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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 27°C. 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 27°C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800°C. 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, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C 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.

**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  $5 \text{ m}^3/\text{min}$  of free air compressed to 0.6 MPa, Suction at 0.1 MPa and  $27^\circ\text{C}$ . Free air conditions are  $15^\circ\text{C}$  and 0.1 MPa clearance is 5% and compression and expansion index is 1.3. For air  $R = 287 \text{ J/kgK}$ . 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  $27^\circ\text{C}$  and delivers at 7 bar. The conditions at the end of suction stroke are pressure 0.98 bar and temperature  $40^\circ\text{C}$ . 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  $16^\circ\text{C}$  respectively. The compressed air cooled at constant pressure to a temperature of  $41^\circ\text{C}$  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 : 10
- i) Dry bulb temperature.      ii) Wet bulb temperature      iii) Dew point temperature
- iv) Absolute humidity      v) Relative humidity.
- b. One stream of air at  $5.5 \text{ m}^3/\text{min}$  at  $15^\circ\text{C}$  and 60% RH flows into another stream of air at  $35 \text{ m}^3/\text{min}$  at  $25^\circ\text{C}$  and 70% R.H. Calculate for the mixture; 10
- i) Dry bulb temperature                      ii) Wet bulb temperature
- iii) Dew point temperature                      iv) Relative humidity.

## 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  $4 \text{ cm}^2$ , 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 =  $5.7 \text{ cm}^2$   
 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 =  $28^\circ\text{C}$   
 Air supplied per kg of fuel = 30 kg  
 Calorific value of fuel = 44, 380 kJ/kg  
 Exhaust gas temperature =  $390^\circ\text{C}$   
 Atmospheric temperature =  $15.5^\circ\text{C}$   
 Specific heat of exhaust gases =  $1 \text{ kJ/kgK}$   
 Determine;
- 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