Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2023

Program Name: B.Tech APE Gas **Semester: IV**

Course Name : Natural Gas Engineering **Time: 3 hr**

Course Code : CHCE 2024 **Max. Marks: 100**

Nos. of page(s) :

Instructions: Answer the questions in sequence.

SECTION A

(Attempt all 5 questions and each carries 4 marks) (5 X 4=20Marks)

S. No.		Marks	CO
Q1.	Define Non-associated gas, dissolved gas and gas condensates, and dry gas.	**4M**	**CO1**
Q2.	Derive the material balance equation for multiphase systems to estimate the phase compositions.	**4M**	**CO2**
Q3.	Illustrate Clearance with a neat diagram and describe volumetric efficiency.	**4M**	**CO3**
Q4.	Describe the parameters with which the flow meters are characterized.	**4M**	**CO4**
Q5.	Explain the field processing of natural gas.	**4M**	**CO5**
	SECTION B **(Attempt all 4 questions and each carries 10 marks) (4 X 10 = 40Marks)**		
Q6.	Given the following weight fractions of a gas: Component | Weight fraction (y_i) C_1 | 0.60 C_2 | 0.17 C_3 | 0.13 n-C_4 | 0.06 n-C_5 | 0.04 Calculate a. Mole fraction of the gas. b. Apparent molecular weight. c. Density at 300 psia and 130°F, assuming real gas behavior. d. Specific gravity, and specific volume at 300 psia and 130°F e. Gas formation volume factor in ft^3/scf.	**10M**	**CO1**
Q7.	Solve the horsepower required by a centrifugal compressor (straight throughflow, no intercooler)for compressing 10 MMcfd gas at suction conditions of 150 psia and 80°F to 500 psia . Assume the specific gravity to be 0.60, k=1.296, Z_1 and Z_2=1.0, polytropic efficiency is 0.725.	**10M**	**CO3**
Q8.	What type of separators should be used for- a)offshore production platform? b)high GOR with liquid surges?	**10M**	**CO5**

	c) low GOR well producing oil, water, gas? d) heavy, waxy crude (GOR can be assumed to be low for heavy oils)? e) gas condensates with a hydrate problem? f)nearly dry gas at high pressure?		
Q9.	Describe the three major components of oil-water-gas separators.	**10M**	**CO5**
	SECTION C **(Attempt all 2 questions and each carries 20 marks) (2X 20 = 40Marks)**		
Q10.	Gas is being compressed from 100 psia and 150°F to 2,500 psia and it is measured at the suction end. A reciprocating: compression system is to be designed to compress 5 MMcfd of the gas, with intercoolers and an aftercooler that cools the gas to 150°F. Find: (a) Brake horsepower using the analytical method. (b) Brake horsepower using the Mollier diagram method. (c) Estimate the cooling requirements from part (b) results. (d) From the results of part (b). determine whether the first stage can be handled by a compressor with a speed 1,200 rpm, piston diameter - 12 in., and stroke length - 3 ft. Assume η=0.80, A - 0.05, Lu =0. and Cl= 0.08. Neglect any gas compressibility factor effects. Specific gravity=0.612,k=1.2565	**20M**	**CO3**
Q11.	Compute the daily flow rate of natural gas through an orifice meter for the following conditions : Barometer=14.5 psia Diameter of a pipe=11.938 in. Orifice diameter=4.000 in Differential pressure across meter=27.0 in water Average downstream gauge pressure=678 psig Flowing temperature=75^{o}F Gas gravity=0.63 Mole fraction CO_2=0.013 Mole fraction N_2=0.031 Type of meter=Flange taps Temperature base=60^{o}F Pressure base=14.65 psia	**20M**	**CO4**

Table 1: Properties of Natural gas components

Compound	Formula	Molecular Weight	Critical Constants P_c psia [kPa]	T_c $^\circ R[^\circ K]$	V_c $ft^3/lb[m^3/kg]$	Z_c
Methane	CH_4	16.043	667.8 [4,604]	343 [190.6]	0.0991 [0.0062]	0.2884
Ethane	C_2H_6	30.070	707.8 [4,880]	549.8 [305.4]	0.0788 [0.00492]	0.2843
Propane	C_3H_8	44.097	616.3 [4,249]	665.7 [369.8]	0.0737 [0.0046]	0.2804
n-Butane	C_4H_{10}	58.124	550.7 [3,797]	765.3 [425.2]	0.0702 [0.00438]	0.2736
Isobutane	C_4H_{10}	58.124	529.1 [3,648]	734.7 [408.2]	0.0724 [0.00452]	0.2824
n-Pentane	C_5H_{12}	72.151	488.6 [3,369]	845.4 [469.7]	0.0675 [0.00422]	0.2623
Isopentane	C_5H_{12}	72.151	490.4 [3,381]	828.8 [460.4]	0.0679 [0.00424]	0.2701
Neopentane	C_5H_{12}	72.151	464.0 [3,199]	781.11 [434]	0.0674 [0.00421]	0.2537
n-Hexane	C_6H_{14}	86.178	436.9 [3,012]	913.4 [507.4]	0.0688 [0.0043]	0.2643
n-Heptane	C_7H_{16}	100.205	396.8 [2,736]	972.5 [540.3]	0.0691 [0.00432]	0.2633
n-Octane	C_8H_{18}	114.232	360.6 [2,486]	1,023.9 [568.8]	0.0690 [0.0043]	0.2587
n-Nonane	C_9H_{20}	128.30	332 [2,289]	1,070.3 [594.6]	0.0684 [0.00427]	0.2536
n-Decane	$C_{10}H_{22}$	142.30	304 [2,096]	1,111.8 [617.7]	0.0679 [0.00424]	0.2462
Ethylene	C_2H_4	28.054	729.8 [5,032]	508.6 [282.6]	0.0737 [0.0046]	0.2765
Propene	C_3H_6	42.081	669. [4,613]	656.9 [364.9]	0.0689 [0.0043]	0.2752
Acetylene	C_2H_2	26.038	890.4 [6,139]	555.3 [308.5]	0.0695 [0.00434]	0.2704
Carbon Dioxide	CO_2	44.010	1071. [7,382]	547.6 [304.2]	0.0342 [0.00214]	0.2742
Hydrogen Sulfide	H_2S	34.076	1306 [9,005]	672.4 [373.6]	0.0459 [0.00287]	0.2831
Sulfur Dioxide	SO_2	64.059	1145. [7,894]	775.5 [430.8]	0.0306 [0.00191]	0.2697
Nitrogen	N_2	28.013	493 [3,399]	227.3 [126.3]	0.0514 [0.00321]	0.2916
Water	H_2O	18.015	3208. [22,105]	1,165.0 [647.2]	0.0500 [0.00312]	0.2350

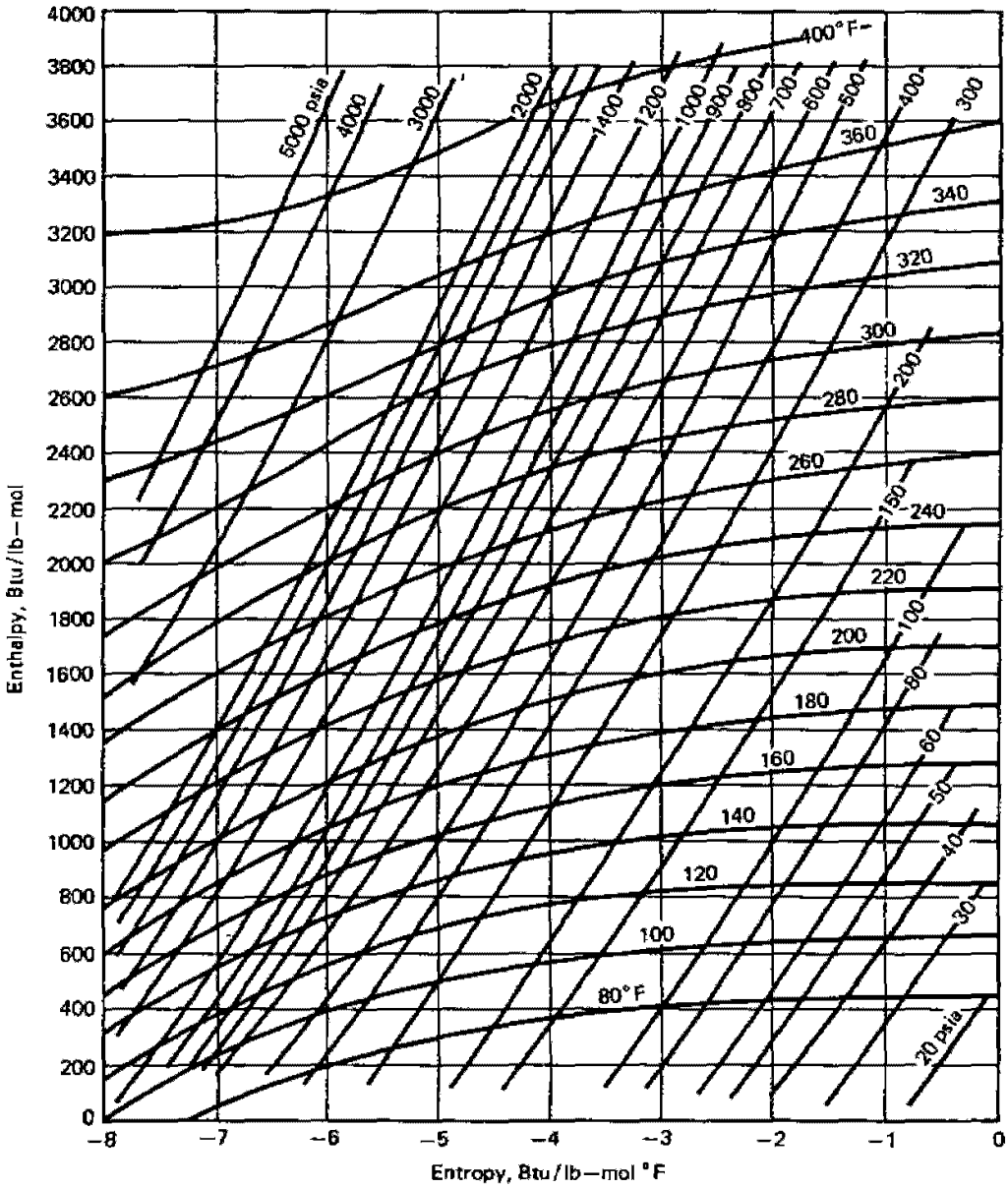

Fig. 3.15 Enthalpy-entropy diagram for a 0.65 to 0.75 specific gravity natural gas. (After Campbell.)