

1.(e).

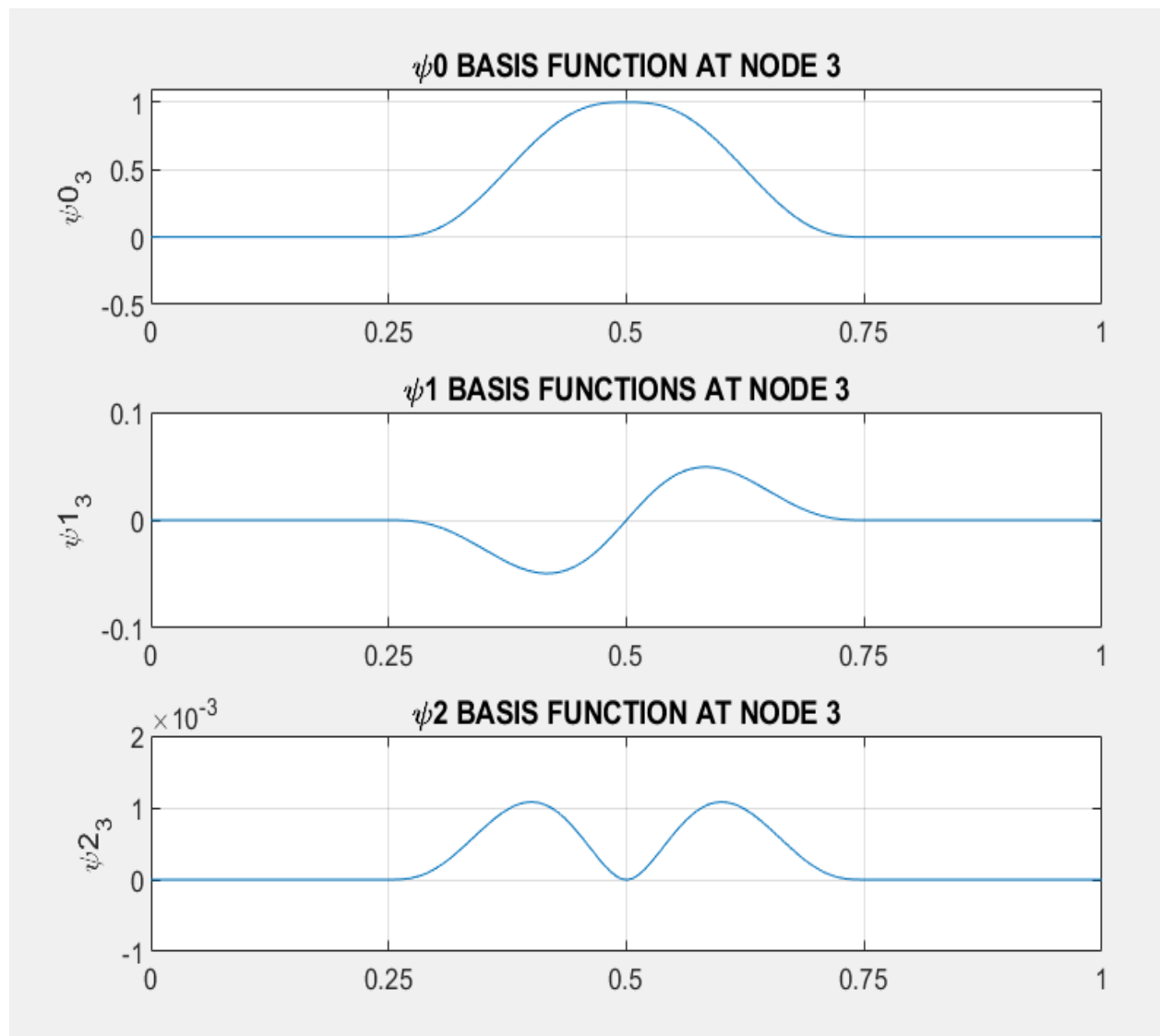


Fig.1.Basis functions psi0, psi1, psi2 at node 3

1.(f). The stiffness matrix for the first element are a union of 9 sub matrices

<b>K00=</b>	<b>K01=</b>	<b>K02=</b>
$\begin{bmatrix} 4.72e+4, & -4.72e+4 \\ -4.72e+4, & 4.72e+4 \end{bmatrix}$	$\begin{bmatrix} 5900.0, & 5900.0 \\ -5900.0, & -5900.0 \end{bmatrix}$	$\begin{bmatrix} 242.0, & -242.0 \\ -242.0, & 242.0 \end{bmatrix}$
<b>K10=</b>	<b>K11=</b>	<b>K12=</b>
$\begin{bmatrix} 5900.0, & -5900.0 \\ 5900.0, & -5900.0 \end{bmatrix}$	$\begin{bmatrix} 790.0, & 684.0 \\ 684.0, & 790.0 \end{bmatrix}$	$\begin{bmatrix} 36.3, & -24.1 \\ 24.1, & -36.3 \end{bmatrix}$
<b>K20=</b>	<b>K21=</b>	<b>K22=</b>
$\begin{bmatrix} 242.0, & -242.0 \\ -242.0, & 242.0 \end{bmatrix}$	$\begin{bmatrix} 36.3, & 24.1 \\ -24.1, & -36.3 \end{bmatrix}$	$\begin{bmatrix} 2.27, & -0.746 \\ -0.746, & 2.27 \end{bmatrix}$

1.(g). The load vector of node three corresponding to the equations of  $w_3, w_3', w_3''$  are

$$F_3^0 = -0.3$$

$$F_3^1 = 0$$

$$F_3^2 = -0.0003125$$

```
clear
clc
%INPUTS
num=4;
L=1;
gamma=0.25;f=12*10^3;
E=2*10^9;I=500*(0.01)^4;
h=L/num;alpha=E*I;
X=0:h:L;
%% SHAPE FUNCTIONS
syms s
N10=(1/16)*(8-15*s+10*s^3-3*s^5);N20=(1/16)*(8+15*s-10*s^3+3*s^5);
N11=(1/16)*(5-7*s-6*s^2+10*s^3+s^4-3*s^5)*(h/2);N21=(1/16)*(-5-7*s+6*s^2+10*s^3-s^4-3*s^5)*(h/2);
N12=(1/16)*(1-s-2*s^2+2*s^3+s^4-s^5)*(h/2)^2;N22=(1/16)*(1+s-2*s^2-2*s^3+s^4+s^5)*(h/2)^2;
figure(1)
subplot(3,1,1),fplot(N10,[-1,1]); hold on ,fplot(N20,[-1,1]); hold
off,legend('N0_1,N0_2')subplot(3,1,2),fplot(N11,[-1,1]); hold on ,fplot(N21,[-1,1]); hold off,
legend('N1_1 N1_2')subplot(3,1,3),fplot(N12,[-1,1]); hold on ,fplot(N22,[-1,1]); hold off,
legend('N2_1 N2_2')%% BASIS FUNCTIONS
```

```

syms x
psi_0(x)=piecewise(0<=x<=X(2),0,X(2)<x<=X(3),subs(N20,s,(x-X(2))/(X(3)-X(2))+(x-X(3))/(X(3)-X(2))),X(3)<=x<=X(4),subs(N10,s,(x-X(3))/(X(4)-X(3))+(x-X(4))/(X(4)-X(3))),X(4)<=x<=X(5),0);
psi_1(x)=piecewise(0<=x<=X(2),0,X(2)<x<=X(3),subs(N21,s,(x-X(2))/(X(3)-X(2))+(x-X(3))/(X(3)-X(2))),X(3)<=x<=X(4),subs(N11,s,(x-X(3))/(X(4)-X(3))+(x-X(4))/(X(4)-X(3))),X(4)<=x<=X(5),0);
psi_2(x)=piecewise(0<=x<=X(2),0,X(2)<x<=X(3),subs(N22,s,(x-X(2))/(X(3)-X(2))+(x-X(3))/(X(3)-X(2))),X(3)<=x<=X(4),subs(N12,s,(x-X(3))/(X(4)-X(3))+(x-X(4))/(X(4)-X(3))),X(4)<=x<=X(5),0);
figure(2)
subplot(3,1,1)
fplot(psi_0),xlim([0 1]),ylim([-0.5 1.1]),xticks(0:0.25:1),grid on,
ylabel(['\psi_0',num2str(3)]),title('\psi_0 BASIS FUNCTION AT NODE 3')
subplot(3,1,2)
fplot(psi_1),xlim([0 1]),ylim([-0.1 0.1]),xticks(0:0.25:1),grid on,
ylabel(['\psi_1',num2str(3)]),title('\psi_1 BASIS FUNCTIONS AT NODE 3')
subplot(3,1,3)
fplot(psi_2),xlim([0 1]),ylim([-0.001 0.002]),xticks(0:0.25:1),grid on,
ylabel(['\psi_2',num2str(3)]),title('\psi_2 BASIS FUNCTION AT NODE 3')
%% ELEMENT STIFFNESS MATRICES
N10_3=diff(N10,3)/(h/2)^3; N10_2=diff(N10,2)/(h/2)^2;
N20_3=diff(N20,3)/(h/2)^3; N20_2=diff(N20,2)/(h/2)^2;%%
N11_3=diff(N11,3)/(h/2)^3; N11_2=diff(N11,2)/(h/2)^2;
N21_3=diff(N21,3)/(h/2)^3; N21_2=diff(N21,2)/(h/2)^2;%%
N12_3=diff(N12,3)/(h/2)^3; N12_2=diff(N12,2)/(h/2)^2;
N22_3=diff(N22,3)/(h/2)^3; N22_2=diff(N22,2)/(h/2)^2;%%
a1=((gamma)^2*(N10_3)^2+(N10_2)^2)*(h/2); d1=((gamma)^2*(N10_3*N11_3)+(N10_2*N11_2))*(h/2);
h1=((gamma)^2*(N10_3*N12_3)+(N10_2*N12_2))*(h/2); b1=((gamma)^2*(N10_3*N20_3)+(N10_2*N20_2))*(h/2);
e1=((gamma)^2*(N10_3*N21_3)+(N10_2*N21_2))*(h/2); i1=((gamma)^2*(N10_3*N22_3)+(N10_2*N22_2))*(h/2);
c1=((gamma)^2*(N20_3)^2+(N20_2)^2)*(h/2); f1=((gamma)^2*(N20_3*N11_3)+(N20_2*N11_2))*(h/2);
j1=((gamma)^2*(N20_3*N12_3)+(N20_2*N12_2))*(h/2);
g1=((gamma)^2*(N20_3*N21_3)+(N20_2*N21_2))*(h/2); k1=((gamma)^2*(N20_3*N22_3)+(N20_2*N22_2))*(h/2);
d2=((gamma)^2*(N11_3*N10_3)+(N11_2*N10_2))*(h/2); a2=((gamma)^2*(N11_3)^2+(N11_2)^2)*(h/2);
l2=((gamma)^2*(N11_3*N12_3)+(N11_2*N12_2))*(h/2); e2=((gamma)^2*(N11_3*N20_3)+(N11_2*N20_2))*(h/2);
b2=((gamma)^2*(N11_3*N21_3)+(N11_2*N21_2))*(h/2); m2=((gamma)^2*(N11_3*N22_3)+(N11_2*N22_2))*(h/2);
f2=((gamma)^2*(N21_3*N10_3)+(N21_2*N10_2))*(h/2); c2=((gamma)^2*(N21_3)^2+(N21_2)^2)*(h/2);
n2=((gamma)^2*(N21_3*N12_3)+(N21_2*N12_2))*(h/2); g2=((gamma)^2*(N21_3*N20_3)+(N21_2*N20_2))*(h/2);
;
o2=((gamma)^2*(N21_3*N22_3)+(N21_2*N22_2))*(h/2); h3=((gamma)^2*(N12_3*N10_3)+(N12_2*N10_2))*(h/2);
; l3=((gamma)^2*(N12_3*N11_3)+(N12_2*N11_2))*(h/2); a3=((gamma)^2*(N12_3)^2+(N12_2)^2)*(h/2);
i3=((gamma)^2*(N12_3*N20_3)+(N12_2*N20_2))*(h/2); m3=((gamma)^2*(N12_3*N21_3)+(N12_2*N21_2))*(h/2);
b3=((gamma)^2*(N12_3*N22_3)+(N12_2*N22_2))*(h/2); j3=((gamma)^2*(N22_3*N10_3)+(N22_2*N10_2))*(h/2);
n3=((gamma)^2*(N22_3*N11_3)+(N22_2*N11_2))*(h/2); c3=((gamma)^2*(N22_3)^2+(N22_2)^2)*(h/2);
k3=((gamma)^2*(N22_3*N20_3)+(N22_2*N20_2))*(h/2);
o3=((gamma)^2*(N22_3*N21_3)+(N22_2*N21_2))*(h/2);
K11_00=int(a1,-1,1);K12_00=int(b1,-1,1); K11_01=int(d1,-1,1);K12_01=int(e1,-1,1);
K11_02=int(h1,-1,1);K12_02=int(i1,-1,1);
K21_00=K12_00;K22_00=int(c1,-1,1); K21_01=int(f1,-1,1);K22_01=int(g1,-1,1);
K21_02=int(j1,-1,1);K22_02=int(k1,-1,1);
K11_10=int(d2,-1,1);K12_10=int(e2,-1,1); K11_11=int(a2,-1,1);K12_11=int(b2,-1,1);
K11_12=int(l2,-1,1);K12_12=int(m2,-1,1);
K21_10=int(f2,-1,1);K22_10=int(g2,-1,1); K21_11=K12_11;K22_11=int(c2,-1,1);
K21_12=int(n2,-1,1);K22_12=int(o2,-1,1);
K11_20=int(h3,-1,1);K12_20=int(i3,-1,1); K11_21=int(l3,-1,1);K12_21=int(m3,-1,1);
K11_22=int(a3,-1,1);K12_22=int(b3,-1,1);
K21_20=int(j3,-1,1);K22_20=int(k3,-1,1); K21_21=int(n3,-1,1);K22_21=int(o3,-1,1); K21_22=K12_22;
K22_22=int(c3,-1,1);
K00=vpa([K11_00,K12_00;K21_00,K22_00],3), K01=vpa([K11_01,K12_01;K21_01,K22_01],3),
K02=vpa([K11_02,K12_02;K21_02,K22_02],3),
K10=vpa([K11_10,K12_10;K21_10,K22_10],3), K11=vpa([K11_11,K12_11;K21_11,K22_11],3),
K12=vpa([K11_12,K12_12;K21_12,K22_12],3),
K20=vpa([K11_20,K12_20;K21_20,K22_20],3), K21=vpa([K11_21,K12_21;K21_21,K22_21],3),
K22=vpa([K11_22,K12_22;K21_22,K22_22],3),K=[K00 K01 K02;K10 K11 K12;K20 K21 K22];K=vpa(K,3)
%% LOAD VECTOR
F3_0=vpa(-(f/alpha)*int(N10,-1,1)*(h/2)-(f/alpha)*int(N20,-1,1)*(h/2))
F3_1=vpa(-(f/alpha)*int(N11,-1,1)*(h/2)-(f/alpha)*int(N21,-1,1)*(h/2))
F3_2=vpa(-(f/alpha)*int(N12,-1,1)*(h/2)-(f/alpha)*int(N22,-1,1)*(h/2))

```