Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Programme Name: B. Tech (APEU) **Semester : V**
Course Name : Natural Gas Engineering **Time : 03 hrs**
Course Code : PTEG 362 **Max. Marks : 100**
Nos. of page(s) : 5

Instructions:

- "**Section A**" have 5 questions of 4 marks each. All question in this section are compulsory.
- "**Section B**" have 4 questions of 10 marks each, out of which 3 questions are compulsory and 1 question have internal choice to attempt any one.
- **"Section C"** have 2 questions of 20 marks each, out of which 1 question is compulsory and 1 question have internal choice to attempt any one.
- All the relevant data and figure are provided with the paper.

SECTION A

S. No.		Marks	CO
Q1.	Define compressibility of gases. Explain its significance	**(4)**	**CO1**
Q2.	How quantitative phase behavior data helps in designing of the gas processing equipment?	**(4)**	**CO2**
Q3.	Write the characteristics of isentropic compression process.	**(4)**	**CO3**
Q4.	Explain different types of accuracy of flow devices with the help of example.	**(4)**	**CO4**
Q5.	Write the advantages and disadvantages of horizontal separators.	**(4)**	**CO5**

SECTION B

Q6.	The pseudo critical pressure and temperature of the sweet natural gas are 663.3 psia and 374.1^0R respectively. Find the isothermal gas compressibility 2000 psia and 150^0F	**(10)**	**CO1**
Q7.	Determine the SBHP in a gas well using average temperature and Z-factor method. The parameters corresponding to gas well are as follows: Depth = 5000 feet, Gas gravity = 0.7, Wellhead temperature = 80^0F, Bottom-hole temperature = 160^0F, Wellhead pressure = 400 psia.	**(10)**	**CO2**

Q8.	A reciprocating compression system is to be designed to compress 5 MMcfd of an ideal gas, of specific gravity 0.6, from 100 psia and 150^0F to 2500 psia. The compression system uses intercoolers and an after-cooler to cool the gas to 150^0F. Calculate the brake horsepower using Mollier diagram for each stage	**(10)**	**CO3**
Q10.	Explain the turbine flow meter with the help of neat schematic diagram. OR Explain the features of rotameter with the help of neat schematic diagram.	**(10)**	**CO4**
SECTION-C			
Q11.	**a)** What are Quickie charts? Write the advantages and disadvantages of using these charts. **b)** Derive an expression for flow rate measurement for an orifice meter using general energy balance equation written between two points in the flowing stream being some point upstream of the orifice plate and at the orifice throat.	**(20)**	**CO3 + CO4**
Q12.	Explain low temperature separation process with the help of process flow diagram used for dew point control. OR Explain low straight refrigeration process with the help of process flow diagram used for dew point control.	**(20)**	**CO5**

Table 1: Physical Constants for Natural Gas Constituents

Compound	Molecular Weight	Critical Pressure (psia)	Critical Temp. (°R)	Crit. Comp. Factor (Z_c)
CH_4	16.043	667.8	343.1	0.289
C_2H_6	30.070	707.8	549.8	0.285
C_3H_8	44.097	616.3	665.7	0.281
n-C_4H_{10}	58.124	550.7	765.4	0.274
i-C_4H_{10}	58.124	529.1	734.7	0.283
n-C_5H_{12}	72.151	488.6	845.4	0.262
i-C_5H_{12}	72.151	490.4	828.8	0.273
n-C_6H_{14}	86.178	436.9	913.4	0.264
n-C_7H_{16}	100.205	396.8	972.5	0.263
n-C_8H_{18}	114.232	360.6	1023.9	0.259
n-C_9H_{20}	128.259	332.0	1070.4	0.251
n-$C_{10}H_{22}$	142.286	304.0	1111.8	0.247
N_2	28.013	493.0	227.3	0.291
CO_2	44.010	1070.9	547.6	0.274
H_2S	34.076	1306.0	672.4	0.266
O_2	31.999	737.1	278.6	0.292
H_2	2.016	188.2	59.9	0.304
H_2O	18.015	3203.6	1165.1	0.230

Figure 1: Compressibility factor chart for Natural Gas as a function of reduced pressure and temperature

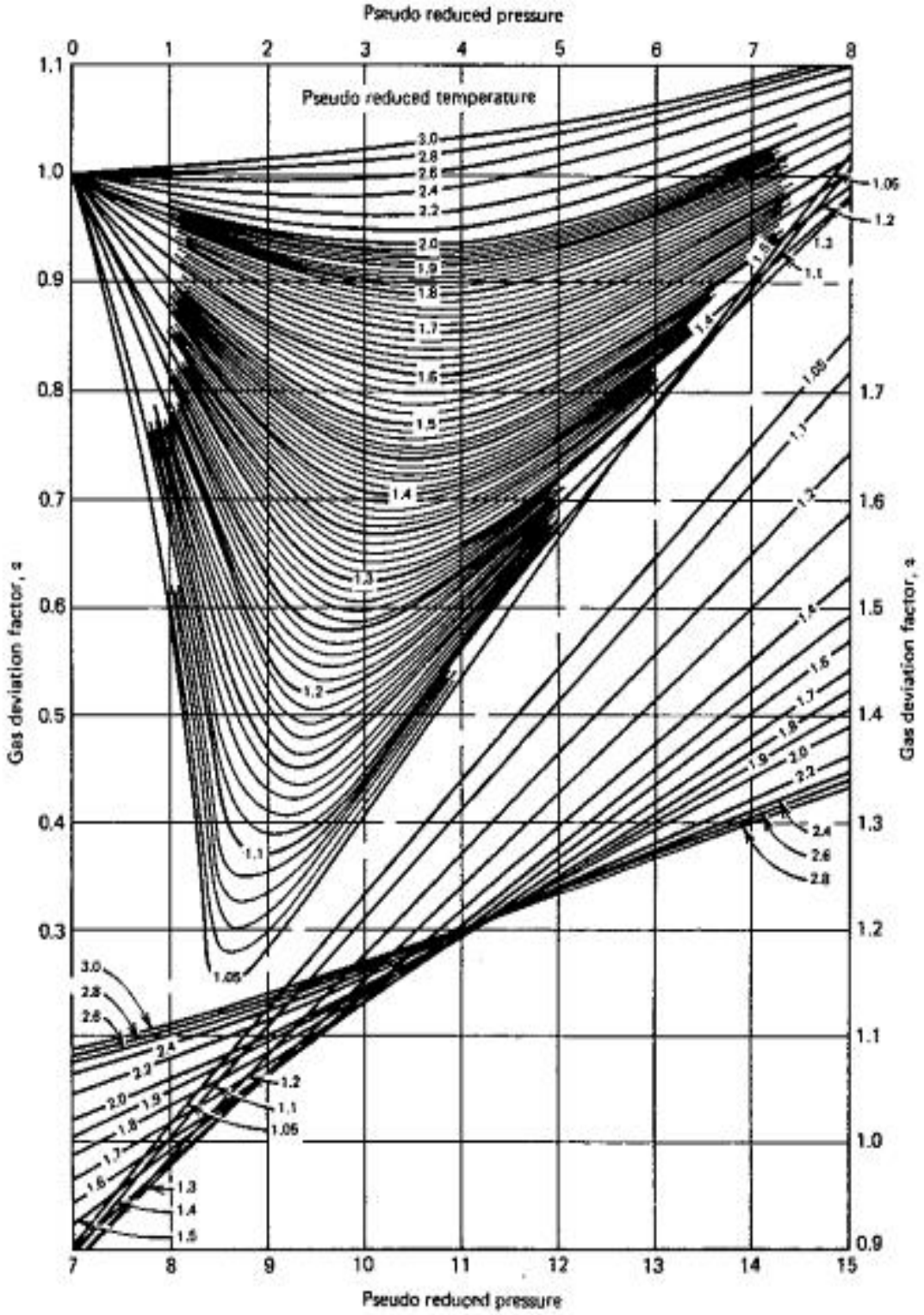
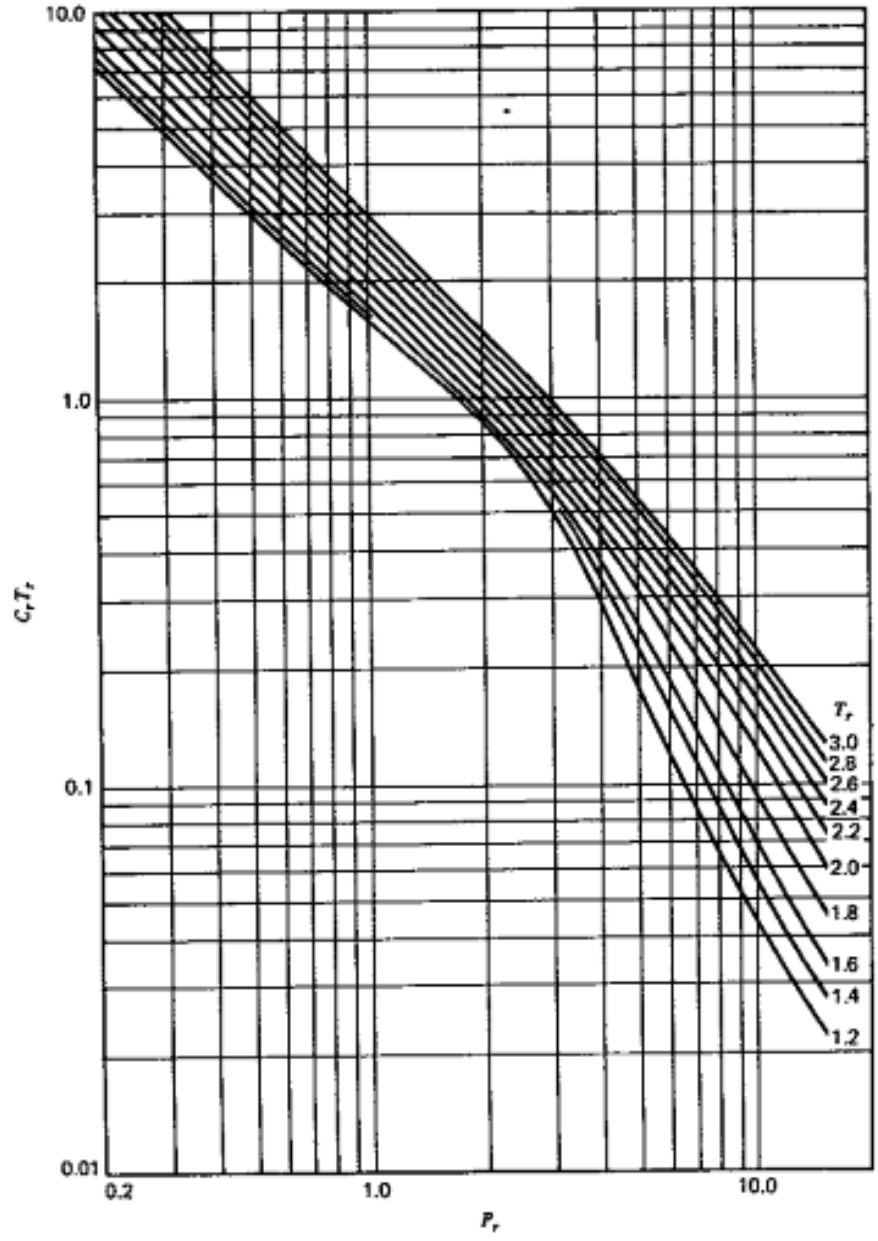


Figure 2: Variation of C_rT_r with reduced temperature and pressure



Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Programme Name: B. Tech (APEU) **Semester : V**
Course Name : Natural Gas Engineering **Time : 03 hrs**
Course Code : PTEG 362 **Max. Marks : 100**
Nos. of page(s) : 4
Instructions:

- "**Section A**" have 5 questions of 4 marks each. All question in this section are compulsory.
- "**Section B**" have 4 questions of 10 marks each, out of which 3 questions are compulsory and 1 question have internal choice to attempt any one.
- "**Section C**" have 2 questions of 20 marks each, out of which 1 question is compulsory and 1 question have internal choice to attempt any one.
- All the relevant data and figure are provided with the paper.

SECTION A

S. No.		Marks	CO
Q1.	Define viscosity of gases. Explain its relevance.	**(4)**	**CO1**
Q2.	How qualitative understanding of phase behavior helps in understanding the gas reservoirs?	**(4)**	**CO2**
Q3.	Write the characteristics of isothermal compression process.	**(4)**	**CO3**
Q4.	Explain rangeability of flow devices with the help of example.	**(4)**	**CO4**
Q5.	Write the advantages and disadvantages of vertical separators.	**(4)**	**CO5**
	SECTION B		
Q6.	At a pressure of 2500 psia and reservoir temperature of 180^0F, the gas deviation factor for the sour natural gas is 0.85. Calculate the gas formation volume factor and the gas expansion factor	**(10)**	**CO1**
Q7.	The Watson's characterization factor and boiling point of the petroleum fraction are 10 and 271^0F respectively. Calculate the molecular weight of the petroleum fraction.	**(10)**	**CO2**

Q8.	A reciprocating compression system is to be designed to compress 5 MMcfd of an ideal gas from 100 psia and 150^0F to 2500 psia. The compression system uses intercoolers and an after-cooler to cool the gas to 150^0F. The gas has the following composition in mole %: C1 = 92.16, C2 = 4.88, C3 = 1.85, i-C4 = 0.39, n-C4 = 0.55, i-C5 = 0.17. The isentropic exponent (k) = 1.2565. Calculate the brake horsepower using analytical method for each stage.	**(10)**	**CO3**
Q10.	Explain the working principle of orifice meter with the help of neat schematic diagram. OR Explain the working principle of venturimeter with the help of neat schematic diagram.	**(10)**	**CO4**
SECTION-C			
Q11.	**a)** What are Mollier charts? Explain them using line diagram. **b)** Draw the different types of pressure tap locations used in orifice metering system and label them.	**(20)**	**CO3 + CO4**
Q12.	Drive an expression for the size of the droplet that can be removed by the centrifuge separator. OR Drive an expression for the size of the droplet that can be removed in a gravity-settling chamber.	**(20)**	**CO5**

Table 1: Physical Constants for Natural Gas Constituents

Compound	Molecular Weight	Critical Pressure (psia)	Critical Temp. (°R)	Crit. Comp. Factor (Z_c)
CH_4	16.043	667.8	343.1	0.289
C_2H_6	30.070	707.8	549.8	0.285
C_3H_8	44.097	616.3	665.7	0.281
n-C_4H_{10}	58.124	550.7	765.4	0.274
i-C_4H_{10}	58.124	529.1	734.7	0.283
n-C_5H_{12}	72.151	488.6	845.4	0.262
i-C_5H_{12}	72.151	490.4	828.8	0.273
n-C_6H_{14}	86.178	436.9	913.4	0.264
n-C_7H_{16}	100.205	396.8	972.5	0.263
n-C_8H_{18}	114.232	360.6	1023.9	0.259
n-C_9H_{20}	128.259	332.0	1070.4	0.251
n-$C_{10}H_{22}$	142.286	304.0	1111.8	0.247
N_2	28.013	493.0	227.3	0.291
CO_2	44.010	1070.9	547.6	0.274
H_2S	34.076	1306.0	672.4	0.266
O_2	31.999	737.1	278.6	0.292
H_2	2.016	188.2	59.9	0.304
H_2O	18.015	3203.6	1165.1	0.230

Figure 1: Compressibility factor chart for Natural Gas as a function of reduced pressure and temperature