University of Illinois **Alvarez, Mironenko, Mironov, Schmitz**

Analog Signal Processing

Thursday, March 24, 8:45-10pm

Exam II

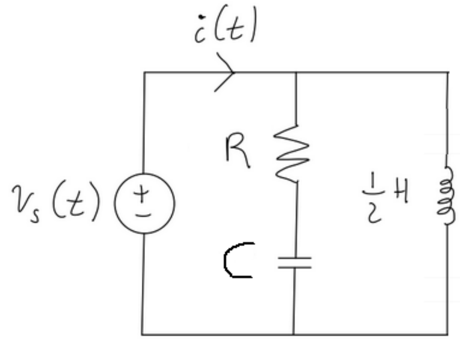
Last Name:	
First Name:	

UIN:		**netID:**	

instructions :

- Clearly PRINT your name in CAPITAL LETTERS.
- Clearly write your UIN and netID.
- This is a closed book and closed notes exam.
- Calculators are not allowed.
- To get credit, you must SHOW ALL your work and/or reasoning. Answers without any work or reasoning may receive no credit.
- To get full credit, simplify your answers.
- Write your final answers in the spaces provided or points may be deducted.
- All answers should INCLUDE UNITS whenever appropriate.
- The exam is printed **double-sided**.

1. (25 pts) Consider the LTI circuit below with voltage $v_s(t) = \cos(2t) + \sin(2t)$ V.

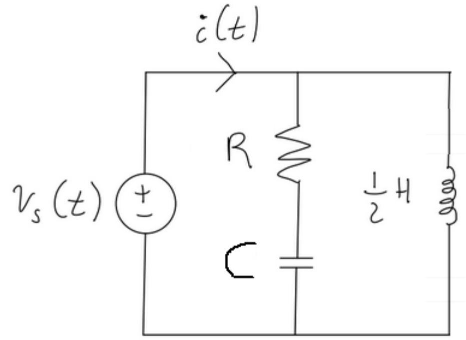


(a) [5 pts] Obtain the corresponding phasor circuit.

(b) [10 pts] If it is known that $C = 1$F and that the current $i(t)$ is in phase with the voltage $v_s(t)$, determine the value of R.

R = ____________

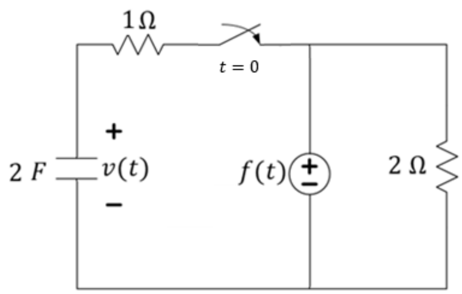
Recall that $v_s(t) = \cos(2t) + \sin(2t)$ V.



(c) [10 pts] If $C = \frac{1}{4}$F, and $R = 2\ \Omega$, determine the average absorbed power in each one of the elements in the circuit.

$P_{2\Omega}$ =__________ $P_{\frac{1}{4}F}$ =__________ $P_{\frac{1}{2}H}$ =__________ P_{v_s} = __________

2. (25 pts) Consider the circuit shown below. The switch is closed at time $t = 0$. The capacitor in the circuit has an initial voltage of $v(0^-) = \frac{3}{2}\,V$. The input $f(t) = 2\sin(\frac{1}{2}t)\,V$.



(a) [8 pts] Find the ODE of the circuit for the capacitor voltage $v(t)$, valid for $t > 0$.

ODE : ______________________________

(b) [12 pts] Find the particular $v_p(t)$ and homogeneous $v_h(t)$ solutions to the ODE.

$v_p(t) =$ ______________________________

$v_h(t) =$ ______________________________

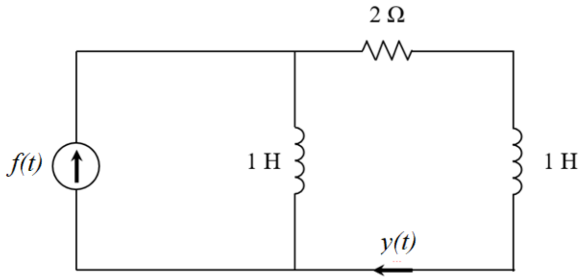
(c) [5 pts] Identify the transient and steady state signals that comprise the voltage of the capacitor $v(t) = v_{tr}(t) + v_{ss}(t)$, $t > 0$.

$v_{tr}(t) =$ ________________________________

$v_{ss}(t) =$ ________________________________

3. (25 pts) The three parts of this problem are not related.

(a) [6 pts] Find the frequency response, $H(\omega)$, of the circuit shown below.



$H(\omega)$ = ____________________

(b) [11 pts] The signal $x(t) = 2 + \cos(2t) + 2\sin(5t)$ was sent through a system having the frequency response $H(\omega) = \frac{1}{3+3j\omega}$. Find the output signal $y(t)$ and express in terms of real-valued functions.

$y(t)$ = ____________________

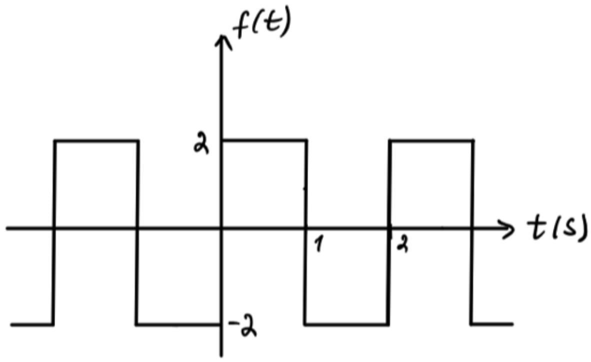
(c) [8 pts] A linear system with input $f(t)$ and output $y(t)$ is described by the ODE

$$\frac{d^2y}{dt^2} + 2y = f$$

Find the frequency response of the system $H(\omega)$ and the output signal $y(t)$ if the input signal $f(t) = 4\,V$.

$H(\omega)$ = ______________________ $y(t)$ = ______________________

4. (25 pts) Consider the periodic function $f(t)$ given below:



Determine:

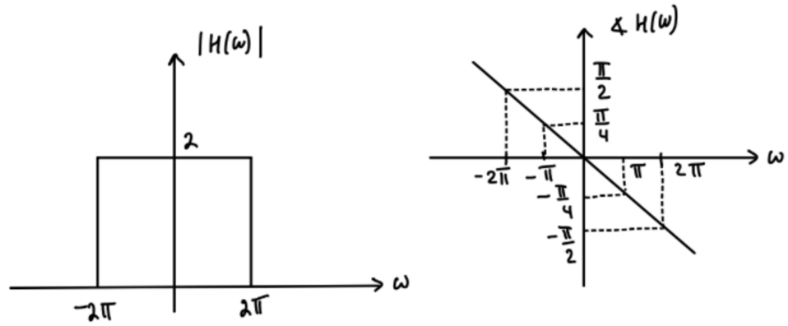
(a) [6 pts] Period T, fundamental frequency ω_0, and exponential Fourier series coefficient F_0.

T = ________________ ω_0 = ____________________ F_0 = ________________

(b) [10 pts] Exponential Fourier series of $f(t)$. Simplify as much as you can.

$f(t)$ = ____

(c) [5 pts] Let $f(t)$ be the input to an ideal low-pass filter with magnitude response $|H(\omega)|$ and phase response $\angle H(\omega)$ given below. Determine the steady-state output $y(t)$.



$y(t) =$ ________________________________

(d) [4 pts] Express $y(t)$ in terms of real-valued functions.

$y(t) =$ ________________________________

You may use this sheet for additional calculations but **do not** separate this sheet from the rest of the exam.

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