NATIONAL UNIVERSITY OF SINGAPORE

EE2111A – ELECTRICAL ENGINEERING PRINCIPLES & PRACTICE II

MID-SEMESTER QUIZ

(Semester 2 : AY2019/2020)
22 February 2020

Time allowed: 90 minutes

INSTRUCTIONS TO STUDENTS:

1. This quiz contains 20 questions and comprises 11 printed pages excluding the cover page.
2. Students are required to answer ALL questions.
3. **Please shade your matriculation number correctly on the scantron sheet.**
4. **Write your matriculation number and your contact number on the scantron sheet.**
5. Use a 2B pencil to shade completely all entries and the correct answers on the scantron sheet.
6. More than one answer (over-writing) per question will carry zero marks.
7. Do not submit the question paper, submit only the scantron sheet.
8. This is an **OPEN BOOK ASSESSMENT**.
9. All materials related to the topic are permitted.
10. No mobile devices are allowed.

1. The I-V characteristics of two different LEDs, LED_1 and LED_2, are shown in Figure 1. Both LEDs require V_{LED} to be above 1.1V to turn on visibly. Find using the graph and the circuit shown, for $R_1 = R_2 = 100\ \Omega$, the smallest value that can be used for V_S?

NOT IN SCOPE.

   (a) 2 V

   (b) 3 V

   (c) 4 V **Correct answer**

   (d) 5 V

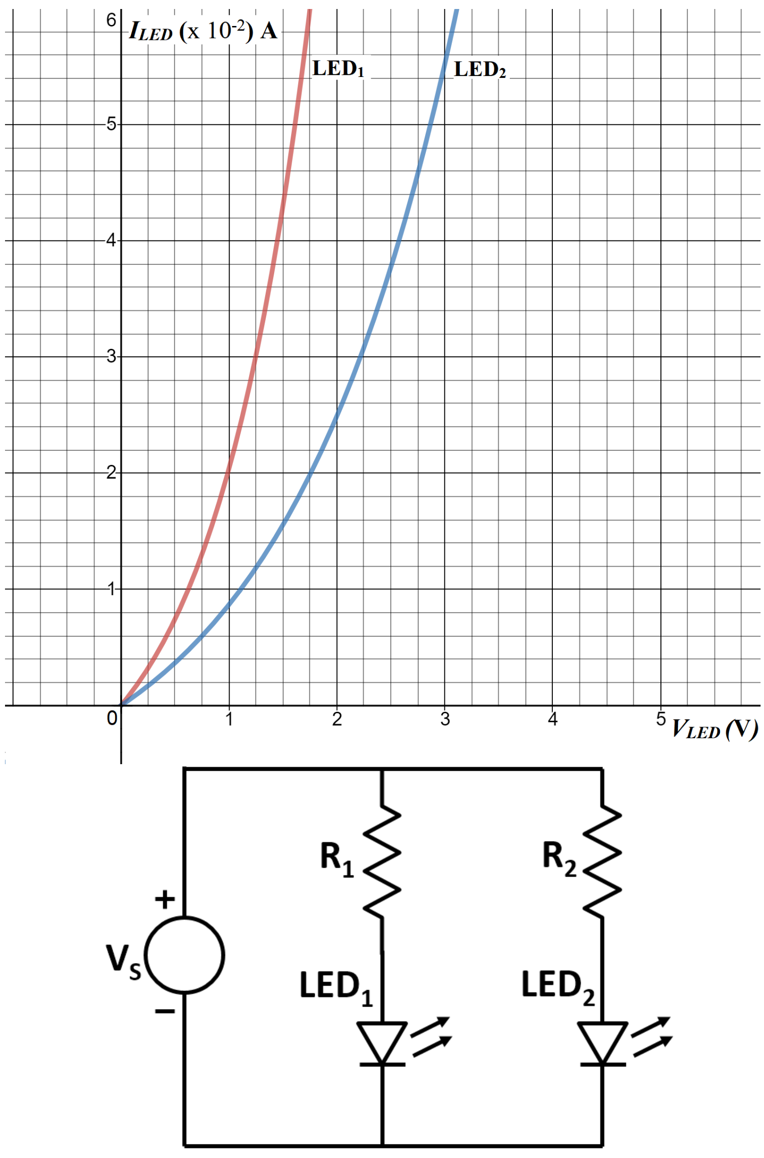


Figure 1: Question 1 and 2

2. For the circuit and the graph of Q1, which of the following values of resistors does ensure that the currents of the LEDs are approximately the same with $V_S = 5V$?

   (a) $R_1 = 100\ \Omega, \quad R_2 = 90\ \Omega$
   (b) $R_1 = 125\ \Omega, \quad R_2 = 90\ \Omega$ **Correct answer**
   (c) $R_1 = 90\ \Omega, \quad R_2 = 100\ \Omega$
   (d) $R_1 = 90\ \Omega, \quad R_2 = 125\ \Omega$

NOT IN SCOPE.

3. Which of the following statements is **FALSE** about oscilloscopes?

   (a) In **Ground** copuling mode, the display is a horizontal line always at 0V.
   (b) In **DC** coupling mode, the average of the waveform is always at 0V. **Correct answer**
   (c) **AC** coupling blocks the DC average of the signal.
   (d) In **AC** coupling mode, the average of the waveform is always at 0V.

4. Bob was observing an AC signal on the oscilloscope and the signal looked like the one shown in Figure 2. The signal was moving and could not be viewed stably. Which of the following could have caused this?

   i) The horizontal time scale was not set correctly.
   ii) The vertical time scale was not set correctly.
   iii) The trigger level was not set correctly.
   iv) The trigger channel was not set correctly.

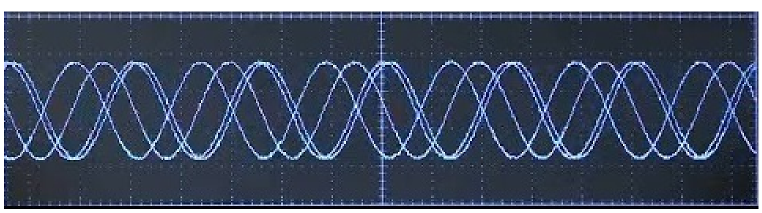


Figure 2: Question 4

   (a) Options ii and iii
   (b) Options iii and iv **Correct answer**
   (c) Options ii and iii and iv
   (d) All the options

5. A thermistor is a type of resistor whose resistance is strongly dependent on temperature. For the thermistor we use in the sensor circuit shown below in Figure 3, the relationship between resistance R_T and temperature T (in Kelvin) is:

$$\frac{1}{T} = \frac{1}{T_0} + \beta \ln \frac{R_T}{R_0}$$

where T_0, β and R_0 are known positive constants.

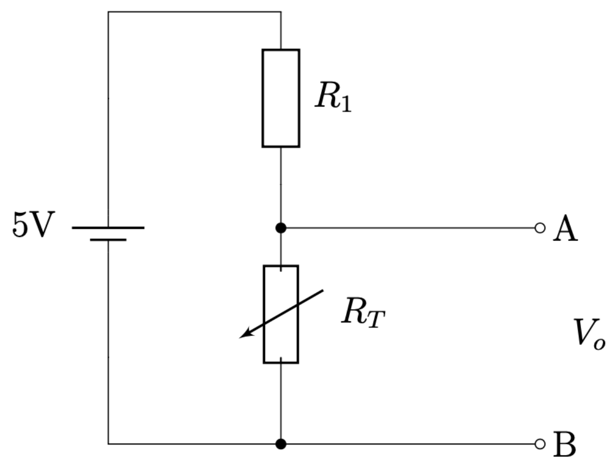


Figure 3: Question 5 - Question 8

Which of the following statements is **TRUE**?

(a) The output voltage V_0 decreases with increasing temperature T. **Correct answer**

(b) The output voltage V_0 is exactly 0V at temperature $T = 0°\text{C}$ (273.15 K).

(c) The resistance R_T increases with temperature T.

(d) The current drawn from the 5V battery is independent of the temperature T.

6. For the sensor circuit and thermistor in Q5, we are given the values of the known constants: $T_0 = 298\ K$, $\beta = 10^{-4} K^{-1}$, $R_0 = 1\ k\Omega$, $R_1 = 1\ k\Omega$. What is the power drawn by the sensor circuit from the 5V battery at temperature $T = 300\ K$, when the output V_0 is connected to a high impedance voltmeter?

   (a) No power is drawn from the battery
   (b) Approximately 1.5 W
   (c) Approximately 14 mW **Correct answer**
   (d) Approximately 500 mW

7. For the sensor circuit and thermistor of Q5 and the values of constants given in Q6, we wish to minimize the power drawn from the battery. Which of the following options will help us to do that?

   (a) Reduce the value of resistor R_1
   (b) Replace the potential divider circuit with a Wheatstone bridge with the same resistance R_1 for the fixed resistor.
   (c) Reduce the battery voltage from 5V to 3.3V **Correct answer**
   (d) Add a 10 kΩ resistor in parallel with R_1

8. For the sensor circuit of Q5, we use a voltmeter to measure the output voltage V_0 across terminals A and B. The measured V_0 is then converted to an estimated temperature T, assuming that the voltage was measured using an ideal voltmeter with infinite input impedance. Being a real voltmeter, it has a large but finite input impedance of 1 $M\Omega$. What is the effect on the estimated temperature?

   (a) There will be no effect on the estimated temperature.
   (b) The estimated temperature will be slightly lower than the real temperature.
   (c) The estimated temperature will be slightly higher than the real temperature. **Correct answer**
   (d) We will estimate a fixed value for the temperature, no matter what the real temperature is.

9. The image in Figure 4 shows a voltage waveform (solid line) and a current waveform (dash-dot line). If the phasor representation of the voltage waveform is

$$\bar{V} = 6\angle 0,$$

what is the likely phasor representation of the current waveform?

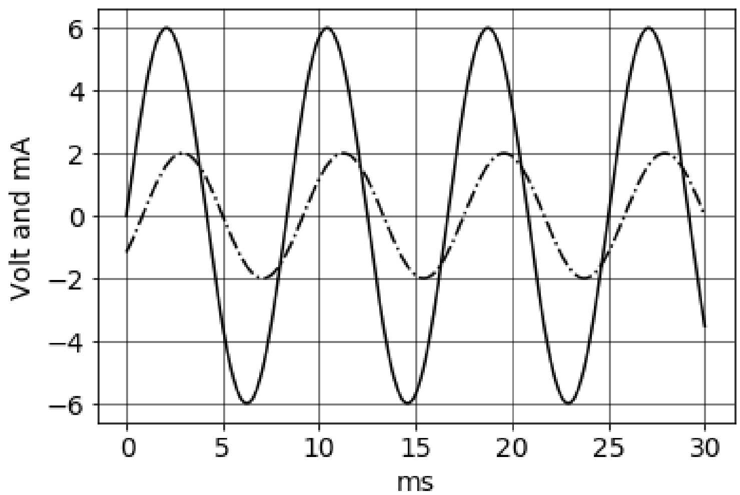


Figure 4: Question 9

(a) $2\angle + \frac{\pi}{3}$
(b) $2\angle - \frac{\pi}{2}$
(c) $2\angle + \frac{\pi}{2}$
(d) $2\angle - \frac{\pi}{5}$ **Correct answer**

10. Tom made a series RLC circuit as shown in Figure 5. Then he connected the circuit to a signal generator and applied a 5 V (peak amplitude) sinusoidal voltage which he observed using channel 1 of an oscilloscope. The resistor was 10 Ω. Then he calculated the reactances of L and C for the frequency chosen and found them to be $X_L = 20\Omega$ and $X_C = 10\Omega$. Then he connected the channel 2 probes across the inductor as shown in the figure. The negative end of the two oscilloscope channels are internally connected to the common ground.

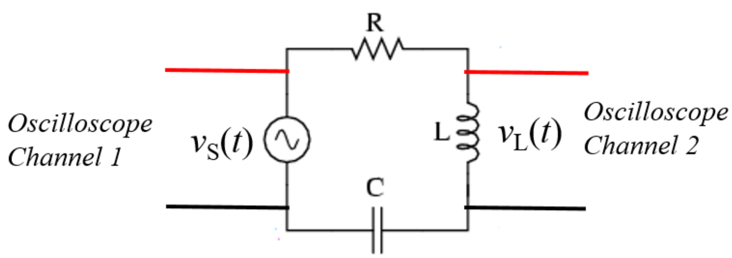
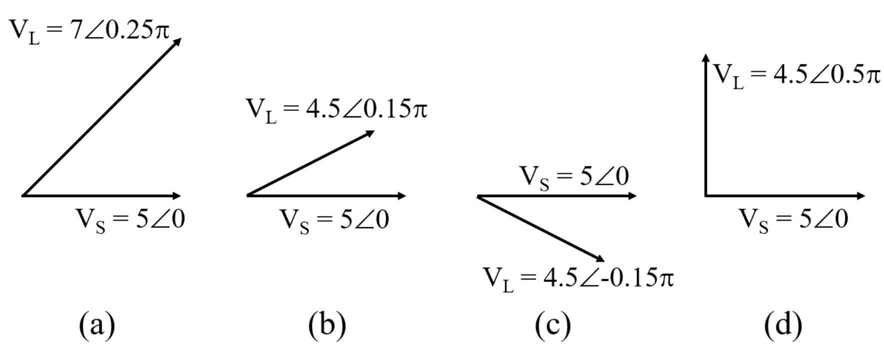


Figure 5: Question 10

He measured the amplitude of $v_L(t)$ as well as its phase shift with respect to the source voltage $v_S(t)$. Which of the following four phasor diagrams does represent these voltages correctly?



Correct answer is (b)

11. In a series RLC circuit, the RMS values of the voltages across R and L are measured as $V_{R,rms} = 100\ V$ and $V_{L,rms} = 50\ V$, respectively. What would be the approximate RMS voltage of the capacitor voltage V_C?

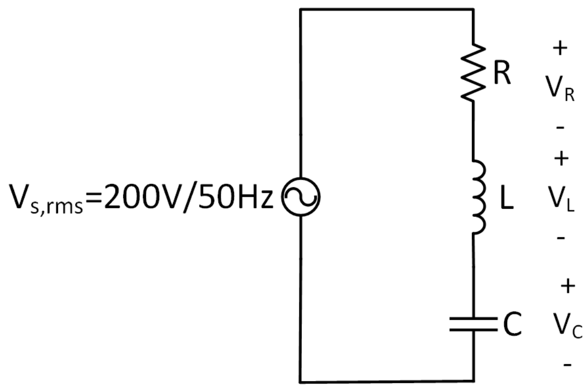


Figure 6: Question 11

(a) 50 V
(b) 123 V
(c) 223 V **Correct answer**
(d) Cannot be determined without knowing the values of R, L and C.

12. Determine the frequency at which the impedance of the circuit shown in Figure 7 is maximum.

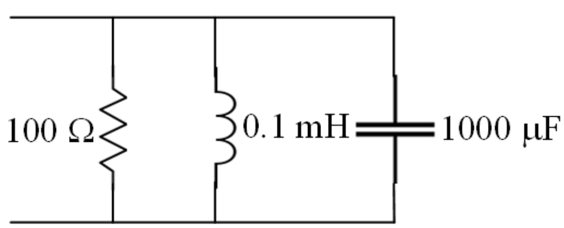


Figure 7: Question 12

(a) $\approx$ 160 Hz
(b) $\approx$ 1000 Hz
(c) $\approx$ 500 Hz **Correct answer**
(d) $\approx$ 100 Hz

13. Find the equivalent impedance of the load represented by the image shown in Figure 8 if $R = 10\Omega$, and the reactances are 10Ω for both the inductor and the capacitor.

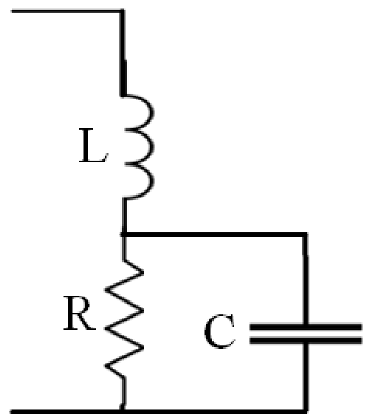


Figure 8: Question 13

(a) $5 - j5\ \Omega$

(b) $5 + j5\ \Omega$ **Correct answer**

(c) $10\ \Omega$

(d) Cannot be determined from the information provided

The symbol j used in the first two options is the imaginary number $j = \sqrt{-1}$.

14. For the circuit given in Figure 9, $v_1(t) = 5\sin(\omega t)$, $v_2(t) = 5\cos\omega t$, where the radian frequency ω is 1000 rad/s. If the current through the R-L branch is $i(t) = 5\sin(\omega t)$, what are the values of the two components R and L?

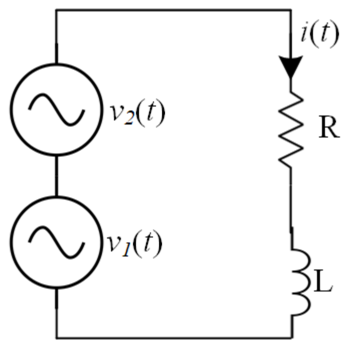


Figure 9: Question 14

(a) $1\ \Omega$ & $1\ H$

(b) $1\ \Omega$ & $2\ mH$

(c) $2\ \Omega$ & $1\ mH$

(d) $1\ \Omega$ & $1\ mH$ **Correct answer**

15. For the circuit given in Figure 10, $v_S(t) = 20\sin(\omega t)$, $R = 10\ \Omega$, $C = 160\ \mu F$, and $L = 30\ mH$. If the frequency is 50 Hz, determine the RMS value of the capacitor voltage.

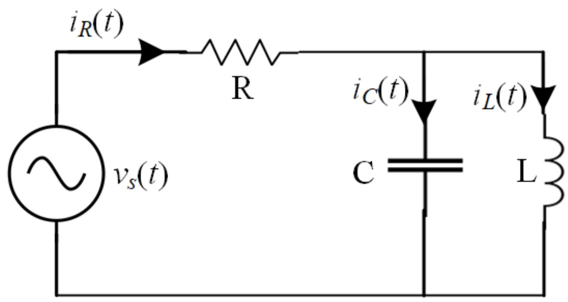


Figure 10: Question 15

(a) $\approx 17\ V$

(b) $\approx 12\ V$ **Correct answer**

(c) $\approx 10\ V$

(d) None of the above

Refer to Figure 11 for answering Questions 16-19.

The circuit below has an AC sinusoidal voltage source with RMS voltage of 100V and frequency of 50 Hz. There are three loads connected in parallel across the source with component values shown. Assume the source voltage as having zero phase (reference signal), answer the next four questions (Q16-Q19).

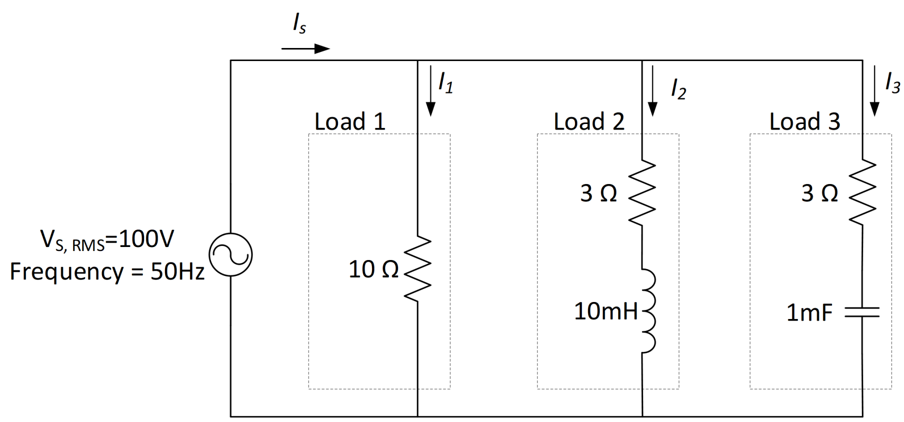


Figure 11: Question 17 - Question 20

16. What is the likely time-domain expression $i_2(t)$ for the current through Load 2?
    (a) $33.2\sin(100t - \pi/2)$
    (b) $32.5\sin(100\pi t - 0.8)$ **Correct answer**
    (c) $33.5\sin(100\pi t + 0.8)$
    (d) 33.2

17. What is the likely phasor for current I_3?
    (a) $32.3\angle 0.81$ **Correct answer**
    (b) 0
    (c) $33.3\angle\pi/2$
    (d) $32.3\angle -0.81$

18. What is the likely phase angle of the source current I_S?

    (a) $\pi/2$
    (b) 0 **Correct answer**
    (c) $\pi/4$
    (d) $-\pi/4$

19. Which of the statements is **TRUE** about phase relationship between I_1, I_2 and I_3?

    (a) I_1 leads both I_2 and I_3
    (b) I_3 leads both I_1 and I_2 **Correct answer**
    (c) I_2 leads both I_1 and I_3
    (d) I_1, I_2 and I_2 are all in-phase

20. The source v_s in the circuit shown below gives a sinusoidal voltage. What is the phase difference between the source voltage v_S and the source current i_S if the circuit is at resonance?

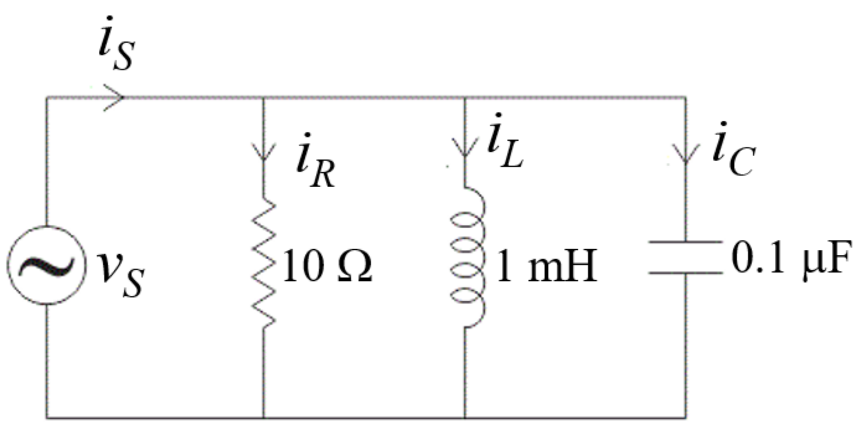


Figure 12: Question 20

    (a) 0 **Correct answer**
    (b) $\pi/3$
    (c) $\pi/4$
    (d) $\pi/2$

- END OF QUIZ -