USN | | | | | | | | | | 06ME43

Fourth Semester B.E. Degree Examination, December 2011
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Use of thermodynamic data handbook/charts/tables is permitted.
3. Any missing data may be assumed suitably.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Distinguish between: i) Theoretical air and excess air
ii) Higher calorific value and lower calorific value. **(04 Marks)**

b. Define the terms: i) Enthalpy of formation ii) Enthalpy of combustion
iii) Adiabatic flame temperature iv)Combustion efficiency **(04 Marks)**

c. Find the stoichiometric air for the combustion of gaseous propane (C_3H_8) on mass basis and molar basis. **(04 Marks)**

d. 4.4 kg propane gas is burnt completely with 3.0 kmol of air. Find the excess air and the molar analysis of the dry combustion products. **(08 Marks)**

2 a. With the help of P-V and T-S diagrams, derive an expression for the air standard efficiency of a diesel cycle. **(08 Marks)**

b. Compare the Otto and Diesel sycles, on the basis of same compression ratio and same heat inputs, with the help of T-S and P-V diagrams. **(04 Marks)**

c. A four stroke, four cylinder petrol engine of 250mm bore and 375mm stroke works on the Otto cycle. The clearance volume is $0.01052 m^3$. The initial pressure and temperature are 1 bar and 47°C. If the maximum pressure is limited to 25bar, find the following:
i) Air standard efficiency ii) Mean effective pressure. **(08 Marks)**

3 a. Derive an expression for the optimum pressure ratio, for the maximum network output, in an Brayton cycle. What is the corresponding cycle efficiency? **(06 Marks)**

b. What are the methods of improving the efficiency of Brayton cycle? **(02 Marks)**

c. In a reheat gas turbine cycle, comprising one compressor and two turbines, air is compressed from 1 bar, 27°C to 6 bar. The highest temperature in the cycle is 900°C. The expansion in the first stage turbine is such that the work from it just equals the work required by the compressor. Air is reheated between the two stages of expansion to 850°C. Assume that the isentropic efficiency of the compressor, the first stage and the second stage turbines are 85% each and that the working substance is air. Calculate the cycle efficiency. **(12 Marks)**

4 a. Discuss the effect of i) Boiler pressure and ii) Condenser pressure, on the performance of a Rankine cycle. **(04 Marks)**

b. Explain the working of the regenerative Rankine cycle with one feed-water heater. **(04 Marks)**

c. In a reheat cycle, steam at 500°C expands in a HP turbine till it is saturated vapour. It is then reheated at constant pressure to 400°C and then expanded in a LP turbine to 40°C. If the maximum moisture content at the turbine exhaust is limited to 15% find, i) the reheat pressure, ii) the pressure of steam at the inlet to the HP turbine. iii) the net specific work output iv) the cycle efficiency v) the steam rate. Assume all the ideal processes. **(12 Marks)**

PART – B

5 a. What are the drawbacks of a single stage compressor for producing high pressure? How are these overcome by multistage compression? **(05 Marks)**

b. Derive an expression for the condition for the minimum work input, required for a two stage compressor, with perfect intercooling. **(07 Marks)**

c. A two stage, single acting reciprocating air compressor, with complete intercooling atmospheric air at 1 bar and 15°C, compresses it polytropically (n = 1.3) to 30 bar. If both cylinders have the same stroke, calculate the diameter of the HP cylinder. The diameter of the LP cylinder is 300mm. **(08 Marks)**

6 a. Explain the effect of superheat and subcooling on the vapour compression cycle with the help of T-S and p-h diagrams. **(06 Marks)**

b. With a neat sketch, explain the working of vapour absorption refrigeration system. **(07 Marks)**

c. In a saturated vapour compression refrigeration cycle operating between an evaporator temperature of -10°C and a condenser temperature of 40°C, the enthalpy of the refrigerant , Freon-12 at the end of compression is 220 kJ/kg. Show the cycle on T-S and p-h planes. Calculate i) COP ii) refrigerating capacity and compressor power assuming a refrigerating flow rate of 1 kg/min. **(07 Marks)**

7 a. Define: i) Relative humidity ii) Specific humidity iii) Dew point temperature iv) Enthalpy of humid air v) Degree of saturation. **(05 Marks)**

b. With a schematic diagram, explain the summer air conditioning system, for hot and wet weather. **(07 Marks)**

c. For a hall to be air-conditioned, the following conditions are given:
Outdoor conditions: 40° DBT, 20°C WBT, required comfort condition - 20°C WBT, 60% RH. Seating capacity of the hall is 1500, amount of outdoor air supplied = 0.3 m^3/min per person. If the required condition is achieved first by adiabatic humidification and then by cooling, estimate i) the capacity of the cooling coil in tones and ii) the capacity of the humidifier in kg/h. **(08 Marks)**

8 a. Describe the principle of conducting Morse test on IC engines. **(04 Marks)**

b. A single cylinder four stroke diesel engine works on the following data:
Cylinder bore = 15cm, stroke = 25cm, speed = 250 rpm, area of indicator diagram = 6 cm^3, length of the indicator diagram = 9 cm, spring constant = 7.5 bar/cm, brake specific fuel consumption = 0.24 kg/kWhr, calorific value = 42000 kJ/kg, diameter of brake wheel = 70cm, rope diameter = 3.5cm, brake load = 40kg. Calculate i) brake power ii) indicated mean effective pressure iii) Indicated power iv) Mechanical efficiency v) Indicated thermal efficiency. **(08 Marks)**

c. The following data were obtained from a Morse test on a 4-cylinder, 4-stroke cycle SI engine coupled to a hydraulic dynamometer, operating a constant speed of 1500 rpm.
Brake load with all four cylinders firing = 296 N
Brake load with cylinder No.1 not firing = 201 N
Brake load with cylinder No.2 not firing = 206 N
Brake load with cylinder No.3 not firing = 192 N
Brake load with cylinder No.4 not firing = 200 N
The brake power in kW is calculated using the equation BP = WN/42300, where W is the brake load in Newtons and N is the speed of the engine in rpm. Calculate
i) Brake power ii) Indicated power iii) Friction power iv) Mechanical efficiency. **(08 Marks)**

* * * * *