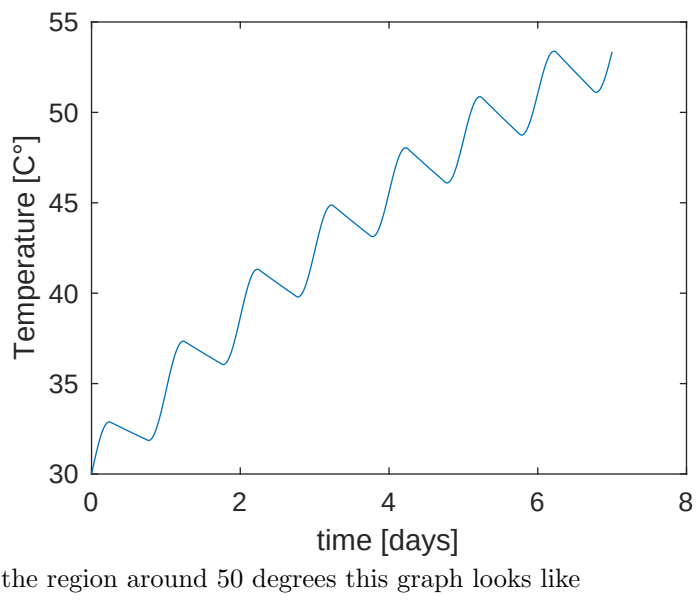
Quiz 2 - Solution

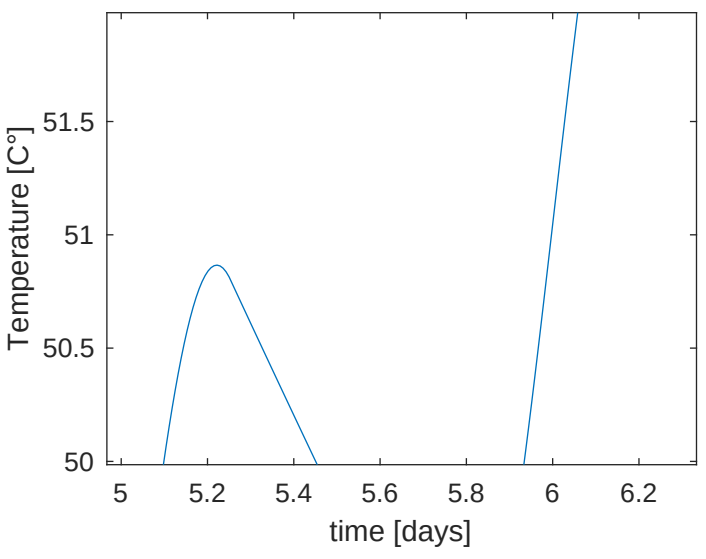
Here is an example of code that will solve the problem.

```
[1]  function [T,t] = quiz2(Te,T_int,t_f) % call with Te=15, T_int=30, t_f=7;
[2]      Ug = 2.25;           % U-factor of glass
[3]      Uw = 0.66;           % U-factor of walls
[4]      c = 4186;            % specific heat of water
[5]      m = 1000;            % mass of water
[6]      mc = m*c;            % heat capacity of water
[7]      Ag = 1;              % area of glass.
[8]      Aw = 5;              % area of non-glass walls.
[9]      phi = 1000;          % intensity of solar radiation
[10]     day = 60*60*24;      % one day in seconds
[11]     dt = 600;            % time step in seconds (ten mintues)
[12]     t = 0:dt:t_f*day;    % set up time array
[13]     Nt = length(t);      % the number of time steps
[14]     T = NaN(1,Nt);       % prealocate memory for temperatures
[15]     T(1) = T_int;        % Assign starting temperature.
[16]
[17]     for n = 1:Nt-1                  % a loop over time.
[18]         theta = 2*pi*t(n)/day;      % the angle of the sun.
[19]         Pin = phi*Ag*cosP(theta);   % power from solar radiation
[20]         Pout = (Ag*Ug+Aw*Uw)*(T(n)-Te); % power loss through conduction
[21]         f = (Pin - Pout)/mc;        % comptue f = dT/dt
[22]         T(n+1) = T(n) + f*dt;       % update the temperature
[23]     end
[24]     t = t/day;
[25]     plot(t,T);  % plot the results.
[26]     xlabel('time [days]')
[27]     ylabel('Temperature [C]');
[28] end
[29]
[30] function y = cosP(x)
[31]     y = max(0,cos(x));
[32] end
[33]
```

The output is



Zooming in on the region around 50 degrees this graph looks like

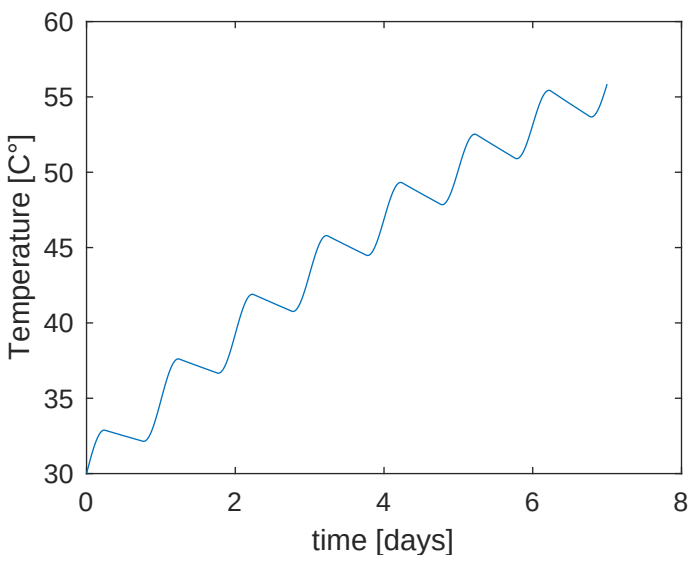


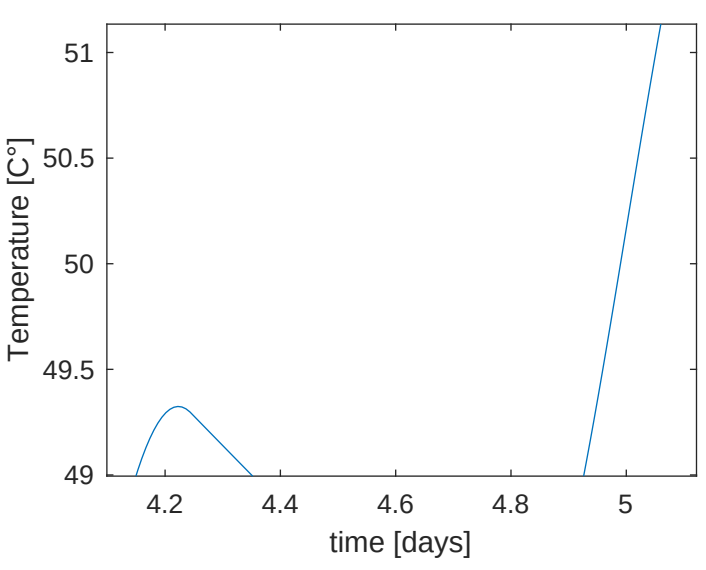
We can see that it first reaches 50 degrees at about 5.1 days but it drops below 50 at 5.45 days and then passes 50 again, not to return, at 5.95 days.

Extra credit problem:

```
[1]  function T = quiz2ex(Te,T_int,t_f) % call with Te=15, T_int=30, t_f=7;
[2]      Ug = 2.25;           % U-factor of glass
[3]      Uw = 0.66;           % U-factor of walls
[4]      c = 4186;            % specific heat of water
[5]      m = 1000;            % mass of water
[6]      mc = m*c;            % heat capacity of water
[7]      Ag = 1;              % area of glass.
[8]      Aw = 5;              % area of non-glass walls.
[9]      phi = 1000;          % intensity of solar radiation
[10]     day = 60*60*24;      % one day in seconds
[11]     dt = 600;            % time step in seconds (ten mintues)
[12]     t = 0:dt:t_f*day;    % set up time array
[13]     Nt = length(t);      % the number of time steps
[14]     T = NaN(1,Nt);       % prealocate memory for temperatures
[15]     T(1) = T_int;        % Assign starting temperature.
[16]
[17]     for n = 1:Nt-1                  % a loop over time.
[18]         theta = 2*pi*t(n)/day;      % the angle of the sun.
[19]         Pin = phi*Ag*cosP(theta);   % power from solar radiation
[20]         P_covered   =  0 -  (Aw+Ag)*Uw *(T(n)-Te); % net power covered
[21]         P_uncovered = Pin-(Ag*Ug+Aw*Uw)*(T(n)-Te); % net power uncovered
[22]         if P_covered > P_uncovered  % decide if it is better to cover
[23]             f = P_covered/mc;       % comptue f = dT/dt
[24]         else
[25]             f = P_uncovered/mc;     % comptue f = dT/dt
[26]         end
[27]         T(n+1) = T(n) + f*dt;       % update the temperature
[28]     end
[29]     plot(t/day,T);  % plot the results.
[30]     xlabel('time [days]')
[31]     ylabel('Temperature [C]');
[32] end
[33]
[34] function y = cosP(x)
[35]     y = max(0,cos(x));
[36] end
[37]
```

The output is





We see that the 50 degree mark is passed roughly one day earlier. Here is a graph of the two systems together. It can be seen that eventually the smart system is about ten degrees higher.