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| **Name:**<br><br>**Enrolment No:** | UPES UNIVERSITY OF TOMORROW |

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, December 2024**

**Course:** Particulate Technology — **Semester:** 5
**Program:** B. Tech (Chemical Engineering) — **Time:** 03 hrs.
**Course Code:** CHCE2026 — **Max. Marks:** 100

**Instructions:**

1. This is a **closed book** examination. Possessing a mobile phone or any form of communicating devices will be considered unfair means.
2. In case of any missing data or information, make necessary assumptions with proper reason.
3. Make sure you have **Appendix-1,** and submitted along with your answer script.

**SECTION A (4M × 5Q = 20 M)**

| S. No. | Questions | Marks | CO |
|---|---|---|---|
| Q 1 | Write an expression of a parameter that can be used represent the (i) particle size and (ii) particle shape of an irregular shape objects or particle. (*4 – 5 lines of accurate answers is enough for Section A*) | 2+2 | **CO1** |
| Q 2 | Write the statement and expression of Ritinger's law of comminution. | 4 | **CO1** |
| Q 3 | Write the full equation involving force balance for a particle settling in a stationary medium or fluid. | 4 | **CO2** |
| Q 4 | Draw the schematic representation of the graph that shows the mode of operation of a batch filtration to obtain maximum output. | 4 | **CO2** |
| Q 5 | Differentiate between a clarifier and a thickener using a table. (minimum 2 points each) | 4 | **CO3** |

**SECTION B (10M × 4Q = 40 M)**

| S. No. | Questions | Marks | CO |
|---|---|---|---|
| Q 6 | A slurry has a concentration of 5% by weight of solids with specific gravity = 2.4, needs to be clarified using continuous sedimentation. The feed to the clarifier is 5000 $m^3$/day. The underflow contains 10% solids. Determine the diameter (in m) of the clarifier required. The batch sedimentation data is provided below. (Assume $SF_1$ and $SF_2$ as 1.5 and 1.7) | 10 | **CO4** |
| Q 7 | A particle of square shape having 2.3 mm × 2.3 mm face with a thickness of ***b*** mm falling in water. Compute the terminal settling velocity ($V_t$) in m/s.<br>Given data: Density of particle ($\rho_p$) = 3500 kg/$m^3$, acceleration due to gravity ($g$) = 9.8 $m/s^2$. Here ***b*** = (last digit of your roll number + 3) × 0.01 (in mm) | 10 | **CO4** |

Q 6 batch sedimentation data:

| **Height of interface (cm)** | **42** | **27** | **17** | **8** | **5** | **3** | **1.8** | **1.6** |
|---|---|---|---|---|---|---|---|---|
| Time (min) | 0 | 5 | 12 | 24 | 40 | 70 | 250 | Infinity |

| | | | |
|---|---|---|---|
| Q 8 | With the help of five (5) examples and applications, elaborate in detail about the various unique properties of nanoparticles or nanotechnology that have played important role in the improvement of modern human civilization.<br>**OR**<br>Based on similar points (or parameters) tabulate the difference between free settling and hindered settling. Use a table to show at-least 5 points for each. | 10 | **CO2** |
| Q 9 | With the help of a diagram, derive the expression for the pressure drop across a filter cake.<br>**OR**<br>Using appropriate assumptions (with valid reasons) and diagrams, derive an expression for calculating the pressure gradient for fluid flowing (at low *Re*) through a fixed packed bed of solid particles. | 10<br><br>10 | **CO3** |
| **SECTION C (20M × 2Q = 40 M)** | | | |
| Q 10 | Powdered coal with following screen analysis is feed to a vibrating 48-mesh screen. The particle size distribution of feed, oversize, and undersize is shown in the **Table 2** in APPENDIX -1. Determine (i) effectiveness of the screen, considering oversize as the desired product, (ii) ratio of quantity of oversize to feed, and (iii) Explain 3 reasons due to which the effectiveness of an actual screen is never 100%.<br>**OR**<br>Powdered coal with following screen analysis is feed to a vibrating 48-mesh screen. The particle size distribution of feed, oversize, and undersize is shown in the **Table 2** in APPENDIX -1. Determine (i) effectiveness of the screen, considering undersize as the desired product, (ii) ratio of quantity of oversize to feed, and (iii) How does increasing or decreasing the capacity of a screen affect the effectiveness of an actual screen. | **10+5+5**<br><br>**10+5+5** | **CO4** |
| Q 11 | A ball mill is fed with fresh feed ($F$) as $30 \times 10^3$ kg/h and the product ($P$) is screened using a screen of 290 μm aperture size. Oversize are recycled at a rate of $60 \times 10^3$ kg/h. (i) Draw the schematic diagram of the whole operation. Calculate the energy consumption of the ball mill for (ii) closed circuit as well as (iii) open circuit grinding.<br>**Given data:** Work index = ***b*** kW hr/ton. The screen analysis data for feed, recycle (oversize) and desired product (undersize) is given in **Table 1** of **APPENDIX-1**.<br>***b*** = (last digit of your roll number + 1) × 15 (in kW hr/ton) | **5+10+5** | **CO4** |

**APPENDIX- 1**

**Instruction:** Submit the Appendix- 1 page along with your answer script (compulsory)

**Roll number:** **Name:**

**Signature of the invigilator:**

**Table 1:** Screen analysis data for Feed ($F$), Recycle ($R$), and product ($P_1$) stream in a ball mill.

| **Mesh size,** | **Mass fraction** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **in µm** | **F** | **R** | **$P_1$** | | | | | |
| **-833 +589** | **0.804** | **0.868** | **0** | | | | | |
| **-589 +417** | **0.026** | **0.036** | **0.051** | | | | | |
| **-417 +295** | **0.019** | **0.026** | **0.125** | | | | | |
| **-295 +208** | **0.021** | **0.014** | **0.19** | | | | | |
| **-147 +104** | **0.13** | **0.056** | **0.634** | | | | | |

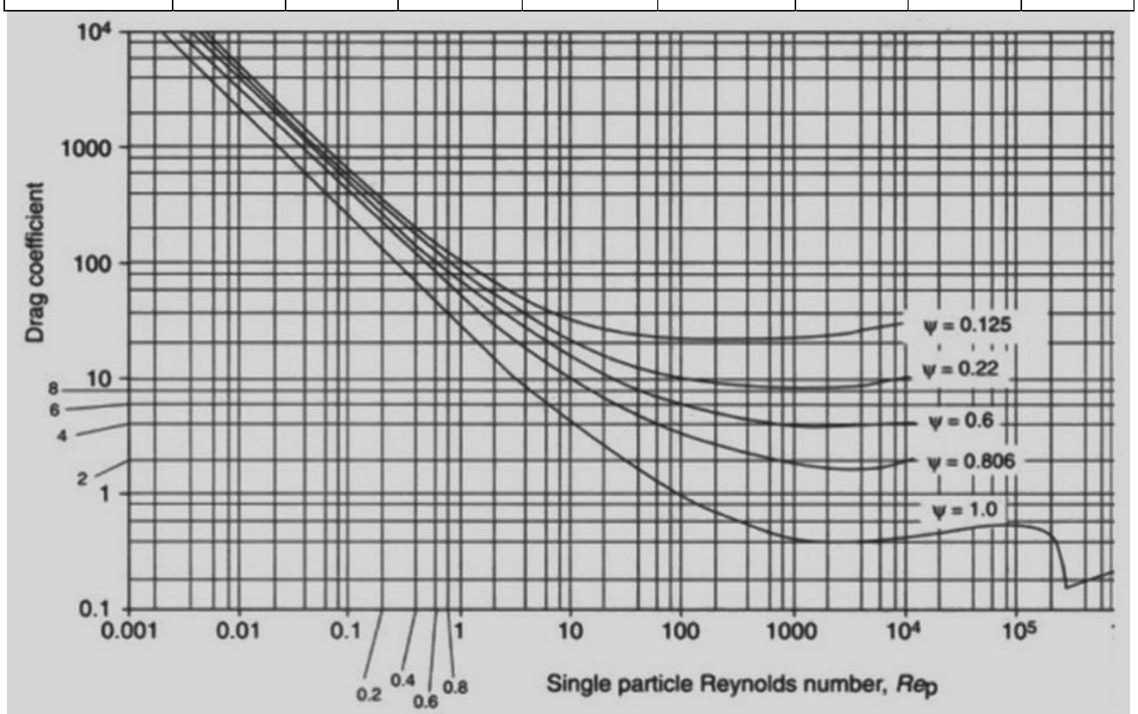


**Fig. 1:** Relationship of drag coefficient ($C_D$) with particle Reynolds number ($Re_p$) for particle with various values of sphericity ($\psi$).

**Table 2:** Screen analysis data for Feed (F), oversize, and undersize in %.

| Mesh | % mass feed | % retained overflow | % retained underflow | | | | |
|---|---|---|---|---|---|---|---|
| -20 +28 | 61.19 | 80.4 | 0 | | | | |
| -28 +35 | 10.77 | 10.4 | 11.95 | | | | |
| -35 +48 | 10.13 | 6.5 | 21.98 | | | | |
| -48 +65 | 7.46 | 2.5 | 23.91 | | | | |
| -65 +100 | 5.01 | 0.2 | 18.77 | | | | |
| -100 +150 | 5.42 | 0 | 23.39 | | | | |