

Registration No. :

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Total number of printed pages – 3

B. Tech
BE 2103

First Semester Examination – 2013

THERMODYNAMICS

QUESTION CODE : C- 615

Full Marks – 70

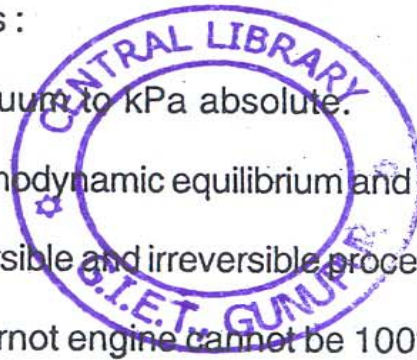
Time : 3 Hours

Answer Question No. 1 which is compulsory and any five from the rest.

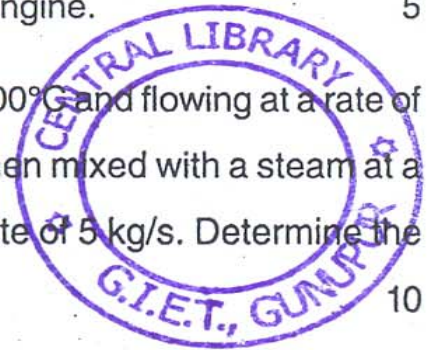
The figures in the right-hand margin indicate marks.

Steam table and Molliers chart are allowed.

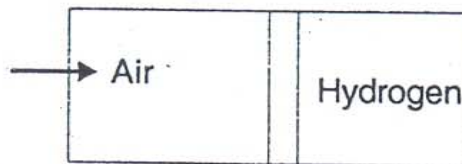
1. Answer the following questions : 2×10
- (a) Convert 40 cm of Hg vacuum to kPa absolute.
 - (b) Differentiate between thermodynamic equilibrium and thermal equilibrium.
 - (c) Differentiate between reversible and irreversible process with examples.
 - (d) Why the efficiency of a Carnot engine cannot be 100% ?
 - (e) What are mass fraction and mole fraction and how they are related ?
 - (f) Define pure substance and an ideal gas.
 - (g) Find the specific enthalpy, specific volume and density of 1 kg of steam at a pressure of 1.5 MPa, having a dryness fraction of 0.9 using a steam table.
 - (h) Calculate the characteristic gas constant of air.
 - (i) Define a free expansion process.
 - (j) Write the name of four mountings of a boiler.



2. (a) A gas is compressed hyperbolically from a pressure and volume of 100 kN/m^2 and 0.056 m^3 respectively, to a volume of 0.007 m^3 . Determine the final pressure and work done on the gas. 5
- (b) During the working stroke of an engine the heat transferred out of the system was 150 kJ/kg of working substance. The internal energy also decreased by 400 kJ/kg of working substance. Determine the work done and state whether the work done by or on the engine. 5
3. Steam at a pressure of 2.0 MPa , a temperature of 300°C and flowing at a rate of 2.0 kg/s is throttled to a pressure of 800 kPa . It is then mixed with a steam at a pressure of 800 Pa and 0.9 dry which flows at a rate of 5 kg/s . Determine the condition of the resulting mixture. 10
4. A pure substance is contained in a cylinder closed by a piston. A stirrer rotated by means of a shaft protruding through the cylinder end plate, causes the substance to undergo adiabatically a fully resisted constant pressure expansion process as the piston moves outward slowly. Show that the shaft work done on the system is equal to the increase in enthalpy of the substance. 10
5. A heat engine is used to drive a heat pump. The heat transfers from the heat engine and the heat pump are used to heat the water circulating through the radiators of a building. It is given that the efficiency of the heat engine is 30% and the COP of the heat pump is 4 . How much heat is transferred to the radiator water for every kJ heat transferred to the heat engine ? 10
6. Consider a closed cylinder divided initially to two compartments of equal volume of 25 liters each by an insulated frictionless piston. All the sides of the cylinder is insulated except the left hand face which is a good conductor of heat. Initially the cylinder contains air (150 kPa and 27°C) and hydrogen (150 kPa and 27°C)



as shown in the figure. Air is heated now slowly until the pressure increases to 300 kPa. Calculate the final temperatures of air and hydrogen and also the heat transferred to air. Assume air and hydrogen behaves as ideal gas. 10



7. With a neat sketch discuss the working principle of a household refrigerator. 10
8. Write short notes on the following : 2.5×4
- (a) Calibration of thermometer
 - (b) Bourden tube pressure gauge
 - (c) Clausius inequality
 - (d) Combined mode of heat transfer.