

Question 1**(Total Marks 10)**

- A. Determine the current i_o of the ideal op amp circuit shown in Figure 1(a).

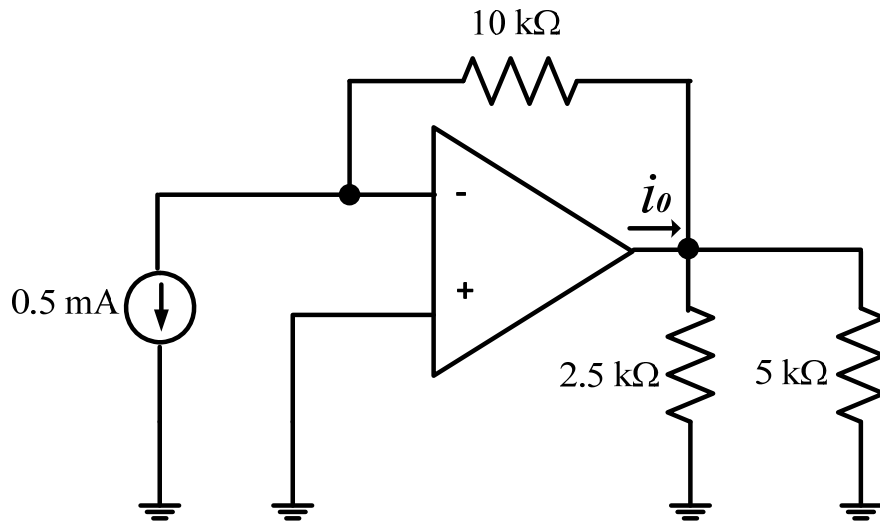
(5 Marks)

Figure 1(a)

- B. A logic system has two input sensors A and B and two outputs. Output 1 is high only when both sensors A and B are low. Output 2 is high only when either sensor A is low and sensor B is high, or when both sensors A and B are high.

- (i) Complete the truth table to satisfy these conditions **(2 Marks)**
 (ii) Draw the circuit diagram for the logic system. **(3 Marks)**

Question 2**(Total Marks 10)**

- A. Determine the currents I_1 , I_2 , and I_D in the circuit shown in Figure 2(a) when the built-in voltage of the diode $V_\gamma = 0.7\text{V}$.

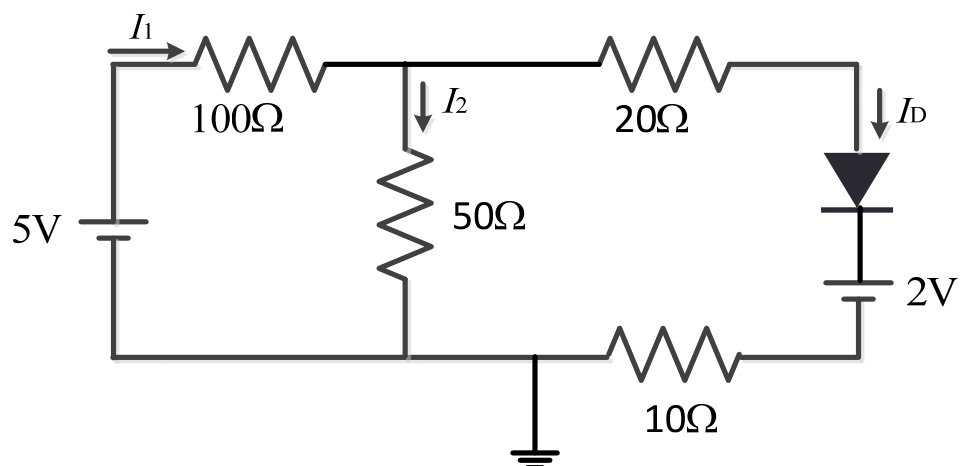
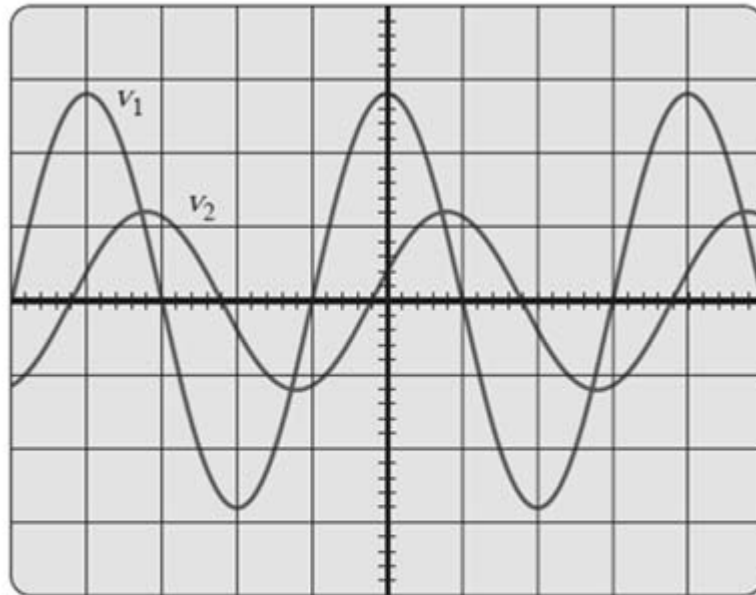
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Figure 2(a)

- B. Waveforms displayed in an oscilloscope are shown in Figure 2(b).
- Determine the frequency of each waveform. **(1 Mark)**
 - Determine the peak-to-peak and rms values of each waveform. **(2 Marks)**
 - Determine the phase relationship between the waveforms and indicate which one leads or lags. **(2 Marks)**



Vertical sensitivity = 0.5V/div

Horizontal sensitivity = 0.2 ms/div

Figure 2(b)

Question 3

(Total Marks 10)

- Name the three regions that a bipolar junction transistor (BJT) can operate. **(1 Mark)**
- Calculate the common emitter current gain β of a bipolar junction transistor biased in the forward-active region, when the base current $I_B = 3.66\mu\text{A}$ and the emitter current $I_E = 425\mu\text{A}$. **(2 Marks)**
- For the transistor circuit shown in Figure 3, assuming that the transistor is in the forward active mode, and $\beta = 100$ and $v_{BE} = 0.7\text{V}$,
 - mark the Base current I_B , Collector current I_C , Emitter current I_E and Collector to emitter voltage V_{CE} in the circuit diagram **(1 Mark)**
 - calculate the base current I_B **(1 Mark)**
 - calculate the collector current I_C **(1 Mark)**
 - calculate the emitter current I_E **(1 Mark)**
 - calculate the current I_0 through the $8\text{ k}\Omega$ resistor **(2 Marks)**
 - calculate the collector to emitter voltage V_{CE} **(1 Mark)**

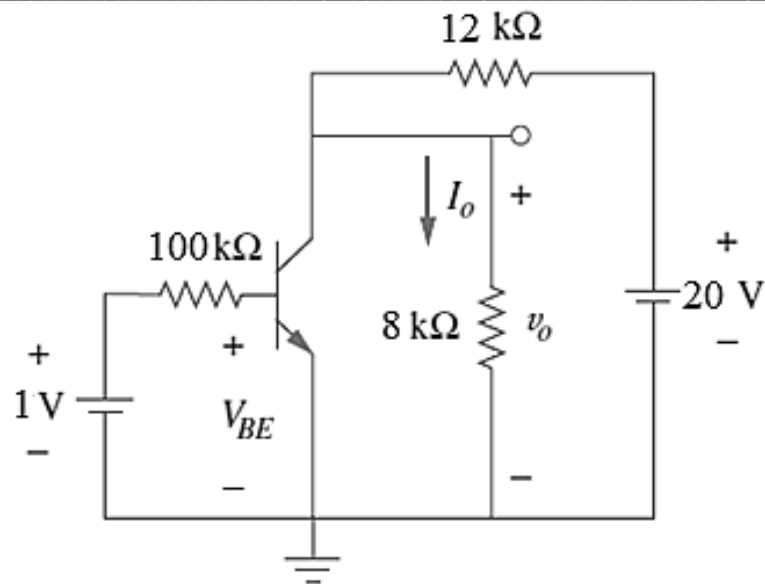


Figure 3

Question 4**(Total Marks 10)**

- A. The current through a 40mH inductor is given by $i(t) = 40 \sin(300t + 45^\circ)$. Determine the voltage across the inductor in
- (i) Sinusoidal form **(2 Marks)**
 - (ii) Phasor form **(1 Mark)**
- B. For the circuit shown in Figure 4, determine
- (i) the total impedance Z_T seen by the voltage source **(4 Marks)**
 - (ii) the currents, I_T , I_1 , and I_2 **(3 Marks)**

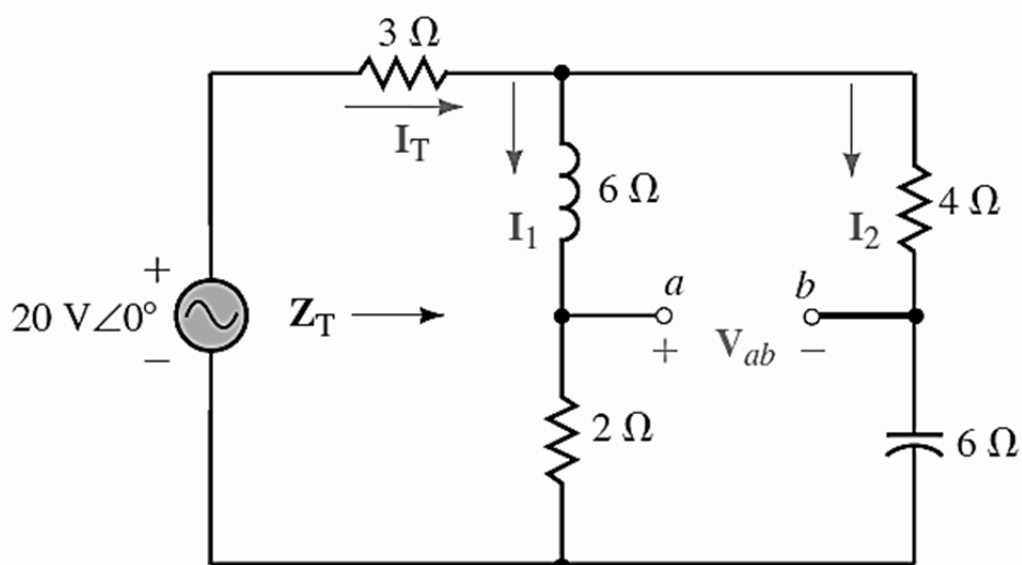


Figure 4

Question 5**(Total Marks 10)**

- A. The resolution of a 4-bit analog-to-digital converter is 0.5 volts. Determine
- (i) the voltage range of the input **(2 Mark)**
 - (ii) digital output equivalent to 6.5V **(1 Mark)**
 - (iii) analog input corresponding to a digital output of $(1001)_2$ **(2 Mark)**
- B. Answer the multiple choice questions below stating the best answer from (a) – (d). **(1 Mark each totalling 5 Marks)**
- (i) Which of these can an Arduino be used for?
 - a) controlling servos
 - b) displaying analog inputs
 - c) building robots
 - d) All of the above
 - (ii) What are the Arduino's two main program structures?
 - a) setup and loop
 - b) main and setup
 - c) loop and main
 - d) int and setup
 - (iii) Which of these is a digital input device?
 - a) pressure sensor
 - b) stepper motor
 - c) switch
 - d) potentiometer
 - (iv) Which of these is an analog input device?
 - a) pressure sensor
 - b) stepper motor
 - c) switch
 - d) LED
 - (v) Which of these is an output device?
 - a) pressure sensor
 - b) stepper motor
 - c) switch
 - d) potentiometer

END OF EXAM