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(*finite difference method for solving bundary value problems *)

(*Problem:-Solve the differnetial equation of simple harmonic oscillaior*)
deq = x''[t] + w^2 x[t] == 0;
(*Define the rules of finite difference method*)
FDRules = {x''[t] → (x[i + 1] - 2 x[i] + x[i - 1]) / h^2,
  x'[t] → (x[i + 1] - x[i - 1]) / (2 h), x[t] → x[i], t → i}

(*Apply the finite difference rules on the differential equation*)
fdeq = deq /. FDRules

(*Define the Given information*)
ω = 2; T = (2 * π) / ω; tmin = 0; tmax = (5 T) / 4; n = 60; h = (tmax - tmin) / (n - 1);
(*Generate list of algebraic equations*)
aeqs = Table[fdeq, {i, 2, n - 1}]

(*include the boundary conditions among the aeqs*)

a = 2;
aeqs = Join[{x[1] == a, x[20] == 0}, aeqs]

(*geberate the list of unknowns*)

unknowns = Table[x[i], {i, 1, n}]

(*use the Sove command to get values of unknowns *)

knowns = Solve[aeqs, unknowns]

(*Arange the value*)

xgrid = unknowns /. knowns[[1]] // N

(*now generate the value of t*)

tgrid = Table[tmin + (i - 1) * h, {i, 1, n}]

(*Make the list of (t,x) Points*)

txgrid = Table[{tgrid[[i]], xgrid[[i]]}, {i, 1, n}]

ListPlot[txgrid, PlotRange → All, PlotStyle → {{Red, Thick}}, Joined → True]
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