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 2010-11

APPLIED THERMODYNAMICS

Time : 3 Hours *Total Marks : 100*

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

(2) Each question carries equal marks.

(3) Use of steam table and Mollier chart is permitted.

(4) Assume suitably, any missing data.

1. Attempt any **two** parts of the following : **(10×2=20)**

(a) Define mathematical condition for exact differential. For some substance relation Pv=BT exists where P, v, T & B are pressure, sp. Volume, temperature and constant respectively. The quantity S is give by

$$dS = \frac{cdT}{T} - \frac{vdP}{T}$$

Where c is constant. Check whether s is property or not.

(b) Determine the availability of the following closed systems. Reference environmental conditions are 27°C and 100 kPa:

(i) 4 kg of water at 100 kPa and 80°C

(ii) 0.5 kg of steam at 5 MPa and 500°C.

(c) Define :

(i) Availability and dead state

(ii) Adiabatic and Isothermal Compressibility

(iii) Statements of second law of thermodynamics.

2. Attempt any **two** parts of the following : **(10×2=20)**

(a) What are requirements of good boiler ? Describe the working of Benson boiler with neat sketch.

(b) (i) State the function of economizer and air preheater. Also indicate suitable location of superheater, economizer and air preheater on a boiler with line diagram.

(ii) Steam at 20 bar pressure and 0.9 dry is throttled to a pressure of 0.2 bar. Determine the final pressure, temperature and condition of steam.

(c) Describe the function of chimney in a boiler. Derive the condition for maximum discharge through a chimney in natural draught.

3. Attempt any **two** parts of the following : **(10×2=20)**

(a) A double acting steam engine is supplied with dry saturated steam at 14 kg/cm^2. The original cutoff was at 40% of the stroke. To effect saving in economy it was decided that the cutoff should occur earlier at 25% of the stroke. The power output was however kept constant by increasing engine speed. Assuming same diagram factor in both cases, find (i) ratio of new to original speed (ii) the percentage saving in steam consumption.

(b) (i) For a convergent-divergent nozzle, sketch the variation of specific volume, velocity, area and pressure along the nozzle axis.

(ii) Find the velocity and diameter at the exit of a nozzle if 5 kg/sec air at 9 bar and 200°C expands through the nozzle in a space at 1.1 bar. Approach velocity is 50 m/s.

(c) (i) Discuss the phenomenon of supersaturation in steam nozzle.

(ii) A steam engine has throttle governing such that it develops 37.5 kW with steam consumption of 1000 kg/hr. Steam consumption at no load is 125 kg/hr. Find the steam consumption for 26 kW power developed.

4. Attempt any **two** parts of the following : **(10×2=20)**

(a) Show the variation of pressure and velocity in different stages of reaction turbine. In a simple impulse turbine, 5 kg/sec saturated steam at 10 bar pressure is supplied through a convergent divergent nozzle. Nozzle exit angle is 20° and nozzle efficiency is 80%. The steam pressure leaving the nozzle is 1 bar. Blades of turbine are equiangular. For maximum diagram efficiency, determine blade angles, power developed and diagram efficiency with the help of velocity diagram. **(3+7)**

(b) Discuss the effect of pressure and temperature of steam at inlet of turbine and condenser pressure on the performance of ranking cycle.

(c) Discuss . Compounding of steam turbines in detail.

5. Attempt any **two** parts of the following : **(10×2=20)**

(a) Obtain optimum pressure ratio condition for minimal compressor work requirement in two stage perfect intercooling.

(b) An open cycle gas turbine draws air at 1 kg_f/cm^2. After passing through heat exchanger and combustor, the working medium expands to an intermediate pressure in the HP turbine which drives the compressor. Further expansion continues in the LP turbine. Find the specific output and overall thermal efficiency. Assume polytropic efficiency of compression = 85%, isentropic efficiency for both the turbine = 90%, maximum temperature = 900 K, thermal ratio = 0.75, for air c_p = 0.24 kcal/kg-K, γ = 1.4 and for gases c_p = 0.27 kcal/kg-K, γ = 1.33.

(c) Write short notes on :

(i) Propulsive power and propulsive efficiency

(ii) Turboprop and rocket engines.