Sir Syed University of Engineering & Technology (SSUET)

Computer Engineering Department

Course Name: Basic Electronics

Semester: Spring 2011, 3rd

Batch: 2010(Sections: A,B)

Assignments # 4

Course Responsible

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SIR SYED UNIVERSITY OF ENGINEERING AND TECHNOLOGY
COMPUTER ENGINEERING DEPARTMENT
BASIC ELECTRONICS
2010 BATCH (Sections: A, B)
Last Submission Date: 17th MARCH, 2011, 4PM.

Assignment Solution #4

1. Clamper: Q37 – to – Q41

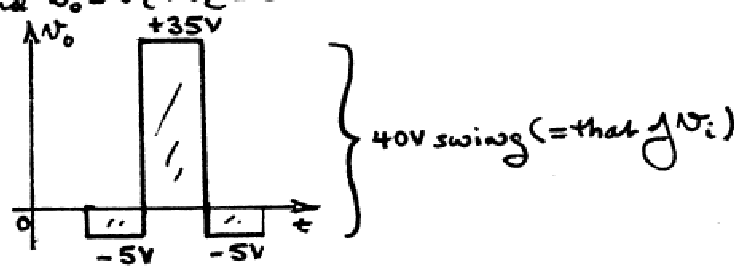
Q37.

37 (a) Starting with $v_i = -20V$, the diode is in the "on" state and the capacitor quickly charges to $-20V+$. During this interval of time v_o is across the "on" diode (short-circuit equivalent) and $v_o = 0V$

When v_i switches to the $+20V$ level the diode enters the "off" state (open-circuit equivalent) and $v_o = v_i + v_C = 20V + 20V = +40V$

(b) Starting with $v_i = -20V$, the diode is in the "on" state and the capacitor quickly charges up to $-15V+$. Note that $v_i = +20V$ and the 5V supply are additive across the capacitor. During this time interval v_o is across "on" diode and 5V supply and $v_o = -5V$.

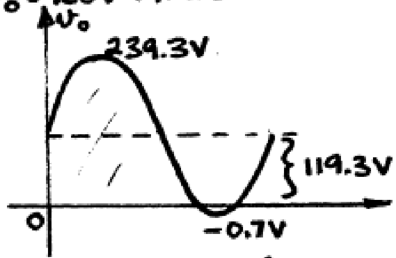
When v_i switches to the $+20V$ level the diode enters the "off" state and $v_o = v_i + v_C = 20V + 15V = 35V$



Q38.

38. (a) For negative half cycle capacitor changes to peak value of $120V - 0.7V = 119.3V$ with polarity (− ⊣⊢ +). The output v_o is directly across the "on" diode resulting in $v_o = -0.7V$ as a negative peak value.

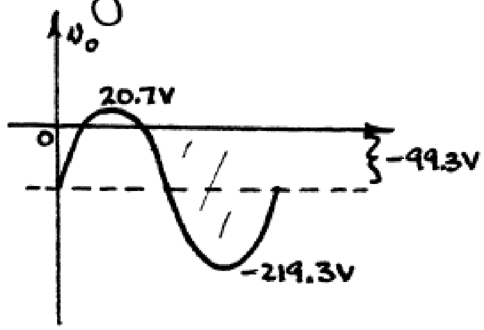
For the next positive half cycle $v_o = v_i + 119.3V$ with a peak value of $v_o = 120V + 119.3V = 239.3V$.



↑ vertical shift of 119.3V

(b) For positive half cycle capacitor changes to peak value of $120V - 20V - 0.7V = 99.3V$ with polarity (+ ⊣⊢ −). The output $v_o = 20V + 0.7V = 20.7V$

For next negative half cycle $v_o = v_i - 99.3V$ with negative peak value of $v_o = -120V - 99.3V = -219.3V$



↓ vertical shift of −99.3V

Using the ideal diode approximation the vertical shift of part (a) would be 120V rather than 119.3V and −100V rather than −99.3V for part (b). Using the ideal diode approximation would certainly be appropriate in this case.

Q39.

39. (a) $\tau = RC = (56k\Omega)(0.1\mu F) = 5.6ms$

$5\tau = \underline{28ms}$

(b) $5\tau = 28ms >> \frac{T}{2} = \frac{1ms}{2} = \underline{0.5ms}$, 56 : 1

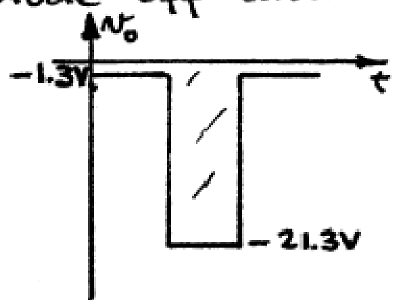
(c) Positive pulse of v_i:

Diode "on" and $V_o = -2V + 0.7V = -1.3V$

Capacitor charges to $10V + 2V - 0.7V = 11.3V$

Negative pulse of v_i:

Diode "off" and $V_o = -10V - 11.3V = -21.3V$

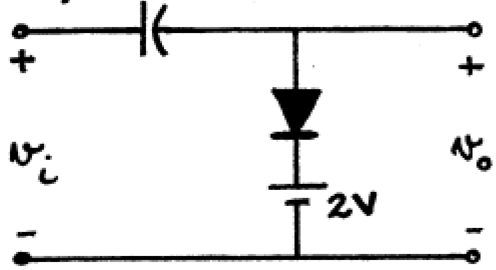


Q40.

40. Solution is network of Fig. 2.159(b) using a 10V supply in place of the 5V source.

Q41.

41. Network of Fig. 2.161 with 2V battery reversed.



2. <u>Zener Diode: Q42 – to – Q46</u>

Q42.

42. (a) In the absence of the Zener diode

$$V_L = \frac{180\Omega(20V)}{180\Omega + 220\Omega} = 9V$$

$V_L = 9V < V_Z = 10V$ and diode non-conducting

Therefore, $I_L = I_R = \frac{20V}{220\Omega + 180\Omega} = \underline{50mA}$

with $I_Z = \underline{0mA}$

and $V_L = \underline{9V}$

(b) In the absence of the Zener diode

$$V_L = \frac{470\Omega(20V)}{470\Omega + 220\Omega} = 13.62V$$

$V_L = 13.62 > V_Z = 10V$ and Zener diode "on"

Therefore $V_L = \underline{10V}$ and $V_{R_s} = 10V$

$I_{R_s} = V_{R_s}/R_s = 10V/220\Omega = \underline{45.45mA}$

$I_L = V_L/R_L = 10V/470\Omega = \underline{21.28mA}$

and $I_Z = I_{R_s} - I_L = 45.45mA - 21.28mA = \underline{24.17mA}$

(c) $P_{Z_{max}} = 400mW = V_Z I_Z = (10V) I_Z$

$$I_Z = \frac{400mW}{10V} = 40mA$$

$I_{L_{min}} = I_{R_s} - I_{Z_{max}} = 45.45mA - 40mA = 5.45mA$

$$R_L = \frac{V_L}{I_{L_{min}}} = \frac{10V}{5.45mA} = \underline{1{,}834.86\Omega}$$

Large R_L reduces I_L and forces more of I_{R_s} to pass through Zener diode.

(d) In the absence of the Zener diode

$$V_L = 10V = \frac{R_L(20V)}{R_L + 220\Omega}$$

$$10R_L + 2200 = 20R_L$$

$$10R_L = 2200$$

$$R_L = \underline{220\Omega}$$

Q43.

43. (a) $V_Z = \underline{12 V}$, $R_L = \frac{V_L}{I_L} = \frac{12V}{200mA} = \underline{60\Omega}$

$$V_L = V_Z = 12V = \frac{R_L V_i}{R_L + R_s} = \frac{60\Omega(16V)}{60\Omega + R_s}$$

$$720 + 12R_s = 960$$

$$12R_s = 240$$

$$R_s = \underline{20\Omega}$$

(b) $P_{Z_{max}} = V_Z I_{Z_{max}}$

$$= (12V)(200mA)$$

$$= \underline{2.4W}$$

Q44.

44. Since $I_L = \frac{V_L}{R_L} = \frac{V_Z}{R_L}$ is fixed in magnitude the maximum value of I_{R_s} will occur when I_Z is a maximum. The maximum level of I_{R_s} will in turn determine the maximum permissible level of V_i.

$$I_{Z_{max}} = \frac{P_{Z_{max}}}{V_Z} = \frac{400mW}{8V} = 50mA$$

$$I_L = \frac{V_L}{R_L} = \frac{V_Z}{R_L} = \frac{8V}{220\Omega} = 36.36mA$$

$$I_{R_S} = I_Z + I_L = 50mA + 36.36mA = 86.36mA$$

$$I_{R_s} = \frac{V_i - V_Z}{R_s}$$

or $V_i = I_{R_s} R_s + V_Z$

$$= (86.36mA)(91\Omega) + 8V = 7.86V + 8V = \underline{15.86V}$$

Any value of V_i that exceeds 15.86V will result in a current I_Z that will exceed the maximum value.

Q45.

45. At 30V we have to be sure Zener diode is "on"

$$\therefore V_L = 20V = \frac{R_L V_i}{R_L + R_s} = \frac{1k\Omega(30V)}{1k\Omega + R_s}$$

Solving, $R_s = \underline{0.5k\Omega}$

At 50V $I_{R_s} = \frac{50V - 20V}{0.5k\Omega} = 60mA$, $I_L = \frac{20V}{1k\Omega} = 20mA$

$$I_{ZM} = I_{R_s} - I_L = 60mA - 20mA = \underline{40mA}$$

Q46.

46. For $v_i = +50V$:

Z_1 forward-biased at 0.7V

Z_2 reverse-biased at the Zener potential and $V_{Z_2} = 10V$.

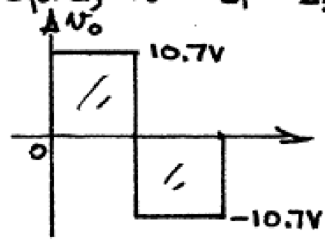
Therefore, $V_o = V_{Z_1} + V_{Z_2} = 0.7V + 10V = \underline{10.7V}$

For $v_i = -50V$:

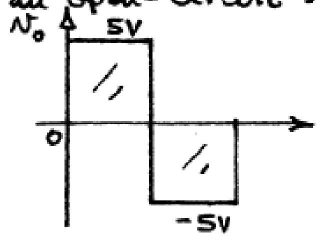
Z_1 reverse-biased at the Zener potential and $V_{Z_1} = -10V$.

Z_2 forward-biased at $-0.7V$

therefore, $V_o = V_{Z_1} + V_{Z_2} = \underline{-10.7V}$



For a 5V-square wave neither Zener diode will reach its Zener potential. In fact, for either polarity of v_i one Zener diode will be in an open-circuit state resulting in $v_o = v_i$.



3. <u>Voltage Multiplier: Q47 – to – Q48</u>

Q47.

47. $V_m = 1.414(120V) = 169.68V$

$2V_m = 2(169.68V) = \underline{339.36V}$

Q48.

48. The PIV for each diode is $\underline{2V_m}$

$\therefore$ PIV $= 2(1.414)(V_{rms})$