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%% task set B
clc
close all
h = 0.1;
t = 0:h:24;
N = 241;
T = zeros(1, N);
T(1) = 50;% Initial condition
f = @(t,T) .25*(75-T)
for n = 1:N-1
    k1 = f(t(n), T(n));
    k2 = f(t(n)+ h/2, T(n) + h*k1/2);
    k3 = f(t(n) +h/2,T(n) +h*k2/2);
    k4 = f(t(n) + h, T(n) + h*k3);
    T(n+1) =T(n) + (h/6)*(k1 +2*k2 + 2*k3 + k4);
end
T_exact = ( 75 - 25 * exp(-.25 * t))
% Plot
figure;
plot(t, T, 'ro');
hold on
plot(t ,T_exact, 'b-')
xlabel('t');
ylabel('T(t)');
legend( 'RK4 Approximation','exact');
title('RK4 ');
max(T)

%% task set C
clc
close all
grid on
t=[0:.1:24]
Mt = M - 12 * cos((pi * (t-5))/12)
M=35
T0=65
t0= Mt-T0
k=.25
T = Mt - t0 .* exp(-0.25 * t)
plot(t,T, 'b')
hold on
plot(t,Mt, 'ro')
min(Mt)
max(Mt)
min(T)
max(T)

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%% task set D
clc
close all
grid on
t=[0:.1:24]
T= (56/3) * atan(tanh((3/8) * (t-10))) + 79.6504
plot(t,T)
max(T)
min(T)

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%% task set E
clc
close all
grid on
t=[0:.1:24];
Ta=77-12 * exp(-.2 * t)
Tb=77-12 * exp(-2 * t)
Tc=77+18 * exp(-.2 * t)
Td=77+18 * exp(-2 * t)
plot(t,Ta)
hold on
plot(t,Tb)
hold on
plot(t,Tc)
hold on
plot(t,Td)

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%% task set F question 1
clc
clear all
h = 0.1;
t = 0:h:24;
N = 241;
T = zeros(1, N);
T(1) = 75;% Initial condition
f = @(t,T) 7 * sech((3/4) * (t-10)) + 2*(77-T);
for n = 1:N-1
    k1 = f(t(n), T(n));
    k2 = f(t(n)+ h/2, T(n) + h*k1/2);
    k3 = f(t(n) +h/2,T(n) +h*k2/2);
    k4 = f(t(n) + h, T(n) + h*k3);
    T(n+1) =T(n) + (h/6)*(k1 +2*k2 + 2*k3 + k4);
end
% Plot
figure;
plot(t, T, 'ro');
xlabel('t');
ylabel('T(t)');
legend( 'RK4 Approximation');

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title('RK4 ');
max(T)

%% task set F question 2
clc
close all
h = 0.01;
t = 0:h:24;
N = 2401;
T = zeros(1, N);
T(1) = 75;% Initial condition
f = @(t,T) .25*(85-10*cos((pi*(t-5))/12)-T);
for n = 1:N-1
    k1 = f(t(n), T(n));
    k2 = f(t(n)+ h/2, T(n) + h*k1/2);
    k3 = f(t(n) +h/2,T(n) +h*k2/2);
    k4 = f(t(n) + h, T(n) + h*k3);
    T(n+1) =T(n) + (h/6)*(k1 +2*k2 + 2*k3 + k4);
end
% Plot
figure;
plot(t, T, 'ro');
xlabel('t');
ylabel('T(t)');
legend('RK4 Approximation');
title('RK4 ');
max(T)

%% task set F question 3
clc
close all
h = 0.1
t = 0:h:24;
N = 241;
T = zeros(1, N);
T(1) = 75;% Initial condition
f = @(t,T) .25*(85-10*cos((pi*(t-5))/12)-T)+2*(77-T);
for n = 1:N-1
    k1 = f(t(n), T(n));
    k2 = f(t(n)+ h/2, T(n) + h*k1/2);
    k3 = f(t(n) +h/2,T(n) +h*k2/2);
    k4 = f(t(n) + h, T(n) + h*k3);
    T(n+1) =T(n) + (h/6)*(k1 +2*k2 + 2*k3 + k4);
end
% Plot
figure;
plot(t, T, 'ro');
xlabel('t');
ylabel('T(t)');

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legend( 'RK4 Approximation');
title('RK4 ');
max(T)

%% task set F question 4
clc
close all
h = 0.1;
t = 0:h:72;
N = 721;% Number of steps
T = zeros(1, N);
T(1) = 75;% Initial condition
f = @(t,T) .25*(85-10*cos((pi*(t-5))/12))-T+7*sech((3/4)*(t-10))+2*(77-T);
for n = 1:N-1
    k1 = f(t(n), T(n));
    k2 = f(t(n)+ h/2, T(n) + h*k1/2);
    k3 = f(t(n) +h/2,T(n) +h*k2/2);
    k4 = f(t(n) + h, T(n) + h*k3);
    T(n+1) =T(n) + (h/6)*(k1 +2*k2 + 2*k3 + k4);
end
% Plot
figure;
plot(t, T, 'ro');
hold on
xlabel('t');
ylabel('T(t)');
legend( 'RK4 Approximation');
title('RK4 ');
max(T)
m = (85-10*cos((pi*(t-5))/12));
plot(t,m)

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