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```
1 %% Implicit Euler
2 %y(n+1)=y(n)+h*(f(n,t(n))+h^2*f(y(n),t(n))/dt+O(h^3)
3 - x_d = 1.32;
4 - K = 2.40;
5 - g = 9.81;
6 - m=200;
7
8 - t=10; h=0.01;
9 - N = round(t/h,0);
10 - time=0:h:t
11 - y0 = [2;0];
12 - sigma = size(y0) + 1;
13
14 - f = @(y,t) [ y(2); -g*(1-(x_d/y(1))^K) ];
15
16 - y = zeros(size(y0,1),size(time,2));
17 - opt = optimset('Display','off','TolFun',1e-8);
18
19 - E=zeros(size(y,2));
20
21
22 - y(:,1)=1;
23
24 - for i = 1:N-1
25
26 -     y(:,1+i) = (y(:,i) + h*f(y(:,i), time(i)));
27 -     E(i)=(m*g/(K-1)) * (x_d^K/(y(1,i)^(K-1)))+m*g*y(1,i)+1/2*m*y(2,i)^2;
28 - end
29
30
31 %plot(time,y(1,:))
32
33 plot(time,E,'black')
34
```

```

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9 - time=0:h:t
0 - y0 = [2;0];
1 - sigma = size(y0) + 1;
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3 - f = @(y,t) [ y(2); -g*(1-(x_d/y(1))^K) ];
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5 - y = zeros(size(y0,1),size(time,2));
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7
8
9
0 - y(:,1)=1;
1
2
3 - for i = 1:N-1
4     %y(:,1+i) = (y(:,i) + h*feval(f, y(:,i), time(i)));
5     r = @(ynext) (y(:,i) + h*feval(f, ynext, time(i+1)) - ynext);
6     y(:,i+1) = fsolve(r, y(:,i), opt);
7     E(i)=(m*g/(K-1)) *(x_d^K/(y(1,i)^(K-1)))+m*g*y(1,i)+1/2*m*y(2,i)^2;
8 - end
9
0 - hold on;
1 - plot(time,E,'green')
2
3

```

```

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15 - y = zeros(size(y0,1),size(time,2));
16 - opt = optimset('Display','off','TolFun',1e-8);
17
18
19
20 - y(:,1)=1;
21
22
23 - for i = 1:N-1
24 -     r = @(ynext) (y(:,i) + h*feval(f, (ynext+y(:,i))/2, time(i+1)+h/2) - ynext);
25 -     y(:,i+1) = fsolve(r, y(:,i), opt);
26 -     E(i)=(m*g/(K-1)) * (x_d^K/(y(1,i)^(K-1)))+m*g*y(1,i)+1/2*m*y(2,i)^2;
27 - end
28
29 - hold on;
30 - plot(time,E,'red')
31 %plot(time,y(1,:))
32

```