Registration No. | | | | | | | | | |

M.E./M.Tech. Degree Examinations, January 2017

First Semester

INTERNAL COMBUSTION ENGINEERING

IC16102 – ADVANCED THERMODYNAMICS

(Regulation 2016)

(Use of approved Thermodynamic tables and charts are permitted)

QP Code: 553509

Time: Three hours **Maximum : 100 marks**

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

1. What do the Maxwell relations represent?
2. State the approximations which are involved on the Clapeyron-Clausius equation.
3. Define fugacity.
4. What do you mean by ideal solution?
5. How does reversible work differ from useful work?
6. State the purpose of availability analysis of thermal systems.
7. What do you mean by disassociation losses in IC engines?
8. State the difference between air standard cycle and actual cycle of SI engine with respect to heat addition process.
9. What is Enthalpy of formation?
10. What does the Gibbs function of formation of a compound represent?

PART B - (5 X16 = 80 Marks)

11. (a) For a perfect gas obeying pv = RT, show that cv and cp are independent of pressure. **(16)**

(OR)

(b) Using the first Maxwell equation, derive the remaining three. **(16)**

12. (a) Determine the specific volume of refrigerant-134a at 1 MPa and 50°C, using (i) the ideal gas equation of state and (ii) the generalized compressibility chart. Compare the values obtained to the actual value of 0.021796 m^3/kg and determine the error involved in each case. **(16)**

(OR)

(b) A piston cylinder device contains 6 kg of H_2 and 21 kg of N_2 at 160 K and 5 MPa. Heat is now transferred to the device, and the mixture expands at constant pressure until the temperature rises to 200 K. Determine the heat transfer during this process by treating the mixture as a non-ideal gas and using Amagat's law. **(16)**

13. (a) A mass of 6.98 kg of air is in a vessel at 200 kPa, 27°C. Heat is transferred to the air from a reservoir at 727°C until the temperature of air rises to 327°C. The environment is at 100 kPa, 17°C. Determine (i) The initial and final availability of air (ii) The maximum useful work associated with the process. **(16)**

(OR)

(b) Air at the rate of 25 kg/min is compressed in a centrifugal air compressor from 1 bar to 2 bar. The temperature increases from 15°C to 100°C during compression. Determine actual and minimum power required to run the compressor. The surrounding air temperature is 15°C. Neglect the heat interaction between the compressor and surroundings and changes in potential and kinetic energy. **(16)**

14. (a) What is the percentage change in the efficiency of Otto cycle having a compression ratio of 7, if the specific heat at constant volume increases by 1%? **(16)**

(OR)

(b) Enlist the losses considered in the actual cycle analysis of IC Engines and explain them in detail with the help of P-v diagrams. **(16)**

15. (a) The gravimetric analysis of a sample of coal is given as 82% C, 10% H2 and 8% ash. Calculate: (i) The stoichiometric A/F ratio (ii) The analysis of the products by volume. **(16)**

(OR)

(b) A petrol engine delivers 150 kW. The fuel used is C8H18 and it enters the engine at 25˚C. The air which is 150% theoretical, enters at 45˚C. The products of combustion leave the engine at 750 K, and the heat transfer from the engine is 205 kW. Determine the fuel consumption per hour, if the complete combustion is achieved. **(16)**