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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B. E. - Mechanical Engineering

Semester End Examination; August - 2023

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Derive an expression for the air standard efficiency of Diesel cycle with neat p-v and T-s representation. 10

b. The pressure and temperature of air at the beginning of compression in an Otto cycle is 103 kPa and 27°C, respectively. The heat added per kg of air is 1850 kJ. The compression ratio is 8. Determine maximum temperature, maximum pressure and thermal efficiency. 10

OR

2 a. The thermal efficiency of the Brayton needs to be increased, what are the thermal refinement methods? Explain any two of them. 10

b. A gas turbine working on an air standard Brayton cycle operates between the temperature limits of 300 K and 1200 K and pressure limits of 101 kPa and 505 kPa. Calculate; 10

i) Thermal efficiency of the cycle ii) Compressor work in kJ/kg

iii) Turbine work in kJ/kg iv) Air flow rate for 2.0 kW of net power output

UNIT - II

3 a. Give limitations of Carnot vapour power cycle and explain how Rankine cycle helps in overcoming them. Draw the schematic for a simple Rankine cycle. Draw p-v and T-s diagrams for this cycle and deduce the expression for efficiency of the Rankine cycle. 10

b. Steam enters the turbine as 100% saturated vapour at 6 MPa and saturated liquid enters the pump at a pressure of 0.01 MPa. If the heat rate to boiler is 150 MW, determine; 10

i) The thermal efficiency

ii) The mass flow rate of the steam

iii) Work ratio

OR

4 a. Explain the working and analysis of the regenerative Rankine cycle with open fed-water heater. 10

b. A steam power plant operates on an ideal Rankine cycle between a boiler pressure of 40 bar, 300°C and a condenser pressure of 0.035 bar. Calculate cycle efficiency, work ratio, and specific steam consumption for Rankine cycle, when expansion process has an isentropic efficiency of 80%. 10

Contd... 2

UNIT - III

5 a. Why is the intercooler provided between stages? Obtain the optimum pressure ratio for minimum work in a two-stage compressor with perfect intercooling and deduce the equation for minimum work. 10

b. A two-stage single acting reciprocating compressor takes in air at the rate of 0.2 m^3/s. The intake pressure and the temperature of air are 0.1 Mpa and 16ºC. The air is compressed to a final pressure of 0.7 Mpa. The intercooling is perfect and the intermediate pressure is for minimum work input conditions. The compression index in both the stages is 1.25 and the compressor runs at 600 RPM. Neglecting the clearance, determine; 10

i) The intermediate pressure

ii) The total volume of each cylinder

iii) The power required to drive the compressor

iv) The rate of heat rejection in the intercooler

OR

6 a. Define volumetric efficiency. Discuss the effect of clearance on volumetric efficiency for a single stage reciprocating air compressor. Write the expression for volumetric efficiency with clearance effect of a compressor referred to ambient conditions. 10

b. A single cylinder reciprocating compressor has a piston displacement of 0.1 m^3. The suction pressure and temperature are 1 bar and 298 K respectively. If the delivery pressure after compression is 7 bar, calculate; 10

i) The work required to compress the air isentropically with $\gamma = 1.4$ and polytropically according to the law $Pv^{1.25} = C$

ii) The isothermal efficiency for a isentropic and polytropic compression process

UNIT - IV

7 a. Sketch the vapour compression cycle on a T-s diagram and derive an expression for its COP. 10

b. Explain the effect of superheating and sub-cooling of liquid in a refrigeration system. 10

OR

8 a. Write short notes on the following terms: 10

i) Refrigerants and its properties

ii) Refrigeration effect

iii) Ton of refrigeration

b. Refrigerant 134a is the working fluid in an ideal vapour compression refrigeration cycle, that operated between a cold region at 0°C and a warm region at 26°C. The saturate a vapour enters the compressor at -10°C and the saturate liquid leaves the condenser at a pressure of 9 bar. Determine for m = 0.08 kg/s; 10

Contd... 3

i) Compression power in kW

ii) Refrigeration capacity in tonnes

iii) Coefficient of performance

UNIT - V

9 a. Explain the following:

i) The Morse test for determining the indicated power of a multi-cylinder engine 10

ii) Rope Brake Dynamometer

b. The following data and results refer to a test on a single-cylinder, two-stroke cycle engine: Indicated mean effective pressure = 550 kPa; cylinder diameter = 21 cm; piston stroke = 28 cm; engine speed = 360 rpm; brake torque = 628 Nm; fuel consumption = 8.16 kg/h; calorific value of fuel = 42700 kJ/kg-K. Calculate; 10

i) Mechanical effiency

ii) The indicated thermal efficiency

iii) The brake thermal effiency

iv) Brake specific fuel consumption in kg/kWh

OR

10. Write short note on any four of the following: 20

i) Heat balance sheet

ii) Willian's line method

iii) Hydraulic dynamometer

iv) Motoring Test

v) Air box method to calculate air consumption

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