In[1]:=
```
(* MA39110 / Assignment 2.4 / 16MA20053 / NER ROHIT *)
ClearAll["Global`*"];
```

In[2]:=
```
Thomas[a_, b_, c_, d_] :=
  Module[{c1 = Range[Length[c]], d1 = Range[Length[d]], x = Range[Length[b]]},
   c1[[1]] = c[[1]] / b[[1]]; d1[[1]] = d[[1]] / b[[1]];
   Do[
    If[i ≠ Length[d], c1[[i]] = c[[i]] / (b[[i]] - a[[i - 1]] * c1[[i - 1]])];
    d1[[i]] = (d[[i]] - a[[i - 1]] * d1[[i - 1]]) / (b[[i]] - a[[i - 1]] * c1[[i - 1]]);
    , {i, 2, Length[d]}];
   x[[Length[b]]] = d1[[Length[b]]];
   Do[
    x[[i]] = d1[[i]] - c1[[i]] * x[[i + 1]];
    , {i, Length[b] - 1, 1, -1}];
   x];
Model[n0_] := Module[{n = n0},
   x0 = 0; xf = 1; h = (xf - x0) / n;
   A = Table[0, {x, 1, n - 1}, {y, 1, n - 1}];
   X = Table[x0 + x * h, {x, 1, n - 1}];
   B = Table[0, {x, 1, n - 1}];
   For[i = 1, i < n, i++,
    {
     A[[i, i]] = 1 - 2 / h^2;
     If[i ≠ 1, A[[i, i - 1]] = 1 / h^2];
     If[i ≠ n - 1, A[[i, i + 1]] = 1 / h^2, B[[i]] = -1 / h^2];
    }];
   Thomas[Diagonal[A, -1], Diagonal[A], Diagonal[A, 1], B]];
```

In[4]:=
```
sol = Model[4];
solt = DSolve[{y''[x] + y[x] == 0, y[0] == 0, y[1] == 1}, y[x], x]
err1 = Abs[DSolveValue[{y''[x] + y[x] == 0, y[0] == 0, y[1] == 1}, y[X], x] - sol];
perr1 = ListPlot[Transpose[{X, err1}], PlotStyle → Red];
N[Max[err1]]
p1 = Show[{Plot[Evaluate[y[x] /. solt],
     {x, x0, xf}, PlotLabel → Style["h=0.25", FontSize → 18]]},
   {ListPlot[Transpose[{X, sol}], PlotStyle → Red]}];
```

Out[5]=
```
{{y[x] → Csc[1] Sin[x]}}
```

Out[8]=
```
0.000408938
```

In[10]:=
```
sol = Model[8];
err2 = Abs[DSolveValue[{y''[x] + y[x] == 0, y[0] == 0, y[1] == 1}, y[X], x] - sol];
perr2 = ListPlot[Transpose[{X, err2}], PlotStyle → Green];
N[Max[err2]]
p2 = Show[{Plot[Evaluate[y[x] /. solt],
      {x, x0, xf}, PlotLabel → Style["h=0.25/2", FontSize → 18]]},
   {ListPlot[Transpose[{X, sol}], PlotStyle → Red]}];
```

Out[13]= 0.000101708

In[15]:=
```
sol = Model[16];
err3 = Abs[DSolveValue[{y''[x] + y[x] == 0, y[0] == 0, y[1] == 1}, y[X], x] - sol];
perr3 = ListPlot[Transpose[{X, err3}], PlotStyle → Blue];
N[Max[err3]]
p3 = Show[{Plot[Evaluate[y[x] /. solt],
      {x, x0, xf}, PlotLabel → Style["h=0.25/4", FontSize → 18]]},
   {ListPlot[Transpose[{X, sol}], PlotStyle → Red]}];
```

Out[18]= 0.0000258177

In[20]:=
```
p4 = Show[{Plot[y[x] = 10^-4, {x, 0, 1}, PlotStyle → {Dashed, Black}]}, {perr1},
   {perr2}, {perr3}, PlotLabel → Style["Truncation Error", FontSize → 18],
   PlotRange → {{0, 1}, {0, 0.0004}}];
GraphicsGrid[{{p1, p2}, {p3, p4}}]
```

Out[21]=