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Fourth Semester B.E. Degree Examination, June/July 2016
Applied Thermodynamics

Time: 3 hrs.

Max. Marks:100

- Note: 1. Answer FIVE full questions, selecting at least TWO questions from each part.**
2. Use of Thermodynamics Data Hand book permitted.

PART – A

- 1 a. Define the following :
- i) Adiabatic flame temperature ii) Stoichiometric air iii) Excess air
 iv) Enthalpy of formation v) Enthalpy of combustion. (10 Marks)
- b. Methane (CH₄) is burned with atmospheric air. The analysis of the products of combustion on a dry basis is as follows: CO₂ – 10% O₂ – 2.37% CO – 0.53% and N₂ – 87.10%. Calculate the air fuel ratio and the percent theoretical air and determine the combustion equation. (10 Marks)
- 2 a. Explain the method of findings friction power using
 i) Morse test ii) Motoring test of an engine. (08 Marks)
- b. In a test of 4-cylinders, 4-stroke petrol engine of 75mm bore and 100mm stroke. The following results were obtained at full throttle at a constant speed and with a fixed setting of the fuel supply at 0.082 kg/min. BP with all the 4 – cylinders working = 15.24kW. B.P with cylinder No.1 cutoff = 10.45kW, BP with cylinder No.2 cutoff = 10.33 kW, BP with cylinder No.3 cutoff = 10.23kW, BP with cylinder No.4 cutoff = 10.45kW.
 Determine :
 i) The indicated power
 ii) The indicated thermal efficiency, if CV of the fuel = 44mJ/kg.
 iii) Relative efficiency based on IP is clearance volume in each cylinder = 115CC. (12 Marks)
- 3 a. Derive an expression for thermal efficiency of Dual cycle with PV and TS diagrams. (10 Marks)
- b. An engine operates on air standard diesel cycle. The pressure and temperatures at the beginning of compression are 100KPa and 27°. The compression ratio is 18. The heat added per kg of air is 1850kJ. Determine maximum pressure, Maximum temperature, thermal efficiency, network done and mean effective pressure of the cycle. Assume $\gamma = 1.4$ and $C_p = 1.005$ kJ/kg K. (10 Marks)
- 4 a. With T-S and schematic diagrams explain regenerative cycle with open feed water heater. (10 Marks)
- b. A 40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10KPa. The steam leaves the boiler and enters the turbine at 400°C. the isentropic efficiency of the steam turbine is 85% determine:
 i) The cycle efficiency ii) The quality of exhaust steam from turbine
 iii) Steam flow rate in kg/hr. consider pump work. (10 Marks)

PART – B

- 5 a. Derive expression for the intermediate pressure which gives minimum power in a two stage compressor with perfect inter cooling. (08 Marks)
- b. A single cylinder, double acting air compressor is required to deliver $100\text{m}^3/\text{min}$ of air at a mean piston speed of $500\text{m}/\text{min}$ measured at 1bar and 15°C . The air is delivered at 7bar . Assume a clearance volume of $\frac{1}{15}$ th of swept volume per stroke. Find volumetric efficiency speed, bore, stroke for the following two cases.
- If ambient and suction conditions are same
 - If ambient and suction conditions are different.
- Assume, Ambient pressure = 1.0bar ,
Ambient temperature = 15°C , Suction pressure = 0.98bar . Suction temperature = 30°C
- $$\frac{L}{D} = 1.25 \quad (10 \text{ Marks})$$
- c. Write the uses of compressed air. (02 Marks)
- 6 a. Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency. (06 Marks)
- b. Explain the working of a ramjet engine with the help of a sketch. What are its advantages, disadvantages and applications? (10 Marks)
- c. Explain with neat sketch any one method to improve thermal efficiency of Gas Turbine cycle. (04 Marks)
- 7 a. A refrigerating unit takes air from a cold chamber at 5°C and compresses it from 1bar to 6.5bar . The index of compression is 1.25 . The compressed air is cooled to a temperature which is 10°C above the ambient temperature of 30°C before being expanded isentropically in an expander. Neglecting the clearance volume of compressor and expander. Find the COP and the amount of air circulated in m^3/min . If 2000kg of ice is to be formed per day at 0°C from water at 25°C , what the tonnage of the unit? (12 Marks)
- b. Draw neat PV and TS diagram for reversed Brayton cycle. (02 Marks)
- c. Show that COP reversed Brayton cycle = $\frac{1}{R_p^{\frac{\gamma-1}{\gamma}} - 1}$
- Where R_p = pressure ratio
 $\gamma = \frac{C_p}{C_v}$, remains same during expansion and compression process. (06 Marks)
- 8 a. With a neat sketch, briefly describe a summer air conditioning system. (08 Marks)
- b. Define the following: i) DBT ii) Specific humidity iii) Relative humidity. (06 Marks)
- c. Show the following processes on Psychrometric chart.
- Sensible heating and cooling
 - Cooling and dehumidification
 - Adiabatic mixing of two streams
 - Heating and humidification. (06 Marks)
