SLOT: D1+TD1

REG.NO.:

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Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF CHEMICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST (CAT) -II
WINTER SEMESTER 2025-2026

Programme Name & Branch	**: B.Tech Chemical Engineering**
Course Code	**: BACHE103**
Course Name	**: Momentum Transfer**
Faculty Name(s)	**: Naga Samrat Maruvada V V**
Class Number(s)	**: VL2025260503968**
Date of Examination	**: 18 March 2026**
Exam Duration	**: 90 minutes**

Maximum Marks: 50

General instruction(s):

- Answer All Questions
- Open Textbook/ Notebook examination
- Scientific calculator and data sheet are permitted
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes Statements:
  - CO3: Evaluate pressure losses, energy balance, and flow in pipelines using pumps, compressors, and flow meters
  - CO4: Use dimensional analysis and similitude concepts to formulate and scale fluid flow experiments

Q. No	Question	M	CO	BL
1.	In the design of a Magnetic Levitation (MagLev) actuator, a current-carrying coil produces a magnetic force F on a nearby superconducting disk. The force F is assumed to depend on the physical variables Current in the coil I (A), vertical distance between the coil and the disk z (m), Permeability of free space $\mu 0$ (kg m/s^{2}A^2), and Radius of the coil R (m). Use the Buckingham π Theorem to determine the functional relationship for the magnetic force F	10	4	3
2.	Starting from Newton's Second Law ($F = ma$) applied to a fluid element, derive the Bernoulli equation for steady, incompressible, and inviscid flow.	10	3	3
3.	In the design of a new high-speed submarine, engineers must predict the total drag force F_p at a cruising speed of $v_p = 10$ m/s in sea water (ρ_p = 1030 kg/m^3, ν_p = 1.2 x 10^{-6} m^2/s). Due to the lack of a sufficiently large towing tank, a 1:150-scale model is proposed for testing in a high-speed wind tunnel (ρ_m = 1.24 kg/m^3, ν_m = 1.6 x 10^{-5} m^2/s, Speed of sound in air: c = 340 m/s). a. Calculate the required air velocity (v_m) in the wind tunnel to achieve exact Reynolds similarity with the prototype ($Re_m = Re_p$). Also determine the Mach	10	4	3

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	number of the model test and comment on the validity of the flow. b. Derive and calculate the expression for the ratio of drag forces F_n, assuming Reynolds similarity is maintained.			
4.	Two reservoirs with a surface level difference of 20 m are to be connected by 1 m diameter pipe 6 km long. Use the Karman-Prandtl equation to compute the friction factor for turbulent flow through rough pipes $\frac{1}{\sqrt{f}} = 2log_{10}\left(R_0/k\right) + 1.74$, where f = friction factor, R_0 = pipe radius, k = average roughness. a. What will be the discharge when a cast iron pipe of roughness $k = 0.3$ mm is used? b. What will be the percentage increase in the discharge if the cast iron pipe is replaced by a steel pipe of roughness $k = 0.1$ mm? Neglect all local losses.	10	3	3
5.	Water enters a hydraulic turbine through a 30-cm-diameter pipe at a rate of 0.6 m^3/s and exits through a 25-cm-diameter pipe. The pressure drop in the turbine is measured by a mercury manometer to be 1.2 m. For a combined turbine–generator efficiency of 83 %, determine the net electric power output. Disregard the effect of the kinetic energy correction factors.	10	3	3

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