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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; July / Aug. - 2022

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1 a. Write the drawback of Carnot cycle and derive and expression for the air standard efficiency of an Otto cycle and state the assumptions made. 10

b. An engine with 200 mm cylinder diameter and 300mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27ºC. The cut- off is 8% of the stoke, determine;

i) Pressures and temperatures at all salient points

ii) Theoreticalair standard efficiency 10

iii) Mean effective pressure

iv) Power of the engine if the working cycles per minute are 380

Assume that compression ratio is 15 and working fluid is air. Consider all conditions to be ideal.

2 a. Discuss briefly any two methods employed for improvement of thermal efficiency of gas turbine plant. 10

b. In a turbine plant working on Brayton cycle, the air inlet is 27ºC, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800ºC. The turbine and compressor efficiencies are each 80%. Find compressor work, turbine work, heat supplied cycle efficiency and turbine exhaust temperature. Mass of air may be considered as 1 kg. Draw T-s diagram. 10

UNIT - II

3 a. Describe the different operation of Rankine cycle. Derive also the expression for its efficiency. 7

b. In a steam turbine steam at 20 bar, 360ºC expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes; find per kg of steam the net work and the cycle efficiency. 9

c. Briefly explain effects of maximum pressure and maximum temperature on the performance of simple Rankine cycle. 4

4 a. Explain the working and analysis of the regenerative Rankine cycle with closed feed water heater. 10

b. A turbine is supplied with steam at a pressure of 32 bar and a temperature 410ºC. The steam expands isentropic ally to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of 400ºC and then expanded isentropic ally to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle. 10

UNIT - III

5 a. Obtain the optimum pressure ratio for minimum works in a two-stage compressor with perfect inter cooling and deduce the equation for minimum work. 12

b. A single-eating, single-cylinder reciprocating air compressor has a cylinder diameter of 200 mm and a stroke of 300 mm. Air enters the cylinder at 1 bar; 27ºC. It is then compressed polytrophic ally to 8 bar according to the law $PV^{1.3}$ = constant. If the speed of the compressor is 250 rpm, calculate the mass of air compressed per minute, and the power required in kW for driving the compressor. 8

6 a. Define the volumetric efficiency and isothermal efficiency. Explain the effect of clearance volume on volumetric efficiency of a single-stage reciprocating compressor. 10

b. A single-acting, single-stage reciprocating air compressor of 250 mm bore and 350 mm stroke runs at 200 rpm. The suction and delivery pressures are 1 bar and 6 bar respectively. Calculate the theoretical power required to run be compressor under each of the following conditions of compression: 10

i) Isothermal ii) Polytrophic n = 1.3 and iii) Isentropic, $\gamma = 1.4$,

Neglect the effect of clearance and also calculate isothermal efficiency in each of the above cases.

UNIT - IV

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

b. Sketch and explain the vapour compression cycle on a T-S diagram and deduce an expression for its COP. 10

8 a. Write short notes on the following terms: 12

i) Properties of good refrigerant

ii) Steam jet refrigeration

iii) Refrigeration effect and TON of refrigeration

b. A simple vapour compression plant produces 5 tones of refrigeration. The enthalpy values at inlet to compressor, at exit from the compressor, and at exit from the condenser are 183.19, 209.41 and 74.59kJ/kg respectively. Estimate; 8

i) The refrigerant flow rate

ii) The C.O.P

iii) The power required to drive the compressor

iv) The rate of heat rejection to the condenser

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UNIT - V

9 a. Explain the following:

i) The Morse test for determining the indicated power of a multi-cylinder engine 8

ii) Air box method to determine air consumption

b. The following observations were made during a test on a two-stroke oil engine.

Room temperature = 22ºC, Bore = 20 cm, Stroke = 25 cm, speed = 350 rpm, Brake drum diameter = 1.2 m, Net brake load = 450 N, Mean effective pressure = 2.8 bar, Oil consumption = 3.6 kg/hr, Calorific value of oil = 41800 kJ/gk, Quantity of Jacket cooling water = 455 kg/hr, Rise in temperature o jacket water = 28ºC. Temperature of exhaust gases entering and leaving the exhaust gas calorimeter are 320ºC and 220ºC respectively. Quantity of water passing through the exhaust gas calorimeter is 8 kg/min. Temperature rise of calorimeter water = 9ºC. Determine the indicated and brake power, mechanical efficiency and brake thermal efficiency. Draw the heat balance sheet on one minute basis. 12

10. Write short notes on;

a) Motoring Method

b) Basic measurements for engine performance 20

c) Willian's line method

d) Indicated power, Brake power and Friction Power

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