BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

UG

Name: …… Roll No.: ……..

Branch: …… Signature of Invigilator: ……

Semester: IVth Date: 02/05/2022 (MORNING)

Subject with Code: **CL225 FLUID-SOLID OPERATION**

Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.
2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**
3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.
4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.
5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.
6. Write on both side of the leaf and use pens with same ink.
7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.
8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.
9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.
10. Always maintain the highest level of integrity. Remember you are a BITian.
11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B.TECH. **SEMESTER : IV**
BRANCH: CHEMICAL ENGINEERING & CHEMICAL ENGINEERING (P&P) **SESSION : SP/22**

SUBJECT: CL 225 FLUID-SOLID OPERATION

TIME: 2.00 HRS. **FULL MARKS: 50**

INSTRUCTIONS:

1. This question paper has two (02) sections, **SECTION-1** and **SECTION-2**.

2. SECTION-1 contains MCQs. Attempt all questions in **SECTION-1**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer. There is NO NEGATIVE marking for wrong answer.

3. SECTION-2 has descriptive and numerical based questions.

3. The missing data, if any, may be assumed suitably.

SECTION-1: ***ATTEMPT ALL QUESTIONS.***

1. What is the dimension of drag coefficient? [1]
   (a) Dimensionless (b) MLT^(-2)
   (c) ML^(-3) (d) L

2. Bodies with a larger cross section will have____ [1]
   (a) Higher drag (b) Lower drag
   (c) Same drag (d) No drag

3. Drag force is directly proportional to_____ [1]
   (a) Flow speed (b) Area
   (c) Density of fluid (d) Mass density

4. Laser diffraction technique is applicable to measure size range of [1]
   (a) >2 µm (b) 0.1-600 µm
   (c) 5-100 µm (d) None

5. The value of drag coefficient is constant in [1]
   (a) Laminar regime (b) Transitional regime
   (c) Newton's regime (d) None

6. Stoke's equation is valid in the Reynolds number range [1]
   (a) 0.01 to 0.1 (b) 0.1 to 2
   (c) 2 to 10 (d) 10 to 100

7. Drag co-efficient for flow past immersed body is the ratio of _____ to the product of velocity head and density. [1]

(a) Shear stress
(b) Shear force
(c) Average drag per unit projected area
(d) None of these

8. Fluid flow through a packed bed is represented by the _____ equation. [1]

(a) Hagen-Poiseuille's
(b) Ergun's
(c) Fanning's
(d) None of these

9. Identify the correct statement – [1]

(a) Terminal settling velocity of a particle in Stoke's region is proportional to its diameter.
(b) Terminal settling velocity of a particle in Newton's region is inversely proportional to the viscosity of the medium.
(c) If particles of different sizes are allowed to settle in a medium, the larger particles will settle in the Stoke' region while the fines will settle in the Newton's region.
(d) If particles of different sizes are allowed to settle in a medium, the larger particles will settle in the Stoke' region while the fines will settle in the Newton's region.

10. Identify the incorrect statement [1]

(a) In a froth flotation cell, the hydrophobic particles get collected in the froth.
(b) Magnetic drum separators use stationary permanent magnets inside a rotating drum.
(c) In electrostatic precipitators, the -ve electrode is a thin wire from where corona discharge takes place.
(d) Bag filters bags are cylindrical, hung vertically and during filtering the flow is from outside the cylinder to inside of the cylinder. through the bag material.

11. _____ measures the resistance to fluid flow through a compacted powder bed to calculate specific surface of the powder. [1]

(a) Permeametry
(b) Sedimentation method
(c) Elutriation method
(d) Gas adsorption method

12. The given equation is known as :$\frac{-\Delta p}{L} = 180\frac{\mu(1-\varepsilon)^2}{x^2\varepsilon^3}U$ [1]

(a) Burke Plummer equation
(b) Ergun equation
(c) Kozney-Carman equation
(d) None

13. Jigging is a technique by which different particles can be [1]

(a) Mixed
(b) Separated by particle size.
(c) Separated by particle density.
(d) Separated by particle shape

14. Pine oil used in froth floatation technique acts as a/an [1]
    (a) Collector (b) Activator
    (c) Frother (d) Modifier

15. For a particle settling in water at its terminal settling velocity, which of the following is true? [1]
    (a) Buoyancy = weight + drag (b) Weight = buoyancy + drag
    (c) Drag = buoyancy + weight (d) Drag = weight

16. The terminal velocity of a spherical particle in gravitational settling under stokes regime varies [1]
    (a) linearly with the particle diameter. (b) linearly with the viscosity of the liquid.
    (c) directly with the square of particle diameter. (d) inversely with the density of particle.

17. The term classification is used to designate separation of solid particles based on the difference in their _____ velocities in the fluid. [1]
    (a) maximum (b) minimum
    (c) optimum (d) None of these

18. Gasification refers to a group of processes that converts _____ fuels into a combustible gas with or without contact with a gasification medium. [1]
    (a) solid (b) liquid
    (c) both (a) and (b) (d) None of these

19. The reduction of steam by carbon monoxide to produce hydrogen is a highly desirable reaction in gasification. This reaction is commonly known as _____. [1]
    (a) water-gas reaction (b) water-gas shift reaction
    (c) Boudouard reaction (d) None of these

20. _____ blown gasification produces a low heating value gas. [1]
    (a) Oxygen (b) Air
    (c) Steam (d) None of these

21. The most valued product obtained from fluidized catalytic cracking unit is ___. [1]
    (a) Light gas oil (b) Heavy gas oil
    (c) Vacuum gas oil (d) None of these

22. *Geldart Group D* particle size ranges from [1]
    (a) 30-150 µm (b) 150-550 µm
    (c) 550-1000 µm (d) > 1000 µm

23. *Geldart Group* ___ particles are difficult to fluidize. [1]
    (a) *A* (b) *B*
    (c) *C* (d) *D*

24. Zeolite-based catalyst used in fluidized catalytic cracking unit belongs to *Geldart Group* ____ particle. [1]

(a) *A* (b) *B*
(c) *C* (d) *D*

25. The height of a fluidized bed at incipient fluidization is 0.075 m and corresponding voidage is 0.38. If the voidage of the bed increases to 0.5, then the height of the bed would be: [2]

(a) 0.058 m (b) 0.061 m
(c) 0.075 m (d) 0.093 m

26. Calculate the diameter of particle settling under laminar conditions with terminal settling velocity 0.005m/s. The density of particle is 2600kg/m3 and viscosity of fluid medium is 8.11* 10^(-4) kg/ms. [2]

(a) 1µm (b) 0.4µm
(c) 0.9µm (d) 0.7µm

27. A mixture of two spherical materials A (8000kg/m3) and B(3000kg/m3) is to be separated using an elutriator. The size range of both the materials is 15-35µm. Find the minimum density of fluid required to achieve complete separation. [2]

(a) 2000 kg/m3 (b) 1875 kg/m3
(c) 1522 kg/m3 (d) 750 kg/m3

SECTION 2: ***ATTEMPT ANY 4 QUESTIONS.***

Q.1(a) What are the different solid particle characterization techniques? [2]

Q.1(b) Explain the principle and application of Sedimentation & elutriation process. [3]

Q.2(a) Discuss the technique to measure permeability. [3]

Q.2(b) Calculate the volume-surface diameter of carbon raschig rings (specific packing surface 125m^2/m^3, bed porosity 0.67) in a packed bed. Specific packing surface is the total surface area of rings per unit volume of bed. [2]

Q.3(a) A bed fluidized by water is used for cleaning sand contaminated with salt. The particles of sand and salt have the same shape and size but different densities (ρ_{sand} = 2500 kg/m^3 and ρ_{salt} = 2000 kg/m^3). If the initial volume fraction of the salt in the mixture is 0.3 and if the initial value of the minimum fluidization velocity (U_{mf}) is 0.9 m/s, find the final value of the U_{mf} (in m/s) when the sand is washed free of the salt. Assume that the bed characteristics (bed porosity and solid surface area per unit volume) do not change during the operation and that the pressure drop per unit length is directly proportional to the fluid velocity. [2.5]

Q.3(b) Briefly describe the characteristics of *Geldart Group A* and *Geldart Group B* particles. [2.5]

Q.4(a) Classify gasifiers based on (a) Gasification medium, and (b) How the gas and fuel contact each other. [2.5]

Q.4(b) Write advantages of a circulating fluidized bed combustion (CFBC) boiler compared to a bubbling fluidized bed combustion (BFBC) boiler. [2.5]

Q.5(a) Mixture (particle size = 0.36 mm – 0.58 mm) of an ore (density = 2000 kg/m^3) and gangue (density = 7000 kg/m^3) is to be separated in a hydraulic elutriator. Predict the upward velocity of water in elutriator so that entire ore is collected in the overflow. Also ensure that not gangue should be present in overflow. [2]

Use $f_D = {20}/{Re_p^{0.5}}$

Q.5(b) Describe the working and use of Electrostatic separators. [3]

----------03.05.2022----------