

[illegible]

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%% INICIO PRE-PROCESO MALLA  %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
meshparam=[Li Ld Ti Tf Mx Nt];    % Numero de particones espacio y tiempo
paramr=[thetax alphac varphix k1 betac Lambdax psix muv muvstar k2];%
Parametros reaccion
paramd=[d1 d2 d3 d4 d5 d6];      % Parametros difusion

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%% FIN PRE-PROCESO MALLA  %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

[x,t,u]=implicit_HLB_1d(meshparam,paramr,paramd,ncomp);

for n=1:Nt+1
    for i=1:Mx+1
        Sc(n,i)=u(n,1,i);
        Lc(n,i)=u(n,2,i);
        lc(n,i)=u(n,3,i);
        Sv(n,i)=u(n,4,i);
        Ev(n,i)=u(n,5,i);
        lv(n,i)=u(n,6,i);
    end
end

%%% initial condition
figure
plot(x,Sc(1,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $S_c^0(x)$','FontSize',16,'Interpreter','latex')
set([gca],'FontName','Times New Roman' );
set([gca],'FontSize', 16);
print -depsc2 -r300 FIGURAS/Sc_ic_example_1

figure
plot(x,Lc(1,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $L_c^0(x)$','FontSize',16,'Interpreter','latex')
set([gca],'FontName','Times New Roman' );
set([gca],'FontSize', 16);
print -depsc2 -r300 FIGURAS/Lc_ic_example_1

figure
plot(x,lc(1,:),'LineWidth', 3,'MarkerSize',10)

```

```

xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $I_c^0(x)$','FontSize',16,'Interpreter','latex')
set(gca,'FontName','Times New Roman' );
set(gca,'FontSize', 16);
print -depsc2 -r300 FIGURAS/lc_ic_example_1

```

```

figure
plot(x,Sv(1,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $I_v^0(x)$','FontSize',16,'Interpreter','latex')
set(gca,'FontName','Times New Roman' );
set(gca,'FontSize', 16);
print -depsc2 -r300 FIGURAS/Sv_ic_example_1

```

```

figure
plot(x,Ev(1,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $E_v^0(x)$','FontSize',16,'Interpreter','latex')
set(gca,'FontName','Times New Roman' );
set(gca,'FontSize', 16);
print -depsc2 -r300 FIGURAS/Ev_ic_example_1

```

```

figure
plot(x,lv(1,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $I_v^0(x)$','FontSize',16,'Interpreter','latex')
set(gca,'FontName','Times New Roman' );
set(gca,'FontSize', 16);
print -depsc2 -r300 FIGURAS/lv_ic_example_1

```

```

%% end simulation

```

```

figure
plot(x,Sc(Nt,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $S_c(x,T)$','FontSize',16,'Interpreter','latex')
set(gca,'FontName','Times New Roman' );
set(gca,'FontSize', 16);
print -depsc2 -r300 FIGURAS/Sc_end_example_1

```

```

figure
plot(x,Lc(Nt,:),'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it $L_c(x,T)$','FontSize',16,'Interpreter','latex')

```

```

set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Lc_end_example_1

```

```

figure
plot(x, lc(Nt,:), 'LineWidth', 3, 'MarkerSize', 10)
xlabel('\it x', 'FontSize', 16, 'Interpreter', 'latex')
ylabel('\it $I_c(x,T)$', 'FontSize', 16, 'Interpreter', 'latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/lc_end_example_1

```

```

figure
plot(x, Sv(Nt,:), 'LineWidth', 3, 'MarkerSize', 10)
xlabel('\it x', 'FontSize', 16, 'Interpreter', 'latex')
ylabel('\it $S_v(x,T)$', 'FontSize', 16, 'Interpreter', 'latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Sv_end_example_1

```

```

figure
plot(x, Ev(Nt,:), 'LineWidth', 3, 'MarkerSize', 10)
xlabel('\it x', 'FontSize', 16, 'Interpreter', 'latex')
ylabel('\it $E_v(x,T)$', 'FontSize', 16, 'Interpreter', 'latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Ev_end_example_1

```

```

figure
plot(x, lv(Nt,:), 'LineWidth', 3, 'MarkerSize', 10)
xlabel('\it x', 'FontSize', 16, 'Interpreter', 'latex')
ylabel('\it $I_v(x,T)$', 'FontSize', 16, 'Interpreter', 'latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/lv_end_example_1

```

%%% Full simulation

```

figure
mesh(x, t, Sc, 'LineWidth', 3, 'MarkerSize', 10)
xlabel('\it x', 'FontSize', 16, 'Interpreter', 'latex')
ylabel('\it t', 'FontSize', 16, 'Interpreter', 'latex')
zlabel('\it $S_c(x,t)$', 'FontSize', 16, 'Interpreter', 'latex')

```

```

set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Sc_example_1

```

```

figure
mesh(x,t,Lc,'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it t','FontSize',16,'Interpreter','latex')
zlabel('\it $L_c(x,t)$','FontSize',16,'Interpreter','latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Lc_example_1

```

```

figure
mesh(x,t,lc,'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it t','FontSize',16,'Interpreter','latex')
zlabel('\it $l_c(x,t)$','FontSize',16,'Interpreter','latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/lc_example_1

```

```

figure
mesh(x,t,Sv,'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it t','FontSize',16,'Interpreter','latex')
zlabel('\it $S_v(x,t)$','FontSize',16,'Interpreter','latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Sv_example_1

```

```

figure
mesh(x,t,Ev,'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it t','FontSize',16,'Interpreter','latex')
zlabel('\it $E_v(x,t)$','FontSize',16,'Interpreter','latex')
set([gca], 'FontName', 'Times New Roman' );
set([gca], 'FontSize', 16);
print -depsc2 -r300 FIGURAS/Ev_example_1

```

```

figure
mesh(x,t,lv,'LineWidth', 3,'MarkerSize',10)
xlabel('\it x','FontSize',16,'Interpreter','latex')
ylabel('\it t','FontSize',16,'Interpreter','latex')

```

[illegible]

```
L0=meshparam(1);
L1=meshparam(2);
T0=meshparam(3);
T1=meshparam(4);
M=meshparam(5);
N=meshparam(6);
Dx=(L1-L0)/M;
Dt=(T1-T0)/N;
x=L0:Dx:L1; % Particion del intervalo espacial
t=T0:Dt:T1; % Particion del intervalo temporal
```

```

function [u0] = icHLB_example1d(x)
    %suceptibles citric
    u0(1,:)=(0).*(x<0.25)+...
        -0.4*(4*x-1).*(4*x-3).*((x>0.25)&(x<=0.75))+...
        (0).*(x>0.75);
    %latent citric
    u0(2,:)=0.2.*ones(size(x));
    %infected citric
    u0(3,:)=0.8*x.*(x<=0.25)+...
        (-0.8*x+0.4).*((x>0.25)&(x<=0.5))+...
        (0).*(x>0.5);
    %suceptible vector
    u0(4,:)=(0).*(x<0.5)+...
        -3.2*(2*x-1).*(x-1).*((x>0.5)&(x<=1));
    %exposed vector
    u0(5,:)=0.5.*ones(size(x));
    %infected vector
    u0(6,:)=0*x.*(x<=0.25)+...
        (0.4*x-0.1).*((x>0.25)&(x<=0.5))+...
        -(0.4*x-0.3).*((x>0.5)&(x<=0.75))+...
        (0).*(x>0.75);

end

```

```

function EFE_rhs = efe_HLB1d(x,t,u,paramr)

```

```

    thetax = paramr(1); %
    alphac = paramr(2); %
    varphix = paramr(3); %
    k1 = paramr(4); %
    betac = paramr(5); %
    Lambdax = paramr(6); %
    psix = paramr(7); %
    muv = paramr(8); %
    muvstar = paramr(9); %
    k2 = paramr(10);

```

```

    Sc=u(1,:);
    Lc=u(2,:);
    Ic=u(3,:);
    Sv=u(4,:);
    Ev=u(5,:);
    Iv=u(6,:);

```

```
Cc=Sc+Lc+lc;
```

```
Vv=Sv+Ev+lv;
```

```
EFE_rhs(1,:) = thetax*Cc -alphac .* Sc - varphix * lv.*Sc;
```

```
EFE_rhs(2,:) = varphix * lv.*Sc-k1*Lc-alphac .* Lc;
```

```
EFE_rhs(3,:) = k1*Lc-alphac .* lc-betac .* lc;;
```

```
EFE_rhs(4,:) = Lambdax*Vv -psix .* Sv.*lc - (muv+muvstar)*Sc;
```

```
EFE_rhs(5,:) = psix .* Sv.*lc -k2*Ev- (muv+muvstar)*Sc;
```

```
EFE_rhs(6,:) = k2*Ev - (muv+muvstar)*Sc;
```

```
end
```

```
function HDIFF_full=generate_matrix_H_HLB1d(L0,L1,T0,T1,M, ...  
      N,Dx,Dt,x,t,paramd,ncomp)
```

```
HDd=[0.5 ones(1,length(x)-2) 0.5];
```

```
HDs=ones(1,length(x)-1);
```

```
HDi=HDs;
```

```
H= -diag(HDi,-1)+2*diag(HDd)-diag(HDs,1);
```

```
mu_tmp=(Dt/(Dx*Dx))*paramd;
```

```
dimH=ncomp*(N+1);
```

```
HDIFF_full=zeros(dimH,dimH);
```

```
for i=1:ncomp
```

```
    Indx=(i-1)*(M+1)+1:i*(M+1);
```

```
    HDIFF_tmp(Indx,Indx)=mu_tmp(i)*H;
```

```
end
```

```
HDIFF_full=eye(dimH)+HDIFF_tmp;
```

```
end
```

```
function Efe_full = efe_implicit_HLB(uvect,x,t,LFull,uold,paramr,paramd)
```

```
Dt = t(2)-t(1);
```

```
uold_vector = reshape(uold', [], 1);
```

```
u_matrix_tmp = reshape(uvect, length(x), 6);
```

```
u_matrix = u_matrix_tmp';
```

```
EFE_rhs = efe_HLB1d(x,t,u_matrix,paramr);
```

```
EFE_rhs_vector = reshape(EFE_rhs', [], 1);
```

```
Efe_full = LFull*uvect-Dt*EFE_rhs_vector-uold_vector;
```

```
end
```

```
function [x,t,u]=implicit_HLB_1d(meshparam,paramr,paramd,ncomp)
```

```
%Malla
```

```
[L0,L1,T0,T1,M,N,Dx,Dt,x,t]=mesh_calculus1d(meshparam);
```

```
% Inicializar la matrix H y las matrices LS y LI
```

```
HDIFF_full=generate_matrix_H_HLB1d(L0,L1,T0,T1,M, ...  
    N,Dx,Dt,x,t,paramd,ncomp);
```

```
u0 = icHLB_example1d(x);
```

```
for i=1:M+1
```

```
    for j=1:ncomp
```

```
        u(1,j,i)=u0(j,i);
```

```
    end
```

```
end
```

```
for n=2:N+1
```

```
    % Inicializacion del punto para la solucion del sistema implicito.
```

```
    for i=1:M+1
```

```
        for j=1:ncomp
```

```
            uold(j,i)=u(n-1,j,i);
```

```
        end
```

```
    end
```

```
    uig=reshape(uold', [], 1);
```

```
    c1 =x;
```

```
    c2 =t;
```

```
    c3 =HDIFF_full;
```

```
    c4=uold;
```

```
    c5=paramr;
```

```
    c6=paramd;
```

```
    fun = @(uvect)efe_implicit_HLB(uvect,c1,c2,c3,c4,c5,c6);
```

```
    % Solucion del sistema implicito
```

```
    opts = optimset('Diagnostics','off', 'Display','off');
```

```
    unew = fsolve(fun,uig,opts);
```

```
    unew_matrix_tmp = reshape(unew, M+1, ncomp);
```

```
for i=1:M+1
    for j=1:ncomp
        u(n,j,i)=unew_matrix(j,i);
    end
end
```

end

[illegible]

