Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, DEC 2020

Course: Pipeline Transportation of Oil and Gas **Semester: VII**
Program: B. Tech. APE UPSTREAM **Time 03 hrs.**
Course Code: CHGS3007P **Max. Marks: 100**
Instructions: Attempt All Questions

SECTION A

S. No.	ATTEMPT ALL QUESTIONS (5*6=30 MARKS)	Marks	CO
Q.1	Illustrate the term best efficiency point in Centrifugal pumps.	5	CO1
Q.2	Explain the term compressor ratio. What is the recommended values for compressor ratio for reciprocating and centrifugal compressors?	5	CO4
Q.3	Discuss the term 'Class Location 'for cross- country pipelines.	5	CO1
Q.4	Describe 'Affinity Law' for centrifugal pumps.	5	CO3
Q.5	Explain the difference between "Break Horse Power" and "Horse Power" in pumping stations.	5	CO2
Q.6	Explain hydrostatic test pressure in pipelines	5	CO4

SECTION B

(ATTEMPT ALL QUESTIONS- 5*10=50)

Q.7	(a) Explain the advantages of pipeline transportation over other transportation modes (5 crucial points to be mentioned) (b) Discuss the term "Adiabatic efficiency".	10	CO2
Q.8	Explain performance curves for centrifugal pumps	10	CO5
Q.9	(a) Illustrate the term 'Hydraulic Balance in compressors'. (b) Explain specific speed of compressors	10	CO4
Q.10	Explain SCADA system in pipeline network system	10	CO3
Q.11	Explain in short the process of pipeline construction and laying activities	10	CO2

SECTION-C
(ATTEMPT ANY ONE QUESTION- 20*10=20)
MISSING DATA ARE TO BE SUITABLY ASSUMED

Q.12	The **Salaya – Mathura** pipeline is used for transporting oil from **Salaya** to **Mathura** refinery. There are two intermediate stations, one at **Viramgram** and the other one at **Koyli**. The length of **Salaya- Mathura** pipeline is 48 miles and is of 18 inch in diameter, with 0.281-inch wall thickness. It is constructed of 5LX-65 grade steel. At origin station **Salaya**, crude oil of specific gravity 0.85 and 10 cSt viscosity enters the pipeline at a flow rate of 6000 bbl./hr. At first intermediate station **Viramgram** (milepost 22), a new stream of crude oil with a specific gravity of 0.82 and 3.5 cSt viscosity enters the pipeline at a flow rate of 1000 bbl. /hour. The mixed stream then continues to another intermediate station **Koyli** (milepost 32) where 3000 bbl. / hour is stripped off the pipeline. The remaining volume continues to the end of the pipeline at delivery station **Mathura**. **(a)** Evaluate the pressure required at origin station **Salaya** and the composition of the crude oil arriving at terminus **Mathura** at a minimum delivery pressure of 50 psi. Assume elevations at **Salaya, Viramgram, Koyli,** and **Mathura** to be 100, 150, 250, and 300 feet, respectively. Use the Modified Colebrook-White equation for pressure drop calculations and assume a pipe roughness of 0.002 inches. **(b)** Evaluate the pump HP that will be required at **Salaya** to maintain this flow rate, assuming 50-psi pump suction pressure at Salaya and 80% pump efficiency? **(c)** If a positive displacement (PD) pump is used to inject the stream at **Viramgram,** solve for pressure and HP are required at **Viramgram**? **1. Frictional Pressure drop equation in oil pipelines** $Pm = 0.0605fQ^2(Sg/D^5)$ **2. Reynolds No. for Crude Oil Pipelines** $R=92.24\ Q/(v\ D)$	**20**	**CO5**

3. Modified Colebrook White Equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{e}{3.7D} + \frac{2.825}{\mathrm{Re}\sqrt{f}}\right)$$

Where: Q=Flow rate, bbl/day; D=Internal diameter, in.; ν = Kinematic viscosity, cSt

4. R=353,678 Q/(νD)

Where: Q=Flow rate, m^3/hr.; D=Internal diameter, mm; ν= Kinematic viscosity, cSt

D=Pipe internal diameter, in.

5. Coversion Equations for SSU to Centistokes

$$Centistokes = 0.226(SSU) - \frac{195}{SSU} \qquad 32 \le SSU \le 100$$

$$Centistokes == 0.220(SSU) - \frac{135}{SSU} \qquad SSU \succ 100$$

6. Head to pressure conversion:

$$Head = \frac{2.31 psig}{G}(USCS)$$

7. Specific gravity of blended liquids

$$S_b = \frac{Q_1S_1 + Q_2S_2 + ...Q_nS_n}{Q_1 + Q_2 + ...Q_n}$$

8. Viscosity of blended liquids

$$\sqrt{v_b} = \frac{Q_1 + Q_2 + Q_3....}{\left(\frac{Q_1}{\sqrt{v_1}} + \frac{Q_2}{\sqrt{v_2}} + \frac{Q_3}{\sqrt{v_3}}.....\right)}$$

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<td>9. BHP required to pump the liquid $$BHP = \frac{QP}{2449E}$$
Q = flow rate (barrel per hr.) P = Differentia pressure (psi)</td>
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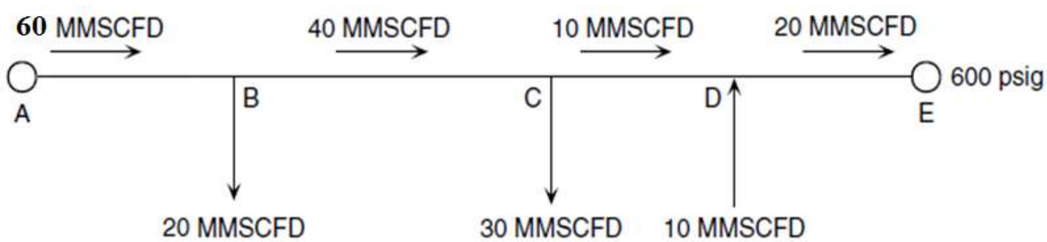
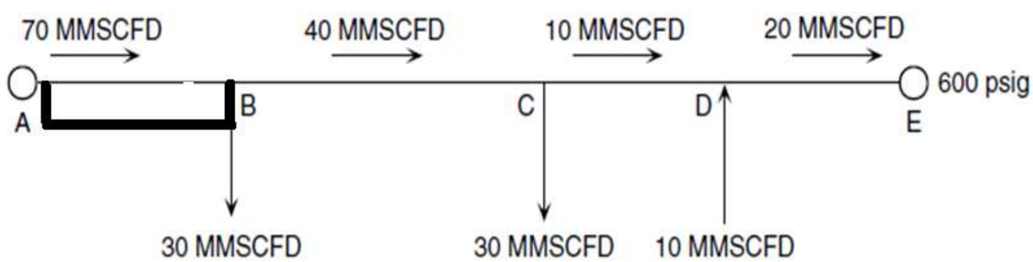
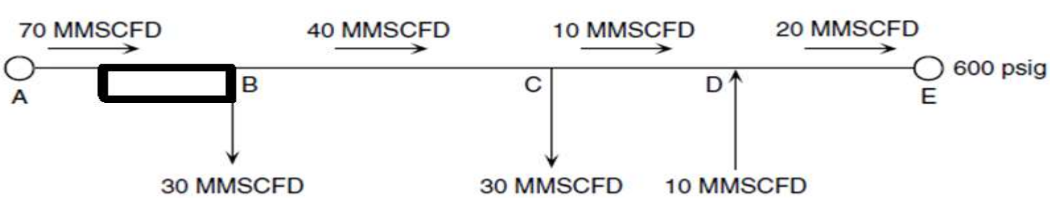
<td>Q13</td>
<td>In a gas distribution pipeline, 60 MMSCFD enters the pipeline at A, as shown in Figure. If the delivery at B is increased from 20 MMSCFD to 30 MMSCFD by increasing the inlet flow at A, keeping all-downstream flow rates the same, calculate the looping necessary if entire length AB is looped to ensure pressures are not changed throughout the pipeline. Pipe AB is NPS 14, 0.250 in. wall thickness; BC is NPS 12, 0.250 in. wall thickness;







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Pipe CD is NPS 10, 0.250 in. wall thickness; and DE is NPS 12, 0.250 in. wall thickness. The delivery pressure at E is fixed at 600 psig. The pipe lengths are as follow: AB = 12 miles; BC = 18 miles; CD = 20 miles; DE = 8 miles

The gas gravity is 0.60, and the flow temperature is 60°F. The compressibility factor and transmission factor can be assumed 0.85 and 20, respectively, throughout the pipeline. The base pressure and base temperature are 14.7 psia and 60°F, respectively. Also, calculate the loop length if a particular length of AB is looped with a diameter of 10 NPS and 0.25-inch wall thickness.

NPS12=12.75 inches; NPS10= 10.75 inches.

1. Pressure drop equation for gas pipelines

$$Q = 77.54\left(\frac{T_b}{P_b}\right)\left(\frac{P_1^2 - P_2^2}{GT_f LZf}\right)^{0.5} D^{2.5}$$

2. Reynolds Equation for Gas Pipelines

$$\text{Re} = 0.5134\left(\frac{P_b}{T_b}\right)\left(\frac{GQ}{\mu D}\right) \quad \text{(SI)}$$

$$\text{Re} = 0.0004778\left(\frac{P_b}{T_b}\right)\left(\frac{GQ}{\mu D}\right) \quad \text{(USCS)}$$

3. Modified Colebrook White Equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{e}{3.7D} + \frac{2.825}{\text{Re}\sqrt{f}}\right)$$

4. Horsepower required to compress gas in compressor

$$HP = 0.0857\left(\frac{\gamma}{\gamma - 1}\right)QT_1\left(\frac{Z_1 + Z_2}{2}\right)\left(\frac{1}{\eta_a}\right)\left[\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]$$

5. Adiabatic Efficiency of Compressor

$$\eta_a = \left(\frac{T_1}{T_2 - T_1}\right)\left[\left(\frac{z_1}{z_2}\right)\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]$$

6. BHP required to pump the liquid

$$BHP = \frac{QP}{2449E}$$

Q = flow rate (barrel per hr.) **P** = Differentia pressure (psi)

7. Equivalent diameter equation

$$D_e = D_1\left[\left(\frac{1+Const}{Const}\right)^2\right]^{1/5} \qquad Const = \sqrt{\left(\frac{D_1}{D_2}\right)^5\left(\frac{L_2}{L_1}\right)}$$