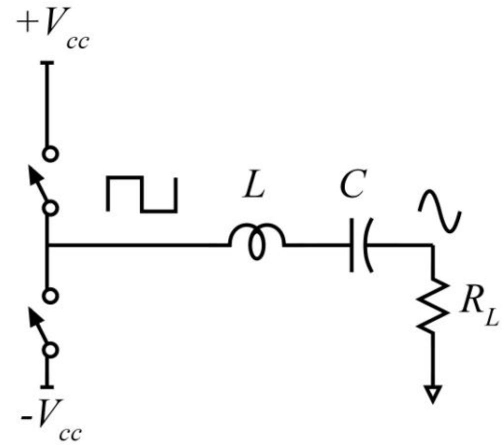
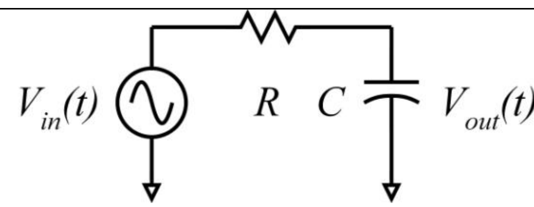
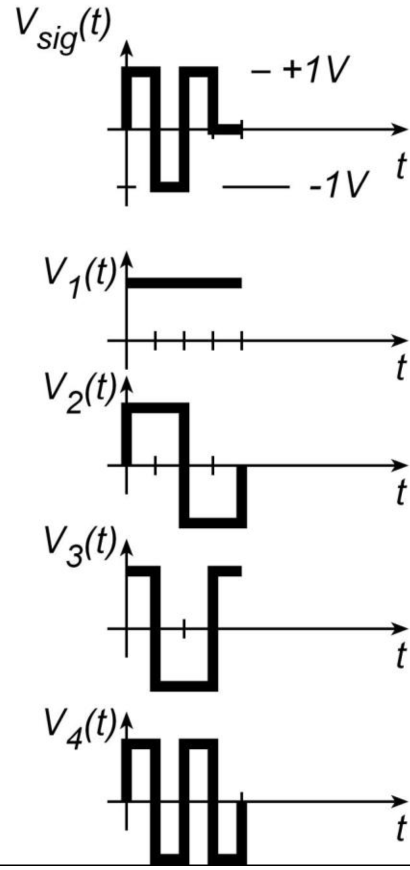
ECE 2c problem set 1 (Fourier Series and Fourier Transforms)

Problem 1: *Practical application of Fourier series.* The drawing shows the concept of a switched-mode radio-frequency transmitter. These use switches to generate a square wave signal which is then filtered to produce the desired sine-wave. The 2 switches are in opposite phase and produce a 1 GHz square wave at their junction point. The LC filter passes only the 1 GHz fundamental compent to the load. (a) Find the AC voltage at the load and (b) if the load is 50 Ohms, find the power.	 Vcc= 5.0 Volts
(c) if we change the filter so that it passes only *3GHz*, again find the AC voltage at the load and the load power.	
Problem 2: (a) Plot the following functions over one cycle , where f =100 MHz. Plot at least 32 points/waveform. To keep it from getting tedious, please use Excel, Matlab, or some other computer program to calculate and to plot. (b) what do you think $V_n(t)$ becomes when n is very large ?	$V_1(t)=1V\cdot\sin(2\pi ft)$ $V_3(t)=V_1(t)+(1/3)\cdot 1V\cdot\sin(3*2\pi ft)$ $V_5(t)=V_3(t)+(1/5)\cdot 1V\cdot\sin(5*2\pi ft)$ $V_7(t)=V_5(t)+(1/7)\cdot 1V\cdot\sin(7*2\pi ft)$ $V_9(t)=V_7(t)+(1/9)\cdot 1V\cdot\sin(9*2\pi ft)$
Problem 3: R=100 Ohms and RC= 1nS. f=100 MHz. (a) Using Phasor analysis, compute note the correction --> $V_{out}(t)$ if $V_{in}(t)=1V\cdot\sin(2\pi ft)$. <---	
(b) repeat with $V_{in}(t)=(1/3)\cdot 1V\cdot\sin(3*2\pi ft)$ (c) repeat with $V_{in}(t)=(1/5)\cdot 1V\cdot\sin(5*2\pi ft)$ (d) repeat with $V_{in}(t)=(1/7)\cdot 1V\cdot\sin(7*2\pi ft)$ (e) repeat with $V_{in}(t)=(1/9)\cdot 1V\cdot\sin(9*2\pi ft)$ use Excel, Matlab, or some other computer program to calculate and to plot the sum of the answers you found in parts (a-e).	
Problem 4: (a) Plot the following functions over one cycle , where f =100 MHz. Plot at least 32 points/waveform. To keep it from getting tedious, please use Excel, Matlab, or some other	$V_1(t)=1V\cdot\sin(2\pi ft)$ $V_2(t)=V_1(t)-(1/2)\cdot 1V\cdot\sin(2*2\pi ft)$ $V_3(t)=V_2(t)+(1/3)\cdot 1V\cdot\sin(3*2\pi ft)$ $V_4(t)=V_3(t)-(1/4)\cdot 1V\cdot\sin(4*2\pi ft)$

<table>
<tr><td>computer program to calculate and to plot. (b) what do you think $V_n(t)$ becomes when n is very large ?.</td><td></td></tr>
<tr><td>Problem 5: Understanding Fourier Transforms. In the graphs at right, the steps in time are 1 ns, so each waveform lasts 4 ns. V_{sig} has amplitudes of +1 V and -1 V. The basis signals $V_1(t)$, $V_2(t)$, $V_3(t)$ and $V_4(t)$ are as sketched, and have voltage values of either +1V or -1V.

(a) Writing $V_{sig}(t) = a_1V_1(t) + a_2V_2(t) + a_3V_3(t) + a_4V_4(t)$, find the values for a1 through a4.

(b) please check the dot products of $V_3(t)$ and $V_4(t)$, where we have defined $\overline{V_a} \cdot \overline{V_b} = \langle V_a | V_b \rangle = \frac{1}{T}\int_0^T V_a(t)V_b(t)dt$ where T=4 ns.</td><td>
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<tr><td colspan="2">We can view V1 as the DC component, V2 and V3 as the sine and cosine components of the first harmonic, and V4 as the 2nd harmonic</td></tr>
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