Printed Pages : 4 TME302

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

PAPER ID : 4069 Roll No.

B.Tech

(SEM III) ODD SEMESTER THEORY EXAMINATION 2009-10

APPLIED THERMODYNAMICS

Time : 3 Hours] *[Total Marks : 100*

Note : *(i) Answer all questions. Each question carries equal marks.*

(ii) Use of steam tables and Mollier's chart is permitted.

1 Attempt any **four** parts : 4×5=20

(a) Give two statements of II law, and show their equivalence.

(b) Derive four maxwell's expressions and give their significance.

(c) What is inversion curve ? Then define Joule-Thomson coefficient. With the help of inversion curve explain how cooling effect can be achieved.

(d) A reversible engine works between three thermal reservoir A, B and C. The engine absorbs an equal amount of heat from reservoirs A and B kept at temperature T_A and T_B respectively and rejects heat to

thermal reservoir C kept at temperature T_C. Efficiency of engine is α times the efficiency of the reversible engine which works between two reservoirs A and C.

Prove that $\frac{T_A}{T_B} = (2\alpha - 1) + 2(1 - \alpha)\frac{T_A}{T_C}$.

(e) Explain dead state. Eighty kg of water at 100°C is mixed with 50 kg of water at 60°C, while temperature of surrounding is 15°C. Determine the decrease in available energy due to mixing.

(f) Define :

(i) Helmholtz function

(ii) Gibbs function

(iii) Clapeyron equation

(iv) Adiabatic and isothermal compressibility.

2 Answer any **two** parts : **10×2=20**

(a) What is difference between boiler mountings and accessories.

With the help of neat sketches explain the working of a water tube boiler.

(b) Steam at 0.8 mPa, 250°C and flowing at the rate of 1 kg/s passes into a pipe carrying wet steam at 0.8 mPa, 0.95 dry. After diabatic mixing the flow rate is 2.3 kg/s. Determine the condition of steam after the mixing. The mixture in now expanded in a frictionless nozzle isentropically to a pressure of 0.4 mPa. Determine the velocity of steam leaving the nozzle.

(c) What are various types of draught ? Differentiate between them. Calculate the dimensions of a chimney if the boiler plant consumers 10,000 kg of coal/h and produces 20 kg of dry flue gases per kg of coal fired. The average temperature of the chimney gases is 573 K. If may be assumed that 6% of the draught is lost in friction of the grate and passages and theoretical draught produced by chimney is 20 mm of water. Ambient temperature of air is 27°C.

3 Attempt any **two** parts : 10×2=20

(a) Explain the following for a steam engine :

(i) Missing quantity

(ii) Governing of steam engine

(iii) Saturation curve

(b) (i) Explain actual indictor diagram of a simple steam engine

(ii) Explain the phenomenon of super-saturation in case of a steam nozzle.

(c) Air at 8.6 bar and 190°C expands at the rate of 4.5 kg/s through a convergent diragent nozzle into a space at 1.03 bar. Assuming that the inlet velocity is negligible, calculate the throat and exit cross-sectional areas of the nozzle.

4 Attempt any **two** parts : 10×2=20

(a) With the help of neat sketches, explain the reheat and feed heater employed (regenerative) steam turbine cycle. Also explain the processes on t-s and h-s diagrams.

(b) In a reheat cycle, steam at 500°C expands in a h.p. turbine till it is saturated vapour then it is reheated at constant pressure to 400°C and then expands in LP turbine to 40°C. If the maximum moisture content at turbine exhaust is limited to 15% find :
   (i) Reheat Pressure
   (ii) Net sp. work output
   (iii) Cycle efficiency

(c) Dry and saturated steam is supplied to a simple impulse turbine at 7 bar at the rate of 200 kg/h exhausting at 0.45 bar. The efficiency of expansion is 85%. The nozzle angle is 20° and blade tip angle at outlet is 30°. The blade speed is 180 m/s. Blade velocity coefficient is 0.85. Find (i) Net power (ii) Axial thrust.

5 Attempt any **two** parts : **10×2=20**

(a) In a gas turbine plant working on the Brayton cycle the air at the inlet is 27°C 0.1 mPA. pressure ratio is 6.25 and maximum temperature is 800°C. The turbine and compressor efficiencies are each 80%. find :
   (i) compressor work
   (ii) Turbine work
   (iii) heat supplied
   (iv) cycle efficiency.

(b) Derive the expression of optimum pressure ratio for maximum net power output in an ideal Brayton cycle. What is the corresponding cycle efficiency ?

(c) With the help of neat sketches explain :
   (i) Turboprop engines
   (ii) Rocket engine.