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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; May / June - 2019**

**Applied Thermodynamics**

*Time: 3 hrs* *Max. Marks: 100*

***Note:*** *i) Answer FIVE full questions, selecting ONE full question from each unit.*
*ii) Missing data, if any, may be suitably assumed.*

**UNIT - I**

1 a. Compare Otto cycle and Diesel cycle on the basis of same compression ratio and same heat rejection with the help of T-S and P-V diagrams. 6

b. Derive an expression for the efficiency of diesel cycle in-terms of compression ratio and cutoff ratio. 6

c. Determine the air standard efficiency of a diesel engine having a cylinder bore of 250 mm and a stroke of 375 mm and a clearance volume of 1500 cc. Fuel cutoff take place at 5% of the stroke. 8

2 a. What are the reasons for deviation of practical gas turbine cycles from ideal cycles? 4

b. What is Regeneration? Explain the Brayton cycle with regenerator using a neat sketch and T-S diagram. 6

c. In a gas turbine power plant working on Brayton cycle, the inlet air is at 27°C and 1 Bar pressure. The pressure ratio is 6.25 and maximum temperature in the cycle is 800°C. The turbine and compressor efficiency are each 80%. Find cycle efficiency and turbine exhaust temperature. 10

**UNIT - II**

3 a. With a neat sketch, explain the working of a Rankine cycle with open type feed water heater regenerative cycle. Draw T-S diagram and expression for efficiency of the cycle. 10

b. Steam power plants operate on an ideal reheat Rankine cycle between pressure limits of 9 MPa and 10 kPa. The steam enters both stages of turbine at 500°C. If the dryness fraction of steam at the exit is 90%. Determine; 10

i) The reheat pressure ii) Heat added in the re-heater per kg of steam

iii) Thermal efficiency of the cycle. Neglect pump work

4 a. Explain with a neat sketch and T-S diagram the working of a Rankine cycle with closed type regenerative feed water heater. Derive expression for efficiency. 10

b. The following data refers to an ideal reheat Rankine cycle. Boiler pressure 10 MPa, Pressure at the LP turbine 2 MPa, condenser pressure 10 kPa. Turbine at inlet to turbine is 500°C, net work done 1500 kJ/kg and thermal efficiency = 40.0%. Determine the temperature of steam leaving the re-heaters. Neglect pump work. 10

**UNIT - III**

5 a. What are the uses of compressed air? 4

b. Derive an expression for the volumetric efficiency of an air compressor. 6

Contd… 2

c. A single stage, single acting air compressor takes in air at 1.0 Bar and 15°C. The quantity of air taking in is 1.0 $m^3$/min. The delivery pressure is 7 Bar. Assuming $\eta$ = 1.35 and neglecting clearance. Determine; i) Indicated power ii) Power required, if $\eta_m$ = 0.9 iii) Cylinder bore and stroke assuming stroke to bore ratio is 1.5 and rpm = 300 — 10

6 a. Derive an expression for the optimum intermediate pressures for two stage air compressor with imperfect inter cooling. — 8

b. A single stage, single acting air compressor delivers 0.6 kg/min of air at 6 Bar. Initial temperature and pressure of air are 30°C and 1 Bar. The bore and stroke are 100 mm and 150 mm. The clearance volume is 3% of stroke. Take *n* = 1.3. Determine; i) Volumetric efficiency ii) Power required of mechanical efficiency is 0.85 and speed of the compressor — 12

## UNIT - IV

7 a. What are the desirable properties of a good refrigerant? — 4

b. With a simple sketch, explain the working of steam jet refrigeration cycle. — 6

c. A single ammonia vapor compression system has a condenser temperature of 30°C and evaporator temperature of -15°C. The liquid is sub-cooled to 10°C. The volumetric efficiency of the compression is 0.8. Determine the refrigeration effect and COP of the machine. — 10

8 a. With a neat sketch, explain the working principle of a vapor absorption refrigeration system. — 8

b. A two ton refrigerating unit uses ammonia as the refrigerant working pressure limits are 2 Bar and 10 Bar respectively. The refrigerant is just dry and saturated before it enters the compressor. After compression the energy rejected by the refrigerant in the condenser is 1550 kJ/kg. The liquid emerging from the condenser is found to be sub cooled by 10°C. Find the actual COP, mass flow rate of ammonia, the power required to drive the compressor of mechanical efficiency is 0.8. — 12

## UNIT - V

9 a. Explain the AIR-BOX method of determining the quantity of air consumed in an I-C engine. — 6

b. List the basic testing factors in testing of IC engine. — 4

c. The following reading was taken on a single cylinder, for stroke gas engine, 30 cm in diameter and 40 cm in stroke. RPM = 200, Number of explosions = 80 / minute, Brake diameter = 150 cm, Net load on the brake =1200 N, Net mean effective pressure = 6 Bar, gas used 11.5 cum/hr. Pressure of gas = 15 cm of water above atmospheric pressure, Barometer reading =755 mm Hg. Ambient temperature = 20°C, CV of the gas used = 21000 kJ/$m^3$ at NTD. Find mechanical efficiency and break thermal efficiency. — 10

10 a. Explain the Morse test method for the determination of IP of a multi cylinder engine. — 8

b. The following observations are recorded in a test of one hour duration on a single cylinder oil engine working on four stroke cycle. Bore = 300 mm, stroke = 450 mm, fuel used = 8.8 kg, $C_V$ of fuel = 41800 kJ/kg, speed = 200 rpm, mep = 5.8 Bar, brake load =1860 N; quantity of cooling water = 650 kg, Temperature rise = 22°C, Dia of Brake drum = 1.22 m. Calculate mechanical efficiency, brake thermal efficiency and draw up heat balance sheet. — 12

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