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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/July - 2015

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each **Unit**.*
ii) Assume suitable missing data if any. iii) Use of thermodynamic data hand book is permitted.

UNIT - I

1. a. What are the assumptions made in the derivations of air standard cycles? 4

b. Show that efficiency of Brayton cycle with regular depends not only on the pressure ratio, but also on the ratio of limiting temperatures. 8

c. An engine works on diesel cycle has a stroke of 30cm and a bore of 17 cm. The clearance volume 440 cm^3 and fuel injection takes place at constant pressure for 5% of stroke. Determine the air standard efficiency of the cycle. 8

2 a. What are the reasons for deviation of actual Brayton cycle from ideal Brayton cycle? 4

b. Derive an expression for the efficiency of a diesel cache in terms of compression ratio and cutoff ratio. 8

c. In a gas turbine installations, air is supplied at 1 bar and 27ºC into compressor having a compression ratio of 8. The maximum temperature of the cycle is 1100 K. A heat exchanger is fitted with an effectiveness of 0.8. The efficiency of turbine and compressor are 0.9 and 0.85 respectively. Determine cycle efficiency. 8

UNIT – II

3 a. With the help of T-S diagram, explain the effect of
(i) Super heating and (ii) Maximum pressure on the Rankine cycle. 8

b. Compare Rankine cycle with Carnot cycle and mention why Carnot cycle cannot be used as an ideal cycle for Rankine cycle. 4

c. Steam at 4 MPa and 300ºC leaves the boiler and enters the high pressure turbine. It is expanded to 400 kPa. The steam is then related to 300ºC and expanded in the LP turbine to 10 kPa. Calculate the thermal efficiency of the cycle. 8

4 a. With a neat sketch explain the working of ideal regenerative Rankine cycle and mention its limitations. 10

b. A steam power plant running on Rankine cycle has steam entering HP turbine at 20 MPa. 500ºC and leaving L.P. turbine at 90% dryness. Considering condenser pressure of 0.005 MPa and reheating occurring up to 500°C temperature. Determine (i) Pressure at which Stream leaves HP turbine (ii) Thermal efficiency of cycle. 10

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UNIT - III

5 a. What are the advantages of Multistage compression? 4

b. Derive expressions for the intermediate pressure in a two stage air compressor with perfect intercooling. 8

c. In a two stage reciprocating air compressor running at 200 rpm, the air is admitted at 1 bar 17°C and discharged at 25 bar. The quantity of air compressed is 4 kg/min. LP cylinder has a clearance of 5% of stroke volume. Taking η = 1.25 and considering perfect intercooling determine; 8

(i) Power required (ii) Free air delivered

(iii) Volumetric efficacy (iv) Stroke volume of LP cylinder

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

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

c. A two stage double acting air compressor running at 200 rpm has air entering at 1 bar and 25ºC and discharged at 9 bar. The clearance volume is 5% stroke. Bore of LP cylinder is 30 cm and stroke 40 cm. Take η = 1.2. Determine power required to drive compressor and heat rejected in the intercooler. Assume optimum intercooling and pressure. 10

UNIT - IV

7 a. With the help of T.S. and P.H. diagrams explain subcooling and superheating of refrigent in a vapour compression refrigeration system. 10

b. A vapour compression cycle works on Freon-12 refrigirant with condensation temperature of 40º and evaporation temperature of -20ºC. Refrigeration effect of 2.86 ton is derived from the cycle. The compressor runs with1200 rpm and has clearance volume of 20%. Considering compression index of 1.13. Determine COP and Piston displacement of compressor. 10

8 a. Explain with sketches summer air conditioning and winter air conditioning. Represent the process on psychrometric chart. 12

b. Determine the mass of water added and heat transferred for conditioning atmospheric air at 15ºC and 80% relative humidity to temperature of 25ºC and relative humidity of 50%. Final volume of conditioned air is $0.8 m^3/s$. Represent the process on psychrometric chart. 8

UNIT - V

9 a. Explain the air box method of determination of air consumption in an IC engine test setup. 6

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b. During a trial of a single cylinder oil engine, cylinder diameter is 20 cm, stroke 28 cm working on two stroke cycle and firing every cycle the following observations were made. Duration of trial = 1 hour, Total fuel used = 4.22 kg., calorific value = 44670 kJ/kg, proportions of Hydrogen in fuel = 15%, Total no. of Revolutions = 21000, Mean effective pressure = 2.74 Bar. Net Brake load applied to drum of 100cm diameter = 600 N. Mass of cooling water circulated = 495 kg, cooling water inlet temperature13ºC and outlet 38ºC, Air used = 135 kg latent heat of steam = 2256.9 kJ/kg., Room temperature = 20ºC, temperature of exhaust gas = 370ºC, Cp of gasses = 1.005 kJ/kg K, Cp of steam = 2.093 kJ/kg K. Calculate BP, IP, Mech. Efficiency, Thermal efficiency and draw heat balance sheet. 14

10 a. Explain Morse test method of determinations of Indicated power of a multicylinder engine. 6

b. During trial of a four cylinder 4 stroke petrol engine running at full load has speed of 1500 rpm and break load of 250 N when all cylinders are working. After some time each cylinder is cut one by one and then again brought back to some speed of the engine. The brake readings are measured as 175 N, 180 N, 182 N and 170 N. The brake drum radius is 50 cm. Fuel consumption = 0.189 kg/min. CV of fuel = 43 MJ/kg and AF ratio is 12. Exhaust gas temperature = 600ºC. Cooling water flow rate 18 kg/min and enter at 27ºC and leaves at 50°C. The atmospheric temperature = 27 ºC. Take sp. heat of exhaust gas as 1.02 kJ/kg K. Determine brake power indicated power, and mechanical efficiency of the engine. Also draw a heat balance sheet on minute basis. 14

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