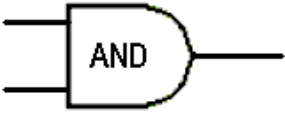
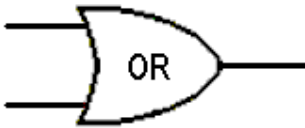
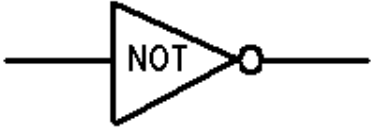

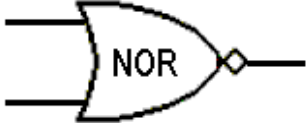

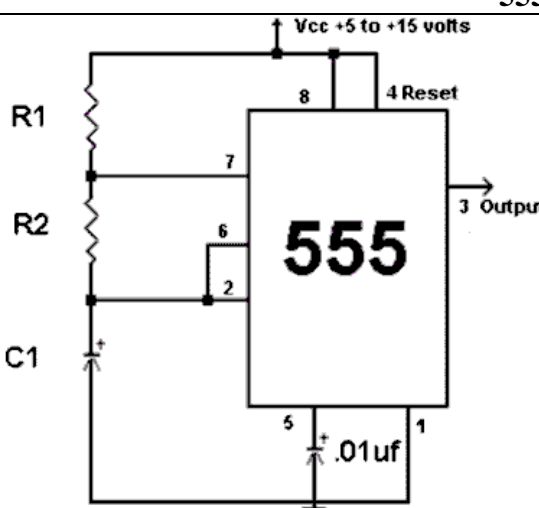


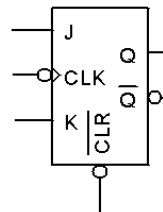
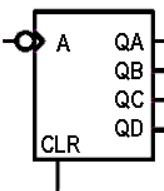
Logic Gates														
														
A	B	$Y = A \cdot B$	A	B	$Y = A + B$	<table border="1" style="margin: auto;"> <tr> <td style="text-align: center;">A</td> <td style="text-align: center;"><math>Y = \bar{A}</math></td> </tr> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> </tr> </table>			A	$Y = \bar{A}$	0	1	1	0
A	$Y = \bar{A}$													
0	1													
1	0													
0	0	0	0	0	0									
0	1	0	0	1	1									
1	0	0	1	0	1									
1	1	1	1	1	1									
														
A	B	$Y = \overline{A \cdot B}$	A	B	$Y = \overline{A + B}$	A	B	$Y = A \oplus B$						
0	0	1	0	0	1	0	0	0						
0	1	1	0	1	0	0	1	1						
1	0	1	1	0	0	1	0	1						
1	1	0	1	1	0	1	1	0						

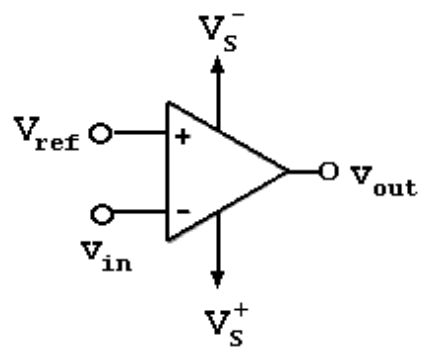
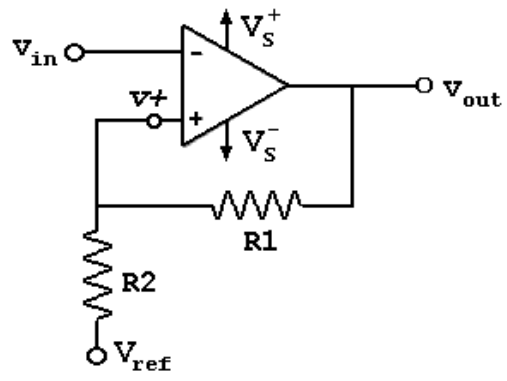
Boolean Algebra Properties			
$A \cdot 0 = 0$ $A + 0 = A$ $A \cdot 1 = A$ $A + 1 = 1$ $A \cdot A = A$ $A + A = A$ $\overline{\overline{A}} = A$	$A \cdot \bar{A} = 0$ $A + \bar{A} = 1$ $A \oplus B = \bar{A} \cdot B + A \cdot \bar{B}$ $\overline{A \oplus B} = \bar{A} \cdot \bar{B} + A \cdot B$ $A \cdot B = B \cdot A$ $A + B = B + A$	$A + A \cdot B = A$ $A \cdot (A + B) = A$ $A \cdot (\bar{A} + B) = A \cdot B$ $A + \bar{A} \cdot B = A + B$ $\bar{A} + A \cdot B = \bar{A} + B$ $\bar{A} + A \cdot \bar{B} = \bar{A} + \bar{B}$	$A \cdot (B + C) = A \cdot B + A \cdot C$ $A + B \cdot C = (A + B) \cdot (A + C)$ $A \cdot (B \cdot C) = (A \cdot B) \cdot C$ $A + (B + C) = (A + B) + C$ $\overline{A \cdot B} = \bar{A} + \bar{B}$ $\overline{A + B} = \bar{A} \cdot \bar{B}$

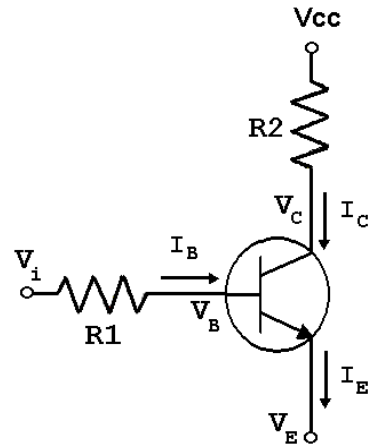
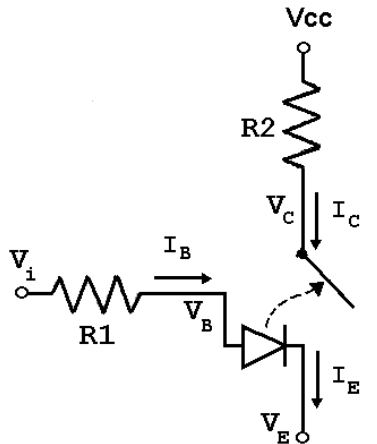
555-Timer	
	<p>Charge Cycle: <math>T1 = 0.693(R1 + R2)C1</math>  <math>\tau1 = (R1 + R2)C1</math></p> <p>Off Time: <math>T2 = 0.693(R2)C1</math>  <math>\tau2 = (R2)C1</math></p> <p>Frequency: <math>f = \frac{1.44}{(R1 + 2R2)C1}</math></p> <p>Period: <math>T = T1 + T2</math></p> <p>Duty Cycle (percentage): <math>D = \frac{T1}{T} \times 100</math></p>


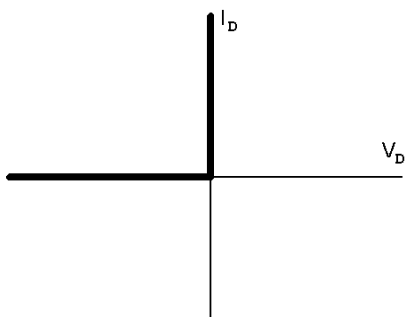
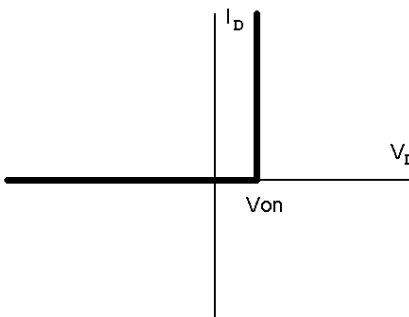
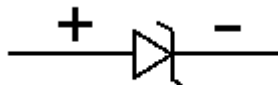
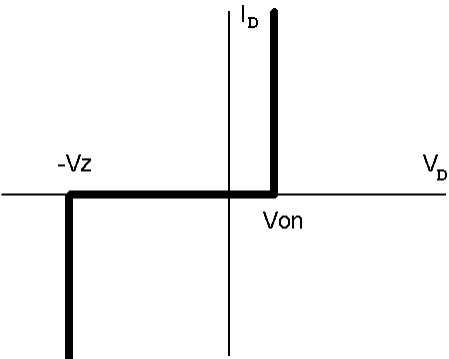
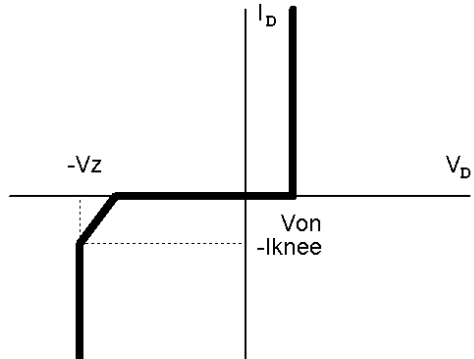
DO NOT WRITE ON THIS SHEET

RETURN SHEET AFTER QUIZ

J-K flip-flop	4-bit Counter																																																												
 <table border="1" style="margin-left: 20px; border-collapse: collapse;"> <thead> <tr> <th>J</th> <th>K</th> <th>C</th> <th>Q</th> <th>Q̄</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>p</td> <td>no change</td> <td></td> </tr> <tr> <td>0</td> <td>1</td> <td>p</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>p</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>p</td> <td>toggle</td> <td></td> </tr> </tbody> </table>	J	K	C	Q	Q̄	0	0	p	no change		0	1	p	0	1	1	0	p	1	0	1	1	p	toggle		 <table border="1" style="margin-left: 20px; border-collapse: collapse;"> <thead> <tr> <th>C</th> <th>QD</th> <th>QC</th> <th>QB</th> <th>QA</th> </tr> </thead> <tbody> <tr> <td>-</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>p</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>p</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>p</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>p</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>(etc.)</td> </tr> </tbody> </table> <p style="text-align: center;"><math>Q_D \times 2^3 + Q_C \times 2^2 + Q_B \times 2^1 + Q_A \times 2^0</math></p>	C	QD	QC	QB	QA	-	0	0	0	0	p	0	0	0	1	p	0	0	1	0	p	0	0	1	1	p	0	1	0	0					(etc.)
J	K	C	Q	Q̄																																																									
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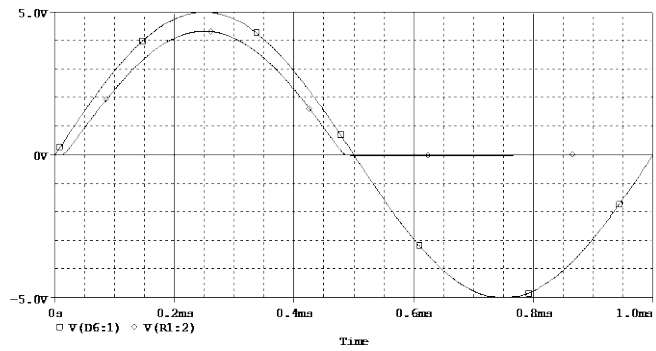
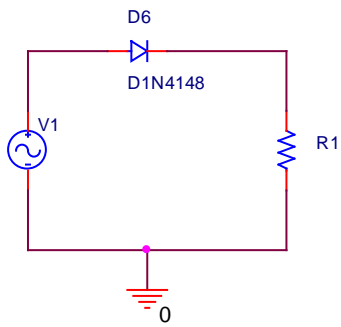
Inverting Comparator	Schmitt Trigger
	
<p><i>if <math>v_{in} &gt; V_{ref}</math> then <math>v_{out} = V_S^-</math></i></p> <p><i>if <math>v_{in} &lt; V_{ref}</math> then <math>v_{out} = V_S^+</math></i></p>	$v_+ = \left( \frac{R_2}{R_1 + R_2} \right) (v_{out} - V_{ref}) + V_{ref}$ <p><i>if <math>v_{in} &gt; v_+</math> then <math>v_{out} = V_S^-</math></i></p> <p><i>if <math>v_{in} &lt; v_+</math> then <math>v_{out} = V_S^+</math></i></p>

Transistor as a switch		
<p>Transistor circuit</p> 	<p>Transistor model</p> 	<p>if <math>(V_i - V_E) &lt; 0.7</math></p> <ul style="list-style-type: none"> <li>* transistor is off</li> <li>* switch is open</li> <li>* <math>I_C = 0 \text{ mA}</math></li> <li>* <math>V_C = V_{CC}</math></li> </ul> <p>if <math>(V_i - V_E) &gt; 0.7</math></p> <ul style="list-style-type: none"> <li>* transistor is on</li> <li>* switch is closed</li> <li>* <math>I_C \gg I_B</math></li> <li>* <math>(V_B - V_E) = 0.7</math></li> <li>* <math>V_{R1} = (V_i - (0.7 + V_E))</math></li> <li>* <math>V_C = V_E</math></li> </ul>

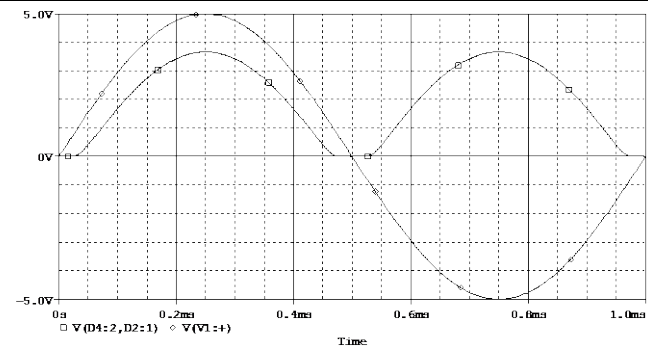
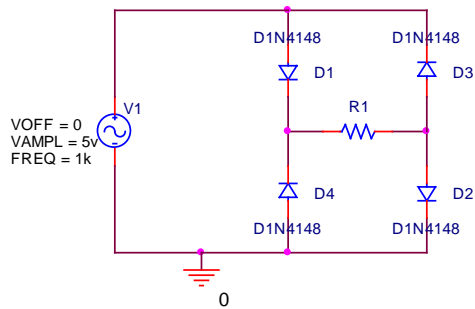
<b>Diodes</b>	
$I_D = I_S \left( e^{\frac{V_D}{nV_T}} - 1 \right)$ $I_S$ : Saturation current, $V_T = 25.9mV$ , $n \approx 1 - 2$	
4148 silicon diode: $V_{on} = 0.7$ Volts	
<p style="text-align: center;"><b>Ideal Diode</b></p> 	<p style="text-align: center;"><b><math>V_{on}</math> Model</b></p> 
$\begin{cases} \text{On: } & V_D = 0 & I_D > 0 \\ \text{Off: } & V_D < 0 & I_D = 0 \end{cases}$	$\begin{cases} \text{On: } & V_D = V_{on} & I_D > 0 \\ \text{Off: } & V_D < V_{on} & I_D = 0 \end{cases}$
<b>Zener Diodes</b>	
750 Zener diode: $V_{on} = 0.7V$ $V_z = 4.7V$ 751 Zener diode: $V_{on} = 0.7V$ $V_z = 5.3V$	
<p style="text-align: center;"><b>Zener Diode</b></p> 	<p style="text-align: center;"><b>Zener Diode, with knee current</b></p> 
$\begin{cases} \text{On: } & V_D = V_{on} & I_D > 0 \\ \text{Off: } & -V_z < V_D < V_{on} & I_D = 0 \\ \text{Zener: } & V_D = -V_z & I_D < 0 \end{cases}$	$\begin{cases} \text{On: } & V_D = V_{on} & I_D > 0 \\ \text{Off: } & -V_z < V_D < V_{on} & I_D = 0 \\ \text{Zener: } & V_D = -V_z & I_D < -I_{knee} \end{cases}$

Diode Circuits

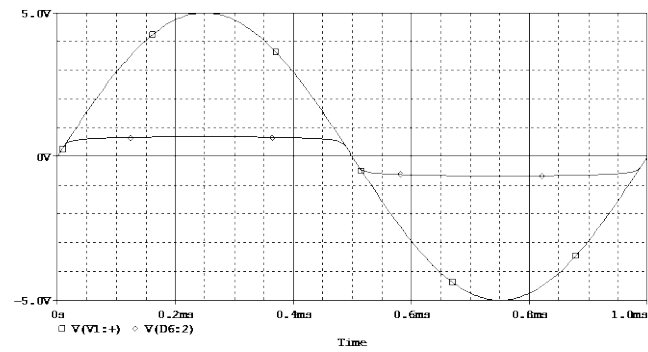
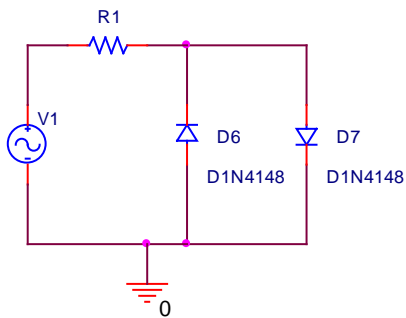
Half-Wave Rectifier



Full-Wave Rectifier



Limiter



Zener Limiter

