U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: VII**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH7DELE2 **Max Marks: 100**
Course: Pilot Plant and Scale up studies **Date: 28.02.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Explain the need for pilot plant studies. Justify with the help of relevant examples. **12**

b) Define the following with respect to pilot plant studies with examples. **08**

i. Model and distorted model
ii. Prototype
iii. Element
iv. Scale ratio

UNIT - II

2 a) Perform dimensional analysis on differential equation for forced convection in fluids to arrive at Nusselt's group. **10**

b) A model airplane is built at 1/10 scale and is to be tested in a wind tunnel operating at a pressure of 20 times the atmospheric. The airplane will fly at 500 km/h speed. At what speed should the wind tunnel operate to give dynamic similarity between model and prototype? If the drag measure on the model is 337.5 N, what will be the drag on the plane? Consider drag force is given as: $F = (\rho l^2 v^2)$ f (Re) **06**

c) Discuss how chemical similarity may be established for a system of reactor vessel emphasizing on the necessary conditions for chemical similitude. **04**

UNIT - III

3 a) Establish similarity criteria for deformation of solids for load controlled and mass controlled static regime and hence obtain scale equations for plastic and elastic deformations. **10**

b) Elucidate on the basic similarity criteria in a homologous system. **05**

c) Arrive at scale equation for velocity, volumetric flow rate, pressure drop and power consumed for gravity controlled dynamic regime. **05**

UNIT - IV

4 a) The power required by a three-bladed square pitched 0.38 m marine propeller prototype rotating at 300 rpm in a 30% NaOH solution at 65°F in a baffled mixer tank of 3.048 m diameter and 2.43 m liquid depth is 157 kW. Under homologous condition and satisfying the similarity criterion, estimate the tip speed of the impeller, rotational speed of the impeller, and power consumption required by the model, which is 0.25 times the size of the prototype. **12**

Data given in prototype:

N = 300 rpm, density of fluid is 1282 kg/m^3, impeller diameter = 0.38 m; viscosity of fluid = 0.418 Pa s.

b) Explain the general scale up conditions for the stirred slurry tank reactor. **08**

OR

5 a) Starting from the basic equation for scale up of mixing equipment arrive at scale equations for the following: **15**

a. Baffled mixers for homogenous liquid mixing

b. Mixers for dispersion of immiscible liquids.

b) Explain the significance of terms of Damkohler group in the scale up of chemical reactors. **05**

UNIT - V

6 a) How the following parameters do influence the scale up of packed towers: **10**

i. Liquid distribution
ii. Flooding velocity
iii. Pressure drop
iv. Height of packing

b) Discuss the theoretical relationships for liquid film controlled and gas film controlled mass transfer systems. **10**

OR

7 a) Explain the scale up of overall heat transfer coefficients by Wilson' s method and method of inference. **12**

b) Explain scale up of extraction systems. **08**

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