Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

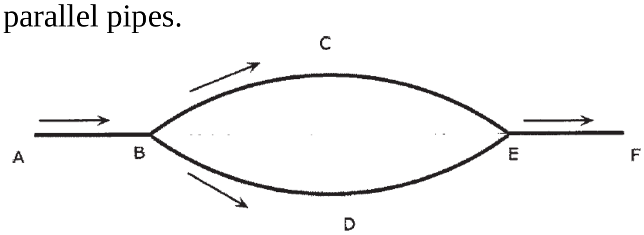
Course: Pipeline Transportation of Oil & Gas **Semester: 7th sem**
Program: B.Tech CERP **Time : 03 hrs.**
Course Code: CHGS3007P **Max. Marks: 100**
Instructions: Assume any missing data suitably

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss the affinity laws in pump?	**4**	**CO1**
Q 2	List the different types of compressors used industrially. How is compressibility factor defined?	**4**	**CO1**
Q 3	Discuss the Bernoulli's theorem with application to pipeline pressure drop.	**4**	**CO1**
Q 4	Three liquids A, B, and C are blended together in the ratio of 20%, 30%, and 50% respectively. Calculate the specific gravity of the blended liquid if the individual liquids have the following specific gravities at 40°C: Specific gravity of liquid A: 0.845 Specific gravity of liquid B: 0.798 Specific gravity of liquid C: 0.901	**4**	**CO1**
Q 5	Explain the Darcy law and its application to the fluid mechanics?	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q 6	Explain the characteristics curves of the following pump types with clear diagram (1) Centrifugal pump (2) Reciprocating pump	**10**	**CO2**
Q 7	Derive the below equation for parallel pipeline flow	**10**	**CO3**

	$Q_1 = \frac{QConst1}{1+Const1}$ Or Explain the concept of Equivalent length in case of series pipeline. Derive the applicable equation.		
Q 8	A parallel pipe system, similar to the one shown in the below Figure is located in a horizontal plane with the following data: Flow rate Q=2000 gal/min of water Pipe branch BCE=12 in. diameter, 8000 ft Pipe branch BDE=10 in. diameter, 6500 ft Calculate the flow rate through each parallel pipe and the equivalent pipe diameter for a single pipe 5000 ft long between B and E to replace the two parallel pipes. 	**10**	**CO4**
Q 9	Natural gas is compressed isothermally at 30°C from an initial pressure of 20 bara to a pressure of 50 bara. The gas gravity is 0.65. Calculate the work done in compressing 4 kg of gas. Use 1 atm and 15.5 °C for the base pressure and temperature, respectively. Specific heat ratio of gas is 1.24 1) Isothermal compression 2) Adiabatic compression 3) Calculate the temperature increase. $Wa = \frac{286.76}{G} T_1 \left(\frac{\gamma}{\gamma-1}\right)\left[\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]$ $Wi = \frac{286.76}{G} T_1 \text{Log}_e\left(\frac{P_2}{P_1}\right)$	**10**	**CO5**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	One large pump and one small pump are operated in series. The H-Q characteristics of the pumps are defined as follows:	**20**	**CO4**

Pump 1

Q, gal/min	0	800	1600	2400	3000
H, ft	2389	2325	2175	1763	1350

Pump 2

Q, gal/min	0	800	1600	2400	3000
H, ft	796	775	725	588	450

(a) Calculate the combined performance of pump 1 and pump 2 in series configuration.

(b) What changes (trimming impellers) must be made to one of the pumps to satisfy the requirement of 2000 ft of head at 2400 gal/min when operated in series? Do the calculation upto the first trial value.

(c) Can these pumps be configured to operate in parallel?

Q 11

A natural gas pipeline consists of **two different pipe segments** connected in **series**, pumping the same uniform flow rate of 3.0 MSm3/day at 20°C. The first segment, DN 500 with 12 mm wall thickness, is 20 km long. The second segment is DN 400, 10 mm wall thickness, and 25 km long. The inlet pressure is 8500 kPa. Assuming flat terrain, calculate the delivery pressure, using the General Flow equation and the Colebrook friction factor of 0.02. The gas gravity = 0.65 and viscosity = 0.000119 Poise. The compressibility factor Z = 0.9. The base temperature = 15°C and base pressure = 101 kPa. Compare results using the equivalent length method as well as the method using individual pipe segment pressure drops.

DN=OD	General flow equation
	$Q = 1.1494 \times 10^{-3}\left(\frac{T_b}{P_b}\right)\left[\frac{\left(P_1^2 - P_2^2\right)}{GT_f LZf}\right]^{0.5} D^{2.5}$ (SI units)

Or

A 16 in. crude oil pipeline (0.250 in. wall thickness) is 30 miles long from point A to point B. The flow rate at the inlet A is 4000 bbl/hr. The crude oil properties are specific gravity of 0.85 and viscosity of 10 cSt at a flowing temperature of 70° F.

(a) Calculate the pressure required at A without any pipe loop. Assume 50 psi delivery pressure at the terminus B and a flat pipeline elevation profile.

(b) If a 10 mile portion CD, starting at milepost 10, is looped with an identical 16 in. pipeline, calculate the reduced pressure at A.

20 **CO5**

	(c) What is the difference in pump HP required at A between cases (a) and (b) above? Assume 80% pump efficiency and 25 psi pump suction pressure. Consider friction factor as f=0.0213 $P_m=0.0605fQ^2(Sg/D^5)$		