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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

Make-up Examination; March/April - 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.	Derive an expression for the air standard efficiency of an Otto cycle and write the expression for mean effective pressure.	10
b.	An engine works on a Diesel cycle with an inlet pressure and temperature of 1-bar and 17° C. The pressure at the end of the adiabatic compression is 35-bars. The ratio of expansion, i.e., after constant pressure heat addition is 5. Calculate the heat addition, heat rejection and efficiency of the cycle.	10
2 a.	Briefly explain the following variations of the Brayton cycle: i) Reheating ii) Intercooling	10
b.	0.5 kg of air (ideal gas) executes a Carnot power cycle having a thermal efficiency of 50%. The heat transfer to the air during the isothermal expansion is 40 kJ. At the beginning of the isothermal expansion the pressure is 7-bar and the volume is 0.12 m^3. Determine; i) The maximum and minimum temperatures for the cycle in K ii) The volume at the end of isothermal expansion in m^3 iii) The heat transfer for each of the four processes in kJ For air C_v = 0.721 kJ/kg K, and C_p = 1.008 kJ/kg K.	10

UNIT - II

3 a.	Explain the effect of exhaust pressure and maximum temperature on the performance of simple Rankine cycle with P-V and T-S plots.	6
b.	In a steam power cycle, the steam supply is at 15-bars and dry and saturated. The condenser pressure is 0.4-bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work.	10
c.	Give a comparison between Carnot cycle and Rankine cycle.	4
4 a.	Explain the Regenerative Rankine cycle with neat diagrams.	10
b.	A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption.	10

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UNIT - III

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

b. A single-cylinder, double-acting, reciprocating air compressor receives air at 1 bar; l 7°C, compresses it to 6 bar according to the law $PV^{1.25}$= constant. The cylinder diameter is 300 mm. The average piston speed is 150 m/min at 100 rpm. Calculate the power required in kW for driving the compressor. Neglect clearance. 8

6 a. Define the volumetric efficiency of a single-stage reciprocating compressor and set up an expression for it in terms of pressure ratio and clearance ratio. The compression and expansion curves follow the law PV^n = constant. 10

b. 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 the compressor under each of the following conditions of compression: 10

i) Isothermal ii) Polytropic n = 1.3 iii) Isentropic, γ= 1.4

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

UNIT - IV

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

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

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

i) Refrigeration ii) Refrigeration effect

iii) Ton of refrigeration iv) Refrigerant

b. An ideal vapour compression system uses R-12 as the refrigerant. The system uses an evaporation temperature of 0°C and a condenser temperature of 40°C. The capacity of the system is 7 Ton of Refrigeration. Determine; 12

i) The mass flow rate of refrigerant ii) Power required to run the compressor

iii) Heat rejected in the condenser iv) COP of the system

Use the properties of R-12 from the table given below:

Temperature° C	Pressure bar	h_f KJ/Kg	h_g KJ/Kg	S_f KJ/Kg K	S_g KJ/Kg K
0	3.0 87	36.05	187.53	0.142	0.696
40	9.609	74.59	203.2	0.727	0.682

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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. A two-stroke single cylinder engine runs at 2000 RPM and consumes 5 kg of fuel during a test trial of 15 minutes. The engine cooling is done with water circulation of 15 kg/min and inlet and exit temperatures of 27º C and 55º C respectively. The total air consumption is 150 kg and exhaust temperature is 420º C. Assume atmospheric temperature as 27º C. Specific heat of exhaust gases 1.25 kJ/kg.K and mechanical efficiency 90%. Determine brake power and draw heat balance sheet on per minute basis. Take brake torque 350N-m and calorific value of the fuel 42000 kJ/kg. A two-stroke single cylinder engine runs at 2000 RPM and consumes 5kg of fuel during a test trial of 15 minutes. The engine cooling is done with water circulation of 15 kg/min and inlet and exit temperatures of 27º C and 55º C respectively. The total air consumption is 150 kg and exhaust temperature is 420º C. Assume atmospheric temperature as 27^0C. Specific heat of exhaust gases 1.25 kJ/kg.K and mechanical efficiency 90%. Determine brake power and draw heat balance sheet on per minute basis. Take brake torque 350N-m and calorific value of the fuel 42000 kJ/kg. 12

10 a. Write short notes on;

i) Rope Brake dynamometer

ii) Basic measurements for engine performance

iii) Willian's line method 20

iv) Indicated power, Brake power and Friction Power

v) Motoring Test

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