(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0430 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2012-13

THERMODYNAMICS

Time : 2 Hours *Total Marks : 50*

Note :— *(1) Attempt **all** questions.*

(2) Notations used have usual meanings.

(3) Use of steam tables and Mollier charts is permitted.

1. Attempt any **TWO** out of the following :— **(5×2=10)**

(a) What do you understand by cyclic and quasi-static process ? Differentiate between point functions and path functions.

(b) A closed room of the size (5 × 6 × 3) m^3 is heated electrically from initial temperature of 0 °C to 20 °C during a winter season. The pressure of air inside the room is same as that of surroundings and is equal to 74.1 cm of mercury. The specific heat of air is 1.005 kJ/kg K. Estimate the amount of electrical energy needed for heating the room, if the heat capacity of furniture and walls is 31.8 kJ/K. Take R as 0.287 kJ/kg-K.

(c) In a piston cylinder arrangement, a gas of amount 1 kg expands from an initial pressure of 6 bar and volume 0.2 m^3 to a final pressure of 1 bar. The process of

expansion follows the law $pv^{1.21}$ = constant. The internal energy is related by

$$u = 241\ pv + 1838$$

where u is in kJ/kg, p is in bar, v is in $\frac{m^3}{kg}$.

Calculate the changes in internal energy, work transfer and heat transfer, considering the expansion to be frictionless.

2. Attempt any **TWO** out of the following :— **(5×2=10)**

(a) All reversible engines working between the two constant temperature reservoirs have the same efficiency. Comment.

(b) A temperature of –5 °C is maintained by steadily circulating a refrigerant at low temperature through passages in the walls of the freezer compartment of a refrigerator. The air surrounding the refrigerator is at 27.1 °C. The power input required to operate the refrigerator is 3316.5 kJ/h and the rate of heat transfer from the freezer compartment to the refrigerant is 8140.5 kJ/h. Draw the system and find the coefficient of performance of the refrigerator and compare with the coefficient of performance of a reversible refrigeration cycle operating between the reservoirs at the same temperature limits. Comment on the results.

(c) Discuss the irreversibility due to :

(i) heat transfer through a finite temperature difference and

(ii) free expansion process.

3. Attempt any **THREE** out of the following :— **(5×3=15)**

(a) Calculate the change in entropy when 0.2 m^3 of air at 1 bar and 59.9 °C is compressed to 0.051 m^3 according to the law $pv^{1.29}$ = constant. Take R = 0.287 $\frac{kJ}{kg\text{-}K}$ and adiabatic index is 1.4. Draw the p-v and T-s diagrams also.

(b) Derive the following Tds equation :

$$Tds = C_v\, dT + \frac{T\beta}{K}\, dv$$

(c) Define dead state and second law efficiency.

(d) Prove that in a closed system, when initial and final temperatures are equal to that of the environment and the system exchanges heat with the environment only, the work done is either equal to or greater than the change in the Helmholtz function.

4. Attempt any **THREE** out of the following :— **(5×3=15)**

(a) During a steady flow process, 4 kg of steam at 15 bar and 260 °C loses 3771 kJ of heat at constant pressure. Determine the final condition of steam.

(b) A steam turbine operating on Rankine cycle receives steam at pressure 20 bar and degree of superheat is 89 °C. The exhaust pressure is 0.07 bar and the expansion

of steam takes place isentropically. Calculate :

(i) heat supplied, assuming that feed pump supplies water to the boiler at 20 bar,

(ii) heat rejected in condenser, and

(iii) work done by turbine.

(c) Differentiate between CI and SI engines.

(d) Define thermal, mechanical and volumetric efficiency of I.C. Engine.