Register No.: .................................. Name: ...............................................................

# SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

**THIRD SEMESTER B.TECH DEGREE EXAMINATION (S), FEBRUARY 2023**
**CHEMICAL ENGINEERING**
**(2020 SCHEME)**

**Course Code :** **20CHT205**

**Course Name:** **Fluid and Particle Mechanics**

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

## PART A

***(Answer all questions. Each question carries 3 marks)***
***Assume any missing data suitably***

1. Calculate pressure, temperature and density of the atmosphere at an altitude of 1200 m, if at zero altitude the temperature is 15 °C and 101 kN/m$^2$. Assume that conditions are adiabatic. K= 1.4, R = 287 J/kg K.
2. Define ideal fluid and potential flow. Explain the condition for potential flow to exist in a conduit.
3. Define stream function. What is its significance?
4. What corrections are incorporated in Bernoulli's equation? Explain the importance associated with those corrections.
5. Derive Hagen Poiseuille equation.
6. Explain the dependence of friction factor on Reynolds number.
7. Define drag. Discuss about different types of drag.
8. List the important applications of fluidization in process industry.
9. Discuss the classification of centrifugal pump.
10. Define surging in centrifugal compressor.

## PART B

***(Answer one full question from each module, each question carries 14 marks)***

### MODULE I

11. a) Derive barometric equation and explain its significance. (7)

b) A simple U tube mercury manometer is installed across an orifice meter to measure the pressure difference due to the flow of $CCl_4$ (Specific gravity = 1.6). The manometer reads 200 mm. Calculate the pressure difference. Assume the Specific gravity of mercury is 13.6. (7)

**OR**

12. a) A continuous gravity decanter is to separate Chlorobenzene (density = 1.11 gm/cc) from an aqueous wash liquid (density = (7)

1.02 gm/cc). The total depth of separator is 1m and the interphase is to be 0.6 m from the vessel floor, calculate the height of heavy liquid overflow leg.

b) Detail about the Rheological classification of Non-Newtonian fluids with neat sketch. Give some examples in chemical engineering practice. (7)

**MODULE II**

13\. a) A liquid of 1.1 gm/cc density and 0.8 cp viscosity flows through a pipe of 2 cm internal diameter. The pressure drop per meter of equivalent pipe length is 15 cm Hg. Find the velocity of the fluid, nature of flow, if necessary $f = 0.045\ NRe^{-0.2}$ may be used. (10)

b) With neat diagram explain the formation of boundary layer separation in straight tube. (4)

**OR**

14\. a) Orifice meter is installed in a pipe line for measurement of flow rate of water. The pressure drop across the orifice meter is 10 centimeters of mercury. Estimate the volumetric flow rate in $m^3/s$.
Data:
Diameter of orifice = 25 mm (8)
Diameter of pipe = 50 mm
Coefficient of orifice = 0.62
Density of water = 1000 $kg/m^3$
Density of Mercury = 13,600 $kg/m^3$

b) Define stream line, path line and streak line and explain its application in fluid mechanics. (6)

**MODULE III**

15\. a) The velocity flow in a badly corroded 7.5 cm pipe is found to increase 20 percent as a pitot tube is moved from a point 1 cm from the wall to a point 2 cm from the wall. Estimate the height of roughness elements. (10)

b) Show that velocity distribution in circular channel is parabola in laminar flow condition. (4)

**OR**

16\. a) Discuss the f v/s $NR_e$ relation in laminar and turbulent flow. (4)

b) A smooth pipe of 80 mm diameter and 1000 m long is carrying water at the rate of 8 liters/sec. If the kinematic viscosity of water is 0.015 stokes and the value of co-efficient of friction 'f',
$f = 0.0791/(Re)^{1/4}$, where Re is Reynolds number, calculate: (10)
i) Loss of head
ii) Wall shearing stress,
iii) Centre-line velocity,

iv) Velocity and shear stress at 20 mm from the pipe wall, and
v) Thickness of laminar sublayer.

## MODULE IV

17. a) From the basic principles derive Ergun equation. State clearly all assumptions. (10)
    b) Explain how minimum fluidization velocity is determined. (4)

**OR**

18. a) A 0.5 m high bed made up of a 1mm diameter glass sphere (density = 2500 $kg/m^3$) is to be fluidized by water. If at a point of incipient fluidization, the bed voidage is 40%. Calculate the pressure drop. (6)
    b) With neat diagram explain the different regimes of fluidization. (8)

## MODULE V

19. a) Suggest a suitable pump for pumping lubricating oil in the compressor. With neat diagram explain the working of that pump. (8)
    b) Differentiate different types of industrial compressors and explain it. (6)

**OR**

20. a) A pump draws benzene (density 800 $kg/m^3$) at 25 °C from a tank, whose level is 2.6 m above the pump inlet. The suction line has a head loss of 0.8 m. The atm pressure is measured to be 98.5 kPa (absolute). Find the available NPSH. The vapor pressure of Benzene is 13.3 kPa (absolute). (7)
    b) Suggest a suitable valve for fluid having corrosive nature. With neat diagram explain the functioning of that valve. (7)

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