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06ME43

Fourth Semester B.E. Degree Examination, December 2012
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 : i) Excess air ii) Adiabatic flame temperature iii) Enthalpy of formation iv) Stochiometric air and v) Enthalpy of formation. **(10 Marks)**

b. A sample of fuel has the following percentage composition: Carbon = 86%, Hydrogen = 8%, Sulphur = 3%, Oxygen = 2%, Ash = 1%. For an airfuel ratio of 12 : 1. Calculate i) Mixture strength as a percentage of rich or weak ii) Volumetric analysis of dry combustion products. **(10 Marks)**

2 a. Sketch neatly the P-V and T-S diagrams of the air standard dual combustion cycle and derive the expression for efficiency of the cycle, stating the assumptions made. **(10 Marks)**

b. The minimum and maximum temperatures in an engine working on constant pressure cycle are 300 K and 1500 K and the heat addition during combustion process is 500 KJ/kg air. Another engine working on semi diesel cycle between the same temperature limits of 300 K and 1500 K has a heat addition of 500 KJ/kg of air which shared equally between the two heat addition processes. Compare their i) Efficiencies ii) Work outputs. **(10 Marks)**

3 a. With neat sketches, explain turbojet and ramjet propulsions. **(10 Marks)**

b. In an open cycle constant pressure gas turbine, air enters the compressor at 1.02 bar and 27°C. The pressure of air after the compression is 4.08 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The A:F ratio used is 80:1. Find the power and thermal efficiency of the cycle, if the flow rate of air is 2.5 kg/sec. Take C_p = 1 KJ/kg and γ = 1.4 for air and gases. C.V. of fuel used = 41720 KJ/kg. **(10 Marks)**

4 a. With the help of a schematic diagram and T-S diagram, explain the working of a practical regenerative vapour power cycle and derive an expression for its overall efficiency. **(08 Marks)**

b. A steam power plant incorporates an ideal reheat cycle to improve the existing efficiency. Steam at 30 bar and 250°C is supplied at high pressure turbine inlet and expands till the pressure becomes 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C by constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency. **(12 Marks)**

PART – B

5 a. Derive the condition for minimum work input to a two stage reciprocating air compressor with perfect intercooling. State clearly the assumptions made. **(08 Marks)**

5 b. The following data refer to a single stage air compressor. Atmospheric conditions = 1 bar and 25°C. Receiver pressure is 10 bar, cylinder diameter = 12 cm, stroke to bore ratio is unity. Clearance volume is $\frac{1}{25}^{th}$ of stroke volume. Index for both compression and expansion = 1.25. Mechanical efficiency = 80%. If the receiver capacity is 600 liters and it takes 8 minutes to fill the receiver till its pressure is 10 bar starting from 1 bar, determine : i) Actual volumetric efficiency ii) Mass of air compressed per second iii) Speed of the compressor iv) Power input. Assume that the receiver temperature remains at 25°C throughout the filling process. **(12 Marks)**

6 a. List properties of good refrigerants. **(04 Marks)**

b. With a neat sketch, describe clearly the working of a Bell-Coleman cycle. **(06 Marks)**

c. A vapour compression refrigerator of 10 tonnes capacity using Freon-12 as the refrigerant has an evaporator temperature of -10°C and a condenser temperature of 30°C. Assuming simple saturation cycle. Determine:

i) Mass flow rate of refrigerant in Fg/min.

ii) Power input.

iii) COP.

Take $C_{P_V} = 0.72$ KJ/kgK **(10 Marks)**

Properties of Freon – 12

Temp	h_f	h_{fg}	h_g	S_f	S_{fg}	S_g
30	64.539	134.936	199.475	0.2397	0.4451	0.6848
-10	26.851	156.207	183.058	0.1079	0.5936	0.7014

7 a. Distinguish between : i) Dry air and atmospheric air ii) Dry bulb temperature and wet bulb temperature iii) Specific humidity and relative humidity.. **(06 Marks)**

b. With a neat sketch describe the working of summer air conditioning system for hot and dry weather. **(07 Marks)**

c. A room measures $5m \times 5m \times 3m$. It contains atmospheric air at 100 KPa, DBT = 30°C and relative humidity = 30%. Find the mass of dry air and the mass of associated water vapour in the room. Solve the problem without the use of psychrometric chart and using the properties of water vapour from steam tables. **(07 Marks)**

8 a. What are the different methods of measuring the friction power of an IC engine and explain any one method. **(06 Marks)**

b. A gas engine working on constant volume cycle gave the following results during a one hour test run. Cylinder diameter 24 cms; stroke 48 cm, Effective diameter of brake wheel 1.25 m. Net load on brake 1236 N. Average speed 226.7 RPM. Average explosions per minute 77, MEP = 7.5 bar, gas used 13 m^3 at 15°C and 771 mm of mercury pressure. Lower calorific value of gas 22000 KJ/m^3 at NTP. Cooling water used 625 kg, inlet temperature of water 25°C. Outlet temperature of water 60°C. Determine

i) Mechanical efficiency.

ii) The specific fuel consumption in m^3/IP hour.

iii) The indicated and brake thermal efficiencies.

Draw up a heat balance for the engine on minute basis. NTP conditions are 760 mm of Hg and 0°C. **(14 Marks)**

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