Paper Code: MME-306	Roll No.										

M.Tech.

Third Semester Examination 2015-16

Advanced Thermal Engineering

Time: 3 Hours **Max. Marks: 100**

Note: ***1. Attempt all questions. Marks are indicated against each question.***
2. Assume any missing data suitably.
3. Use of steam table and compressibility chart is permitted.

1 Answer any four of the following: 5x4=20

a) Butane is burned with dry air at an A/F ration of 20. Find the equivalence ratio and dew point temperature of the products of combustion.
b) Describe Clausius- Clapeyron equation.
c) Show free expansion is irreversible process.
d) What is compressibility factor and generalized compressibility chart.
e) Discuss Joule-Thompson coefficient. And show that for perfect gas its value is zero.
f) Determine the specific volume of steam at pressure of 80 bar and 500 C with the help of ideal gas equation and generalized compressibility chart and determine the error involved in each case with the actual specific volume taken from steam table.

2. Answer any two of the following: 10x2=20

a) Derive Maxwell equations. What is their significance.
b) Prove that $C_p - C_v = (v.T.\beta^2)/\alpha$, where β is volume expansivity and α is isothermal compressibility.
c) Define dead state. Air expands through a turbine from 500 kPa, 520 C to 100 kPa, 300 C. during expansion 20 kJ/kg of heat is lost to the surroundings which is at 98 kPa, 20 C. neglecting Kinetic and potential energy changes, determine per kg of air maximum work output and the irreversibility.

3 Answer any two of the following: 10x2=20

a) Derive generalized Heat Conduction Equation with variable thermal conductivity for Cartesian coordinate system. Discuss some special forms of this general equation such as 'Poisson equation', 'Laplace equation' etc. Also discuss the physical significance of thermal diffusivity.

b) Derive an expression for temperature distribution, heat transfer rate (assuming one dimensional heat transfer) for a plan slab maintained at same temperature on both the sides. Determine the temperature distribution within the solid if the convection boundary conditions are provided (Same fluid at same temperature on both the sides). Also prove that the total energy generated within the slab is lost to the fluid through convection.

c) Set up Navier – Stoke's equations and prove that, for a two dimensional steady flow, the pressure gradient in the direction of flow is equal to shear gradient in the direction normal to the direction of fluid motion.

4 Answer any two of the following: 10x2=20

a) Discuss / Explain the following:
(i) Intensity of Radiation
(ii) Wien's Displacement law
(iii) Surface Resistance

b) Two concentric spheres of diameters D_1=0.3 m and D_2= 0.6 m are maintained at uniform temperatures T_1=1000 K and T_2= 500 K and have emissivities ε_1=0.5 and ε_2=0.7, respectively. Determine the net rate of radiation heat transfer between the two spheres. These spheres are kept inside a very large room at 27 ˚C, find the heat transfer between outer cylinder and the room if the inner walls of the room have emissivity of 0.6.

c) Two long coaxial cylinders of diameters D_1=0.10 m and D_2=0.50 m and emissivities ε_1=0.7 and ε_2=0.4 are maintained at uniform temperature of T_1= 250 K and T2=500 K, respectively. If a coaxial radiation shield of diameter D_3=0.30 m and emissivity ε_3=0.1 is placed between the two cylinders. Determine the net rate of radiation heat transfer between the two cylinders per unit length of the cylinders and compare the result with that without the shield.

5 Answer any two of the following. 10x2=20

a) Define rotational flow. Define circulation and vorticity and find out their relation with each other.

b) In a particular steady state, incompressible flow fluid, the velocity components are given as:
$u=2xy$ and $v=x^2-y^2+c^2$.
Check whether flow exists, and find out the stream function to represent this flow.

c) Explain the characteristics of laminar and turbulent boundary layers. Derive an expression for momentum thickness.