FUNCTIONS

function [p,q] = pcoeff(t,n,k)

p = zeros(1,k);

for j = 1:k

f = @(x) (1);

for i = 1:k

if (i ~= j)

f = @(x) ( ( f(x).\* (x - t(n-i+1)) / (t(n-j+1)-t(n-i+1))));

end

end

p(j) = integral(f,t(n), t(n+1));

end

q = zeros(1,k);

for j = 1:k

f = @(x) (1);

for i = 1:k

if (i ~= j)

f = @(x) ( ( f(x).\* (x - t(n-i+2)) / (t(n-j+2)-t(n-i+2))));

end

end

q(j) = integral(f,t(n), t(n+1));

end

end

function [u, uHist] = ieuler(a, b, ya, f, n, p)

% a, b: interval endpoints with a < b

% n: number of steps with h = (b - a)/n

% ya: vector y(a) of initial conditions

% f: function handle f(t, y) to integrate (y is a vector)

% u: output approximation to the final solution vector y(b)

% p: extra parameters (p = [L]

h = (b - a) / n;

u = ya;

uHist = zeros(length(ya), n + 1);

uHist(:, 1) = u;

tCurr = a;

for i = 1:n

tCurr = tCurr + h;

unext = (u + h\*p(1)\*cos(30\*tCurr) - h\*sin(30\*tCurr)) / (1 + h\*p(1));

u = u + h \* f(tCurr, unext);

% Assumes u is a column vector.

uHist(:, i + 1) = u;

end

end

function [t,u] = pcode(a,b,ua,f,r,k,N)

t = zeros(N, 1);

h = (b-a) / N;

i = 1;

t(1) = a;

h1 = (b-a)\*((h/(b-a))^(k/2));

while h1 < h

i = i + 1;

t(i) = t(i-1) + h1;

h1 = h1 \* (1 + (1/k));

end

h = (b - t(i))/(N-i);

t(i:N) = linspace(t(i), b, N-i);

for n = 1:N-1

k1 = min(k,n);

if (n < i + (2\*k))

[p,q] = pcoeff(t,n,k1);

u = ua(n);

for qind = 1:k1

u(n+1) = u(n) + (q(qind + 1) \* f(n - qind + 2));

end

end

end

end

function [t,u] = solveinteq(a,b,kernel,rhs,p,n)

t = zeros(n);

u = zeros(n,1);

weights = gaussint(n);

f = rhs(t, p);

start = a;

for i = 1:n

s = (b-a)/n;

sum = 0;

for j = 1:n

sum = sum + (kernel(t, s) \* weights(j) \* u(j));

end

u(i) = rhs(i,p) - sum;

end

end

RESULTS

exp(-10) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

3.315563443764691e+00

exp(-10) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100)

ans =

1.351017381987190e-01

exp(-10) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000)

ans =

1.272709315112039e-02

exp(-10) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000)

ans =

1.265474557770374e-03

exp(-10) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000)

ans =

1.264757219953672e-04

exp(-10) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000)

ans =

1.264662753683310e-05

L = 100

L =

100

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000)

ans =

5.866294716938558e-07

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

-2.598884065309795e+09

exp(-L) + cos(30)

ans =

1.542514498875840e-01

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

-2.598884065309795e+09

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100)

ans =

2.026596072924769e-03

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000)

ans =

5.515710030109811e-04

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000)

ans =

5.833887949197036e-05

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000)

ans =

5.865466057325408e-06

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000)

ans =

5.866294716938558e-07

L = 1000

L =

1000

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

-8.859815808243370e+19

exp(-L) + cos(30)

ans =

1.542514498875840e-01

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

-8.859815808243370e+19

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100)

ans =

-2.644198454761683e+95

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000)

ans =

-6.050605095753170e-05

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000)

ans =

-5.647248582429931e-06

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000)

ans =

-5.606345839792581e-07

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000)

ans =

-5.626263388514019e-08

L = 10000

L =

10000

exp(-L) + cos(30)

ans =

1.542514498875840e-01

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

-9.880703688782323e+29

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100)

ans =

-3.658687382576944e+199

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000)

ans =

NaN

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000)

ans =

-6.852349059005558e-07

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000)

ans =

-6.806642266488083e-08

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000)

ans =

-7.042933181100608e-09

L = 100000

L =

100000

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

ans =

-9.988016059391088e+39

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100)

ans =

-9.047517329204188e+299

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000)

ans =

NaN

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000)

ans =

NaN

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000)

ans =

-6.875625041535827e-09

exp(-L) + cos(30) - euler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000)

ans =

-9.275371026795654e-10

diary off

L = 10

L =

10

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

{\_Not enough input arguments.

Error in <a href="matlab:matlab.internal.language.introspective.errorDocCallback('ieuler', '/Users/billywang/Desktop/math128a/PS06/ieuler.m', 15)" style="font-weight:bold">ieuler</a> (<a href="matlab: opentoline('/Users/billywang/Desktop/math128a/PS06/ieuler.m',15,0)">line 15</a>)

unext = (u + h\*p(0)\*cos(30\*tcurr) - h\*sin(30\*tcurr)) / (1 + h\*L);

}\_

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

{\_Array indices must be positive integers or logical values.

Error in <a href="matlab:matlab.internal.language.introspective.errorDocCallback('ieuler', '/Users/billywang/Desktop/math128a/PS06/ieuler.m', 15)" style="font-weight:bold">ieuler</a> (<a href="matlab: opentoline('/Users/billywang/Desktop/math128a/PS06/ieuler.m',15,0)">line 15</a>)

unext = (u + h\*p(0)\*cos(30\*tcurr) - h\*sin(30\*tcurr)) / (1 + h\*L);

}\_

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

{\_Undefined function or variable 'tcurr'.

Error in <a href="matlab:matlab.internal.language.introspective.errorDocCallback('ieuler', '/Users/billywang/Desktop/math128a/PS06/ieuler.m', 15)" style="font-weight:bold">ieuler</a> (<a href="matlab: opentoline('/Users/billywang/Desktop/math128a/PS06/ieuler.m',15,0)">line 15</a>)

unext = (u + h\*p(1)\*cos(30\*tcurr) - h\*sin(30\*tcurr)) / (1 + h\*L);

}\_

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

{\_Undefined function or variable 'L'.

Error in <a href="matlab:matlab.internal.language.introspective.errorDocCallback('ieuler', '/Users/billywang/Desktop/math128a/PS06/ieuler.m', 15)" style="font-weight:bold">ieuler</a> (<a href="matlab: opentoline('/Users/billywang/Desktop/math128a/PS06/ieuler.m',15,0)">line 15</a>)

unext = (u + h\*p(1)\*cos(30\*tCurr) - h\*sin(30\*tCurr)) / (1 + h\*L);

}\_

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

ans =

-1.842785701365238e+00

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100, [L])

ans =

-1.695786708793333e-01

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000, [L])

ans =

-1.686490272106236e-02

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000, [L])

ans =

-1.685478890605219e-03

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000, [L])

ans =

-1.685376215371792e-04

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000, [L])

ans =

-1.685388725336523e-05

L = 100

L =

100

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10)

{\_Not enough input arguments.

Error in <a href="matlab:matlab.internal.language.introspective.errorDocCallback('ieuler', '/Users/billywang/Desktop/math128a/PS06/ieuler.m', 15)" style="font-weight:bold">ieuler</a> (<a href="matlab: opentoline('/Users/billywang/Desktop/math128a/PS06/ieuler.m',15,0)">line 15</a>)

unext = (u + h\*p(1)\*cos(30\*tCurr) - h\*sin(30\*tCurr)) / (1 + h\*p(1));

}\_

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

ans =

-2.606112952928171e+00

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100, [L])

ans =

-2.742263613616738e-01

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000, [L])

ans =

-2.803177569508716e-02

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000, [L])

ans =

-2.809776432048799e-03

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000, [L])

ans =

-2.810440734976882e-04

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000, [L])

ans =

-2.810530476823891e-05

L = 1000

L =

1000

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

ans =

-2.834705063747324e+00

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100, [L])

ans =

-2.862036583422870e-01

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000, [L])

ans =

-2.869670339556538e-02

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000, [L])

ans =

-2.870435660894483e-03

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000, [L])

ans =

-2.870511580702062e-04

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000, [L])

ans =

-2.870543179825380e-05

L = 10000

L =

10000

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

ans =

-2.862176987619049e+00

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100, [L])

ans =

-2.865075330415557e-01

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000, [L])

ans =

-2.865842434501867e-02

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000, [L])

ans =

-2.865918652509514e-03

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000, [L])

ans =

-2.865925697760896e-04

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000, [L])

ans =

-2.865950488215030e-05

L = 100000

L =

100000

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10, [L])

ans =

-2.864979665807135e+00

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100, [L])

ans =

-2.865271175602989e-01

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000, [L])

ans =

-2.865347908556262e-02

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 10000, [L])

ans =

-2.865355523218399e-03

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 100000, [L])

ans =

-2.865355718545959e-04

exp(-L) + cos(30) - ieuler(0,1,[2], @(t,y) (-L\*(y - cos(30\*t)) - 30\*sin(30\*t)), 1000000, [L])

ans =

-2.865379831884507e-05

diary off