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In[1]:= (* MA39110 / Assignment 2.1 / 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;
           y0 = 0; yfd = 1;
           lambda = 2;
           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]] = -(2 + lambda * h^2);
             If[i ≠ 1, A[[i, i - 1]] = 1, B[[i]] = -1];
             If[i ≠ n - 1, A[[i, i + 1]] = 1,
              {A[[i, i]] = A[[i, i]] + 4 / 3, A[[i, i - 1]] = A[[i, i - 1]] - 1 / 3}];
            }];
           Thomas[Diagonal[A, -1], Diagonal[A], Diagonal[A, 1], B]];

In[4]:= sol = Model[8];
        solt = DSolve[{y''[x] == lambda * y[x], y[0] == 1, y'[1] == 0}, y[x], x]
        err1 = Abs[DSolveValue[{y''[x] == lambda * y[x], y[0] == 1, y'[1] == 0}, 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=0.125", FontSize → 18]]},
           {ListPlot[Transpose[{X, sol}], PlotStyle → Red]}];
```

Out[5]= $\left\{\left\{y[x] \to \frac{e^{-\sqrt{2}\,x}\left(e^{2\sqrt{2}} + e^{2\sqrt{2}\,x}\right)}{1 + e^{2\sqrt{2}}}\right\}\right\}$

Out[8]= 0.000394224

In[10]:=
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sol = Model[16];
err2 = Abs[DSolveValue[{y''[x] == lambda * y[x], y[0] == 1, y'[1] == 0}, 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=0.125/2", FontSize → 18]]},
   {ListPlot[Transpose[{X, sol}], PlotStyle → Red]}];
```

Out[13]= 0.000134764

In[15]:=
```
sol = Model[32];
err3 = Abs[DSolveValue[{y''[x] == lambda * y[x], y[0] == 1, y'[1] == 0}, 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=0.125/4", FontSize → 18]]},
   {ListPlot[Transpose[{X, sol}], PlotStyle → Red]}];
```

Out[18]= 0.0000394736

In[20]:=
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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]=