

Key

PETE 301

Exam A

October 4, 2004

(Turn in your 1 cheat sheet with your exam. Show your work. Show the units, if appropriate.)

1. (15 points) We want to estimate the error of the inside volume of a joint of casing. The inside diameter, d , is 5.5 inches \pm 0.43 %. The length of a joint is 31 ft \pm 0.5 ft. Calculate the inside volume of a joint of casing (ft^3). Indicate the relative error in %. Show all the steps.

$$V = \pi \frac{d^2}{4} L = \frac{\pi}{4} \left(\frac{5.5}{12}\right)^2 (31) = \boxed{5.11 \text{ ft}^3}$$

$$\begin{aligned} dV &= \left| \frac{dV}{dd} d(d) \right| + \left| \frac{dV}{dL} dL \right| = \left| \frac{\pi 2dL}{4} (0.0043 \frac{5.5}{12}) + \left(\frac{\pi}{4} (d)^2 \right) (0.5) \right| \\ &= \frac{\pi}{4} 2 \left(\frac{5.5}{12} \right) (31) (0.0043 \frac{5.5}{12}) + \frac{\pi}{4} \left(\frac{5.5}{12} \right)^2 (0.5) \\ &= 0.044 + 0.082 = 0.126 \text{ ft}^3 \end{aligned}$$

$$\text{rel. err.} = \frac{0.126}{5.1} \times 100 = 2.47 \%$$

2. (15 points) Suppose an equation of state is written in following nonlinear "Z-factor form":

$$f(z) = z^3 + 2.3z - 1.7 = 0$$

Use Newton's method to find the root, starting from $z = 1.000$ (we will call it the zero-th approximation of the root). Carry out only the first iteration step and give the first approximation of the root. (Do not continue the iteration process!)

$$-5 \quad f(1) = (1)^3 + 2.3(1) - 1.7 = 1.6$$

$$f'(z) = 3z^2 + 2.3$$

$$-5 \quad f'(1) = 3 + 2.3 = 5.3$$

$$-5 \quad z_{2,1} = z_1 - \frac{f(z_1)}{f'(z_1)} = 1 - \frac{1.6}{5.3} = \boxed{0.698}$$

5. (20 points) Suppose a gas well has a reservoir pressure, $p_r = 2,100$ psia and a wellhead flowing pressure, $p_{wh} = 250$ psia. We want to calculate the flow rate, q (Mscf/d), of this well. We have two equations and know that both equations must have the same bottomhole flowing pressure, p_{wf} . We can use this to set up a root-finding problem in the form $f(q) = 0$.

The reservoir equation: $q = 0.00035 (p_r^2 - p_{wf}^2)$

The tubing equation: $q^2 = 74 (p_{wf}^2 - p_{wh}^2 - 80,000)$

(a) set up the root-finding equation, $f(q) = 0$, then (b) calculate $f(0)$. [Hint: $f(q)$ must only have one unknown, q]

(a) Reservoir equation: $(p_{wf})_{res} = \sqrt{p_r^2 - \frac{q^2}{0.00035^2}}$

Tubing equation: $(p_{wf})_{tub} = \sqrt{\frac{q^2}{74} + p_{wh}^2 + 80,000}$

$$f(q) = \sqrt{p_r^2 - \frac{q^2}{0.00035^2}} - \sqrt{\frac{q^2}{74} + p_{wh}^2 + 80,000} = 0$$

(b)

$$f(0) = \sqrt{p_r^2} - \sqrt{p_{wh}^2 + 80,000}$$

$$= \sqrt{2100^2} - \sqrt{250^2 + 80,000} = 2100 - 377.5$$

$$= \boxed{1722.5}$$

6. (20 points) The following VBA code calculates the minimum of (x,y) by using function call minimum.

Answer the following questions:-

- 1- Mark the errors in this program.
- 2- Pencil in the corrections.
- 3- What local variables are declared in this program? *x, y*
- 4- What public variables are declared in this program? *d*
- 5- Read x from column A, row 6 in worksheet "data".
- 6- Read y from column A, row 7 in worksheet "data".
- 7- Write the value of d in column C, row 2 in worksheet "Output".
- 8- Will the function minimum return two values or one value? *one*

5
5
2
1
2
2
2
1

Option Explicit
Dim d As Double

Sub minnumber()
Dim x As Integer, y As Integer
Worksheets("data").Cells(1, 6) = x
Worksheets("data").Cells(2, 7) = y
End with

d = minimum(x, y)
Worksheets("Output").Cells(3, 2) = d

End Sub

Function minimum(x As Double, y As Double) As Double

If (x < y) Then
minimum = x

Else
minimum = y

End

End Function