Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth semester B.Tech examinations (S), September 2020

Course Code: CH206

Course Name: FLUID AND PARTICLE MECHANICS II (CH)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two questions. Each question carries 15 marks.

1	a)	What is the difference between streamlined and bluff bodies? Is a tennis ball a streamlined or bluff body?	3
	b)	Urea pellets are made by spraying drops of molten urea into cold air at the top of a tall tower and allowing the material to solidify as it falls. Pellets 6 mm in diameter are to be made in a tower 25 m high containing air at 20℃. The density of urea is 1330 kg/m^3. What would be the terminal velocity of pellets, assuming free settling conditions?	9
	c)	The height of a fluidised bed at incipient fluidisation is 0.015 m, and the corresponding voidage is 0.3. Calculate the bed height, if the voidage of the bed increases to 0.5 by increasing the empty tower velocity.	3
2	a)	What is the difference between skin friction drag and pressure drag? Which is usually more significant for streamlined bodies such as airfoils? Justify your answer with mathematical equations.	5
	b)	Write the mathematical expression of flow through packed bed. From the base model derive the formulae to obtain minimum fluidization velocity. Derive the minimum fluidization velocity in case of a low Reynolds number and high Reynolds number for particulate fluidization separately.	10
3	a)	Air (ρ= 1.22 kg/m^3, μ= 1.9 x 10^{-5} Pa.s) is flowing in a fixed bed of diameter 0.5 m and height 2.5 m. The bed is packed with spherical particles of diameter 10 mm. The void fraction is 0.38. The air mass flow rate is 0.5 kg/s. Calculate the pressure drop across the bed of particles	5
	b)	Oil, of density 900 kg/m^3 and viscosity 3 x 10^{-3} Ns/m^2, is passed vertically upwards through a bed of catalyst consisting of approximately spherical particles of diameter	10

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0.1 mm and density 2600 kg/m^3. At approximately what mass rate of flow per unit area of bed (a) fluidisation, and (b) transport of particles will occur?

Given : porosity at minimum fluidisation = 0.48

PART B

Answer any two questions. Each question carries 15 marks

4 a) Explain the working of any two types of positive displacement pumps with neat diagrams — 10

b) Define net positive suction head and required net positive suction head, and explain how these two quantities are used to ensure that cavitation does not occur in a pump. — 5

5 a) An air compressor increases the pressure and the density of air passing through it. If the inlet and outlet diameters are equal, how does average air speed change across the compressor? In particular, is the outlet velocity less than, equal to or greater than inlet velocity? — 5

b) "Multistage compression with inter stage cooling is preferable over single stage compression" Justify the statement. — 5

c) Is it possible to accelerate a fluid to supersonic velocities with a velocity other than the sonic velocity at the nozzle throat? Explain. — 5

6 a) Derive Bernoulli's equation for compressible fluid under adiabatic conditions. — 5

b) Carbon dioxide flows steadily through a varying cross sectional area duct such as a nozzle at a mass flow rate of 3 kg/s. It enters the duct at a pressure of 1400 kPa and 200℃ with a low velocity, and it expands in the nozzle to an exit pressure of 200 kPa. The duct is designed so that the flow can be approximated as isentropic. Determine the density, velocity, flow area and mach no at the nozzle throat and exit of the duct. Given $\gamma = 1.289$, Cp = 0.846 kJ /kg k for CO_2. — 10

PART C

Answer any two questions. Each question carries 20 marks.

7 a) Calculate the theoretical power for a six - blade flat turbine agitator with diameter D_A = 3m running at a speed of 0.2 rev/s. The liquid in the tank has a dynamic viscosity 1 Pa s and density 1000 kg/m^3. The power number and Reynolds number data for the tank is given in the table — 5

Reynolds number	1	5	10	10^2	10^3	10^4	10^5
Power number	60	12	6	4	4.5	5	5

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b) What are the different mixing flow patterns an agitator creates in a vessel? Explain with neat diagrams. 6

c) Show by dimensional analysis that power required by mixer impeller can be correlated by means of power number as a function of Reynolds number and Froude number. 9

8 a) The rheological properties of a china clay suspension can be approximated by either a power law or Bingham plastic model over the shear rate range 10 -100 s^{-1}. If the yield stress is 15 Pa and the plastic viscosity (μ_0) is 150 mPas, what will be the value of power law consistency coefficient and flow behaviour index. 8

b) Scraper blades set to rotate at 35 rpm are used for a pilot plant addition of liquid ingredients into a body-wash product. What should the speed of the blades be in a full-scale plant, if the pilot and the full-scale plants are geometrically similar in design? Assume that scaleup is based on constant tip speed, diameter of the pilot plant scraper blades is 0.6 m, and diameter of the full-scale plant scraper blades is 8 ft. 4

c) A biscuit dough is prepared by mixing flour and other ingredients along with tracer material (2% mass). After 10 minutes of mixing 6 random samples are collected and their composition (% of tracer material) is given below: 8

Sample no	1	2	3	4	5	6
Composition	2.021	1.925	1.826	2.125	2.21	2.015

Calculate the mixing index after 10 minutes of mixing.

9 a) Explain, with neat sketch, the working of the following 10

(i) Change can mixers (ii) Internal mixers

List any two applications of each.

b) Explain, with neat sketch, the working of any two types of mixing equipment used for the non cohesive solids. List any two application of each. 10

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