

Code No: 157EW

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**B. Tech IV Year I Semester Examinations, February/March - 2022****NATURAL GAS ENGINEERING****(Mechanical Engineering)****Time: 3 Hours****Max. Marks: 75****Answer any five questions
All questions carry equal marks**

- 1.a) Draw the graph of viscosity, B_g , C_g and Z factors versus pressure and explain briefly.
- b) Given the natural gas gravity to air $g_g = 0.75$, the pseudocritical pressure, p_{pc} and temperature, T_{pc} are 667 psi and 405 R, respectively. If the pressure and temperature are 1,500 psi and 20^oF, respectively, calculate how many lb of gas can fit in 1,000 ft³ of space? At what pressure increase would the mass increase by 50%, if the temperature remains constant? ($Z=0.51$) [7+8]
- 2.a) Explain briefly the natural gas composition and phase behavior.
- b) Use the real gas law to calculate the volume of 5 lb-mol of a gas mixture at reservoir conditions of $T = 180^{\circ}\text{F}$ and $p = 4,000$ psi. Assume that this natural gas has the following molar composition: $C_1 = 0.874$, $C_2 = 0.083$, $C_3 = 0.022$, $i-C_4 = 0.006$, $n-C_4 = 0.002$, $iC_5 = 0.008$, $n-C_5 = 0.003$, $n-C_6 = 0.001$ and $C_{7+} = 0.001$. [7+8]
- 3.a) Explain the nodal analysis with the Bottom hole node of a gas well for identification of operating points.
- b) Describe briefly the gas well inflow under non-Darcy flow. [9+6]
- 4.a) A gas well produces from a reservoir whose pressure is 3,150 psi, and the reservoir temperature is 148^o F. Gas specific gravity is 0.61 with no sour gases. The net pay is 50 ft. The damage skin factor is equal to 5 and the reservoir permeability is 20 md. The non-Darcy coefficient D is $1.5 \text{ E-3 (Mscf/d)}^{-1}$. Calculate the rate of the well at $p_{wf} = 1,200$ psi assuming pseudo steady state. Also assume that: $\ln(0.472 r_e / r_w) = 7$. What is the apparent skin at that rate? What would be the miscalculated rate if the non-Darcy effects were ignored?
- b) Explain in detail the Unified Fracture Design (UFD). [9+6]
- 5.a) Explain briefly the principle pipeline applications for gel pigs.
- b) Consider a 6-in. pipeline that is 20 miles long. Assuming that the compression and delivery pressures will maintain unchanged, calculate gas capacity increases by using the following measures of improvement: i) replace 10 miles of the 8-in. pipeline by a 6-in. pipeline segment; ii). Place an 8-in. parallel pipeline to share gas transmission. [6+9]

- 6.a) Which conditions are tends to promote the formation of natural gas hydrates in gas pipeline?
b) Natural gas must be delivered as CNG to a destination located 600 nautical miles away from a shipping point at a rate of 500 MMscf/d. What CNG fleet should service this market? Assume that the maximum loading and offloading rate is 150 MMscf/d, the time needed to connect or disconnect to facilities is 1 hour, the sailing velocity is 14 knots, and that 4% of natural gas loaded is consumed as fuel. [6+9]
- 7.a) Describe in detail the entropy analysis of the APCI process with neat diagram.
b) Calculate the mass of methanol (in lb) that can be produced from 4 Bcf of natural gas. Assume that it is all methane. How many pounds of oxygen would be required? [7+8]
- 8.a) What are the alternatives to natural gas fired electricity?
b) Calculation of the average wind velocity to generate 1 MW of power Assuming a power coefficient $c_p = 0.4$, a rotor diameter 54 m, and $\rho \approx 1.2 \text{ kg/m}^3$. [6+9]

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