BRAC University
Dept. of Computer Science and Engineering

Assessment: Assignment 4
Due: 11:59 PM 29 November 2023
Full Marks: **40**

Semester: Fall 2023
Course Code: CSE251
Section: **15 - 21**
Course Name: Electronic Devices and Circuits

Name: _____

Student ID: _____

- ✓ Write down your student ID on the **top right corner of each of the pages**.
- ✓ Clearly write the solutions, along with the questions, on white paper with black ink (no need to use color pen, don't use pencils).
- ✓ Use **CamScanner**, or **Adobe Scan**, or **Microsoft Office Lens**, or any other software to scan the pages and make a **single PDF file**.
- ✓ After creating the PDF, make sure that **(a)** there are no pages missing, **(b)** all of the pages are legible, **(c)** your student ID on each page are visible.
- ✓ Please note, **collaboration ≠ copying**. You are allowed to discuss the questions and clear confusion you might have, but you have to write your solutions independently and be able to explain your answers during a random viva.
- ✓ **[Very Important]** Rename the PDF in the following format: **"A1_StudentID_FullNameWithoutSpace.pdf"**. For example, if my student ID is 12345678 and my name is Shadman Shahid, the filename should be **"A1_12345678_ShadmanShahid.pdf"**.
- ✓ **Submission Link: Section 15 - https://forms.gle/W5aa69aB87v3e9M28, Section – 21 - https://forms.gle/SisEKRxY4yFNJgbDA**

Question 1: 12 Marks

The input of a **Full-wave rectifier** is expressed by, Vs(t)= 7sin(400πt), and the output load resistance is R = 5 kΩ. Silicon diodes are used in this circuit for which the forward drop is V_{D0} = 0.3 V.

(a) Calculate the input and output wave frequency. → 1
(b) Show the input and output waveforms. 1
(c) Calculate the DC value of the output voltage. 2

Now after connecting a capacitor, C= 100 µF in parallel with the load.

(d) Calculate the peak-to-peak ripple voltage, 2
(e) Calculate the average of the output voltage V_{DC} after connecting the capacitor. 2
Compare this with the DC value determined in 'c' and comment on the difference between these two.
(f) How can you provide better filtering for the output waves? 2
(g) What is the frequency of the Ripple voltage? 2

Question 2: 6 Marks

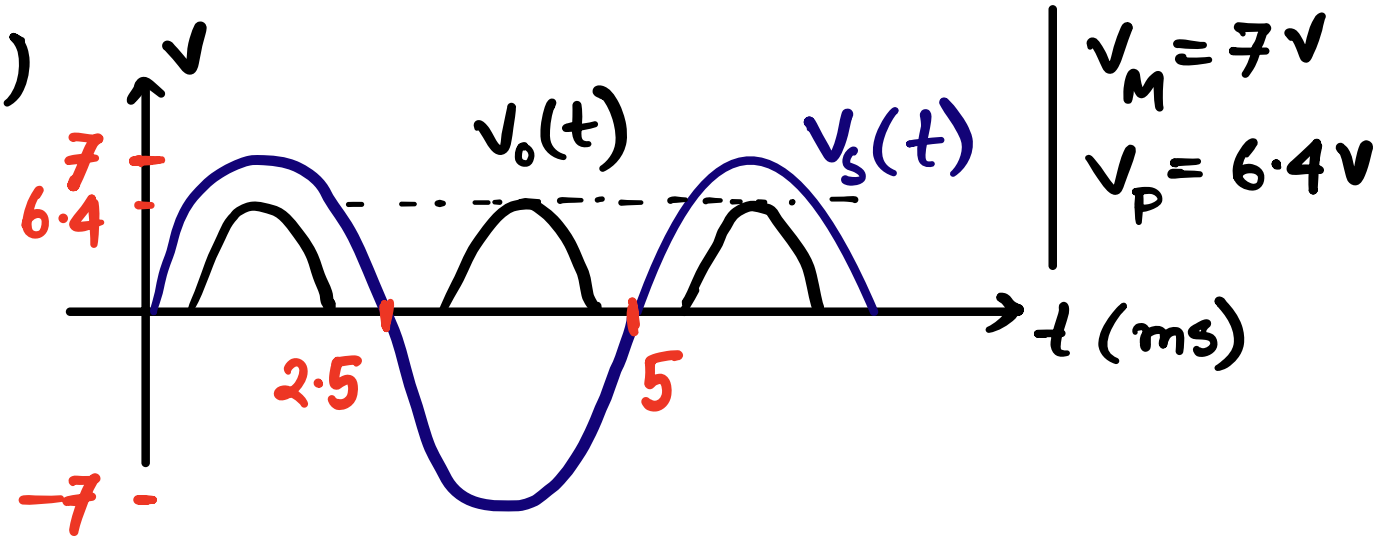
The input of a **Half-wave rectifier** is a **Square** wave voltage with peak V_M= 15 V and frequency 0.5 Hz, and the output load resistance is R = 5 kΩ. Silicon diodes are used in this circuit for which the forward drop is V_{D0} = 0.7 V.

i. Show the input and output waveforms. 3
ii. Draw the VTC (Voltage Transfer Characteristics) curve 3

1. (a) Input freq $= f_i = 200\,Hz$

Output freq $= f_o = 400\,Hz$.

(b)



(c) $V_{DC} = \frac{2V_M}{\pi} - 2V_{DO} = \left(\frac{14}{\pi} - 0.6\right)V = \underline{3.85V}$

(d) $V_r = \frac{V_p}{f_o RC} = \frac{6.4}{400 \times 5 \times 10^3 \times 100 \times 10^{-6}}$

$= \underline{0.032\,V}$

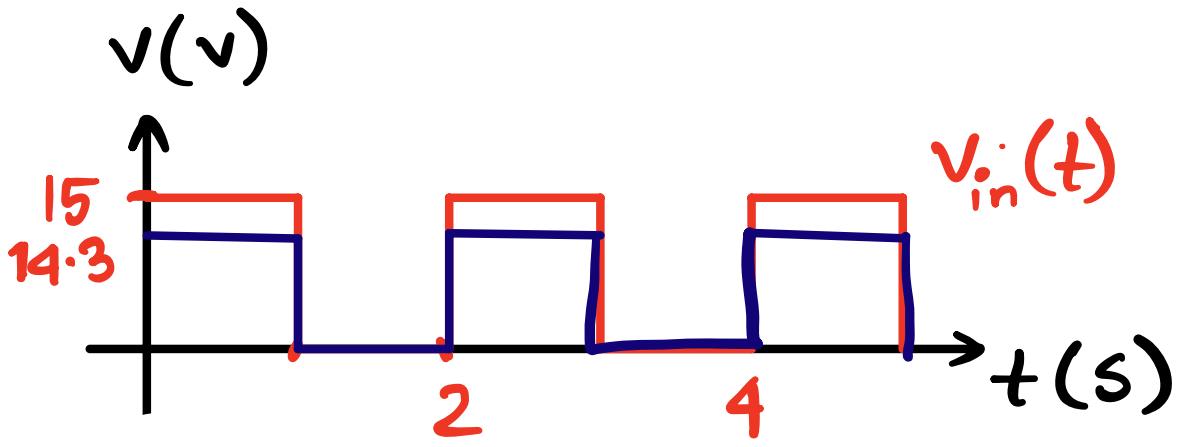
(e) $V_{DC(cap)} = V_p - \frac{V_r}{2} = \left(6.4 - 0.016\right)V$

$= \underline{6.384\,V}$

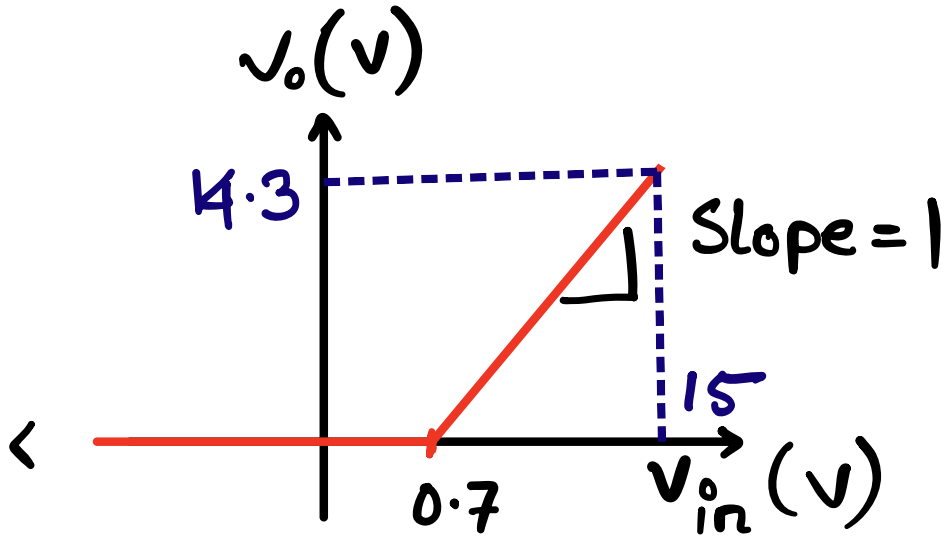
(f) By increasing 'C' value.

(g) $f_r = 2f_i = 400\,Hz$ (Same as output freq)

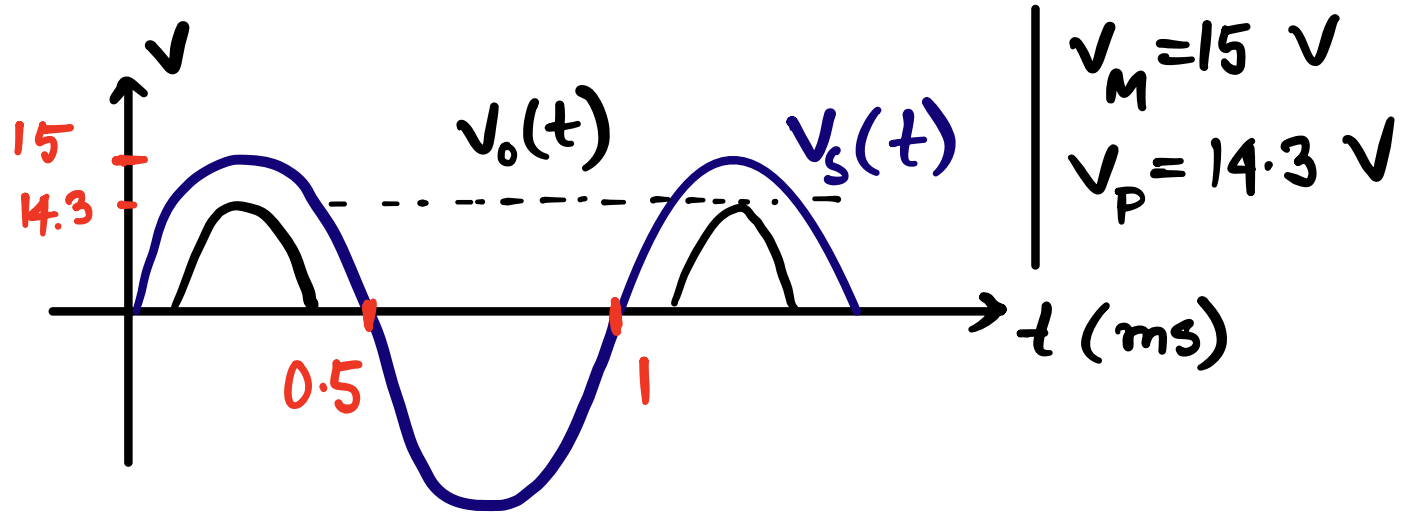
2 (a)



(b)



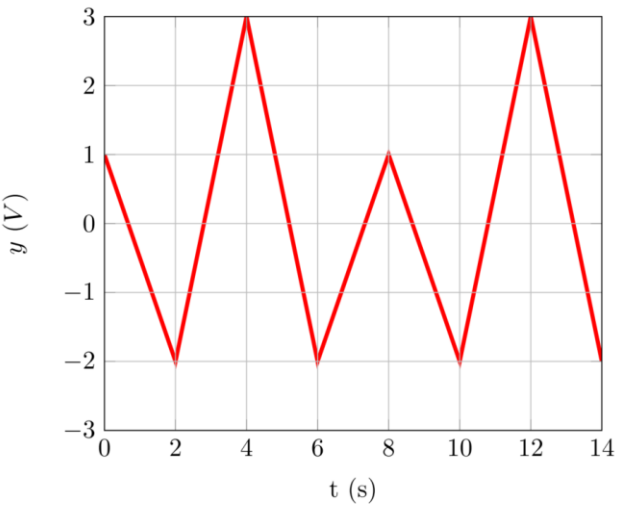
Q3 (a)



(b) $V_{DC} = \frac{V_M}{\pi} - \frac{V_{DO}}{2} = \left(\frac{15}{\pi} - 0.35\right) V$

$= 4.424$ V.

Question 3: 2*6 Marks



(b) Input of the FW rectifier

Part 2: A voltage waveform $V_i = 15\sin(2000\pi t)$ V is fed into a Half-wave rectifier with a load resistance $R = 5$ kΩ. Silicon diodes are used in this circuit for which the forward drop is $V_{D_0} = 0.7$ V.

(a) **Illustrate** the input and output waveforms in separate graphs. Label the graph and **indicate** the voltage levels properly. [2]

(b) **Calculate** the DC/Average value of the output. [1]

(c) A capacitor is now added to reduce the fluctuation of the output voltage, which makes the peak to peak ripple voltage **4%** of the maximum output voltage V_P. **Deduce** is the value of the capacitor from the given data.[2]

(d) The input of a Full-wave rectifier is shown in Figure 1(b) above and output load resistance is $R = 10$ kΩ. Germanium diodes are used in this circuit for which the forward drop is $V_{D_0} = 0.3$ V. **Show** the input and output waveforms [1]

Question 4: 10 Marks

A voltage waveform $v_i = 10\sin(200\pi t)$ V is fed into a Half-wave rectifier with a load resistor, $R = 10$ kΩ. Silicon diodes are used in this circuit where, $V_{D_0} = 0.7$ V.

(a) **Draw** the rectifier circuit. **Label** the input and output voltages properly. Briefly **explain** the application of the circuit. [1+1+1]

(b) **Calculate** the DC value of the output voltage, V_{dc} and the output frequency, f_o. [1+1]

(c) **Draw** the Voltage Transfer Characteristics (VTC) of the Half-wave rectifier and **label** it properly. [2]

(d) Now, you have to connect a capacitor in parallel with the load resistor. You have two capacitors of 4 μF and 7 μF at your disposal. Which capacitor will you use? **Explain** briefly with necessary calculations. [3]

(e) **[Bonus]** A different input waveform is fed into the half-wave rectifier. The new peak-to-peak ripple voltage is 50% of the previous one calculated from (d) with the 4 μF capacitor. The new output frequency is 300 Hz. **Determine** the equation of the input waveform. [2]

3 (c) $V_r = 4\%$ of $V_p = \frac{4}{100} \times V_p$.

$$\Rightarrow \frac{V_p}{f_i RC} = \frac{V_p}{\frac{100}{4}}$$

$$\Rightarrow f_i RC = \frac{100}{4}$$

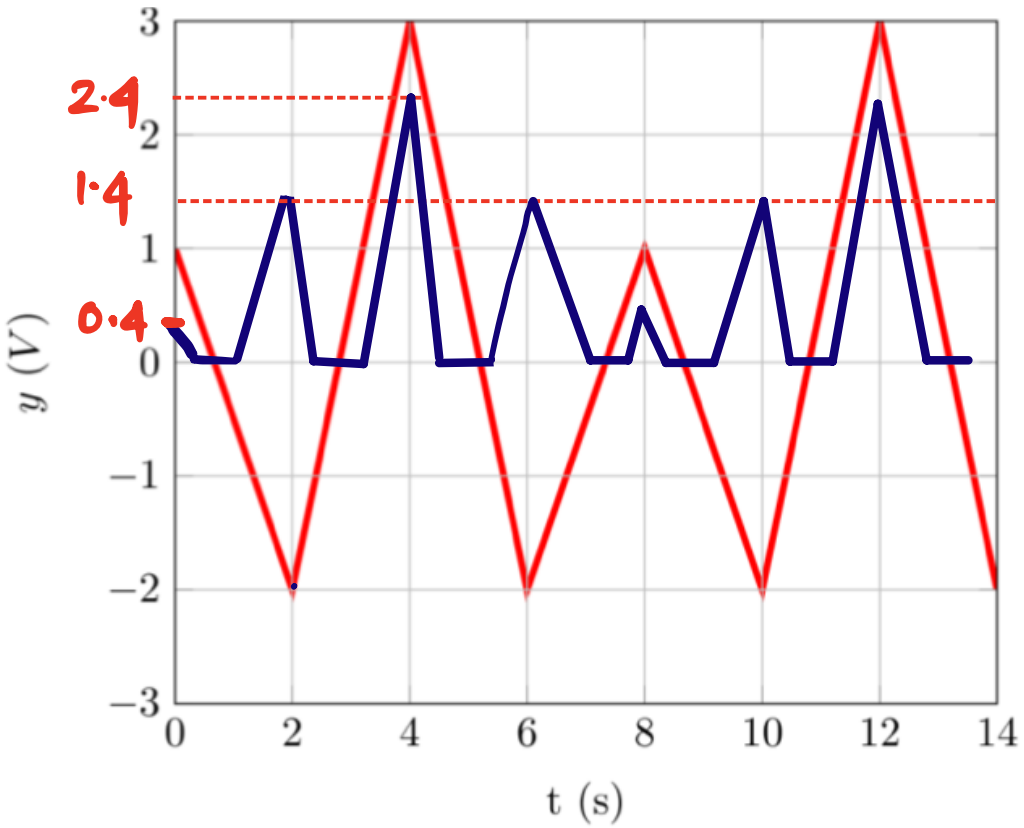
$$\Rightarrow C = \frac{100}{4 \times 1 \times 5 \times 10^6}$$

$f_i = 1000\,Hz$

$R = 5000\,\Omega$

$$\boxed{C = 5\,\mu F}$$

(d)



Question 4: 10 Marks

A voltage waveform $v_i = 10\sin(200\pi t)$ V is fed into a Half-wave rectifier with a load resistor, $R = 10$ kΩ. Silicon diodes are used in this circuit where, $V_{D_0} = 0.7$ V.

(a) **Draw** the rectifier circuit. **Label** the input and output voltages properly. Briefly **explain** the application of the circuit. [1+1+1]

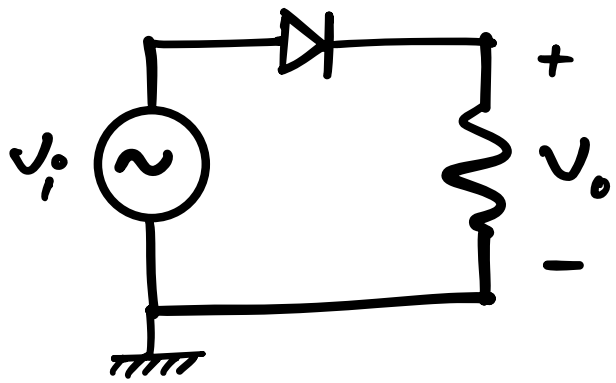
(b) **Calculate** the DC value of the output voltage, V_{dc} and the output frequency, f_o. [1+1]

(c) **Draw** the Voltage Transfer Characteristics (VTC) of the Half-wave rectifier and **label** it properly. [2]

(d) Now, you have to connect a capacitor in parallel with the load resistor. You have two capacitors of 4 μF and 7 μF at your disposal. Which capacitor will you use? **Explain** briefly with necessary calculations. [3]

(e) [**Bonus**] A different input waveform is fed into the half-wave rectifier. The new peak-to-peak ripple voltage is 50% of the previous one calculated from (d) with the 4 μF capacitor. The new output frequency is 300 Hz. **Determine** the equation of the input waveform. [2]

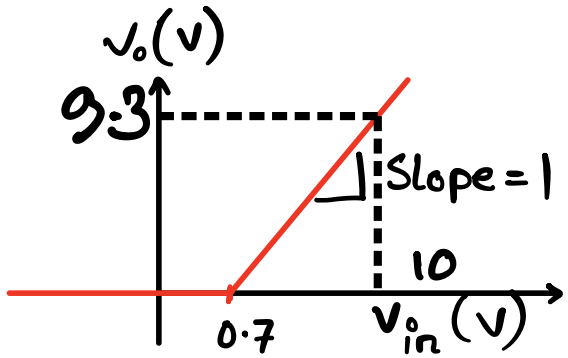
(a)



(b) $$V_{DC} = \frac{V_M}{\pi} - \frac{V_{DO}}{2} = 2.83 \text{ V}$$

$$f_o = \frac{200\pi}{2\pi} = 100 \text{ Hz}$$

(c)



(d) $V_r = \frac{V_p}{f_1 \cdot RC} \Rightarrow V_r \propto \frac{1}{C}$

Larger 'C' leads to lower ripple.

So, we should use the 7 μF capacitor instead of 4 μF.

$$\therefore V_{r(4\mu F)} = \frac{V_p}{f_1 \cdot RC} = \frac{9.3}{100 \times 10 \times 4 \times 10^{-3}}$$

$$V_{r(4\mu F)} = 2.325 \text{ V}$$

$$V_{r(7\mu F)} = \frac{9.3}{100 \times 10 \times 4 \times 10^{-3}}$$

$$= 1.328 \text{ V}$$

Better.

(e) $V_{r.new} = \dfrac{V_M' - 0.7}{f_{new} RC} = \dfrac{V_{r(4\mu F)}}{2}$

$V_M' \rightarrow$ New input voltage amplitude.

$f_{new} = 300\ Hz$

$R = 10k\Omega$

$C = 4\mu F$ or $(7\mu F)$ | Any one would do.

$V_{r(4\mu F)} = \dfrac{9.3}{4}$

$$V_M' = \frac{V_{r(4\mu F)}}{2} f_{new} RC + 0.7$$

$$\therefore V_M' = \frac{9.3}{8} \times 300 \times 10 \times 4 \times 10^{-3} + 0.7$$

or

$$= \frac{9.3}{8} \times 300 \times 10 \times 7 \times 10^{-3} + 0.7$$

$V_M' = 14.65\ V\ (4\mu F)$ or $25.1125\ V\ (7\mu F)$

$$v_{i\,new}(t) = 14.65 \sin(600\pi t)$$