ME317
Basics of CFD
Assignment 2

1) The upward velocity of a rocket is given at three different times in Table 1.

Time, t (s)	Velocity, v (m/s)
5	106.8
8	177.2
12	279.2

The velocity data is approximated by a polynomial as

$$v(t) = a_1 t^2 + a_2 t + a_3, \qquad 5 \le t \le 12$$

The coefficients a_1, a_2, and a_3 for the above expression are given by

$$\begin{bmatrix} 25 & 5 & 1 \\ 64 & 8 & 1 \\ 144 & 12 & 1 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} = \begin{bmatrix} 106.8 \\ 177.2 \\ 279.2 \end{bmatrix}$$

Find the values of a_1, a_2, and a_3.

Find the velocity at t = 6 seconds. You need to solve this problem by developing a code. Also verify the validity of the developed code.

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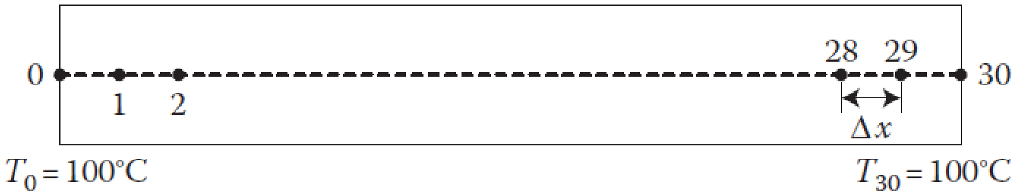
2. The temperature $T(x)$ that arises due to steady-state heat conduction in a bar 30 cm long is governed by the following ODE, if uniform temperature is assumed across any cross section:

$$\frac{d^2T}{dx^2} - GT = 0$$

where T is the temperature difference from the ambient medium, which is at 20°C, x is the axial coordinate distance, and G is a constant that depends on the surface heat transfer rate. This equation may be replaced by a finite difference approximation, using the second order central difference scheme, as

$$\frac{T_{i+1} - 2T_i + T_{i-1}}{(\Delta x)^2} - GT_i = 0$$

where $x = i\,\Delta x$. Considering 30 subdivisions of the length of the rod, with Δx = 1 cm, as shown in Figure below, find the temperature differences Ti, where i = 1, 2, . . ., 29.



The temperatures differences T_0 and T_{30}, at x = 0 and x = 30 cm, respectively, are given as 100°C, and the constant G as $(0.071)^2$ cm^{-2}.

Write a code and solve using Thomas Algorithm. Present your results both in tabular form and in graphical form (T(x) vs x). Compare the numerical results T(x) vs x with analytical results (Validation). Comment on the validity of the developed code.

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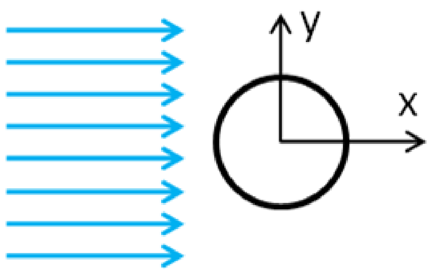
3.



Consider the steady state case of a fluid flowing past a cylinder, as illustrated above. Obtain the velocity and pressure distributions when the Reynolds number is chosen.
Set the properties, the hydraulic diameter of the geometry, the x component of the velocity and the density of the fluid, dynamic viscosity in order to obtain the desired Reynolds number (Refer the Table for corresponding problem).

Reynolds number (Re) and Shape (Circular, Square):

Sl. No.	Register No.	Shape & Re	Sl. No.	Register No.	Shape & Re
1	181232181ME105	Circle, 3	1	181738181ME190	Circle, 51
2	181528181ME106	Square, 96	2	181349181ME202	Square, 48
3	181155181ME107	Circle, 6	3	181452181ME203	Circle, 54
4	181653181ME109	Square, 93	4	181785181ME204	Square, 45
5	181287181ME111	Circle, 9	5	181527181ME206	Circle, 57
6	181210181ME112	Square, 90	6	181059181ME209	Square, 42
7	181062181ME113	Circle, 12	7	181567181ME213	Circle, 60
8	181742181ME115	Square, 87	8	181398181ME218	Square, 39
9	181513181ME116	Circle, 15	9	181590181ME219	Circle, 63
10	181261181ME117	Square, 84	10	181042181ME222	Square, 36
11	181614181ME118	Circle, 18	11	181358181ME224	Circle, 66
12	181733181ME123	Square, 81	12	181814181ME225	Square, 33
13	181090181ME124	Circle, 21	13	181472181ME227	Circle, 69
14	181537181ME125	Square, 78	14	181641181ME228	Square, 30
15	181021181ME128	Circle, 24	15	181054181ME230	Circle, 72
16	181564181ME133	Square, 75	16	181496181ME239	Square, 27
17	181761181ME134	Circle, 27	17	181286181ME241	Circle, 75
18	181285181ME136	Square, 72	18	181112181ME245	Square, 24
19	181735181ME139	Circle, 30	19	181360181ME247	Circle, 78
20	181821181ME143	Square, 69	20	181018181ME253	Square, 21
21	181137181ME152	Circle, 33	21	181680181ME254	Circle, 81
22	181072181ME160	Square, 66	22	181144181ME255	Square, 18
23	181692181ME165	Circle, 36	23	181485181ME256	Circle, 84
24	181267181ME167	Square, 63	24	181493181ME273	Square, 15
25	181633181ME172	Circle, 39	25	181223181ME275	Circle, 87
26	181817181ME174	Square, 60	26	181669181ME276	Square, 12
27	181381181ME175	Circle, 42	27	181463181ME277	Circle, 90
28	181469181ME177	Square, 57	28	181002181ME280	Square, 9
29	181820181ME180	Circle, 45	29	181309181ME283	Circle, 93
30	181248181ME181	Square, 54	30	181524181ME285	Square, 6
31	181057181ME183	Circle, 48	31	181364181ME287	Circle, 96
32	181819181ME184	Square, 51	32	181665181ME290	Square, 3

Problem no: 3: Students should use mandatorily ANSYS student version. Students can download it from ANSYS official website (www.ansys.com).
It is almost 7 – 10 GB in size.

Submission requirements:

1) Front (Cover page): Course name, Name of faculty, Name of the student, Register number, Assignment number, date of submission.

2) From second page onwards Code.

3) Results and discussions: Along with the results you give some comments about the results.

4) Compute CPU time with the help of code and include in your results.

5) Problem 3: Governing Equation, Reynold number, Shape (assigned for your registration number), Preprocessing, Solving, Post processing - Contour plots, Discussion.

Assignment submission: Assignment should be submitted in Moodle only. No email submission is allowed.