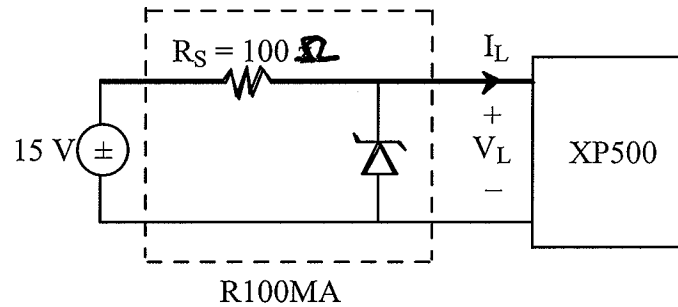


Problem 1 (20 points)

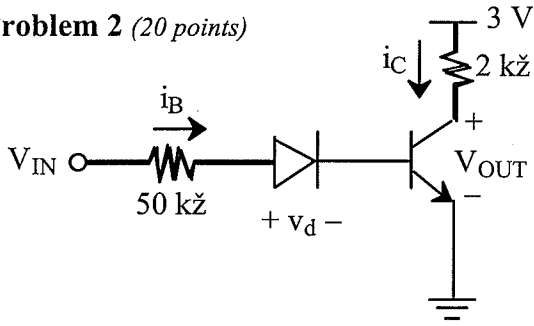
Alex is using a 15 V voltage source and a R100MA voltage regulator with a 5 V, 2 W Zener diode to power the XP500 circuit which is rated at 5 V and 200 mA.

Unfortunately, Alex finds that under maximum load conditions $V_L = 3$ V.

Advise Alex how he can modify the R100MA circuit so that it will supply a constant 5 V to the XP500 circuit over the current range $0 \leq I_L < 200$ mA.



Problem 2 (20 points)



Assume:

$$\beta = 100$$

$$V_{ON} = V_{BEON} = 0.7 \text{ V}$$

$$V_{CESAT} = 0.2 \text{ V}$$

$$V_{IN} = 1.5 + 0.5 \sin \omega t$$

Show **all** of your work for all parts.

a) (2 pts.) Give the range of values for V_{IN} : $\leq V_{IN} \leq$

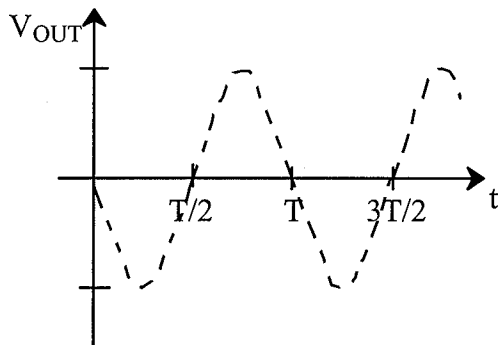
b) (8 pts.) For the given V_{IN} explore all possible states of the BJT in the circuit. If a state is possible, give the range of V_{IN} values for that state (if not, check “not possible”).

State of BJT	not possible	possible, range of V_{IN}
OFF	<input type="checkbox"/>	$\leq V_{IN} \leq$
ACTIVE	<input type="checkbox"/>	(V_{MIN}) $\leq V_{IN} \leq$ (V_{MAX})
SATURATED	<input type="checkbox"/>	$\leq V_{IN} \leq$

c) (6 pts.) Compute the values of i_B , i_C , and V_{OUT} when the BJT is active and for the extreme values of V_{IN} (i.e., for V_{MIN} and V_{MAX}) found in b).

V_{IN}	i_B (μA)	i_C (mA)	V_{OUT} (volts)
$V_{MIN} =$			
$V_{MAX} =$			

d) (4 pts.) For the given V_{IN} , and using parts a), b), and c), sketch $V_{OUT}(t)$.



Indicate **all** relevant values.

Problem 3 (20 points)

- a) Convert the Boolean function $F = \overline{\overline{XY}} \cdot \overline{\overline{X} \overline{Y}}$ to a SOP form. State the identity or method you used in the conversion.

- b) Complete the truth table for the Boolean function in part 3a).

X	Y	F
0	0	
0	1	
1	0	
1	1	

- c) For the given truth table, write a Boolean function for it in canonical SOP form.

X	Y	Z	G
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

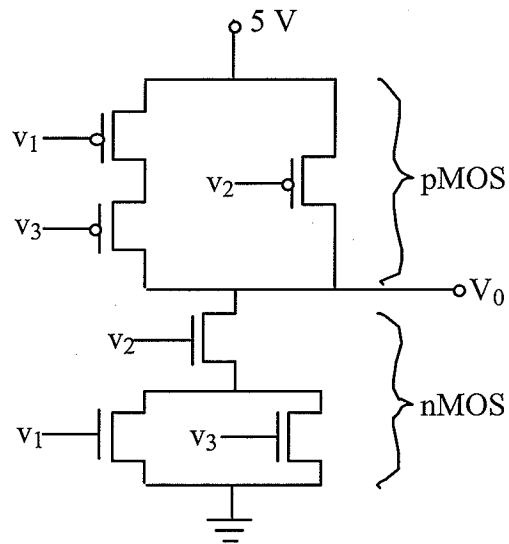
- d) Find the optimal SOP Boolean function for the truth table in 3c).

HINT: The optimal corresponding circuit has 3 gates and 4 inputs. Show your work.

Problem 4 (20 points)

a) (10 pts.) Complete the truth table for the CMOS circuit below. A low voltage is a logic “0” and a high voltage is a logic “1.”

V_1	V_2	V_3	V_0
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

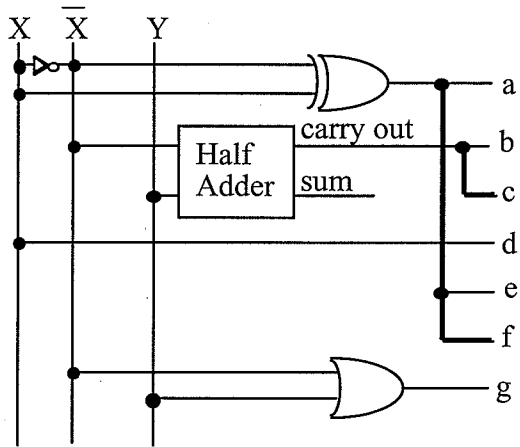


b) (10 pts.) For the given truth table, draw the CMOS circuit that implements the logic function specified by the truth table below.

V_1	V_2	V_0
0	0	1
0	1	0
1	0	0
1	1	0

Problem 5 (20 points)

a) (12 pts.) Fill in the truth tables for the circuit below. Show your work.



X	Y	a	b	c	d	e	f	g
0	0							
0	1							
1	0							
1	1							

b) (8 pts.) The circuit in part a) and four 7-segment displays are used to produce a 4-character display.

circuit in part a)

0	0	0	1	1	0	1	1
X	Y	X	Y	X	Y	X	Y
(CA)	(CA)	(CA)	(CA)	(CA)	(CA)	(CA)	(CA)
display 1	display 2	display 3	display 4	display 1	display 2	display 3	display 4

• Draw what is displayed:

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• State what is displayed:

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7-segment display