



Printed Pages : 4

TME302

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

PAPER ID : 4069

Roll No.

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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 is 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 consumes 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. It 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 indicator 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 divergent 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 :
- Reheat Pressure
 - Net sp. work output
 - 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 :
- compressor work
 - Turbine work
 - heat supplied
 - 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 :
- Turboprop engines
 - Rocket engine.

