Midterm Exam - CSE210 (Electronics I) – Section 1
Department of CSE, Independent University, Bangladesh (IUB)
Summer Term 2023, Date: 08-07-2023

Name	
Student ID	

- This paper contains 6 problems.
- Duration of the exam: 75 minutes.
- Total marks: 50
- This is a closed-book exam, and calculators are allowed.
- Student/s caught guilty of adopting any unfair means shall be expelled from the examination hall immediately and examination of such student/s including the outcome shall be terminated/cancelled right away

Problem 1 **Points: 4 + 4 = 8**

Determine V_{o1} and V_{o2} for the following networks:

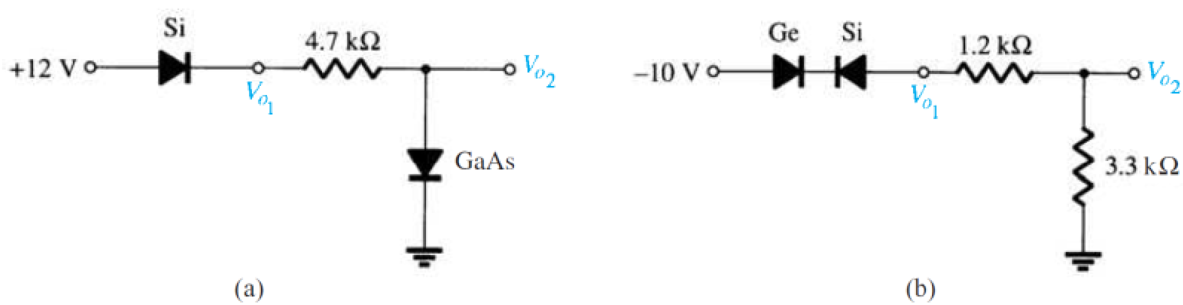


Figure 1

Solution:

(a) $V_{o_1} = 12\text{ V} - 0.7\text{ V} = \mathbf{11.3\ V}$

$V_{o_2} = \mathbf{1.2\ V}$

(b) $V_{o_1} = \mathbf{0\ V}$

$V_{o_2} = \mathbf{0\ V}$

Problem 2 **Points: 2 + 2 + 4 = 8**

For the network below :

(a) Calculate ***5τ***
(b) Compare ***5τ*** to half the period of the applied signal.
(c) Sketch ***vₒ***

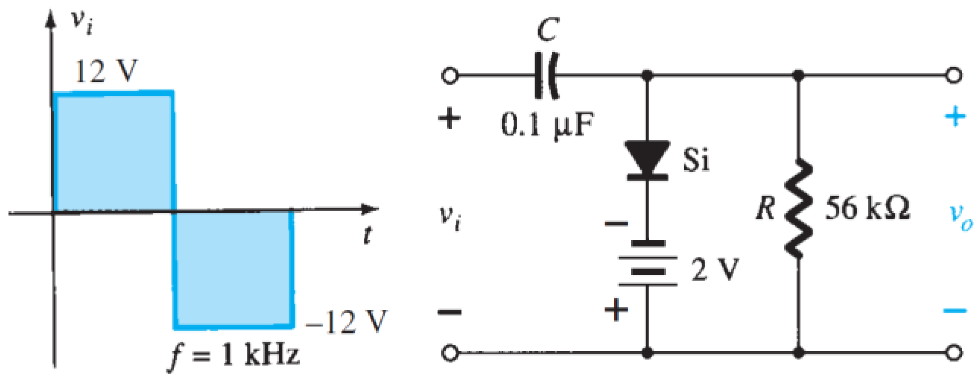


Figure 2

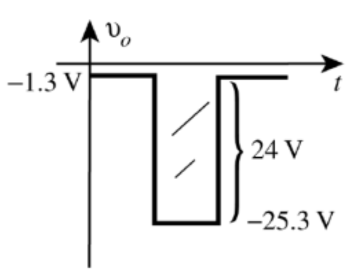
Solution:

(a) $\tau = RC = (56\ \text{k}\Omega)(0.1\ \mu\text{F}) = 5.6\ \text{ms}$
$5\tau = \mathbf{28\ ms}$

(b) $5\tau = 28\ \text{ms} \gg \dfrac{T}{2} = \dfrac{1\ \text{ms}}{2} = \mathbf{0.5\ ms}$, 56:1

(c) Positive pulse of v_i:
Diode "on" and $v_o = -2\ \text{V} + 0.7\ \text{V} = -1.3\ \text{V}$
Capacitor charges to $12\ \text{V} + 2\ \text{V} - 0.7\ \text{V} = 13.3\ \text{V}$

Negative pulse of v_i:
Diode "off" and $v_o = -12\ \text{V} - 13.3\ \text{V} = -25.3\ \text{V}$



Problem 3 **Points: 4 + 4 = 8**

Determine and Sketch $\boldsymbol{v_o}$ for each following networks (a) and (b) For the input shown:

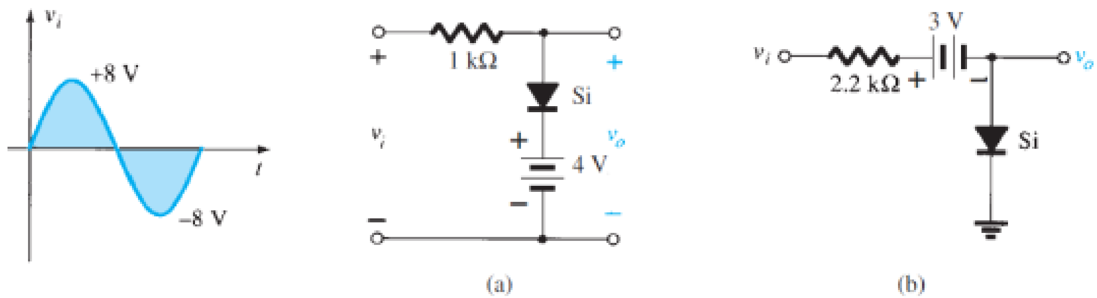
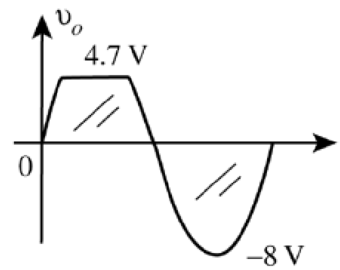


Figure 3

Solution:

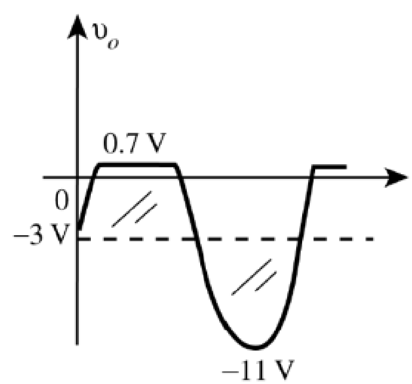
(a) Diode "on" for $v_i \geq 4.7$ V
For $v_i > 4.7$ V, $V_o = 4\text{ V} + 0.7\text{ V} = \mathbf{4.7\ V}$
For $v_i < 4.7$ V, diode "off" and $v_o = \boldsymbol{v_i}$



(b) Again, diode "on" for $v_i \geq 3.7$ V but v_o now defined as the voltage across the diode
For $v_i \geq 3.7$ V, $v_o = \mathbf{0.7\ V}$

For $v_i < 3.7$ V, diode "off", $I_D = I_R = 0$ mA and $V_{2.2\text{ k}\Omega} = IR = (0\text{ mA})R = 0$ V

Therefore, $v_o = v_i - 3$ V
At $v_i = 0$ V, $v_o = \mathbf{-3\ V}$
$v_i = -8$ V, $v_o = -8\text{ V} - 3\text{ V} = \mathbf{-11\ V}$



Problem 4 **Points: 4 + 2 + 4 =10**

Determine the **output waveform** for the following network (Fig-4) and calculate the **output dc level** and the required **PIV** of **each diode**

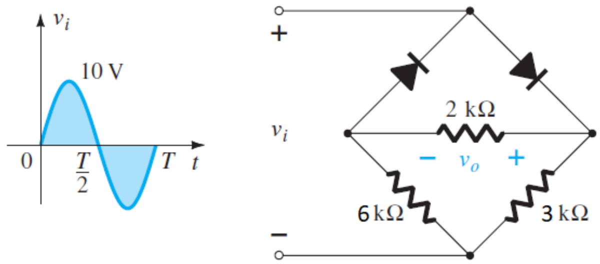
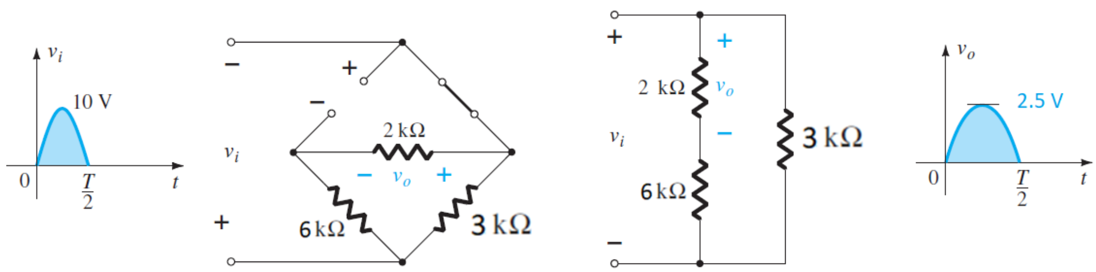


Figure 4

Solution:

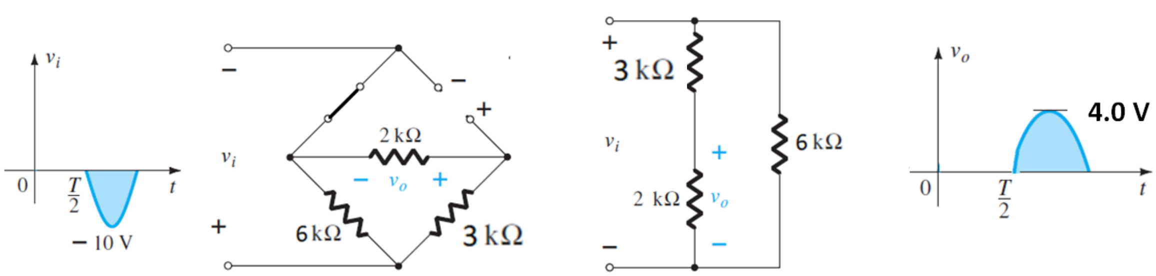


Positive half cycle:

v_o = 2kΩ X 10V/(2kΩ + 6kΩ) = **2.5 V**

Negative half cycle:

v_o = 2kΩ X 10V/(2kΩ + 3kΩ) = **4.0 V**



V_{dc} = 0.318(2.5 V) + 0.318(4.0 V) = **2.067 V**

PIV (Left diode) = 2.5 V **PIV (Right diode) = 4.0 V**

Problem 5 **Points: 4 + 4 = 8**

(a) Given a diode current of ***8 mA*** and ***n = 1***, find I_s if the applied voltage is ***0.5 V*** and the temperature is room temperature (***25°C***).

(b) Given a diode current of ***6 mA***, $V_T = 26\ mV$, ***n = 1***, and $I_s = 1\ nA$, find the applied voltage V_D

Note: Boltzmann's constant $= 1.38 \times 10^{-23}$ J/K

Solution:

(a)

$$V_T = \frac{kT_K}{q} = \frac{(1.38\times10^{-23}\ \text{J/K})(25°\text{C} + 273°\text{C})}{1.6\times10^{-19}\ \text{C}}$$

$$= 25.70\ \text{mV}$$

$$I_D = I_s(e^{V_D/nV_T} - 1)$$

$$8\text{mA} = I_s(e^{(0.5\text{V})/(1)(25.70\ \text{mV})} - 1) = I_s(2.8\times10^8)$$

$$I_s = \frac{8\ \text{mA}}{2.8\times10^8} = \mathbf{28.57\ pA}$$

(b)

$$I_D = I_s(e^{V_D/nV_T} - 1)$$

$$6\ \text{mA} = 1\ \text{nA}(e^{V_D/(1)(26\ \text{mV})} - 1)$$

$$6\times10^6 = e^{V_D/26\ \text{mV}} - 1$$

$$e^{V_D/26\ \text{mV}} = 6\times10^6 - 1 \cong 6\times10^6$$

$$\log_e e^{V_D/26\text{mV}} = \log_e 6\times10^6$$

$$\frac{V_D}{26\ \text{mV}} = 15.61$$

$$V_D = 15.61(26\ \text{mV}) \cong \mathbf{0.41\ V}$$

Problem 6 **Points: 2 + 2 + 2 + 2 = 8**

Find out V_o for network and condition (ON or OFF) of the D1 and D2 germanium diodes of Fig.5 when:

a) $V_1 = 0$ V, $V_2 = 0$ V
b) $V_1 = 5$ V, $V_2 = 0$ V
c) $V_1 = 0$ V, $V_2 = 5$ V
d) $V_1 = 5$ V, $V_2 = 5$ V

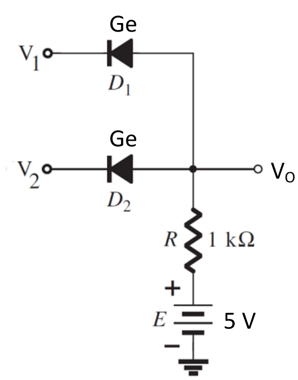


Figure 5

Solution:

#	V_1 (V)	V_2 (V)	D1 (ON/OFF)	D2 (ON/OFF)	V_o (V)
a	0	0	ON	ON	0.3
b	5	0	OFF	ON	0.3
c	0	5	ON	OFF	0.3
d	5	5	OFF	OFF	5