Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A Constituent Institution of MAHE, Manipal)

VII SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2020

SUBJECT: NATURAL GAS ENGINEERING [CHE 4001]

REVISED CREDIT SYSTEM

(30/12/2020 - FN)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions. Read the questions carefully.
- Missing data may be suitably assumed.
- Refer formulae sheet

<table>
<tr><td>1A.</td><td>Explain anticlinal structural trap reservoir using rough sketch? Why to study hydrocarbon phase behaviour and explain PT behaviour of the volatile oil type fluid reservoir?</td><td>6</td></tr>
<tr><td>1B.</td><td>A well produces 0.8 specific gravity natural gas; Calculate the compressibility factor ‘z’ for the following gas composition using Brill-Beggs Method at 140^0F and 800 psig</td><td>4</td></tr>
<tr><td>2A</td><td>Write the mechanical energy balance equation for single phase flow along the tubular string and explain terminology used clearly? Explain the Moody friction factor and fanning Friction factor?</td><td>4</td></tr>
<tr><td>2B.</td><td>A gas well produces 0.65 specific gravity natural gas. The average reservoir pressure is 4,505 psia. Reservoir temperature is 180 °F. The well was tested at two flow rates:
<table>
<tr><th></th><th>Test Point 1</th><th>Test Point 2</th></tr>
<tr><td>Flow rate</td><td>1,152 Mscf/d</td><td>1,548 Mscf/d</td></tr>
<tr><td>Bottom-hole pressure</td><td>3,025 psia</td><td>1,685 psia</td></tr>
</table>
Estimate the deliverability of the gas reservoir under a pseudo-steady state flow condition at a flowing bottom-hole pressure of 2800 psia using the backpressure model with pressure-squared approach.</td><td>3</td></tr>
<tr><td>2C.</td><td>Explain sonic and subsonic flow regime using the typical choke performance curve?</td><td>3</td></tr>
<tr><td>3A.</td><td>How to perform the Nodal analysis at the bottomhole node. Write the procedure in detail.</td><td>4</td></tr>
<tr><td>3B.</td><td>Explain the well deliverability testing methods in detail with the help of schematics.</td><td>6</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

4A.	Derive radial flow basic equation of a single phase, compressible fluid through porous and permeable rock $\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial p}{\partial r}\rho\right)=\frac{\varphi\mu c_t}{k}\rho\frac{\partial p}{\partial t}$; State the assumptions used clearly	**6**
4B.	For the following testing data: Bottom hole pressure: 2200 psia Production rate : 400 stb/day Reservoir pressure: 6100 psia Calculate the productivity index (J)	**4**
5A.	Explain the reciprocating and centrifugal compressors using schematic?	**5**
5B.	Explain liquid loading using schematic?	**5**

Formulae Sheet

☑ **Pseudocritical Properties**

$$P_{pc}=709.604-58.718\gamma_g$$

$$T_{pc}=170.491+307.344\gamma_g$$

☑ **Compressibility Factor: Brill and Beggs' Correlation Constants**

$$A=1.39(T_{pr}-0.92)^{0.5}-0.36T_{pr}-0.1$$

$$B=(0.62-0.23T_{pr})P_{pr}+\left(\frac{0.066}{T_{pr}-0.86}-0.037\right)P_{pr}^2+\frac{0.32P_{pr}^6}{10^{9(T_{pr}-1)}}$$

$$C=0.132-0.32\log(T_{pr})$$

$$D=10\text{^}(0.3106-0.49T_{pr}+0.1824T_{pr}^2)$$

☑ **Pseudosteady state flow IPR for radial flow gas reservoir using pressure square approach and pressure approach**

$$q=\frac{kh\left[\bar{p}^2-p_{wf}{}^2\right]}{1424\bar{\mu}\,\bar{z}\,T\left[\ln\left(\frac{0.472r_e}{r_w}\right)+s+Dq\right]}$$

$$q=\frac{kh\left[\bar{p}-p_{wf}\right]}{141.2X10^3\bar{B}_g\,\bar{\mu}\left[\ln\left(\frac{0.472r_e}{r_w}\right)+s+Dq\right]}$$

☑ **Gas Reservoir Deliverability: Empirical Models (Forchheimer and Backpressure model)**

$$\bar{p}^2-p_{wf}^2=Aq+Bq^2 \qquad q=C(\bar{p}^2-p_{wf}^2)^n$$

☑ **Wellbore Performance: The Average Temperature and Compressibility Factor Method**

$$p_{wf}^2=Exp(s)p_{hf}^2+\frac{6.67X10^{-4}[Exp(s)-1]fq_{sc}^2\bar{z}^2\bar{T}^2}{d_i^5\cos\theta} \qquad s=\frac{0.0375\gamma_g L\cos\theta}{\bar{z}\bar{T}}$$