

Name:

Enrolment No:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2022

Programme Name: B. Tech. APE (Gas)

Semester : IV

Course Name : Natural Gas Engineering

Time : 03 hrs

Course Code : CHCE 2024

Max. Marks: 100

Nos. of page(s) : 4

Instructions:

- ✓ Draw diagrams wherever necessary
- ✓ Attempt questions in sequence
- ✓ Appendix with all the tables and graphs are attached at the end of the question paper

**SECTION A ( 5 X 4= 20 Marks)**

**Answer all questions**

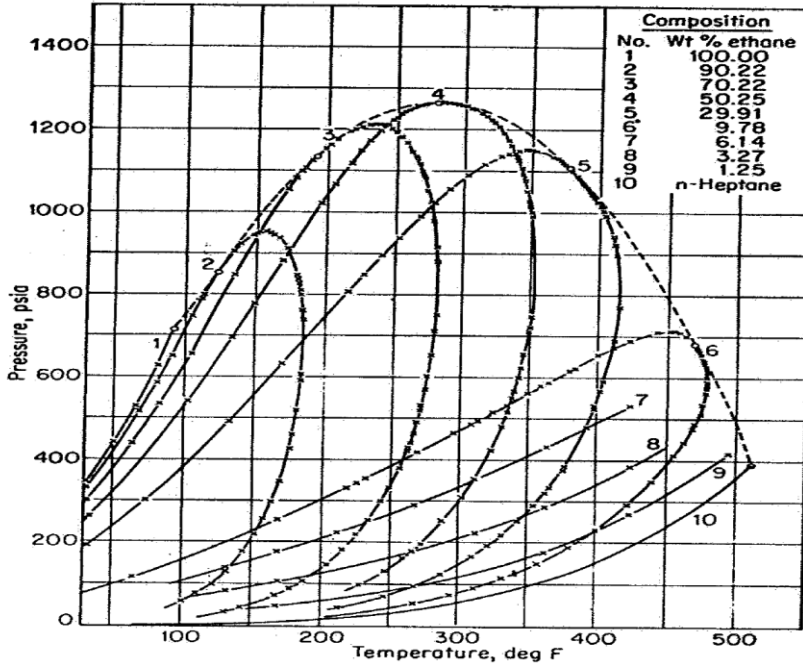
S. No.		Marks	CO																																								
1.	Explain biogenic and thermogenic mechanisms?	4M	CO1																																								
2.	The following is a list of the compositional analysis of different hydrocarbon systems. The compositions are expressed in the terms of mol%. Classify hydrocarbon systems. <table border="1" data-bbox="203 1136 1292 1430"><thead><tr><th>Component</th><th>System #1</th><th>System #2</th><th>System #3</th><th>System #4</th></tr></thead><tbody><tr><td>C<sub>1</sub></td><td>68.00</td><td>25.07</td><td>60.00</td><td>12.15</td></tr><tr><td>C<sub>2</sub></td><td>9.68</td><td>11.67</td><td>8.15</td><td>3.10</td></tr><tr><td>C<sub>3</sub></td><td>5.34</td><td>9.36</td><td>4.85</td><td>2.51</td></tr><tr><td>C<sub>4</sub></td><td>3.48</td><td>6.00</td><td>3.12</td><td>2.61</td></tr><tr><td>C<sub>5</sub></td><td>1.78</td><td>3.98</td><td>1.41</td><td>2.78</td></tr><tr><td>C<sub>6</sub></td><td>1.73</td><td>3.26</td><td>2.47</td><td>4.85</td></tr><tr><td>C<sub>7+</sub></td><td>9.99</td><td>40.66</td><td>20.00</td><td>72.00</td></tr></tbody></table>	Component	System #1	System #2	System #3	System #4	C <sub>1</sub>	68.00	25.07	60.00	12.15	C <sub>2</sub>	9.68	11.67	8.15	3.10	C <sub>3</sub>	5.34	9.36	4.85	2.51	C <sub>4</sub>	3.48	6.00	3.12	2.61	C <sub>5</sub>	1.78	3.98	1.41	2.78	C <sub>6</sub>	1.73	3.26	2.47	4.85	C <sub>7+</sub>	9.99	40.66	20.00	72.00	4M	CO2
Component	System #1	System #2	System #3	System #4																																							
C <sub>1</sub>	68.00	25.07	60.00	12.15																																							
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3.	Describe the working principle of an axial flow compressor.	4M	CO3																																								
4.	Compare orifice types including their effect on gas flow measurement.	4M	CO4																																								
5.	Articulate the functions of a well-designed separator.	4M	CO5																																								

**SECTION B ( 4 x 10=40 Marks)**

**Answer all questions**

6.	a) Solve for compressibility for the given gas composition at 200 psia and 80°F. N <sub>2</sub> -1%, C <sub>1</sub> -89%, C <sub>2</sub> -5% and C <sub>3+</sub> =5%. Assume the C <sub>3+</sub> fraction to be equivalent to n-C <sub>5</sub> .	(5+5) 10M	CO1 & CO2
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b) Illustrate the P-T diagram of ethane and heptane system



7. A gas is being compressed from 150 psia and 200°F to 2000 psia. Determine its compression parameters at the suction end. The gas has the following composition expressed as mole fraction.  $C_1=0.9134$ ,  $C_2=0.0456$ ,  $C_3=0.0175$ ,  $i-C_4=0.0043$ ,  $n-C_4=0.0044$ ,  $i-C_5=0.0148$ .

10M

CO3

8. A 4-in diameter orifice meter is installed in a pipe with an inside diameter of 12.09 in. The differential pressure is measured at 30 in of water and the static pressure upstream is 600 psig. Gas gravity= 0.6, gas flowing temperature= 70°F. The base temperature and the base pressure are 60°F and 14.7 psia, respectively. Assuming flange taps, calculate the flow rate in standard ft<sup>3</sup>/h. The barometric pressure is 14.5 psia.

10M

CO4

9. Illustrate the working of a vertical separator with a neat diagram, its advantages and disadvantages.

10M

CO5

**SECTION C ( 2 x 20=40 Marks)**

10. Solve the adiabatic horsepower required to compress 1 MMcf/d of a 0.6 gravity natural gas from 100 psia and 80°F to 1600 psia. Intercoolers cool the gas to 80°F. What is the heat load on the intercoolers and what is the final gas temperature.  
Use:  
a) The enthalpy –entropy diagram

20M

CO3

	b) Analytical expressions.		
11.	<p>Meter equipped with flange taps , with static pressure from downstream tap:</p> <p>D1= line size=8.071 in. actual ID</p> <p>D2=orifice size=1 in</p> <p>Flowing temperature=65°F</p> <p>Ambient temperature=70°F</p> <p>Base pressure=14.65 psia</p> <p>Base temperature= 50°F</p> <p>Specific gravity=0.570</p> <p>Total heating value=999.1 Btu/cu ft</p> <p>Mole fraction of nitrogen content=0.011</p> <p>Mole fraction of carbon dioxide content=0</p> <p>Average differential head=50 in water</p> <p>Average downstream gauge pressure=370 psig</p> <p>Solve for the orifice flow constant and the quantity rate of flow for 1 hour at base conditions</p>	20M	CO4
	(Or)		
	<p>a)A metering system is required to measure approximately 8.5 MMSCFD of 0.62 gravity gas at a line pressure of 250 psig The meter run is to be made of 8 in pipe (7.981 in ID). Determine the size of the orifice plate to give a differential of about 50 inches. Flowing temperature averages about 80°F. Use flange taps.</p> <p>b)A 2 in [5.1 cm] orifice plate is used in 3.438 in [8.7 cm] ID pipeline. The differential pressure is 30 in of water. The static pressure upstream is 80 psia and the specific gravity is 0.65. The flowing temperature of gas is 80°F . Flange taps are used. Assume <math>F_{tb} = F_{pb} = 1</math>. Calculate the gas flow rate through the pipe.</p>	(10+10) 20M	CO4