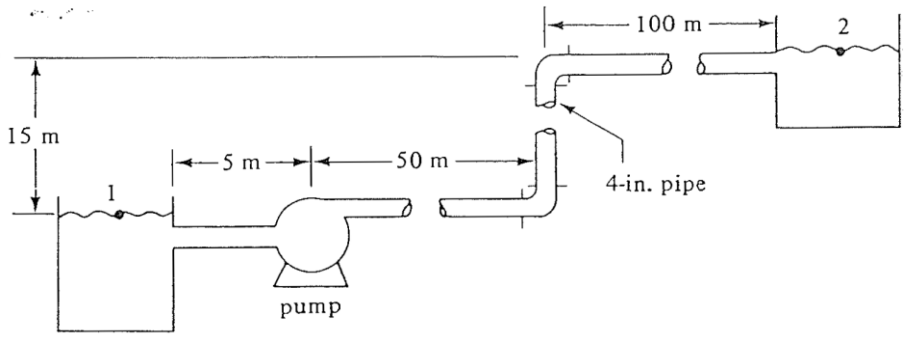
Name: **Enrolment No:**	UPES

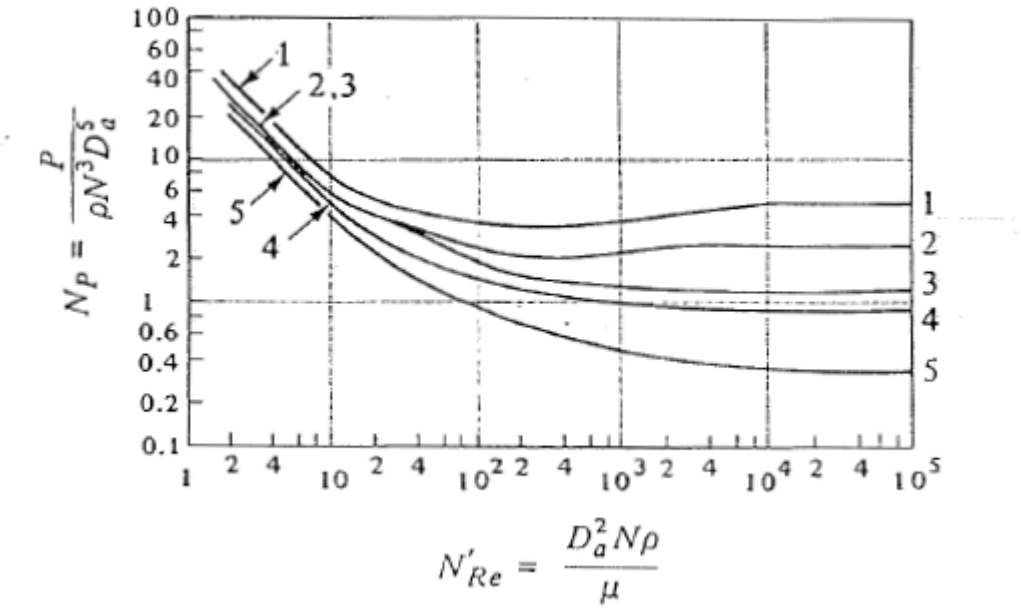
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End-Semester Examination, May 2021

Programme Name: B. Tech. CERP | **Semester** : IV
Course Name : Fluid Mechanics | **Time** : 03 hrs
Course Code : MECH 2007 | **Max. Marks: 100**
Nos. of page(s) : 02
Instructions : Assume any missing data. Draw the diagrams, wherever necessary.

Section-A
(6× 10 = 60 marks)
(Answer all the questions)

		Marks	CO
1.	A tubular centrifugal bowl with an inside diameter **150 mm**, rotating at **800 rpm**, is used to separate **chlorobenzene** of density **1109 kg/m^3** and **aqueous wash liquid** of density **1020 kg/m^3**. The free-liquid surface inside the bowl is **40 mm** from the axis of rotation. If the centrifugal bowl is to contain **equal volumes** of the two liquids, what should be the radial distance from the rotational axis to the top of the overflow dam of heavy liquid?	**10**	**CO1**
2.	Water at **20^{O}C** is being pumped from a tank to an elevated tank at a rate of **5 x 10^{-3} m^3/s**. All of the piping in figure is **Schedule Number 40 pipe**. The pump has an efficiency of **65%.** Calculate the power needed by the pump. **Diameter of Sc 40 4" pipe= 0.1023 m** density of water is **998.2 kg/m^3**, viscosity is **1x10^{-3}** Pa.s, **ε = 4.6 x 10^{-5} m, K_f = 0.75** **Ws = -η Wp (J/kg),** where **Ws** is shaft work, **Wp** is pump work, **η** is efficiency of pump 	**10**	**CO2**
3.	A pipe **450 mm** in diameter branches into two pipes of diameters **300 mm & 200 mm.** if the average velocity in **450 mm** pipe is **3 m/s**, find discharge through **450 mm** pipe and velocity in **200 mm** pipe, if the average velocity in **300 mm** pipe is **2.5 m/s**	**10**	**CO3**

4.	**Derive** an expression for velocity distribution for viscous flow through a circular pipe	**10**	**CO4**
5.	Explain the concept of Boundary Layer Theory with neat diagram	**10**	**CO5**
6.	It is desired to agitate a liquid having viscosity of **1.5×10^{-3} Pa.s** and a density of **969 kg/m^3** in a tank having diameter of **0.91 m**. The agitator will be a **six-bladed** open turbine having a diameter of **0.305 m** operating at **180 rpm**. The tank has **four** vertical baffles with a **width J** of **0.076 m** and also **W = 0.0381 m**, Calculate the required **kW** **Use curve 2 : $D_a/W = 8$, $D_t/J = 12$**  	**10**	**CO6**
	Section-B **Answer any two** **(2 x 20 = 40 marks)**		
7.	(a) Derive an expression for pressure drop in a packed bed (b) Air at **394.3 K** flowing through a packed bed of cylinders having diameter of **12.7 mm** and length same as the diameter. The void fraction is **0.4** and the bed height of **3.66 m**. The air enter the bed at **2.2 atm abs** at the rate of **2.45 kg/ m^2 s** based on the empty cross section of bed. Calculate the pressure drop of the air in the packed bed.	**10** **10**	**CO5**
8.	**(a) E**xplain characteristic curves of centrifugal pump	**10**	**CO6**

	(b) A heavy oil at **20^{O}C** having a density of **900 kg/m^3** and a viscosity of **6 cp** is flowing in a **4" Schedule 40 pipe**. When the flow rate is **0.0174 m^3/s** it is desired to have a pressure drop reading across the manometer equivalent to **0.93 x 105 Pa**. What size orifice should be used if the orifice coefficient is assumed to be **0.61**? What is the permanent pressure losses?	**10**	
9.	a) Derive Navier-Stokes equation of motion with proper assumptions b) Solid spherical particles of coffee extract from a dryer having a diameter of **400 μ m** are falling through air at a temperature of **422 K**. The density of the particles is **1030 kg/m^3**. Calculate the terminal velocity and the distance of fall in **5 s**. The pressure is **101.32 kPa** Density of air at **422 K** is **0.8378 kg/m^3**, viscosity is **0.0237 x 10^{-3} Pa.s**	**10** **10**	**CO5**