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% ECE 202 - MATLAB Exercise M7
% Current, Voltage & Power over a function of time in an RL circuit

clear % clears all variables in the workplace; avoids common errors
clc

% ----- Constants ---------
L = 50;                         % Inductance in miliHenry  (mH)
R = 2;                          % Resistance in Ohms
V0 = 10;                        % Voltage in Volts, (V)
Tau = L / R;                    % Time constant (ms)
tmin = 0;                       % time in miliseconds (ms)
tmax = 10 * Tau;                % time in miliseconds (ms)
N = 400;
t = linspace(tmin, tmax, N+1);  % needed to plot from 0 to 10*Tau (ms)
dt = (tmax -tmin) / N;          % in miliseconds (ms)


%------ Calculations -------
If = V0/R;                          % Current After a very long time in Amperes, A
I = If *(1 - exp(-t/Tau));          % current as a function of inductor in Amperes, A
v = V0*exp(-t/Tau);                 % voltage across the inductor in Volts, V
p = v.*I;                           % power absorbed by the inductor in Watts, W

wf = 0.5 * L * If^(2)                   % final energy stored in inductor in miliJoules, mJ
w_total = sum(p * dt)                   % Total energy after a long time in miliJoules, mJ
w_difference = wf - w_total             % Energy difference between the final and the total, mJ
Percent_Diff = (w_difference)*100 / wf  % Percent difference

%-------- Plots ------------
% Subplot 1
subplot(3,1,1)
plot(t, I, 'b', 'LineWidth', 2)
ylabel('Current (A)', 'FontSize', 16)
title({'ECE 202, Exercise M7';'Power Absorbed P(t), Voltage V(t) & Current i(t)';'in an RL Circuit Charging an Inductor'}, 'FontSize', 20)
text(150, 3, '$$ i(t) = {5}\cdot{(1-{e^{-t\over25}})} $$', ...
'Interpreter', 'latex', 'FontSize', 24)
grid on;

% Subplot 2
subplot(3,1,2)
plot(t, v, 'r', 'LineWidth', 2)
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45 ylabel('Voltage (V)', 'FontSize', 16)
46 text(160, 6, '$$ v(t) = 10\cdot{e^{-t\over25}} $$', ...
47 'Interpreter', 'latex', 'FontSize', 24)
48 grid on;
49
50 % Subplot 3
51 subplot(3,1,3)
52 plot(t, p, 'k', 'LineWidth', 2)
53 xlabel('time t (ms)', 'FontSize', 18)
54 ylabel('Absorbed Power (W) ', 'FontSize', 16)
55 text(160, 11, '$$ p(t) = v(t)\cdot{i(t)} $$', ...
56 'Interpreter', 'latex', 'FontSize', 24)
57 grid on;
58
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