Calculating water height in a channel

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Bernoulli equation

$$\frac{u^2}{2g} + \frac{p}{\rho g} + (z_b + h - d) = H$$

If the horizontal flow is steady and there are vertical components then

$$p = \rho g d \to \frac{p}{\rho g} = d$$

if d is h then this simplifies to

$$\frac{u^2}{2g} + h + z_b = H$$

we can equate energy $E + z_b = H$ and if we assume that $z_b = 0$ then we get relationship between the Energy and the water volume

$$E = \frac{U^2}{2g} + h$$

We assume that the channel is rectangular and that we know the energy and the amount of water that flows out

$$Q = Uwh$$

with width w=width, and h=height

$$q_w = Q/w = Uh$$

were $q_w w$ is the outflow, using $U = qw/h$ we can estimate the the height if we know the energy E and the flow rate q_w

$$E = \frac{q_w^2}{2gh^2} + h \text{ or } h^3 - Eh^2 + \frac{q_w^2}{2g} = 0$$

Simplified Bernoulli fluid equation

this equation is in the form E=f(x) for the root finding further down in the script we will need to change it to g(x)=0., for example using 0=f(x)-E

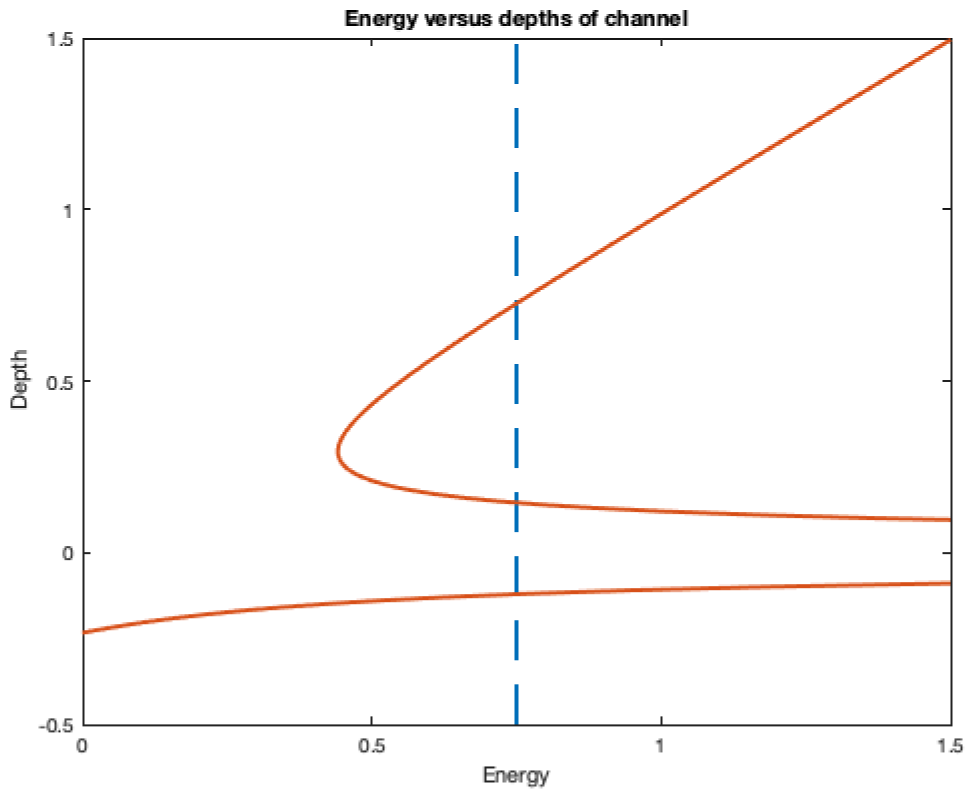
```
bfluid = @(qw,h,g) qw.^2./(2.*g.* h .* h) + h
```

```
bfluid =

  function_handle with value:

    @(qw,h,g)qw.^2./(2.*g.*h.*h)+h
```

Plot of energy x depth (h)

```
depth = -0.5:0.01:1.5;
g = 9.81
qw = 0.5
energy = bfluid(qw,depth,g);
hold off
h1 = plot(0.75 * ones(1,length(depth)),depth,'--');
hold on
h2 = plot(energy, depth);
set([h1 h2],'LineWidth',2)
title('Energy versus depths of channel');
xlabel('Energy');
ylabel('Depth');
axis([0,1.5,-0.5,1.5])
```

```
g =

   9.810000000000000


qw =

   0.500000000000000
```



Finding the height for Energy=0.75 m and for

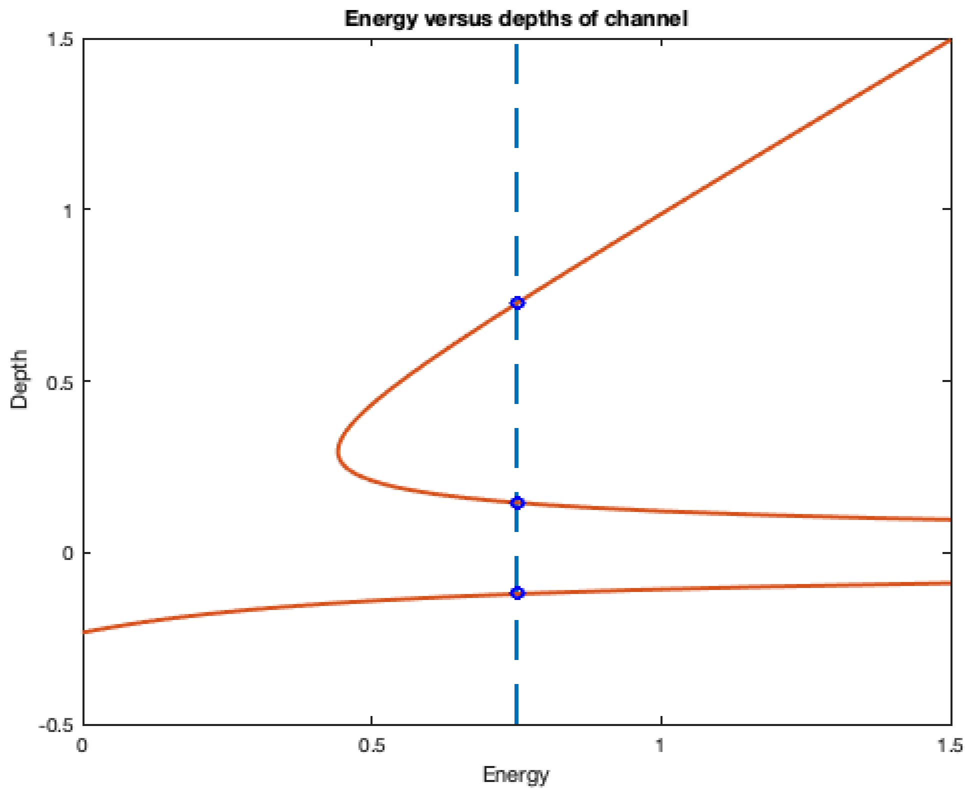
$q_w = 0.5 m^2/s$

```
energy = 0.75;
results = NaN*ones(10,1);
startingpoints=linspace(-0.5,1.5,10);
for i=1:10
results(i) = fzero(@(x) bfluid(qw,x,g)-energy,startingpoints(i));
end
```

All solutions for h :

```
results = uniquetol(results) %results(diff(results)>1e-12)
% and potting them into the graph
plot([energy energy energy],results,'bo')
```

```
results =

  -0.120954692349088
   0.145142260165042
   0.725812432184046
```



A step in the water, how does the height change, before the step

we use the E=0.8 before the step with hight difference of 0.1

```
energy1 = 0.8;
results = NaN*ones(10,1);
startingpoints=linspace(-0.5,1.5,10);
for i=1:10
results(i) = fzero(@(x) bfluid(qw,x,g)-energy1,startingpoints(i));
end
```

All solutions for h (before step):

```
results2 = uniquetol(results)
```

```
results2 =

  -0.117825793599866
   0.138823074512539
   0.779002719087326
```

A step in the water, how does the height change, during the step Δz

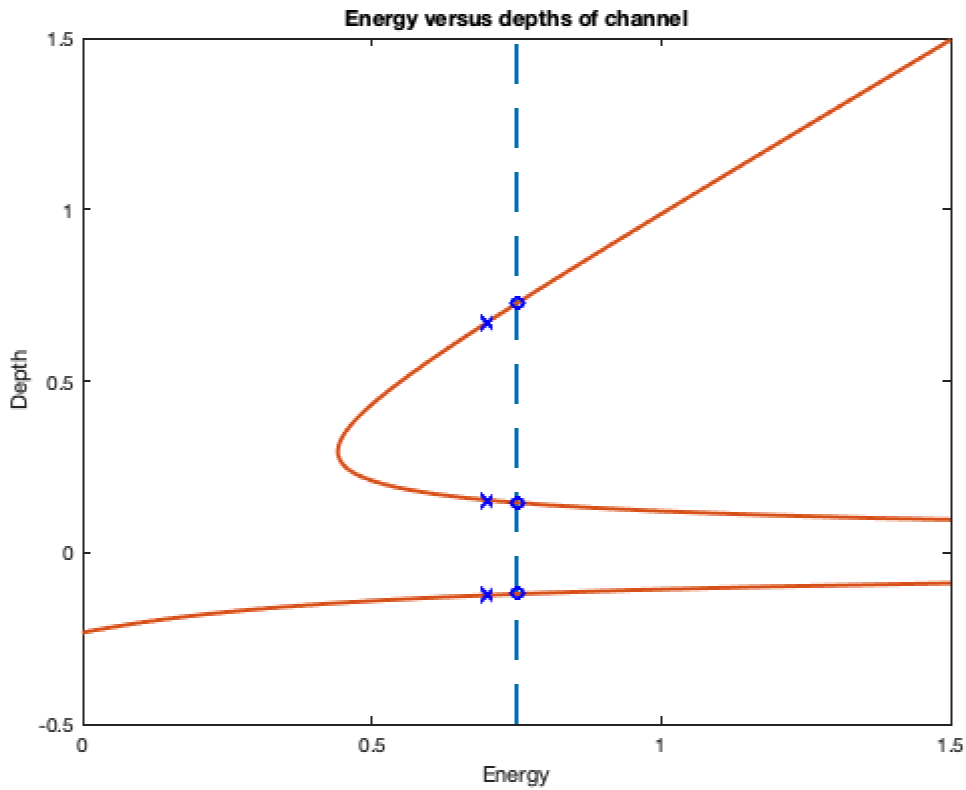
```
deltaz=0.1
energy2 = energy1-deltaz;
results = NaN*ones(10,1);
startingpoints=linspace(-0.5,1.5,10);
for i=1:10
results(i) = fzero(@(x) bfluid(qw,x,g)-energy2,startingpoints(i));
end
```

```
deltaz =

   0.100000000000000
```

All solutions for h (after step):

```
results2 = uniquetol(results) %results(diff(results)>1e-12)
plot([energy2 energy2 energy2],results2,'bx')
```

```
results2 =

  -0.124328407149284
   0.152564718059856
   0.671763689089429
```



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