NATIONAL UNIVERSITY OF SINGAPORE

EE2111A – ELECTRICAL ENGINEERING PRINCIPLES & PRACTICE II

END-SEMESTER QUIZ

(Semester 2 : AY2019/2020)

Time Allowed : 1.5 Hour

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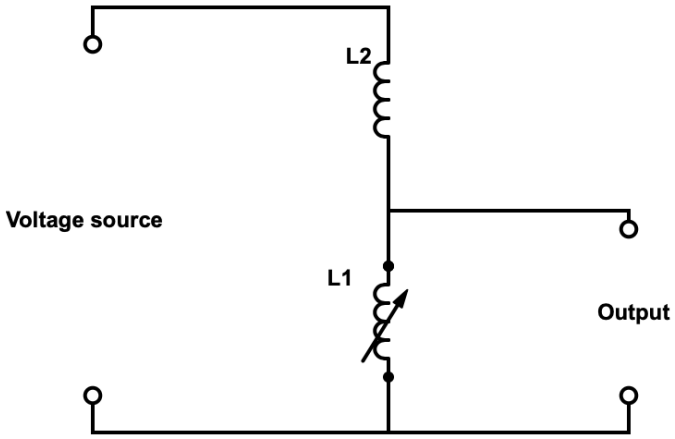
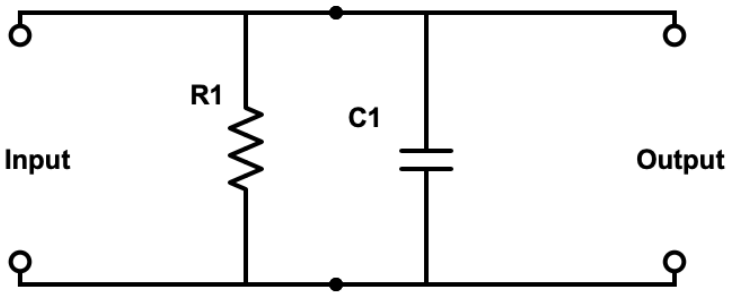
1. Consider the following sensor circuit, where the sensing element is a coil modeled as a variable inductor L1. The inductance of L1 changes when a metal is close to the coil. You have been tasked to recommend an operating voltage source, and a measurement device for the output. What would you recommend?



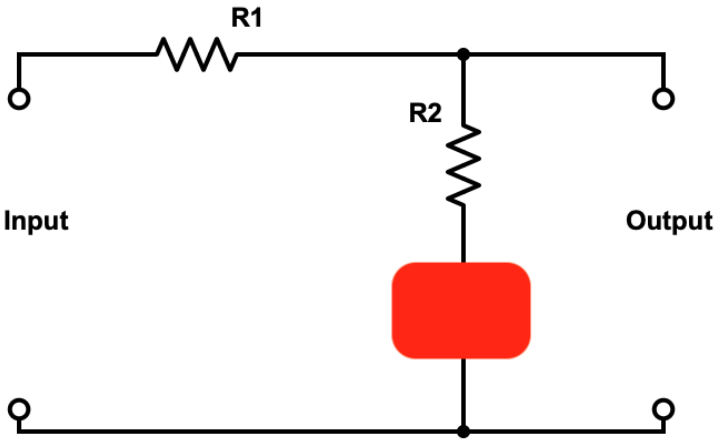
A. DC voltage source, and multimeter to measure average output voltage
B. DC voltage source, and multimeter to measure RMS output voltage
C. AC voltage source, and multimeter to measure RMS output voltage
D. AC voltage source, and multimeter to measure average output voltage

2. Consider the following filter circuit that a colleague designed. What type of a filter does this implement?

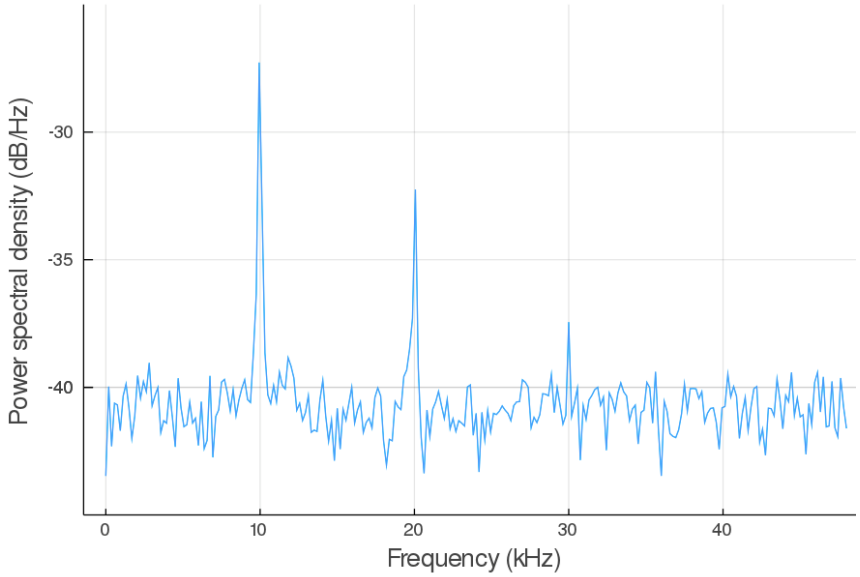


A. Low-pass filter
B. High-pass filter
C. Band-pass filter
D. All-pass filter (all frequencies pass through)

3. While repairing an old instrument, you find a simple circuit board with 3 components on it. You identify two of the components and traces on the board and draw the following schematic for the circuit:



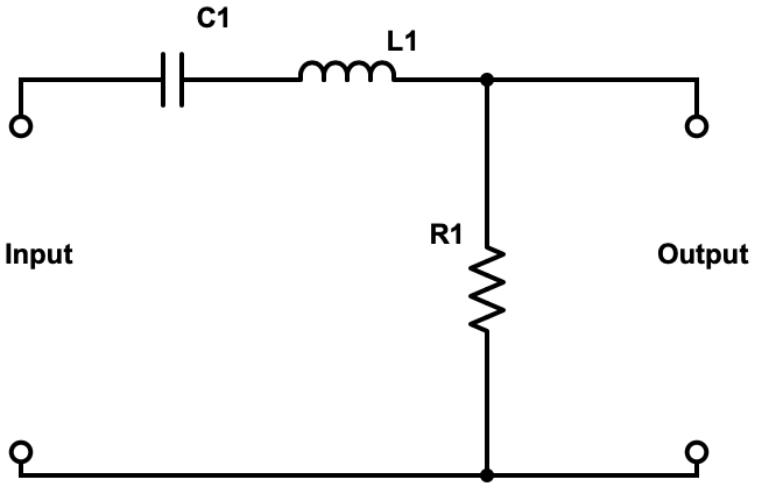
The red box represents the third component that you can't identify, as it is covered with some opaque red glue. You feed in a 10 kHz sinusoidal waveform at the input of this circuit and measure the power spectral density at the output:



Of the components from the list below, which one do you think is the most likely component hiding under the red box?

A. Capacitor
B. Diode
C. Inductor
D. Resistor

4. Consider the following filter circuit:



The values of the components are: R1 = 30 Ω, C1 = 2 μF, and L1 = 20 mH. What kind of a filter is this?

A. Band-pass filter with a center frequency of about 800 Hz
B. High pass filter with a cut-off frequency of about 2.7 kHz
C. Low pass filter with a cut-off frequency of about 240 Hz
D. Low pass filter with a cut-off frequency of about 2.7 kHz

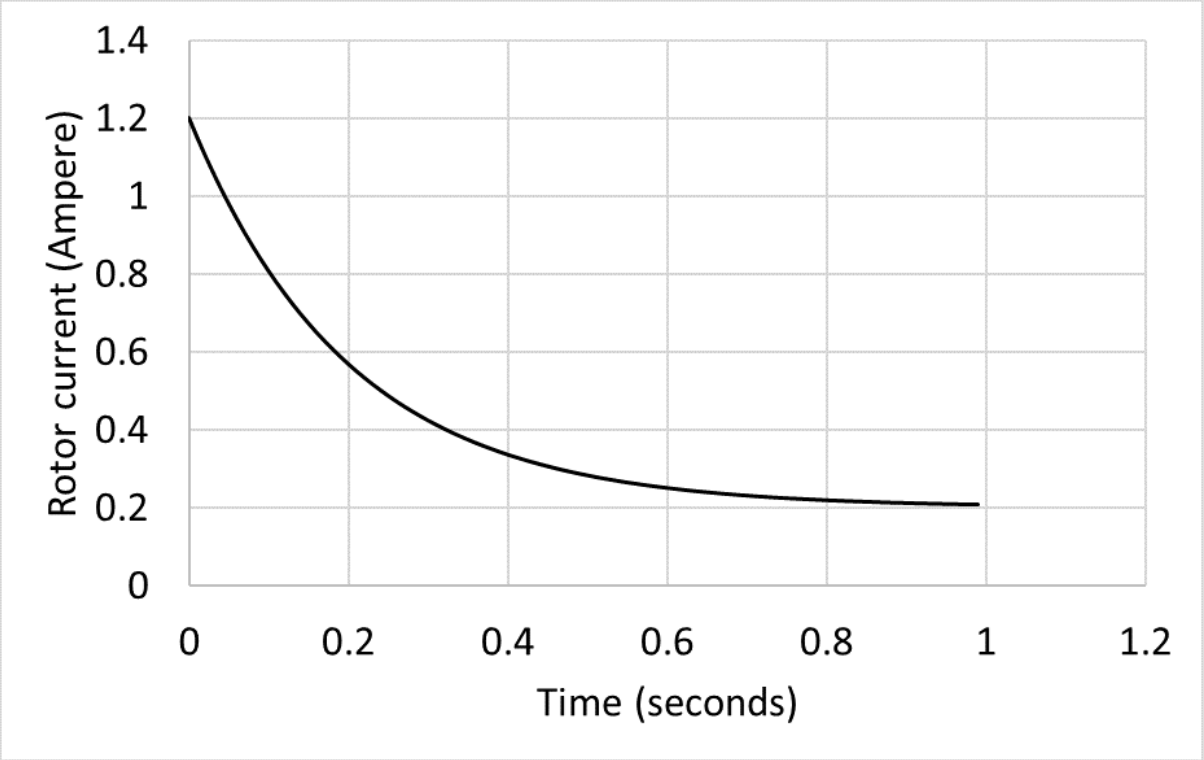
5. Which of the following statements are TRUE for DC motors?
   i. Speed is always proportional to the back emf ($\omega \propto E_b$)
   ii. Electromagnetic torque developed is always proportional to armature current ($T_{em} \propto I_{armature}$)
   iii. Whenever load torque is increased, speed is decreased.

A. Statement (i) and (ii) only
B. Statement (i) and (iii) only
C. Statement (ii) and (iii) only
D. All three statements

6. A PMDC motor with torque constant (Kt) 50 mNm/A and armature resistance of 10 Ω is powered by a 12 V DC source. Find the electromagnetic torque (Tem) developed if the motor drives a load at 1200 RPM.

A. Approximately 57 mNm
B. Approximately 29 mNm
C. Approximately 15 mNm
D. Approximately 12 mNm

7. The figure below shows the rotor current of a PMDC motor immediately after a 12V source is connected to it. If the back emf constant (Ke) of this motor is 30 mV/rad/s, then what is the steady state speed of this motor?



A. 3183 RPM
B. 5140 RPM
C. 8313 RPM
D. 5211 RPM

8. A 250 V, DC shunt motor runs at 1200 RPM and draws 4.5 A from the voltage source. The resistances of the field winding and the armature winding are 167 ohm and 0.22 ohm, respectively. When mechanical load is changed, the current drawn from the source is increased to 56.5 A. What is the most likely speed of rotation under the new loading?

A. 120 RPM
B. 96 RPM
C. 1145 RPM
D. Cannot be determined using the given information

9. The back emf constant (Ke) and the rotor resistance (Rm) of a PMDC motor are 30 mV/rad/s and 10ohm, respectively. The motor is driven by an H-bridge power converter

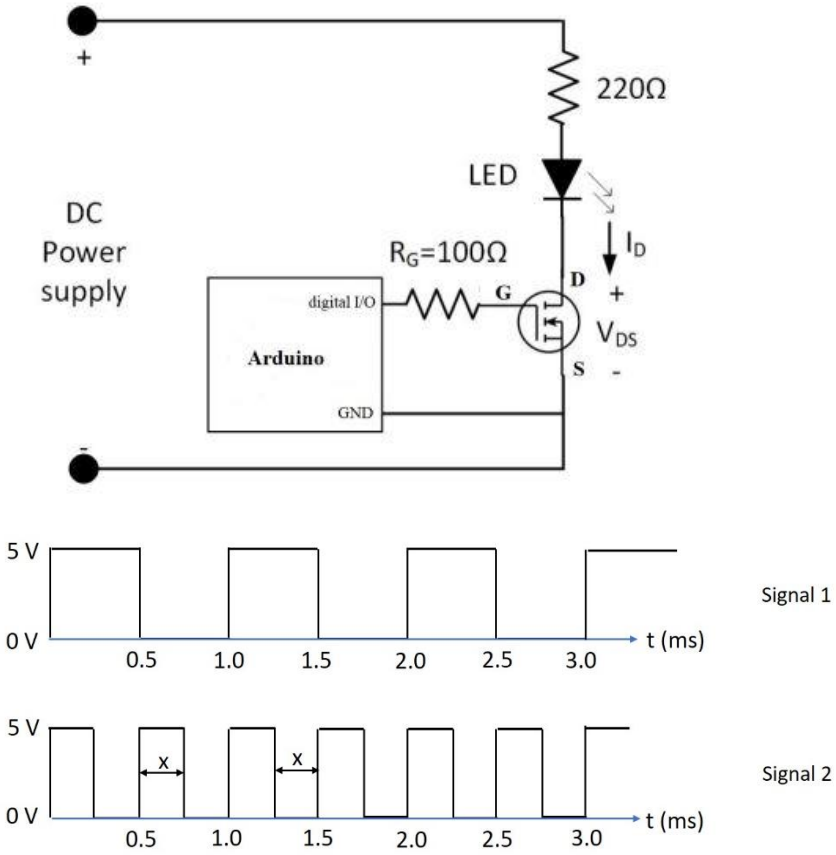
with a 12V power supply. When the H-bridge is controlled using 80% duty cycle, the motor runs at 2000 RPM. Due to a change in load torque, the speed is increased to 2400 RPM. What should be the new duty cycle to bring the motor speed back to 2000 RPM?

A. 70%
B. 67%
C. 83%
D. 75%

10. The armature (rotor) of a separately excited DC motor is powered by 250 V DC source. Armature resistance (Ra) is 0.2 Ω and it draws an armature current (Ia) of 50 A to spin a load at 750 RPM. Then the stator voltage is changed to bring the stator flux (ϕ) down to 90% of its original value. If nothing else is changed, what would be the approximate speed with the new stator voltage?

A. 581 RPM
B. 675 RPM
C. 833 RPM
D. None of the options

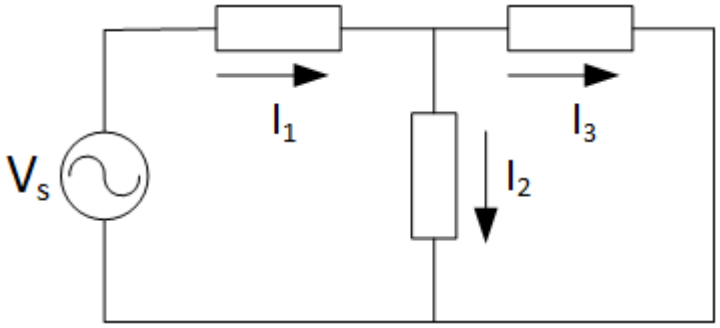
11. John made the LED dimmer circuit shown in the figure below with DC power supply set to 9V. The MOSFET acts as an ON/OFF switch which is controlled by the voltage VGS applied between gate (G) and source (S). When VGS=5V, the switch is turned ON, i.e., the MOSFET conducts with negligibly small resistance. When VGS=0V, the MOSFET is turned OFF.



John tested the circuit first using Signal 1 and then using Signal 2; both signals are generated using Arduino. What did John most likely observe?

A. LED was not be turned ON as voltage supply was continuously disrupted by the MOSFET switch
B. The LED was brighter when signal 1 was used
C. The LED was brighter when Signal 2 was used
D. The LED brightness was nearly the same with both signals.

12. The figure shows an AC circuit with three branches having unknown combination of R, L and C. The RMS values of currents in two branches are given as I2=3A and I3=4A.

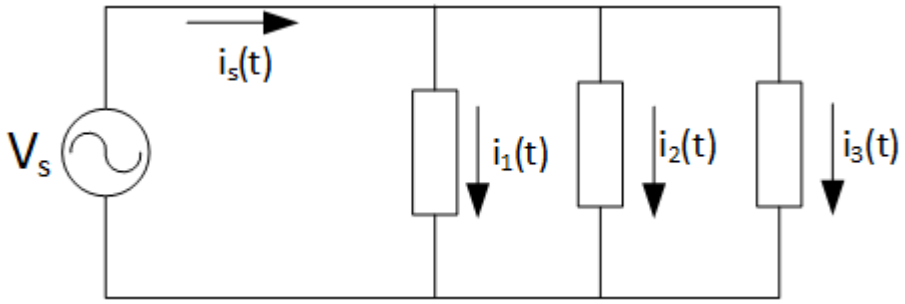


What is the RMS value of current I1?

A. 5A
B. 7A
C. 2.64A
D. Cannot be determined from the given information

13. An AC voltage source is supplying current to three parallel loads as given below:

$$i_1(t) = 2Sin(100t - 45^0)$$
$$i_2(t) = 0.5\,Cos(100t - 60^0)$$
$$i_3(t) = 1\,Sin(100t + 60^0)$$

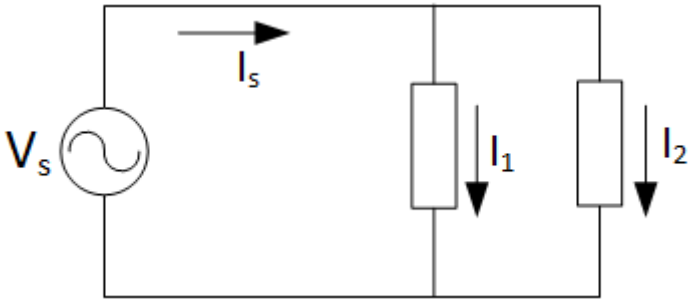


What is the amplitude of the source current, $i_s(t)$?

A. 3.5A
B. 0.5A
C. 2.36A
D. 2.48A

14. The circuit shows an AC voltage source supplying power to two parallel connected loads. Various phasors for the circuit are given as:

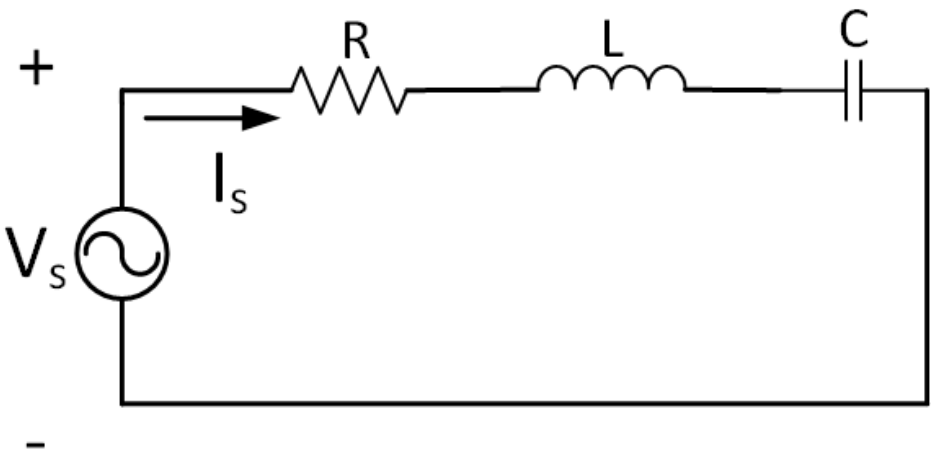
$V_S = 5\angle 0^0$, $I_1 = 1\angle 45°A$, $I_2 = 1\angle -45°A$



What is the closest value of the equivalent load impedance seen by the source?

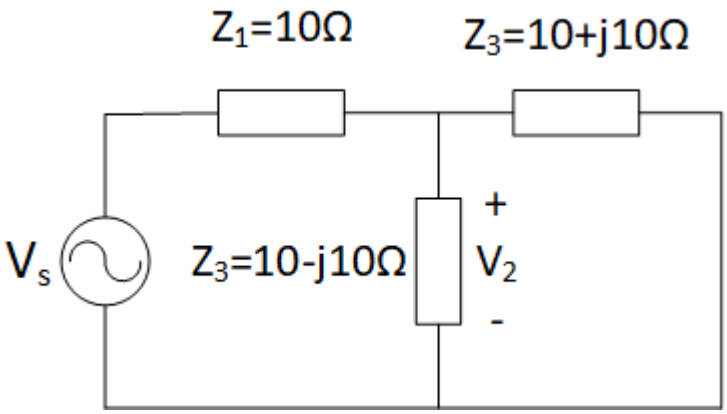
A. 2.5 Ω
B. 3.5 Ω
C. 2.5+j2.5 Ω
D. 2.5-j2.5 Ω

15. The Series RLC circuit given in Figure below is in resonance. If the supply frequency is further increased above the resonance frequency, what will be the phase relationship between the supply voltage, V_S and supply current, I_S ?



A. There will be no change in phase relationship.
B. The supply voltage, Vs will be leading the supply current, Is.
C. The supply voltage, Vs will be lagging the supply current, Is.
D. It is NOT possible to tell this without knowing the actual values of L and C.

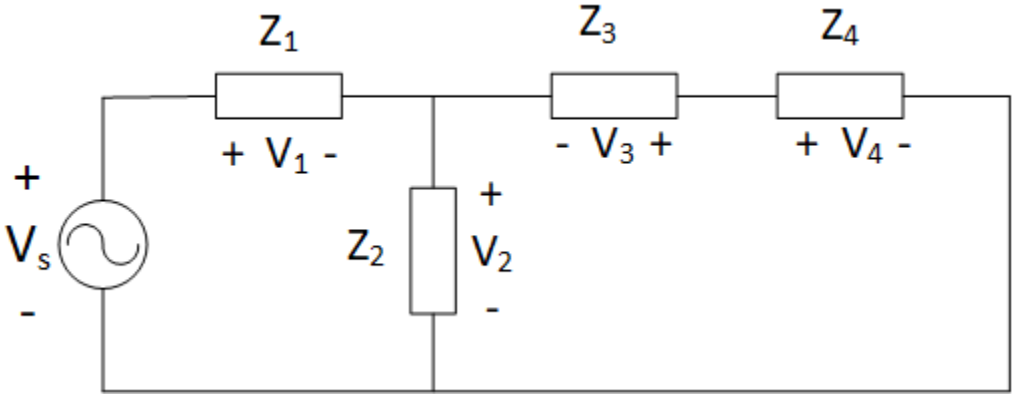
16. In the AC circuit given below, RMS value of supply voltage,Vs=5V. What is the RMS value of voltage V_2?



A. 5V
B. 5/2V
C. 5/3V
D. 5/4V

17. An AC circuit has a few branches with unknown impedance connected as shown in the Figure below. Some voltage phasors are given as:

$V_S=10\angle 45^o, V_1=5\angle 0^o, V_3=5\angle 45^o$



Which are the correct values of the remaining voltage phasors?

A. $V_2 = 5\angle 45^o, V_4 = 5\angle 45^o$

B. $V_2 = 7.37\angle 73.68^o, V_4 = 12\angle 62.14^o$

C. $V_2 = 7.17\angle 63.68^o, V_4 = 12\angle 52.14^o$

D. $V_2 = 5\angle 90^o, V_4 = 8.67\angle 45^o$

18. A diode bridge rectifier is connected to the AC utility, which is 230V(RMS) at 50Hz. The output of the diode bridge rectifier is directly connected to a resistive load. Which of the following options gives closest values for the following properties of the load voltage (Vo); maximum value, peak-to-peak value, average value? Note: Assume zero voltage drop across the diodes.

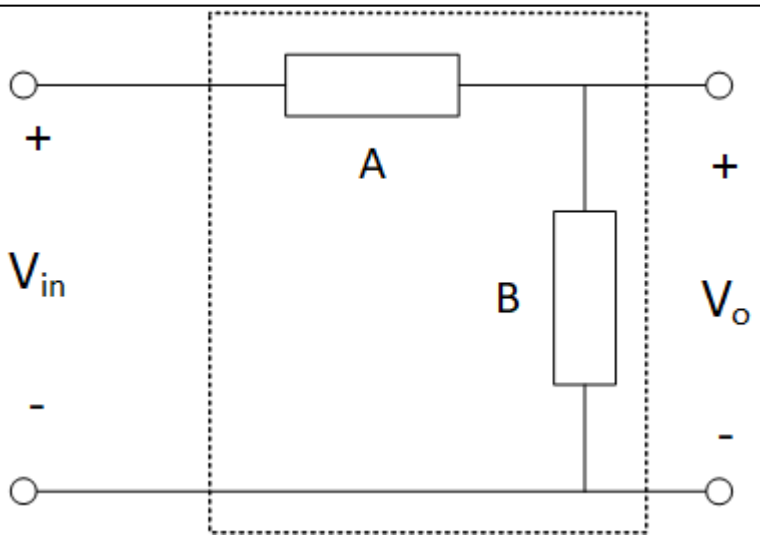
A. $V_{o,max}=325V, V_{o,peak\text{-}to\text{-}peak}=650V, V_{o,ave}=207V$

B. $V_{o,max}=325V, V_{o,peak\text{-}to\text{-}peak}=325V, V_{o,ave}=207V$

C. $V_{o,max}=325V, V_{o,peak\text{-}to\text{-}peak}=325V, V_{o,ave}=146V$

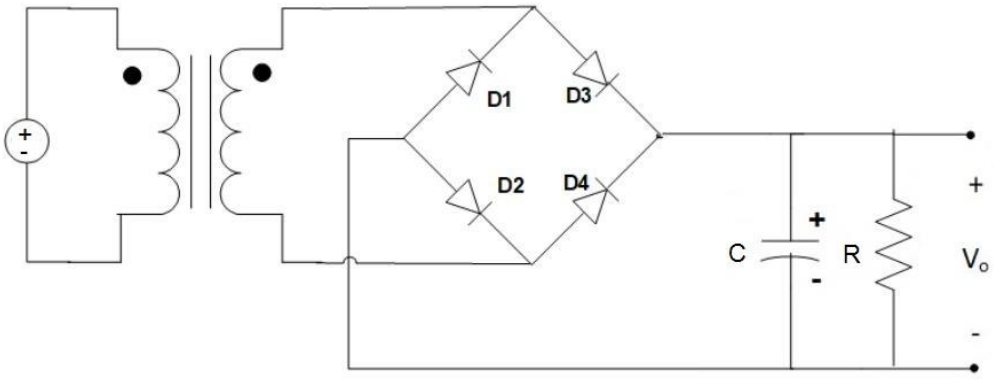
D. $V_{o,max}=230V, V_{o,peak\text{-}to\text{-}peak}=460V, V_{o,ave}=146V$

19. The circuit given in Figure below is a low-pass filter. What is the phase relationship between Vo and Vin?



A. Vo and Vin have no phase difference.
B. Vo leads Vin
C. Vo lags Vin
D. The phase difference between Vo and Vin is independent of the frequency.

20. The diode bridge rectifier circuit below is connected to a DC input voltage source of 240V (RMS). The output of the diode bridge rectifier is connected to a resistive load of R= 1 kΩ, with a capacitive filter of value C =1000μF.
What is the ripple voltage, ΔV_O , observed in the output voltage V_O? Note: Assume zero voltage drop across the diodes.



A. 0V
B. 2.4V
C. 3.3V
D. 4.8V

- END OF QUIZ -