MT240_NR_9_1_1 Sinusoid Source

Table of Contents

Title

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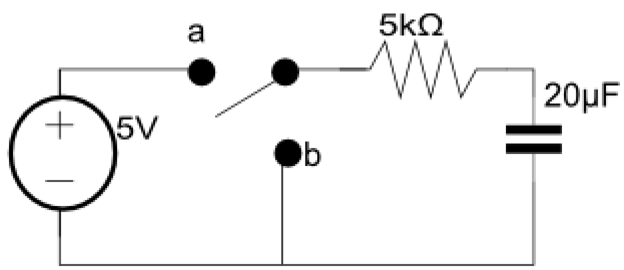
Description

An AC voltage source can be modeled by a DC source toggling on it and off via a switch.

You hava a circuit as described in the image below. The switch toggles between position a and b. At t = 0 there is no energy stored in the capacitor and the switch is in position a. At t = 2*tau (tau is the time constant of the circuit) the switch moves to position b and so on. The table below indicates the time the switch moves and into which position.

```
| time       | position |
| t = 0      |    a     |
| t = 2*tau  |    b     |
| t = 2*tau  |    a     |
| t = 4*tau  |    b     |
| t = tau/4  |    a     |
| t = 4*tau  |    b     |
| t = tau/6  |    a     |
| t = 2*tau  |    b     |
| t = tau/10 |    a     |
| t = 4*tau  |   end    | End the simulation
```



Exercise

1. Calculate the voltage across the capacitor as a function of time
2. Plot the voltage as a function of time with time being in ms

Questions

1. How would you create a waveform that closely approximates a triangle?
2. Approximate how fast must the switch toggle between position a and b in order for the waveform to approximate a triangle?

Useful Information

General Solution for a RC circuit

$$x(t) = x_f - (x_f - x_i)e^{(-t/\tau)}$$

```
xi refers to the initial amount. In this exercise, xi refers to the
voltage across the capacitor right before the switch changes position.
xf refers to the final amoun. In this exercise, xf refers to the voltage
that the capacitor will have provided that no future switch event
occurs. For example, when the switch is in position a xf is 5V, and
when the switch is in position b xf is 0V.
```

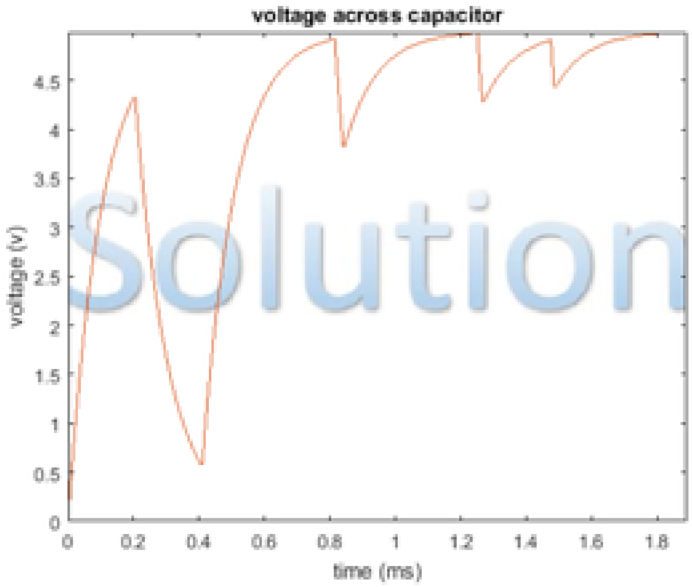
Provided Code

```
% Parameters
R = 5000;           % Ohms
C = 20e-6;          % 20uF
tau = (R*C);        % Time constant, s
Vs = 5;             % Voltage source, s
Vi = 0;             % Voltage across capacitor when the switch changes
Vt = [];            % Stores the voltage as a function of time
Vf = Vs;            % The final voltage.
time_beg = 0;
time_step = 0.005;    % Time step, s

x = 9;      % number of cycles (switch on and off)
counter =0; % counts the number of cycles

% The while loop iterates through every switch event.
% During every switch event, a new time array is
% calculated. Notice how the time array starts
% over at 0 whenever a switch even occurs and its
% duration is the time duration of every switch event.
while counter < x
     % the capacitor is charging at first
```

```
                    if counter ==0 % switch event to charge
                        t = time_beg:time_step:2*tau;
                        Vf = Vs;
                    elseif counter ==1 % switch event to discharge
                         t = time_beg:time_step:2*tau;
                         Vf = 0;
                    elseif  counter ==2 % switch event to charge
                         t = time_beg:time_step:4*tau;
                         Vf = Vs;
                    elseif  counter == 3 % switch event to discharge
                         t = time_beg:time_step:tau/4;
                         Vf = 0;
                    elseif  counter == 4 % switch event to charge
                         t = time_beg:time_step:4*tau;
                         Vf = Vs;
                    elseif  counter == 5 % switch event to discharge
                         t = time_beg:time_step:tau/6;
                         Vf = 0;
                    elseif  counter == 6 % switch event to charge
                         t = time_beg:time_step:2*tau;
                         Vf = Vs;
                    elseif  counter == 7 % switch event to discharge
                         t = time_beg:time_step:tau/10;
                         Vf = 0;
                    elseif  counter == 8 % switch event to charge
                        t = time_beg:time_step:4*tau;
                        Vf = Vs;
                    end

% V(t) = Vf - (Vf-Vc)exp(-t/tau)

% Vt is concatenated every iteration adding onto its old values.
Vt = [Vt, % INSERT CODE HERE];
Vi = Vt( % INSERT CODE HERE);
counter = counter + 1; % increments the counter
end

%t = time_beg:time_step:(1111*tau/60)+time_step*8;

figure(1);
plot(t,Vt);
xlabel('time (ms)');
ylabel('voltage (v)');
title('voltage across capacitor');
axis([0 max(t) 0 max(Vt)]); % adjusting the axis
```

Solution

Parameters



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