Methodology for Register-Minimization Retiming in Matlab

Matlab Optimization Toolbox Required

(see the textbook, page 108)
The DFG in Fig. 4.2(a) is retimed so the number of registers is minimized while maintaining a
clock period of \( \Phi(G_r) \leq 2 \)

[Step 1]
Use the gadget to model the original graph Fig. 4.2(a). Redraw the graph as shown in Fig. 13(a). Calculate the cost function. \( COST' = r_2 - r_3 - r_4 + r_5 \)

[Step 2]
Calculate \( w'(e) \) and construct the \( G' \) as shown in Fig. 4.13(b)

[Step 3]
Choose one of the all-pair shortest-path algorithms (Floyd-Warshall algorithm or Johnson algorithm) to compute \( S'_{UF} \), then \( W(U,V) \) and \( D(U,V) \).

[Step 4]
LP formulation
Minimize \( COST' \) subject to
(1) Feasibility Constraints
\[
\begin{align*}
  r(2) - r(1) & \leq 1 \\
  r(3) - r(5) & \leq 1 \\
  r(4) - r(5) & \leq 0
\end{align*}
\]
(2) Clock-period Constraints
\[
\begin{align*}
  r(1) - r(2) & \leq 0 \\
  & \vdots
\end{align*}
\]

[Step 5]
Solving LP using Matlab – \( \text{lp(cost,A,b,initial_value)} \)
Reformulate LP in matrix - to minimize \( COST^T \cdot r \), such that \( Ar \leq b \)
% Retiming for Register Minimization
% by T.J. Lin
% Apr, 1999

% COST = r2-r3-r4+r5
cost=[0 1 -1 -1 1];

% constraint matrix
A=[
  % feasibility constraints
  -1 1 0 0 0
  0 0 1 0 -1
  0 0 0 1 -1
  % clock period constraints
  1 -1 0 0 0
  1 0 -1 0 0
  1 0 0 1 0
  1 0 0 0 -1
  0 1 -1 0 0
  0 1 0 -1 0
  0 1 0 0 -1
  -1 0 1 0 0
  0 -1 1 0 0
  0 0 1 -1 0
  -1 0 0 1 0
  0 -1 0 1 0
  0 0 -1 1 0];

b=[1; 1; 0; 0; 1; 1; 2; 2; 0; -1; 2; 0; -1; 1];

r = LP(cost,A,b,zeros(5,1))