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

(An Autonomous Institution affiliated to VTU, Belgaum)

Fourth Semester, B.E. - Mechanical Engineering

Semester End Examination; June - 2016

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Use of DHB is permitted.

UNIT - I

1 a. Derive an expression for efficiency of Diesel cycle. 10

b. An engine with 200 mm cylinder diameter and 300 mm 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 stroke. Determine; 10

i) Pressures and temperatures at all salient points ii) Theoretical air standard efficiency

iii) Power of the engine, if the working cycles per minute are 380.

Assume compression ratio as 15 and working fluid is air.

2 a. Derive an expression for optimum pressure ratio to get maximum work done in Brayton cycle. 8

b. What are the methods to improve the efficiency? 2

c. In a gas turbine plant working on Brayton cycle, the air at 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 the compressor work, turbine work and cycle efficiency. Mass of air may be considered as 1 kg. 10

UNIT - II

3 a. What are the drawbacks of the Carnot cycle? And why it cannot be used as an ideal cycle for Rankine cycle? 4

b. Mention the different methods of improving the efficiency of a Rankine cycle with T - S diagram. 6

c. In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar, Determine; 10

i) The pump work ii) The turbine work iii) The Rankine efficiency.

Assume flow rate is 9.5 kg/s.

4 a. With a neat sketch explain the working of open type feed water heaters. 10

b. A steam power plant operates on a theoretical reheat cycle-steam at boiler is 150 bar, 550ºC expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550ºC and expands through a low pressure turbine to condenser pressure at 0.1 bar. Find; 10

i) Quality of steam at turbine exhaust ii) Cycle efficiency.

Contd…2

UNIT - III

5 a. Derive an expression for work done with clearance volume for air compressor. 6

b. What are the disadvantages if a single stage compressor is used in place of multistage compressor? 4

c. A single acting, single stage reciprocating air compressor has a stroke 1.25 times the diameter and runs at 150 rpm while delivering 5 m^3/min of free air compressed to 0.6 MPa, Suction at 0.1 MPa and 27ºC. Free air conditions are 15ºC and 0.1 MPa clearance is 5% and compression and expansion index is 1.3. For air R = 287 J/kgK. Determine; 10

i) Volumetric efficiency

ii) Volume of the air taken in per stroke

iii) Dimension of the cylinder.

6 a. Derive an expression for the intermediate pressure in a two stage air compressor with perfect intercooling. 10

b. A single stage double acting air compressor delivers 15 cc of air per minute measured at 1.013 bar and temperature 27ºC and delivers at 7 bar. The conditions at the end of suction stroke are pressure 0.98 bar and temperature 40ºC. The clearance volume is 4% of the swept volume and stroke to bore ratio is 1.3/1, compressor runs at 300 rpm. Calculate; 10

i) Volumetric efficiency ii) Cylinder dimensions.

UNIT - IV

7 a. With a neat sketch briefly explain Vapour compression refrigeration system with T-S diagram. 10

b. A refrigerating machine of 6 tons capacity working on Bell-Coleman cycle has a upper limit pressure of 5.2 bar. The pressure and temperature at the beginning of compression are 1.0 bar and 16ºC respectively. The compressed air cooled at constant pressure to a temperature of 41ºC enters the expansion cylinder. Assuming adiabatic compression and expansion process with $\gamma = 1.4$. Calculate; 10

i) C.O.P

ii) Quantity of air circulated per minute

iii) Piston displacement of the compressor.

8 a. Define the following :

i) Dry bulb temperature. ii) Wet bulb temperature iii) Dew point temperature 10

iv) Absolute humidity v) Relative humidity.

b. One stream of air at 5.5 m^3/min at 15ºC and 60% RH flows into another stream of air at 35 m^3/min at 25ºC and 70% R.H. Calculate for the mixture; 10

i) Dry bulb temperature ii) Wet bulb temperature

iii) Dew point temperature iv) Relative humidity.

Contd…3

UNIT - V

9 a. Mention the various methods for determination of frictional power and briefly explain any one method. 8

b. In a test on a single cylinder 4-stroke engine having bore of 10 cm and a stroke at 15 cms, the indicator diagram has an area of 4 cm^2, length 6 cm and spring stiffness 12. The diameter of the brake wheel is 60 cm, rope diameter is 3 cm and the dead load is 0.25 kN when the spring balance load is 0.05 kN. The engine runs at 400 rpm. The fuel consumption is 0.23 kg/KWh and the fuel has the calorific value of 44000 kJ/kg. Calculate brake power, indicated power, mechanical efficiency and indicated thermal efficiency. 12

10 a. The following results were obtained during a test on a single cylinder four stroke oil engine.

Cylinder diameter = 25 cm

Stroke = 38 cm

Duration of test = 60 min

Total revolutions = 19,710

Fuel oil used = 6.25 kg.

Average area of indicator diagram = 5.7 cm^2

Length of indicator diagram = 7.6 cm

Spring number = 8 bar per cm

Net load on the brake = 60 N

Radius of brake drum = 1.2 m

Cooling water flow rate = 5.7 kg/min

Cooling water Temperature rise = 28ºC

Air supplied per kg of fuel = 30 kg

Calorific value of fuel = 44, 380 kJ/kg

Exhaust gas temperature =390ºC

Atmospheric temperature = 15.5ºC

Specific heat of exhaust gases=1 kJ/kgK

Determine; 14

i) Mechanical efficiency

ii) Brake thermal efficiency

iii) Draw up a heat balance sheet on minute basis

b. Explain the air box method of determination of air consumption in an IC engine test set up. 6

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