Test Five Topics:

- RMS Resistive Power Loss (I^2R)
- AC Reactance, Impedance, Power Factor
- RCL Circuit Analysis
  - Calculate Series RCL Impedance
  - Calculate Series RCL Resonance Frequency
  - Determine whether Series RCL circuit at resonance has maximum or minimum current
  - Calculate Parallel RCL Impedance
  - Calculate Parallel RCL Resonance Frequency
  - Determine whether Parallel RCL circuit at resonance has maximum or minimum current
- RCL Passive Filters
  - Using a schematic of a RC or RL circuit, determine if the circuit depicts a low pass filter or a high pass filter
  - Calculate the time constant
  - Calculate the filter's cut-off frequency
  - Sketch the V_{out} / V_{in} Curve
    - Label both axes, the horizontal asymptote, the cut-off frequency, and the ½ power point

Review materials include:

- Reading Assignments & Homework Problems
- Course Notes
- Review Problems including Reactance & Impedance Quizzes
- Additional Review Problems (AC Circuit Analyses)
- Additional Review Problems (Reactance, Filters)
- Reactance & Filter Quizzes

See Test Five Review Problems (attached)

For the test, you may use:

- a calculator,
- two page of YOUR OWN self-generated review notes

*Note: Phones may **NOT** be used during the exam; NOT as calculators, NOT as Internet connections, NOT for resource retrieval (i.e., electronic copies of notes, files, tables, etc.), NOT for communications. If the exam proctor suspects the use of a phone during the exam, your test will be confiscated and zero points will be assigned.*

Calculate Capacitive and Inductive Reactance and Complex Impedance
Calculate Series & Parallel Equivalent Impedance for Resistors, Capacitors, Inductors, Impedances
Determine Passive RC and RL Passive Filter Characteristics

1. Calculate Series & Parallel Impedance Frequency = 420 Hz.

RCL Series Configuration	RCL Parallel Configuration
R = 20 Ω	R = 20 Ω
C = 25 μF	C = 25 μF
L = 50 mH	L = 50 mH

Answers:

R = 20 Ohms	XC = 15.2 Ohms	XL = 131.9 Ohms	
RCL Series Configuration		Z = 20 + j 116.8	Z = 118.5 @ 80.3
RCL Parallel Configuration		Z = 8.46 - j 9.88	Z = 13.1 @ -49.4

2. For Figure A, calculate the circuit impedance if the excitation frequency is 1800 Hz. (Answer: Z = 300 + j 6428)

3. For Figure B, calculate the circuit impedance if the excitation frequency is 900 KHz. (Answer: Z = 3000 + j 141)

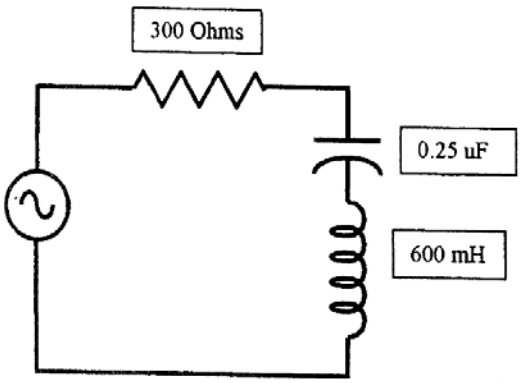


Figure A

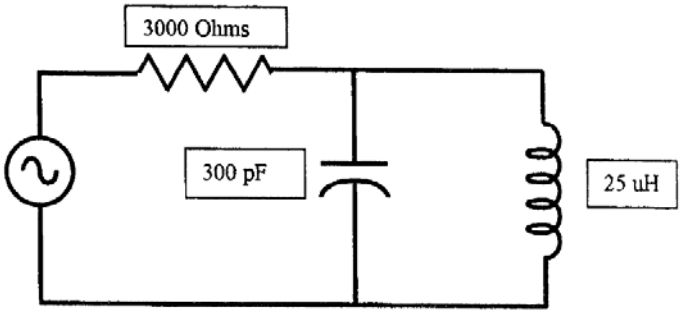


Figure B

4. Sketch RC Filter & V_{out}/V_{in} Curve
a. Calculate the cut-off frequency (half power point) if R = 1500 ohms and C = 0.100 uF. (Answer f_0 = 1060 Hz)
b. Calculate the time constant. (Answer t = 0.9 msec)
c. Sketch the circuit for a RC low pass filter
d. Sketch the circuit for a RC high pass filter

5. Sketch RL Filter & V_{out}/V_{in} Curve
a. Calculate the cut-off frequency (half power point) if R = 1500 ohms and L =12 H. (Answer f_0 = 20 Hz)
b. Calculate the time constant. (Answer t = 8 msec)
c. Sketch the circuit for a RL low pass filter
d. Sketch the circuit for a RL high pass filter

6. Reactance Quiz

7. Complex Impedance Quiz

8. Passive Filter Recognition Quiz

9. Additional AC Circuit Analysis Problems (see page 2)

9. Additional AC Circuit Analysis Problems

Basic Electronics for Scientists - James J. Brophy

5-3 Determine the rms current in the 1000-Ω resistor of the circuit in Fig. 5-22. Is the current inductive or capacitive?

Answer: 6.5 mA; capacitive

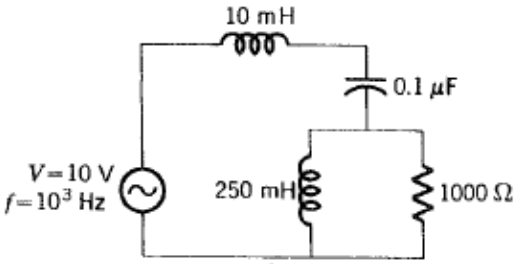


Figure 5-22

5-4 Calculate the equivalent impedance of the circuit in Fig. 5-23 at a frequency of 100 Hz. Repeat for 1000 Hz.

Answer: $0.198 + j2.63 \times 10^6\ \Omega$; $384 + j2.47 \times 10^9\ \Omega$

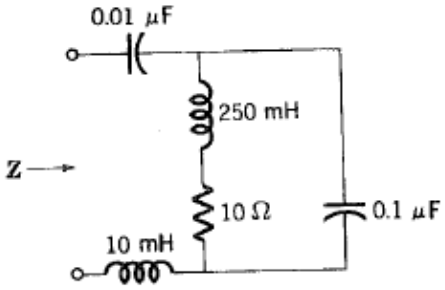
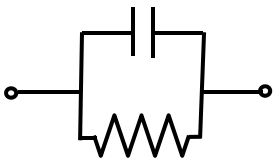
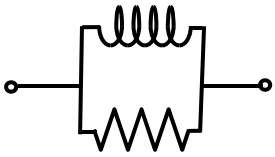


Figure 5-23

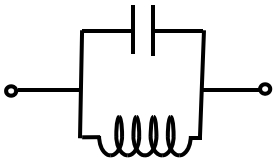
Reactance Quiz



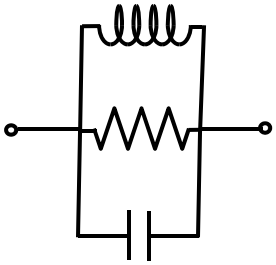
A & E



B & F



C & G



D & H

For each of the above configurations for both $\omega = 0$ and $\omega = \infty$, determine whether or not the resulting circuit appears as either a resistive circuit, a short circuit, or an open circuit. Check the appropriate blank(s).

For $\omega = 0$

Figure	Resistive Circuit	Short Circuit	Open Circuit
A.	_____	_____	_____
B.	_____	_____	_____
C.	_____	_____	_____
D.	_____	_____	_____

For $\omega = \infty$

Figure	Resistive Circuit	Short Circuit	Open Circuit
E.	_____	_____	_____
F.	_____	_____	_____
G.	_____	_____	_____
H.	_____	_____	_____

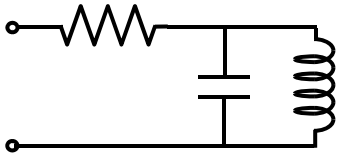
Complex Impedance Quiz

Devise formulas for each of the complex impedance configurations using R, X_C, and X_L.

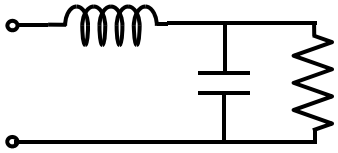
Hint: Impedances in series add, i.e., $Z = Z_1 + Z_2$

Two impedances in parallel equal the "*product over the sum*", i.e. $Z = \dfrac{Z_1 Z_2}{Z_1 + Z_2}$

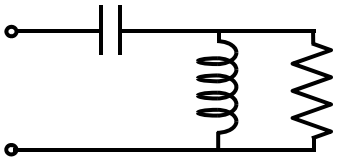
A.



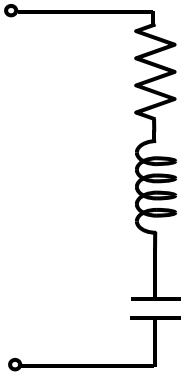
B.



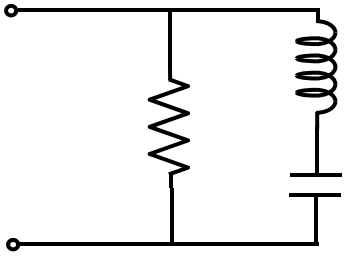
C.



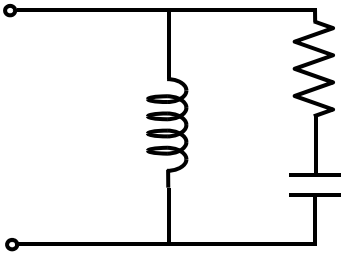
D.



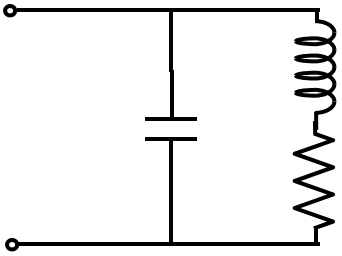
E.



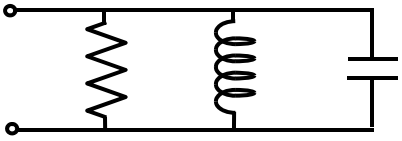
F.



G.



H.



Passive Filter Quick Recognition Quiz

For each of the four schematics, indicate whether or not the configuration represents a *Low Pass Filter* or a *High Pass Filter*.

Hint: Consider the reactance when $\omega = 0$.

$X_L = 0$	$V_L = 0$	$V_R = V_{in}$
$X_C >> 0$	$V_C = V_{in}$	$V_R = 0$

If $V_{out} = V_{in}$, then since $\omega = 0$, passes low frequencies, hence Low Pass Filter.

If $V_{out} = 0$, then since $\omega = 0$, blocks low frequencies, hence passes only high frequencies, i.e., High Pass Filter.

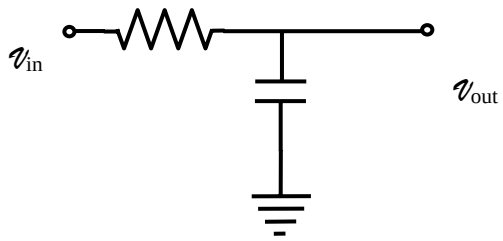
Similarly: Consider the reactance when $\omega >> 0$.

$X_L >> 0$	$V_L = V_{in}$	$V_R = 0$
$X_C = 0$	$V_C = 0$	$V_R = V_{in}$

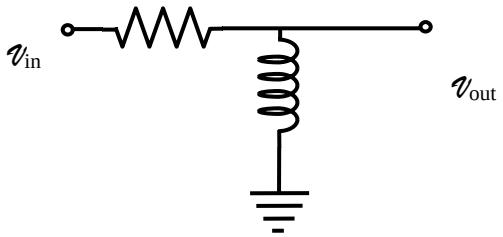
If $V_{out} = V_{in}$, then since $\omega >> 0$, passes high frequencies, hence High Pass Filter.

If $V_{out} = 0$, then since $\omega >> 0$, blocks high frequencies, hence passes only low frequencies, i.e., Low Pass Filter.

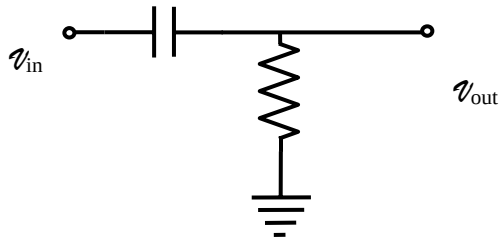
A.



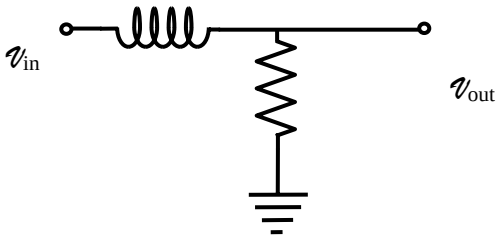
B.



C.



D.



A. _____

B. _____

C. _____

D. _____

RC & RL Charging and Discharging Curves
http://hades.mech.northwestern.edu/index.php/RC_and_RL_Exponential_Responses

Reactance Quiz

A. Resistive **B.** Short Circuit **C.** Short Circuit **D.** Short Circuit

E. Short Circuit **F.** Resistive **G.** Short Circuit **H.** Short Circuit

Complex Impedance Quiz

A. $R + \frac{X_C X_L}{X_C + X_L}$ **B.** $X_L + \frac{R X_C}{R + X_C}$ **C.** $X_C + \frac{R X_L}{R + X_L}$ **D.** $R + X_C + X_L$

E. $\frac{R(X_C + X_L)}{R + X_C + X_L}$ **F.** $\frac{X_L(R + X_C)}{R + X_C + X_L}$ **G.** $\frac{X_C(R + X_L)}{R + X_C + X_L}$

H. $\frac{1}{Z} = \frac{1}{R} + \frac{1}{X_C} + \frac{1}{X_L} = \frac{X_C X_L + R X_L + R X_C}{R X_C X_L}$ $Z = \frac{R X_C X_L}{R X_C + R X_L + X_C X_L}$

Passive Filter Quiz

A. Low Pass **B.** High Pass **C.** High Pass **D.** Low Pass