Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH (NEW)/SEM-2/ME-201/2011

2011
ENGINEERING THERMODYNAMICS & FLUID MECHANICS

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words as far as practicable.*

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

    $10 \times 1 = 10$

    i)   A flow process with equal inflow and outflow rates and time-independent states is known as a/an

        a)   steady state steady flow process

        b)   unsteady state steady flow process

        c)   steady state unsteady flow process

        d)   uniform state uniform flow process.

    ii) Isobaric condensation of saturated steam to saturated liquid is also an.................process.

        a)   isothermal   b)   isentropic

        c)   isenthalpic   d)   isochoric.

    iii) Efficiency of a reversible heat engine does not depend on

        a)   source temperature   b)   sink temperature

        c)   working fluid   d)   any of these.

2123   [Turn over

iv) Entropy of a system

a) can never increase

b) can never decrease

c) may increase or decrease depending on the process

d) always remains constant.

v) The standard atmospheric pressure is $101 \cdot 32 \, \text{kPa}$. The local atmospheric pressure at a location was $91 \cdot 52$ kPa. If a pressure is recorded as $22 \cdot 48$ kPa (gauge), it is equivalent to

a) $123 \cdot 80$ kPa (abs)   b) $88 \cdot 84$ kPa (abs)

c) $114 \cdot 00$ kPa (abs)   d) $69 \cdot 04$ kPa (abs).

vi) Steam function is defined for

a) Flow of perfect fluid only

b) All 2-D incompressible flows

c) All 3-D flows

d) Irrotational flows only.

vii) In a circular pipe of certain length carrying oil at a Reynolds number 100, it is proposed to triple the discharge. If the viscosity remains unchanged, the power input will have to be

a) decreased to 1/3 its original value

b) increased by 100%

c) increased to 3 times the original value

d) increased to 9 times the original value.
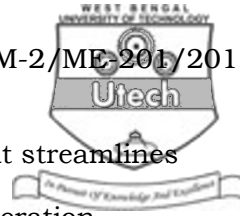
viii) A steady flow having diverging straight streamlines

    a)   is a uniform flow with local acceleration

    b)   has convective normal acceleration

    c)   has convective tangential acceleration

    d)   has convective, normal as well as tangential acceleration.

ix) Velocity potential exists for

    a)   Flow of perfect fluid only

    b)   Steady irrotational flow only

    c)   All irrotational flows

    d)   All 3-D flows.

x) For a fluid, the shear stress was found to be directly proportional to the rate of angular deformation. The fluid is classified as

    a)   Dilatant fluid   b)   Thixotropic

    c)   Newtonian   d)   Non-Newtonian.

xi) Normal stresses are of the same magnitude in all directions at a point in a fluid

    a)   only when the fluid is frictionless

    b)   only when the fluid is at rest

    c)   only when there is no shear stress

    d)   in all cases of fluid motion.

xii) A metal block is thrown into a deep lake. As it sinks deeper in water, the buoyant force acting on it

    a)   increases

    b)   remains the same

    c)   decreases

    d)   first increases then decreases.

xiii) In a barometer mercury is preferred over water because

    a)   it is a better conductor of heat

    b)   its surface is easier to read

    c)   it has a higher density and lower vapour pressure

    d)   it has a higher vapour pressure and bulk modulus.

xiv) The area under a curve, representing a non-cyclic process on a temperature entropy (T-s) plane represents

    a)   heat transfer for a reversible process

    b)   work transfer for a reversible process

    c)   heat transfer for any process

    d)   work transfer for any process.

xv) For an ideal gas for which process can decrease temperature of a system even if heat is added to it, is

    a)   isobaric   b)   isothermal

    c)   isentropic   d)   polytropic.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. Oil is stored in a closed tank up to a certain height. Air is entrapped at the top portion of the tank above oil. One end of a mercury manometer is connected to the tank as shown in figure-1. The other end of the manometer is open to atmosphere. The values of *X*, *Y* and *Z* are 2m, 0·5 m and 0·4 m respectively. Find out the air pressure in the tank. Assume density of water 1000 kg/ m^3, specific gravity of oil 0·86, specific gravity of mercury 13·6 and atmospheric air pressure as 101 kPa.   5
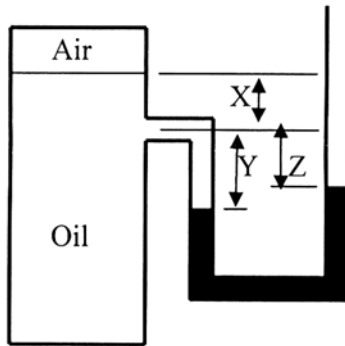

Figure-1

3. Find out the velocity potential of a uniform steam with velocity *V* inclined at an angle *A* to the *x*-axis.   5

4. Define heat and work. Draw a comparison between heat and work.   1 + 1 + 3

5. Steam enters into a nozzle at 5 bar at dry saturated condition. It is expanded up to 1 bar. Assuming there is no loss in the process, find out the velocity of steam at nozzle exit. Assume zero velocity of steam at nozzle inlet. Deduce the expression you are using through simplification of steady state steady flow process. 5

6. Deduce the expression for efficiency of Otto cycle. 5

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Write down the measurement principle of a venturimeter. 8

   b) Water at $20°C$ flows through a 10 cm inner diameter pipe. A static pressure tap of a Pitot tube at a cross-section indicates a gauge pressure of 34kPa. The stagnation tap at that cross-section indicates $39·2$ kPa gauge pressure. Find out the water velocity at that cross-section. Assume density of water at $20°C$ as 998 kg/m^3. 7

8. a) Liquid flows from a large tank, open to atmosphere, through a small, well rounded aperture into the atmosphere. The aperture is at a depth 'h' from the liquid level in the tank. Neglecting losses, find out an expression for the velocity of efflux from the tank. 6

   b) What do you understand by the term 'drag' ? Write a brief note on drag coefficient. 2 + 4

c) Write down the differences between incompressible and compressible fluid. 3

9. a) 5 kg of steam water mixture is kept in a closed vessel at 3 bar, 0·4 dry. Heat is added to the system until the pressure reaches 8 bar. Find out the final condition of steam and the heat transferred during the process. 6

b) Deduce the expression for heat transfer in a polytropic process of ideal gas. Also deduce the expression for specific heat in this process. 6 + 3

10. a) Show that violation of Kelvin-Planck statement is equivalent to the violation of Clausius statement. 8

b) Prove that entropy is a property of the system. 7

11. a) Steam enters into the turbine of a steam power plant, working in Rankine cycle, at 15 bar, $350°C$. The condenser pressure of the plant is 0·5 bar. The condensate is collected from the condenser, which is pumped again to the boiler, at saturated liquid condition. Find out the power developed by the turbine for a mass flow rate of 1 kg/s. Find out the efficiency of the cycle without neglecting the pump work. Assume the efficiencies of the turbine and the pump as 0·85 and 0·8 respectively. Sketch the enthalpy-entropy diagram of the cycle. 12

b) Write down the effect of back pressure on Rankine cycle efficiency. 3