jet propulsion cycle, air enters the compressor at 1atm, 15°C. The pressure of air leaving the compressor is 5 atm and the maximum temperature is 870°C. The air expands in the turbine to such a pressure that the turbine work is equal to the compressor work. On leaving the turbine, the air expands reversibly and adiabatically in a nozzle to 1 atm. Determine the velocity of air leaving the nozzle.

(c) A gas turbine unit receives air at 1 bar and 300 K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 85%. The fuel has a heating value of 44 186 kJ/kg and fuel-air ratio is 0.02 kg of fuel per kg of air. The turbine internal efficiency is 90%. Calculate the work of turbine and compressor per kg of air and thermal efficiency of the cycle. For products of combustion, $C_p = 1.147$ kJ/kgK and $\gamma = 1.333$.

3. Answer any four of the following: $(4 \times 5 = 20)$

(a) For a single-stage reciprocating compressor with pressure ratio 4, find the maximum clearance at which the volumetric efficiency becomes zero. Take n=1.3.

(b) For efficient run of a compressor, surging zone in the head-capacity characteristics is avoided – Elaborate.

(c) Draw the velocity vector diagrams for the impeller of a centrifugal compressor and show how the outlet velocity diagram is affected by slip.

(d) In a vapour compression refrigeration plant, the enthalpy values at different points are: enthalpy at the exit of the evaporator = 185 kJ/kg, enthalpy at exit of the compressor = 210 kJ/kg, enthalpy at exit of the condenser = 85 kJ/kg. What is the power required per kW of cooling to be produced?

(e) Calculate the amount of heat removed per kg of dry air if the initial condition of air is 35°C, 70% RH and the final condition is 25°C, 60% RH.

(f) R – 134a is an eco-friendly refrigerant – write a note on the comment comparing it with other refrigerants.