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(* MA39110 / Assignment 5 / 16MA20053 / NER ROHIT *)
ClearAll["Global`*"];
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; yf = 0;
   A = Table[0, {x, 1, n - 1}, {y, 1, n - 1}];
   X = Table[x0 + x * h, {x, 1, n - 1}];
   XT = Table[x0 + x * h, {x, 0, n}];
   B = Table[0, {x, 1, n - 1}];
   eps = 0.0001;
   PLT = {};
   (*Initial Approximation: Parabola passing through the points (x0,y0) and (xn,yn).*)
   y[x_] = x (1 - x);
   Y = Table[x * 0, {x, 1, n + 1}];
   Y0 = Y;
   YT = Y;
   c = 1;
   While[{
     Y = YT;
     For[i = 1, i < n, i++,
      {
       im = i + 1;
       A[[i, i]] = -2 / h^2;
       B[[i]] = -Y[[im]]^2 + 2;
       If[i ≠ 1, A[[i, i - 1]] = 1 / h^2 + Y[[im]] / (2 h)];
       If[i ≠ n - 1, A[[i, i + 1]] = 1 / h^2 - Y[[im]] / (2 h)];
      }];
     c = c + 1;
     YT =
      N[Flatten[{{y0}, Thomas[Diagonal[A, -1], Diagonal[A], Diagonal[A, 1], B], {yf}}]];
     AppendTo[PLT, ListPlot[Transpose[{XT, YT}],
       PlotStyle -> {Red, Green, Blue, Black}[[Mod[c, 4]]]]];
    }; N[Max[Abs[YT - Y]]] > eps];
   Print[c];
   PLT[[c - 1]] = ListLinePlot[Transpose[{XT, YT}], PlotStyle → Black];
   Show[PLT[[1 ;; ;; 1]], PlotRange → Automatic]
  ];
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In[4]:=
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Model[50]
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Out[4]=

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