INDIAN INSTITUTE OF TECHNOLOGY GANDHINAGAR

MA 202: MATHEMATICS - IV
Semester–II, Academic Year 2022-23
Tutorial Set -1

Instructions

- In this tutorial set, problems 1 and 3 need to be worked on during the tutorial session and **problems 2 and 4 have to be submitted. The deadline for submitting solutions is 11:59 pm on the Sunday, 3rd April**. The extra time is provided so that students will have necessary time to prepare a very good report and upload all the files, and submit.
- You should write a computer program to solve the equations. You may use MATLAB or python.
- The report must be in **PDF format**. Please upload the report and program files separately (that is, please do NOT submit all of them together as a single ZIP file). **Solutions to each problem should be submitted as a separate file**. Name each file as: Tutorialproblemnumber_Rollnumber.***. For example, if your roll number is 19110110 and for problem T1, name your report file as T1_20110110.pdf and program file as T1_20110110.m.

---

1. The Redlich-Kwong equation of state is given by

$$p = \frac{RT}{v-b} - \frac{a}{v(v+b)\sqrt{T}},$$

where R = the gas constant [= 0.518 kJ/(kg K)], T = absolute temperature (K), p = absolute pressure (kPa), and v = the specific volume of a kg of gas (m^3/kg). The parameters a and b are calculated by

$$a = \frac{0.427R^2T_c^{2.5}}{p_c}, \qquad b = 0.0866R\frac{T_c}{p_c},$$

where p_c = critical pressure (kPa) and T_c = critical temperature (K). You are asked to determine the amount of methane fuel (p_c = 4580 kPa and T_c = 191 K) that can be held in a 3-m^3 tank at a temperature of -50°C with a pressure of 65,000 kPa. Use the bisection method of your choice to calculate v and then determine the mass of methane contained in the tank.

2. Develop a fixed point iteration scheme to find the root of any given number X. Also find the root using Newton's method.

3. The Manning equation may be written for a rectangular open channel as:

$$Q = \frac{\sqrt{S}(BH)^{5/3}}{n(B+2H)^{2/3}}$$

where Q is the flow rate (m^3/s), S is the slope (m/m), H is the depth (m) and n is the Mannin roughness coefficient. Solve the above equation for H, when $Q = 5$, $S = 0.0002$, $B = 20$ and $n = 0.03$, using the Newton's method.

4. Use Newton's method to find the root of the equation: $e^{-0.5x}(4 - x) - 2 = 0$. Try different initial guesses and see to which root(s) do the iterations converge.