信陽師範学院
数学与统计学院
SCHOOL OF MATHEMATICS AND STATISTICS

第5章 微分方程(组)数值解

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5.3 代数微分方程组（DAEs）

例8：求解代数微分方程，初值 $y_1(0)=0.8, y_2(0)=0.1, y_3(0)=0.1$

$$\begin{cases} y_1' = -0.2y_1 + y_2y_3 + 0.3y_1y_2 \\ y_2' = 2y_1y_2 - 5y_2y_3 - 2y_2^2 \\ y_1 + y_2 + y_3 = 1 \end{cases}$$

```
% 函数文件定义
function DyDt = DyDtNestedFun(t,y)
DyDt = [-0.2*y(1)+y(2)*y(3)+0.3*y(1)*y(2);
        2*y(1)*y(2)-5*y(2)*y(3)-2*y(2)^2;
        y(1)+y(2)+y(3)-1];
end
```

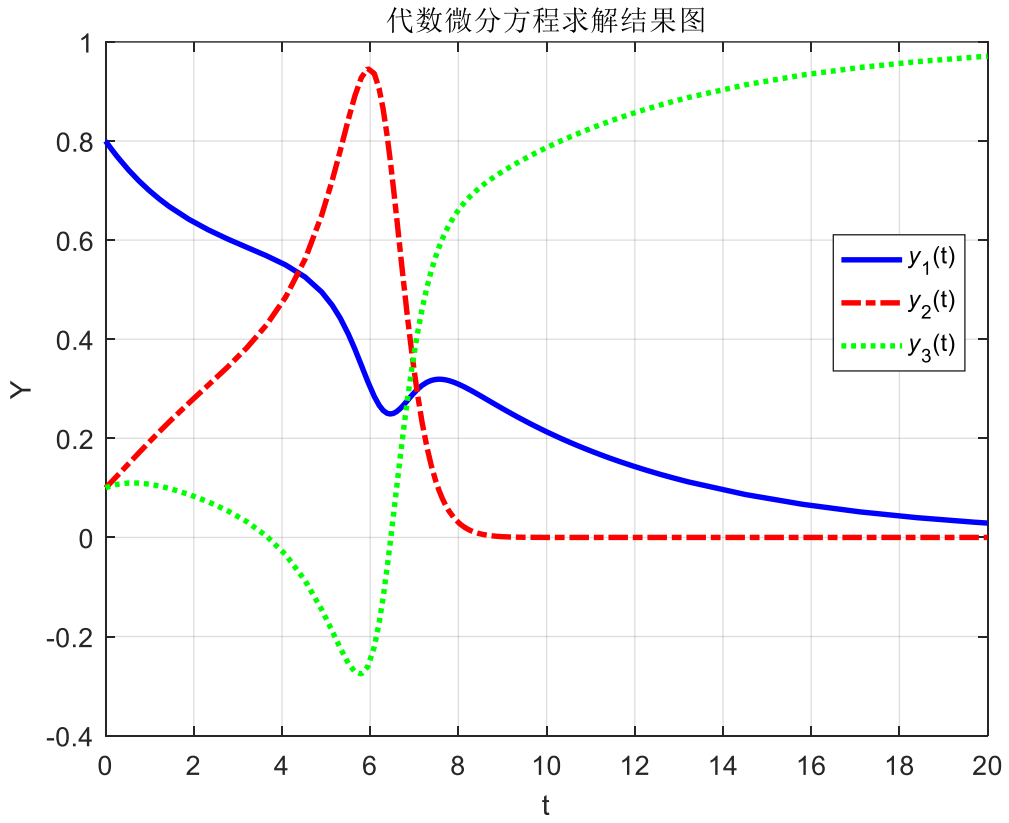
首先，转换为矩形表示

$$M(t,y)y' = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} dy_1/dt \\ dy_2/dt \\ dy_3/dt \end{bmatrix} = \begin{bmatrix} -0.2y_1 + y_2y_3 + 0.3y_1y_2 \\ 2y_1y_1 - 5y_2y_3 - 2y_2^2 \\ y_1 + y_2 + y_3 - 1 \end{bmatrix} = F(t,y)$$

5.3 代数微分方程组（DAEs）

```
M = [1 0 0;0 1 0;0 0 0];%质量矩阵
options = odeset('Mass',M);
y0 = [0.8;0.1;0.1];%初值
tspan = [0 20];
[T,Y] = ode15s(@DyDtNestedFun,tspan,y0,options);
plot(T,Y(:,1),'b-','linewidth',2);
hold on
plot(T,Y(:,2),'r-.','linewidth',2);
plot(T,Y(:,3),'g:','linewidth',2);
legend('{\ity}_1(t)','{\ity}_2(t)','{\ity}_3(t)','Location','best');
title('代数微分方程求解结果图')
```

用ode15s函数求解



5.3 代数微分方程组（DAEs）

- 例9：求解代数微分方程 $y_1(0)=1, y_2(0)=0.5, y_3(0)=0.3, y_4(0)=0.2$

$$\begin{cases} y_1' = -0.3y_1 - 2y_2\sin(y_3') - y_2y_4 \\ y_2' = -y_2 - 0.5\cos(y_1' + y_3) - 0.2\sin(0.6t) \\ y_3' = -0.2y_1y_2 + e^{-y_1'} \\ y_1 + y_2 - y_3 - y_4 = 1 \end{cases}$$

```
% 函数文件定义
function DyDt = DAEsFun(t,y,dy)
DyDt = [dy(1)+0.3*y(1)+2*y(2)*sin(dy(3))+y(2)*y(4);
        dy(2)+y(2)+0.5*cos(dy(1)+y(3))+0.2*sin(0.6*t);
        dy(3)+0.2*y(1)*y(2)-exp(-dy(1));
        y(1)+y(2)-y(3)-y(4)-1];
end
```

5.3 代数微分方程组（DAEs）

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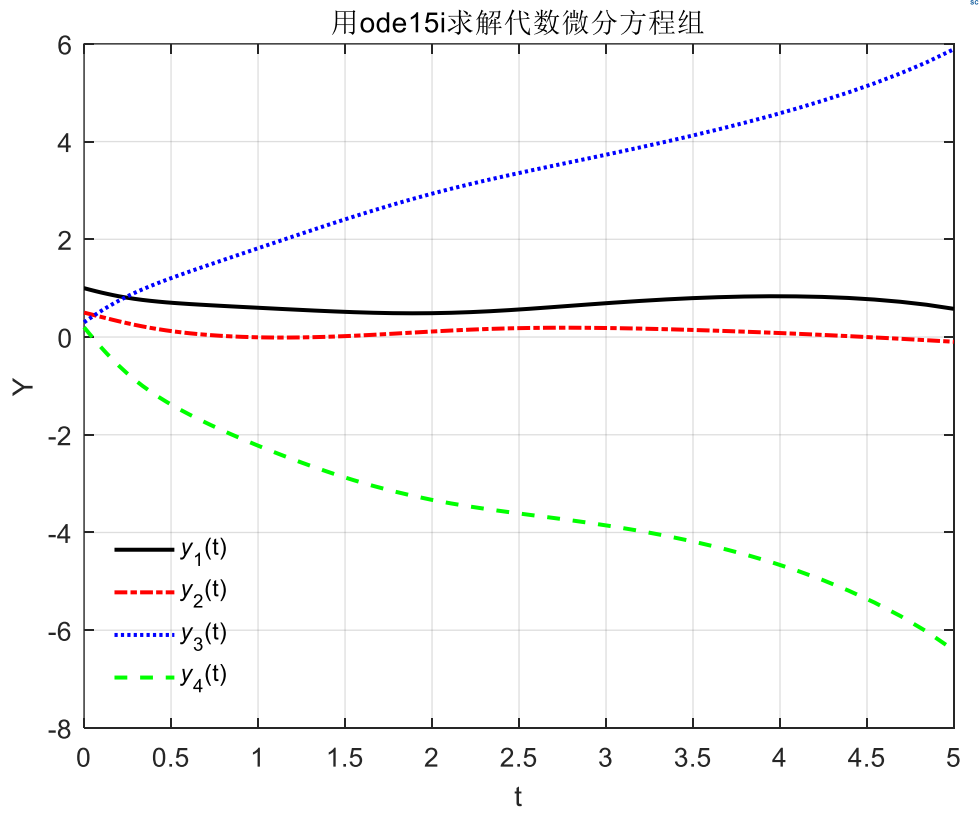
用ode15i函数求解

```
y0 = [1;0.5;0.3;0.2];   %初值
tspan = [0 5];   %求值区间
y0_fix = [0;1;0;0];
dy0 = [-1;-1;2.5;0.5];
dy0_fix = [0;0;0;0]; %该组初值都可以改变，故全部为0
t0 = 0; %时间变量的初值
[y00,dy00] = decic(@DAEsFun,0,y0,y0_fix,dy0,dy0_fix);
[T2,Y2] = ode15i(@DAEsFun,tspan,y00,dy00);
plot(T2,Y2(:,1),'k-',T2,Y2(:,2),'r-.',T2,Y2(:,3),'b:',T2,Y2(:,4),'g--','linewidth',1.5);
legend('{\ity}_1(t)','{\ity}_2(t)','{\ity}_3(t)','{\ity}_4(t)','Location','best');
legend('boxoff')
```

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