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

Question Paper Code : 53306

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth/Sixth Semester

Mechanical Engineering

ME 6404 — THERMAL ENGINEERING

(Common to Mechanical Engineering (Sandwich))

(Regulation 2013)

Time : Three hours | Maximum : 100 marks

(Use of approved thermodynamics refrigeration table is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the assumptions made in the air standard analysis?

2. Define mean effective pressure and comment its application in internal combustion engines.

3. What are homogeneous and heterogeneous mixtures? In Which engines these mixtures are used?

4. What are the advantages of air cooling system?

5. What is supersaturated flow in steam nozzles?

6. Define critical pressure ratio for the nozzle of a steam turbine.

7. What is the function of a compressor? What are the different types of compressors?

8. What is the need of staging the compression process?

9. Show the simple vapour compression cycle on P-h chart.

10. Define the terms GSHF and RSHF.

PART B — (5 × 13 = 65 marks)

11. (a) An air-standard diesel cycle has a compression ratio of 18, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of compression stroke, the pressure is 1 bar and the temperature is 300 K. Calculate :

(i) the thermal efficiency,

(ii) the mean effective pressure.

Or

(b) A gas engine operating on the ideal Otto cycle has a compression ratio of 6. The pressure and temperature at the commencement of compression are 1 bar and 27°C. Heat added during the constant volume combustion process is 1170 kJ/kg. Determine the peak pressure and temperature, work output per kg of air and air-standard efficiency. Assume $C_v = 0.717$ kJ/kg and $\gamma = 1.4$ for air.

12. (a) Discuss the difference between ideal and actual valve timing diagrams of a petrol engine.

Or

(b) Explain with neat sketches the various stages of combustion in CI engines.

13. (a) The inlet conditions to a steam nozzle are 10 bar and 250°C. The exit pressure is 2 bar. Assuming isentropic expansion and negligible velocity, determine :

(i) the throat area

(ii) the exit velocity

(iii) the exit area of the nozzle.

Or

(b) Explain the pressure compounded impulse turbine showing pressure and velocity variations along the axis of the turbine.

14. (a) A single stage single-acting air compressor running at 1000 rpm delivers air at 25 bar, for this purpose, the induction and free air conditions can be taken as 1.013 bar and 15°C. and the free air delivery as 0.25 m^3/min. The clearance volume is 3% of the swept volume and stroke/bore ratio is 1.2:1. Calculate the :

(i) bore and stroke

(ii) the volumetric efficiency

(iii) the indicated power and

(iv) the isothermal efficiency of the compressor.

Take the index compression and expansion as 1.3.

Or

(b) A three stage compressor is used to air from 1.013 bar to 36 bar. The compression in all stages follows the law $PV^{1.25} = C$. The temperature of air at the inlet of compressor is 300 K. Neglecting the clearance and assuming perfect intercooling, determine :

(i) the indicated power required in kW to deliver 15 m^3/min measured at inlet conditions and

(ii) intermediate pressures.

Take R = 0.287 kJ/kg K.

15. (a) 28 tonnes of ice from and at 0°C is produced per day in an ammonia refrigerator. The temperature range in the compressor is from 25°C to –15 °C. The vapour is dry and saturated at the end of compression and an expansion valve is used. Assuming a co-efficient of performance of 62% of the theoretical, calculate the power required to drive the compressor.

Temperature °C	Enthalpy (kJ/kg)		Entropy of liquid (kJ/kg K)	Entropy of vapour (kJ/kg K)
	Liquid	Vapour		
25	100.04	1319.22	0.3473	4.4852
–15	–54.56	1304.99	–2.1338	5.0585

Take latent heat of ice = 335 kJ/kg.

Or

(b) Explain with neat sketches the simple vapour compression system.

PART C — (1 × 15 = 15 marks)

16. (a) Air is used as the working fluid in a simple ideal Brayton cycle that has a pressure ratio of 12, a compressor inlet temperature of 300 K, and a turbine temperature of 1000 K. Determine the required mass flow rate of air for a net power output of 70 MW, assuming both the compressor and the turbine have an isentropic efficiency of 85 %.

Or

(b) A multistage air compressor compresses air from 1 bar to 40 bar. The maximum temperature in any stage is not to exceed 400 K.

(i) If the law of compression for all the stages is $PV^{1.3} = C$, and the initial temperature is 300 K, find the number of stages for the minimum power input.

(ii) Find the intermediate pressures for optimum compression as well as the power needed.

(iii) What is the heat transfer in each of the intercooler?