Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – December 2025

Date: 13 – 12- 2025 **Time:** 01:00pm – 04:00pm

School: SOE	**Program:** B.Tech.-PET	
Course Code: PET3009	**Course Name:** Natural Gas Reservoir Engineering	
Semester: VII	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**10**	**4**	**32**	**28**	**26**

Instructions:

(i) Read all questions carefully and answer accordingly.
(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1.	State ‘Active Water Drive’ in the gas reservoir.	**2 Marks**	**L1**	**CO2**
2.	Describe ‘Energy Plot’ in a volumetric gas reservoir.	**2 Marks**	**L1**	**CO2**
3.	Define the instantaneous (nominal) decline rate in decline curve analysis.	**2 Marks**	**L1**	**CO3**
4.	List the key aspects of non-Darcy flow in a gas reservoir.	**2 Marks**	**L1**	**CO4**
5.	Outline the gas reservoir conditions under which the modified isochronal test can be applied.	**2 Marks**	**L1**	**CO4**
6.	Define Absolute Open Flow Potential for a gas reservoir.	**2 Marks**	**L1**	**CO4**
7.	State ‘Multirate test’ in a gas well.	**2 Marks**	**L1**	**CO4**
8.	Describe the ‘Early Time Region’ in Horner’s Plot.	**2 Marks**	**L1**	**CO5**
9.	Tabulate the difference between the decline curve and type curve analysis.	**2 Marks**	**L1**	**CO5**
10.	List out the main reasons for the Wellbore storage effect in a gas well.	**2 Marks**	**L1**	**CO5**

Part B

Answer the Questions. **Total Marks 80M**

<table>
<tr><td>11.</td><td>a.</td><td>Describe the various natural gas reserves, their availability and their geological conditions.</td><td>5 Marks</td><td>L2</td><td>CO1</td></tr>
<tr><td></td><td>b.</td><td>Natural gas from the Morgan County, Colorado, D-Sand, has a heating value of 1,228 Btu/scf. If this gas is combusted to drive a gas turbine for a gas compressor of 1,000 hp, then estimate the required gas flow rate in MMscf/day. Assume that the overall efficiency is 30%.</td><td>5 Marks</td><td>L2</td><td>CO1</td></tr>
<tr><td colspan="6">Or</td></tr>
<tr><td>12.</td><td>a.</td><td>Extrapolate the real gas law in reservoir and standard conditions to determine the given equation, where Bg is expressed in rb/scf.:
$$B_g = 0.00504 \frac{zT}{p}$$</td><td>4 Marks</td><td>L2</td><td>CO1</td></tr>
<tr><td></td><td>b.</td><td>For the gas composition given in the following table from C1 to C4, estimate the apparent molecular weight, specific gravity, pseudo-critical pressure, and pseudocritical temperature of the gas.
<table>
<tr><th>Component</th><th>Mole Fraction (yi)</th></tr>
<tr><td>C1</td><td>0.775</td></tr>
<tr><td>C2</td><td>0.083</td></tr>
<tr><td>C3</td><td>0.021</td></tr>
<tr><td>i-C4</td><td>0.006</td></tr>
<tr><td>n-C4</td><td>0.002</td></tr>
</table>
Consider the following equations:
$$p_{pc} = 709.604 - 58.718\gamma_g$$
$$T_{pc} = 170.491 + 307.344\gamma_g,$$
which are valid for H_2S < 3%, N_2 < 5%, and total content of inorganic compounds less than 7%.</td><td>6 Marks</td><td>L2</td><td>CO1</td></tr>
</table>

<table>
<tr><td>13.</td><td>Illustrate the main conceptual ideas and uses of the ‘Fetkovich Decline Type Curve’. Also, classify two important features of modern decline analysis that improve upon the traditional techniques.</td><td>10 Marks</td><td>L3</td><td>CO3</td></tr>
<tr><td colspan="5">Or</td></tr>
<tr><td>14.</td><td>Demonstrate the main conceptual ideas and uses of the ‘Carter Decline Type Curve’. Also classify four specially defined dimensionless parameters of the type curve presented by Carter.</td><td>10 Marks</td><td>L3</td><td>CO3</td></tr>
</table>

15.	**a.**	Classify the pros and cons of using Decline Curve Analysis.	**5 Marks**	**L3**	**CO3**
	b.	Demonstrate the objectives and assumptions taken for Decline Curve Analysis.	**5 Marks**	**L3**	**CO3**
Or					
16.		Sketch all three types of Arp's Model along with mathematical terms expressing i) flow rate with nominal decline rate and Arp's exponent, ii) cumulative gas production and iii) EUR.	**10 Marks**	**L3**	**CO3**

17.		The following production data are available from a dry gas field:	**10 Marks**	**L3**	**CO3**

Q_t (MMscf/day)	**Gp (MMscf)**	**Q_t (MMscf/day)**	**Gp (MMscf)**
320	16000	208	304000
336	32000	197	352000
304	48000	184	368000
309	96000	176	384000
272	160000	184	400000
248	240000		

Estimate:

(a) The future cumulative gas production when the gas flow rate reaches 90 MMscf/day

(b) Extra production and time to reach 90 MMscf/day

Or					
18.		Illustrate $q_t = \frac{q_i}{(1+bD_it)^{\frac{1}{b}}}$ in exponential decline form of flow rate. An exponential decline curve is to be used to estimate the oil reserves of a well. The current oil production rate is 1000 m^3 per day and yearly decline rate is 6% per year. Suppose the minimum oil flow rate economically sustainable for the well is 2 m^3 per day. In that case, determine the reserves (economically producible) associated with the well (m^3) (rounded off to two decimal places. Use 1 year = 365 days) and time period of production in years.	**10 Marks**	**L3**	**CO3**

19.	**a.**	Demonstrate the pressure profile and flow rate with respect to the time period for the Pressure Drawdown and Pressure Build Up Test of a gas well.	**10 Marks**	**L3**	**CO4**
	b.	Classify and the various gas transient tests based on the determination of reservoir parameters and test type (single well or multiple well).	**10 Marks**	**L3**	**CO4**
Or					

20.

A vertical gas well has been producing at a constant rate of 5 MMCFD for 20 days, after which it is shut-in to perform a pressure buildup test. The shut-in pressure is recorded over time.

The well and reservoir data are:

- Flowing bottom-hole pressure before shut-in = 2700 psi
- Reservoir thickness, h = 50 ft
- Wellbore Radius = 0.25 ft
- Porosity = 0.15
- Gas viscosity = 0.01 cp
- Total compressibility = 1×10^{-5} psi^{-1}
- Gas formation volume factor = 0.005 res ft^3/scf
- After analysing the semilog plot (pressure vs. log time after shut-in), the slope is found to be 50 psi per log cycle.
- Using the Horner plot, the reservoir pressure at a unity time ratio is extrapolated and found to be 3000 psi.
- The observed pressure at 1 hour shut-in (from the Horner plot) is 2800 psi.

Using these data, calculate the following:

1. The permeability of the reservoir (in md).
2. The skin factor and determine the nature of the wellbore.
3. The pressure drop caused by the skin effect.
4. The flow efficiency of the well.
5. The radius of investigation (in ft) after 20 days of shut-in.

Assume steady-state flow and isothermal conditions. Use the gas flow equations for pressure buildup tests, and consider the total shut-in time (after shut-in) to be 480 hours.

20 Marks

L3

CO4

21.

A modified isochronal test was conducted on a gas well located in a reservoir that had average wellhead and reservoir pressures of 2388 psia and 3700 psia, respectively. The well was flowed on four choke sizes: 16, 24, 32, and 48 inches. The flow rate, wellhead, and flowing bottom-hole pressures were measured at 6 hr for each choke size. An extended test was conducted for a period of 24 hr at a rate of 6.148 mmscf/d, at which time the Wellhead and flowing bottom-hole pressures were measured at 1015 and 1727 psia, respectively.

Sequence of test	**Duration (hr)**	**Bottom-hole Pressure (psia)**	**Choke Size (inches)**	**Flow Rate (mmscf/d)**
Initial shut-in	147.12	3700	-	-
Flow 1	6	3144	16	2.397
Shut-in	6	3700	-	-
Flow 2	6	2566	24	5.214
Shut-in	6	3700	-	-
Flow 3	6	2158	32	6.144
Shut-in	6	3698	-	-
Flow 4	6	1836	48	7.186
Shut-in	22.75	3690	-	-
Extended	24	1727	32	6.148

Calculate the value of the Performance constant and AOF both theoretically and graphically.

20 Marks

L4

CO5

Or

22. The following table presents data obtained from an Isochronal Test conducted on a gas well. During the test, the well was flowed at different rates for specified durations, followed by shut-in periods that allowed the well pressure to stabilize. The stabilized shut-in pressure (p_{ws}) and flowing bottom-hole pressure (p_{wf}) were recorded, and the corresponding gas flow rates (q_g) were measured.

Test	**Duration (hr)**	**p_{ws} or p_{wf} (psi)**	**Q_{sc} (mmscfd)**
Initial shut-in	48	1952	
First flow	12	1761	2.6
First shut-in	15	1952	
Second flow	12	1694	3.3
Second shut-in	17	1952	
Third flow	12	1510	5.0
Third shut-in	18	1952	
Fourth flow	12	1320	6.3
Extended flow	72	1151	6.0
Final shut-in	100	1952	

Compare the resultant Q_{max} and Performance Constant both graphically and theoretically by gas flow equations.

20 Marks **L4** **CO5**