Note: Assume any data required, state your assumption clearly.
Answer all questions

Question (1)   (35 Marks)

1-a) Explain using neat sketches the flow pattern of air/water mixture in horizontal and vertical pipes. (8 Marks)

1-b) Explain the difference between separation and grade efficiencies and show using graph the importance of d_{50} and d_a. (4 Marks)

1-c) Differentiate between degree of mixing and rate of mixing. (4 Marks)

1-d) The performance of a solids mixer was assessed by calculating the variance occurring in the mass fraction of a component amongst a selection of samples withdrawn from the mixture. The quality was tested at intervals of 30 s and the data obtained are:

sample variance (−)	0.025	0.006	0.015	0.018	0.019
mixing time (s)	30	60	90	120	150

If the component analyzed represents 20 per cent of the mixture by mass and each of the samples removed contains approximately 100 particles, comment on the quality of the mixture produced and present the data in graphical form showing the variation of the mixing index with time. (12 Marks)

1-e) The collection efficiency of a cyclone is 45 per cent over the size range 0–5 μm, 80 per cent over the size range 5–10 μm, and 96 per cent for particles exceeding 10 μm. Calculate the efficiency of collection for a dust with a mass distribution of 50 per cent 0–5 μm, 30 per cent 5–10 μm and 20 per cent above 10 μm. (7 Marks)

Question (2)   (30 Marks)

2-a) Define surface mean diameter, Volume mean diameter and grade efficiency (6 Marks)

2-b) Calculate the sphericity of a cube and Tetrahedron each of side length, l= 8 mm (6 Marks)

2-c) Discuss only five methods for particle size measurement. (5 Marks)

2-d) The size distribution of a dust as measured by a microscope is as follows. Convert these data to obtain the distribution on a mass basis, and calculate the specific surface and Sauter mean diameter assuming spherical particles of density 2650 kg/m³. (13 Marks)

Size range (μm)	0-2	2-4	4-8	8-12	12-16	16-20	20-24
Number of particle in range (-)	2000	600	140	40	15	5	2

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Question (3)   (35 Marks)

3-a) Explain the evolution of the steam/water flow in a vertical boiler tube. (5 Marks)

3-b) Explain using neat sketches the working principles of the settling tank, the elutriator, the Spitzkasten and the double cone classifier. (8 Marks)

3-c) Differentiate between dispersed and separated flows. (5 Marks)

3-d) The size distribution by mass of the dust carried in a gas, together with the efficiency of collection over each size range, is as follows:

Size range (µm)	0–5	5–10	10–20	20–40	40–80	80–160
Mass (per cent)	10	15	35	20	10	10
Efficiency (per cent)	20	40	80	90	95	100

Calculate the overall efficiency of the collector, and the percentage by mass of the emitted dust that is smaller than 20 µm in diameter. If the dust burden is 18 g/m^3 at entry and the gas flow 0.3 m^3/s, calculate the mass flow of dust emitted. (8 Marks)

GOOD LUCK

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