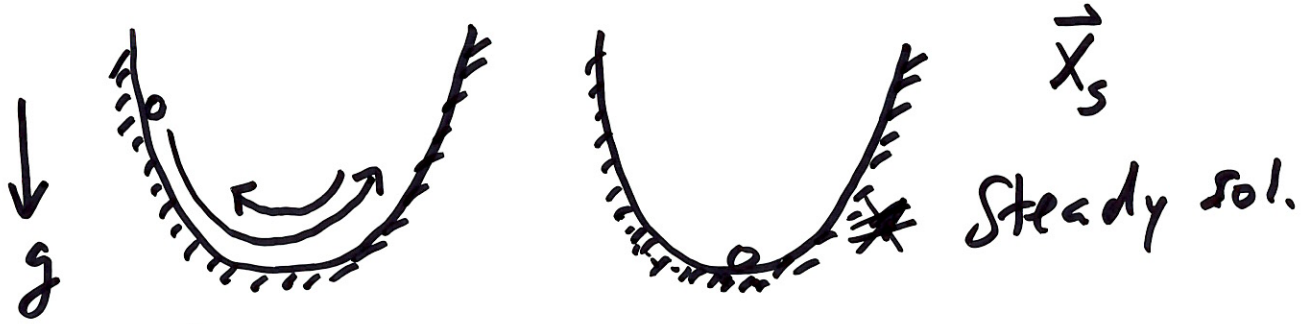
Lecture 12

9/30

Lec 11: Transient vs. steady sol.



Navier-Stokes eq. (transient) (*)

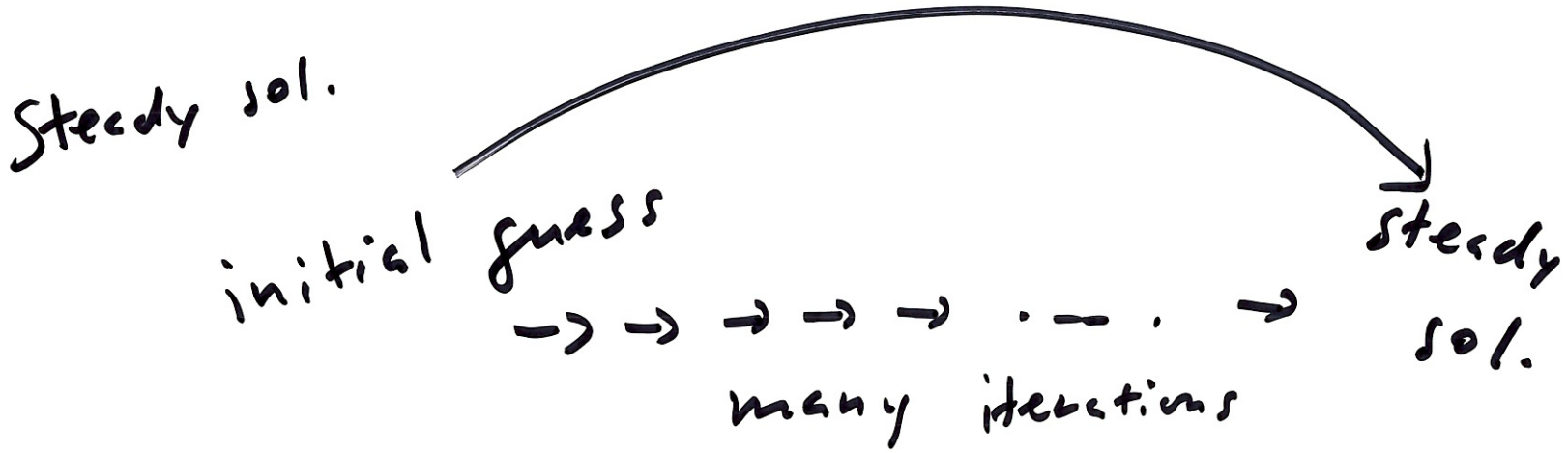
x-momentum

$$\frac{\partial u}{\partial t} = -u\frac{\partial u}{\partial x} - v\frac{\partial u}{\partial y} - w\frac{\partial u}{\partial z} - \frac{1}{\rho}\frac{\partial p}{\partial x} + \{\text{visc.}\}$$

(Steady)

$$0 = -u\frac{\partial u}{\partial x} - v\frac{\partial u}{\partial y} - w\frac{\partial u}{\partial z} - \frac{1}{\rho}\frac{\partial p}{\partial x} + \{\text{visc.}\}$$

Residual



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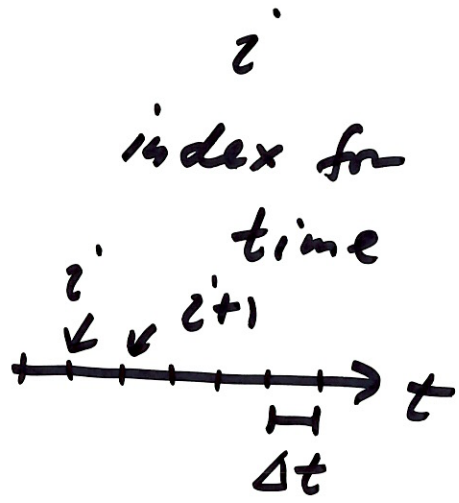
transient — discretize $\underline{t}$ in (*)

(*) → implicit scheme

$$\frac{u_{i+1} - u_i}{\Delta t} = \{ \underbrace{-u_0 \frac{\partial u}{\partial x} - v \frac{\partial u}{\partial y} \cdots}_{RHS} \}^{i+1}$$

$$u_{i+1} = u_i + \{RHS\}^{i+1} \cdot \Delta t$$



Fluent solve it iteratively within this time step (i^{th})

only need a small # of iterations

Transient sol. in Fluent

Ex: Task 2b in Proj 1

Need the sol. up to $t = 20$ min

1200 s

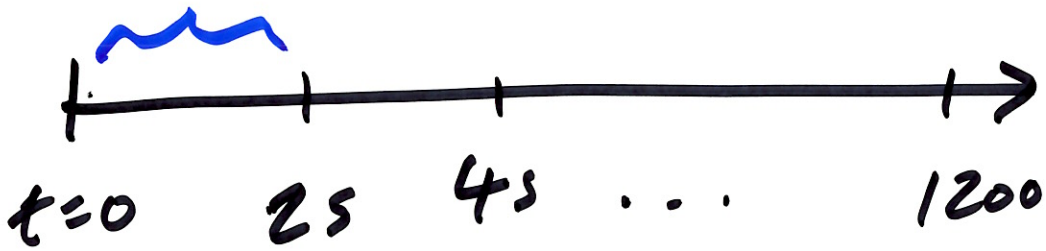
↑ initialize

2s: ith

4s: $(i+1)$th hypothetically

- time step size $\Delta t = 2$ s
- # of time step = 600
- Max # of iterations per time step

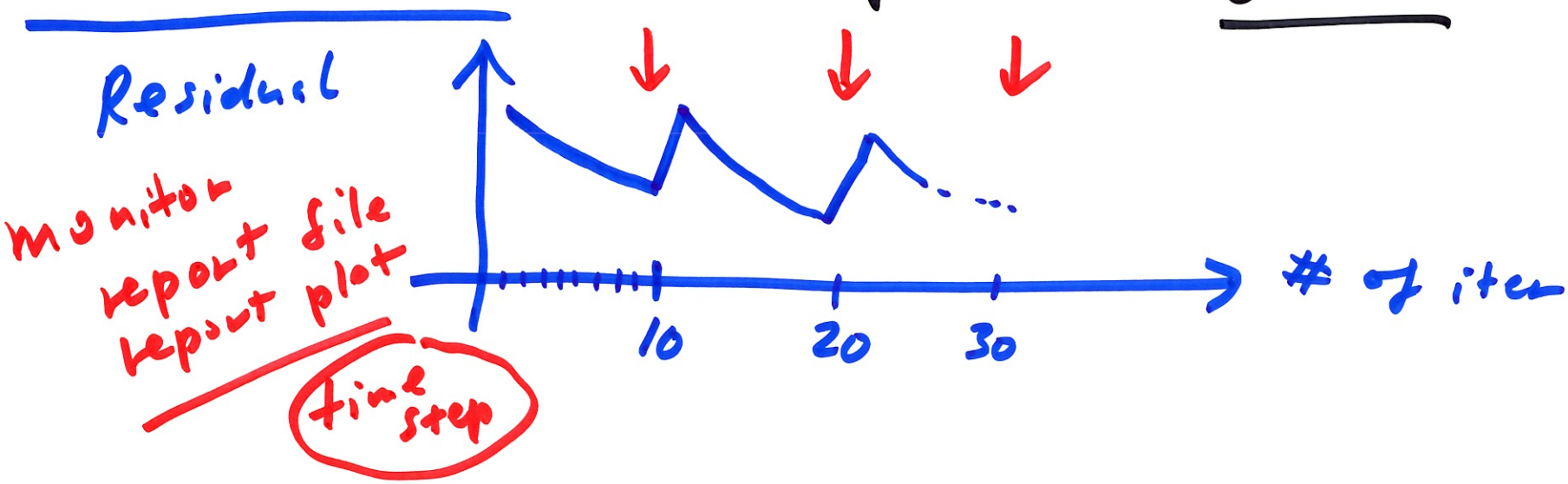
* These #s are arbitrary. DO NOT use them for Proj 1



600 time steps

say # of iter per time step ~ 10

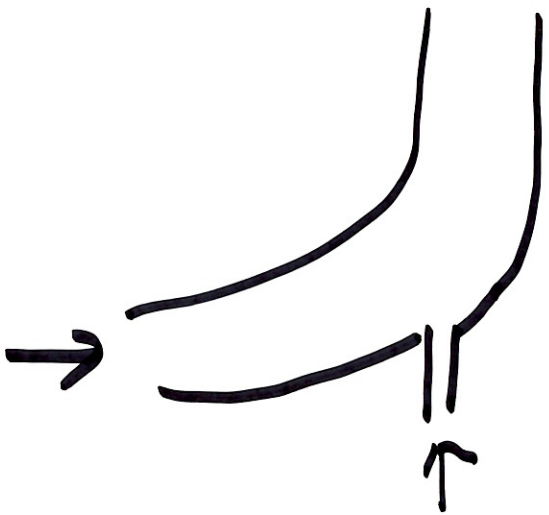
total # of iter = 6000



Demo: Tutorial #1 (Steady sol.)

↙ change to

Transient sol.



Say initialize

& T inside

as = big outlet

(t=0)

20°C

u, v, w = 0

Task 2

Outside Ansys

Matlab

data (with unit in mind)

$0 \le \tau \le 12\pi$

$X(\tau) = R\cos(\tau)$

$Y(\tau) = R\sin(\tau)$

$Z(\tau) = C\tau$

$R = 0.3\,m$

~~$R = 0.15\,m$~~

$C = \frac{0.15\,m}{2\pi}$

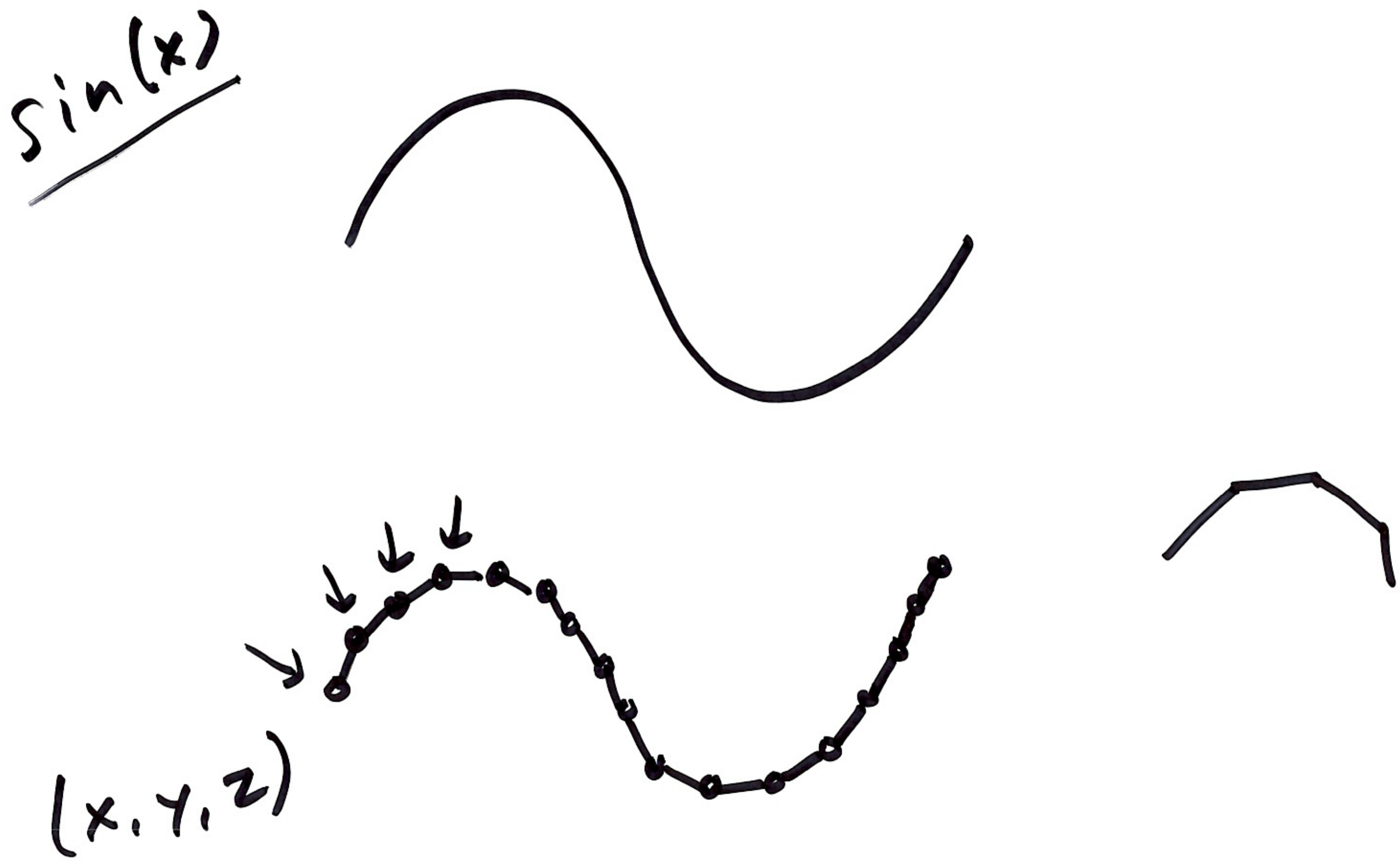
3-D curve

↓

Design Module

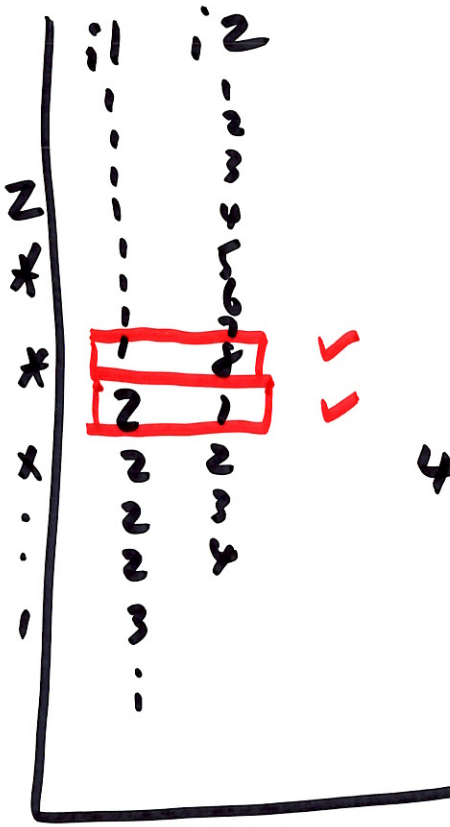
Say want to use cm

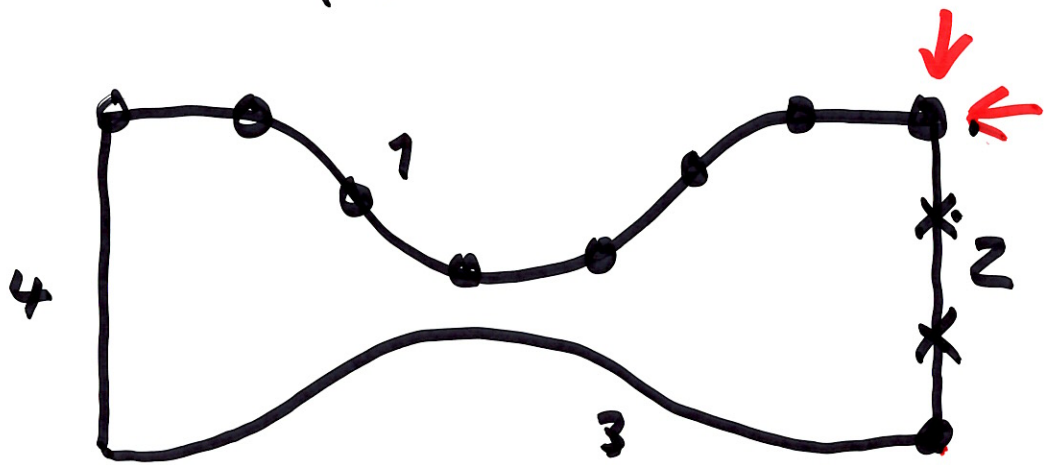
sweep

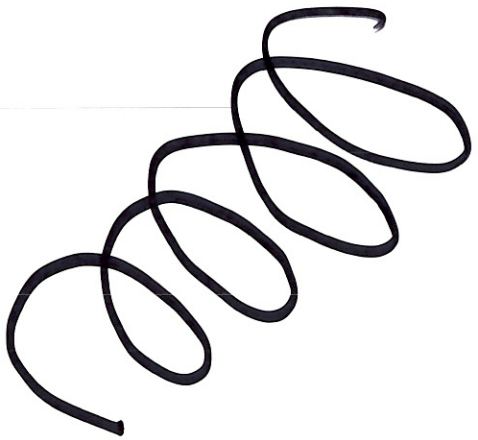

sin(x)
(x, y, z)

Format

i1	i2	X	Y
1	1	*	*
1	2	*	*
1	3	*	*
1	4	*	*
1	...	...	...
	8		
1			



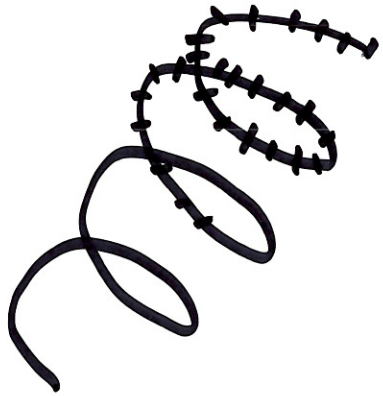




1 section

```
clear
dtau = 12*π/500;
tau = [0 : dtau : 12*pi];
R = 0.3 * 100;
C =  0.15 * 100/(2*pi);
```

Cm as unit



500 section.

501

```
X = R* cos(tau);
y = R* sin(tau);
z = C * tau;
```

```
fileID = fopen('today.txt', 'w')
i1 = 1
for i2 = 1 : length(tau)
  fprintf(fileID, '%i3  %i3  %9.6f  %9.6f  %9.6f
          \n', i1, i2, x(i2), y(i2), z(i2));
end
fclose(fileID)
```