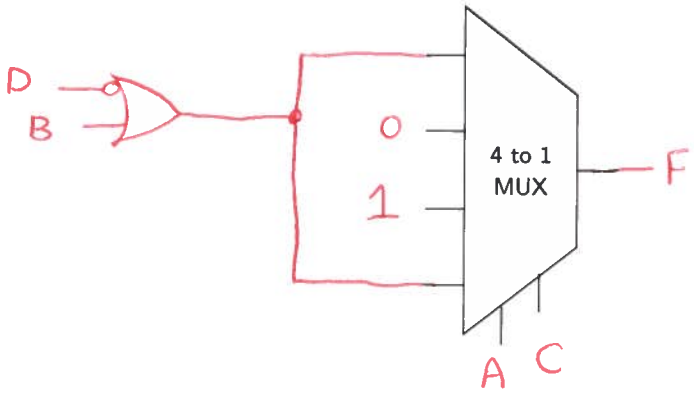
Name: SOLUTIONS

Read each question carefully before answering. Answer all parts. Show all work, calculations, and/or reasoning, otherwise no points will be awarded. Properly labeled loops must be shown on K-maps. Point values are as indicated.

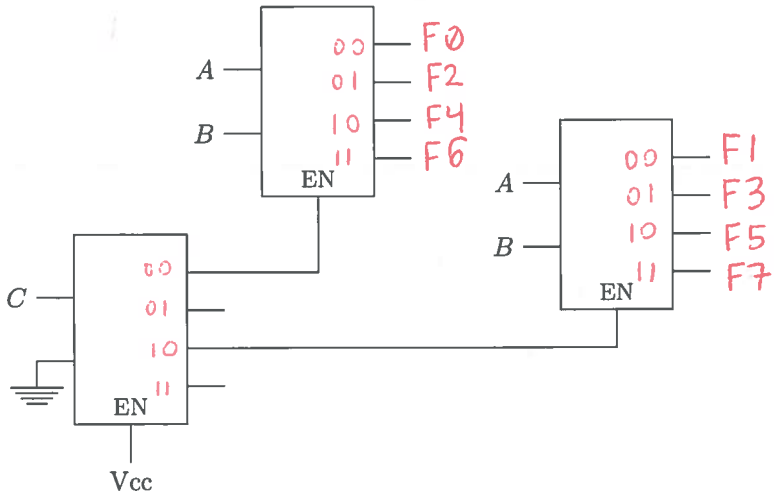
1. (20 points) You receive two 2-bit numbers designated as AB and CD. If $AB \geq CD$, an LED should turn on. The output of this function, F, will therefore be 1 if the LED should be on. Otherwise F will be 0. Implement this using a 4 to 1 MUX and a minimum number of external gates. Fill in the corresponding circuit diagram. Clearly indicate your control bits, and include your multiplexer equation at the bottom of the page.

		0	1	AB 3	2
	CD	00	01	11	10
0	00	1	1	1	1
1	01	0	1	1	1
3	11	0	0	1	0
2	10	0	0	1	1

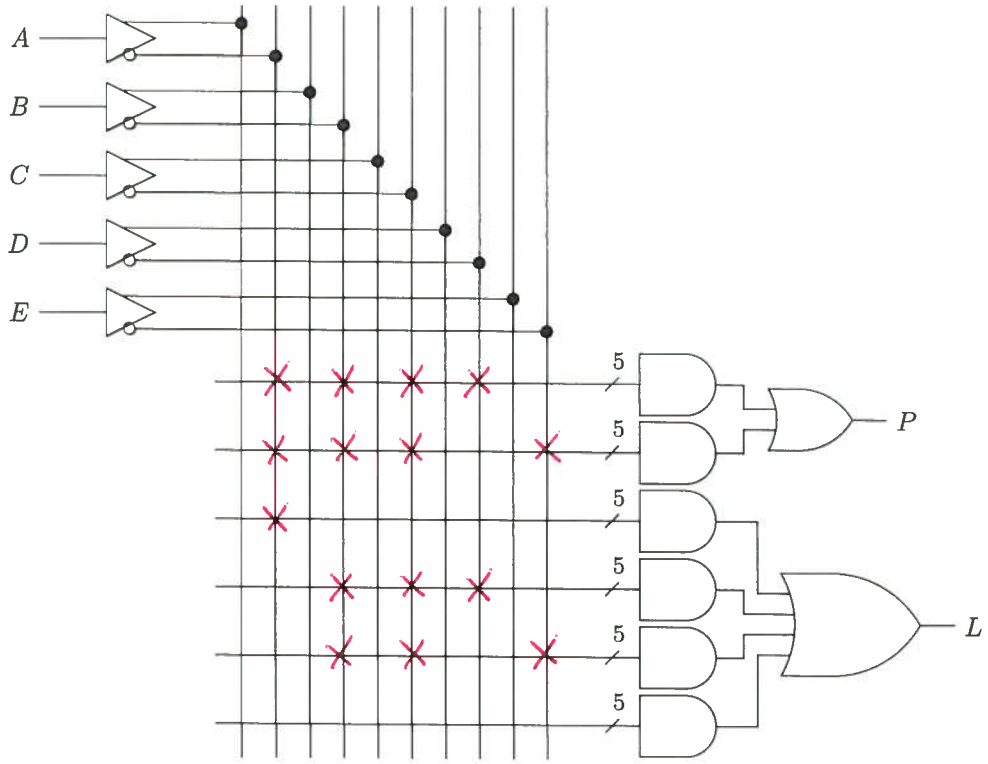


$F = A'C'(D'+B) + A'C(0) + AC'(1) + AC(D'+B)$

2. (20 points) Your buddy wired up a 3 to 8 decoder using only 2 to 4 decoders as follows. The MSB of the control bits is A, and the LSB of the control bits is C. Label the circuit diagram with the correct outputs from $F_0 - F_7$.



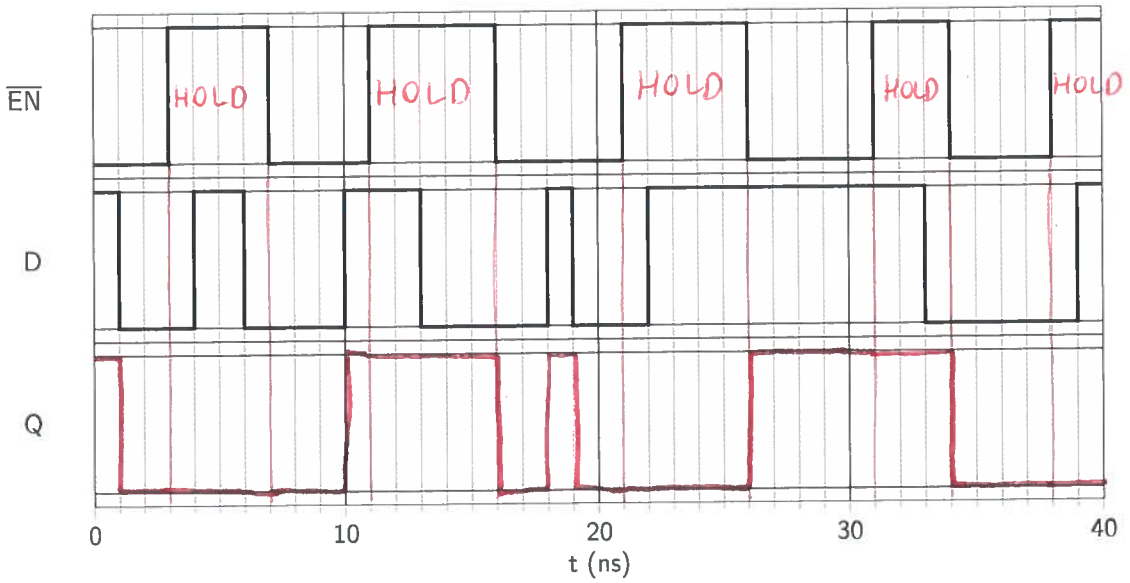
3. (25 points) A sensor on a car tire sends a 5-bit binary signal ($ABCDE$) that represents the tire pressure in PSI. The output L (low pressure) should be 1 if the pressure is less than 19. The output P (puncture) should be 1 if the pressure is less than 3. Use the following PAL diagram to implement outputs L and P. You will **not** need to add any gates to the PAL diagram!



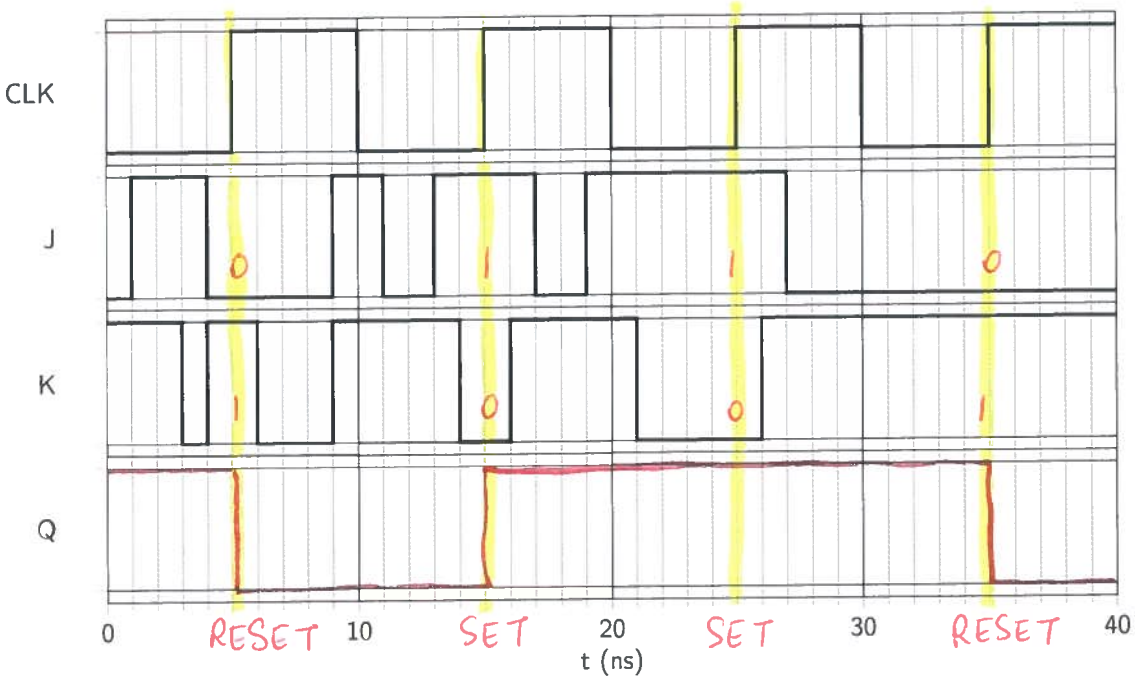
$P = A'B'C'D' + A'B'C'E'$

$L = A' + B'C'D' + B'C'E'$

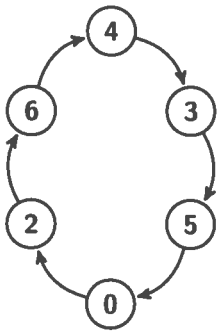
4. (10 points) Fill out the following timing diagram for an active-low gated D latch. Ignore all gate delays. $Q(0) = 0$.



5. (10 points) Fill out the following timing diagram for a rising-edge triggered JK flip-flop. Ignore all gate delays. $Q(0) = 1$.



6. (25 points) Design a 3-bit counter that counts in the sequence given in the state diagram below. Use T flip-flops and a minimum number of external gates. Write each flip-flop equation, then draw the circuit diagram using the template below.

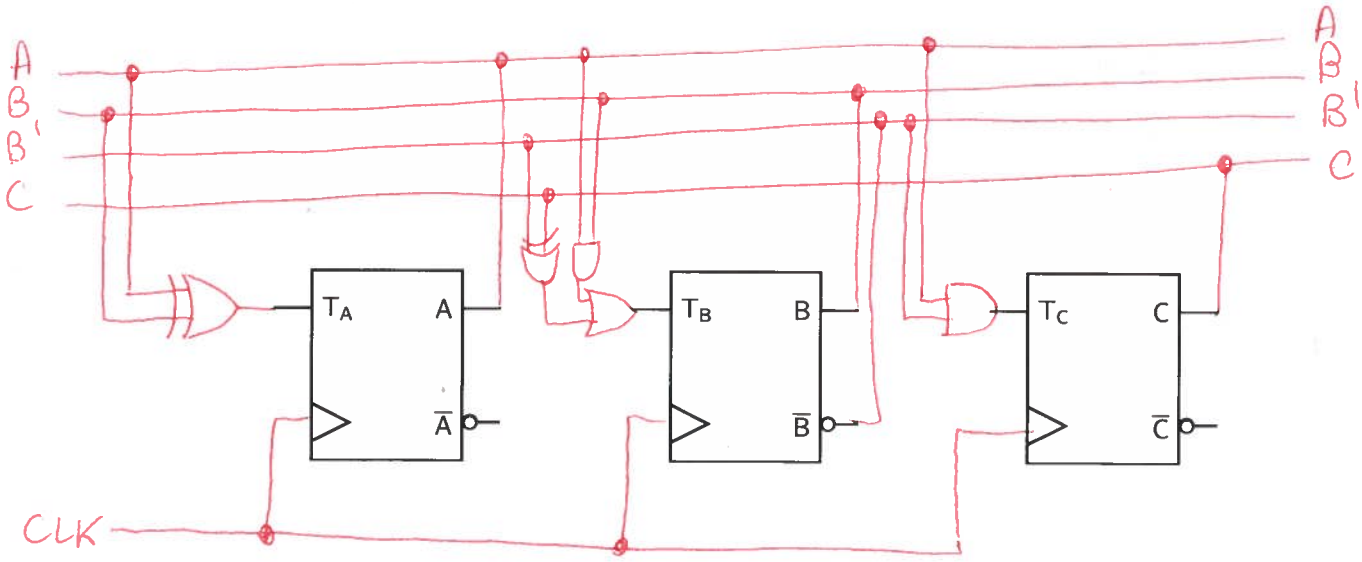


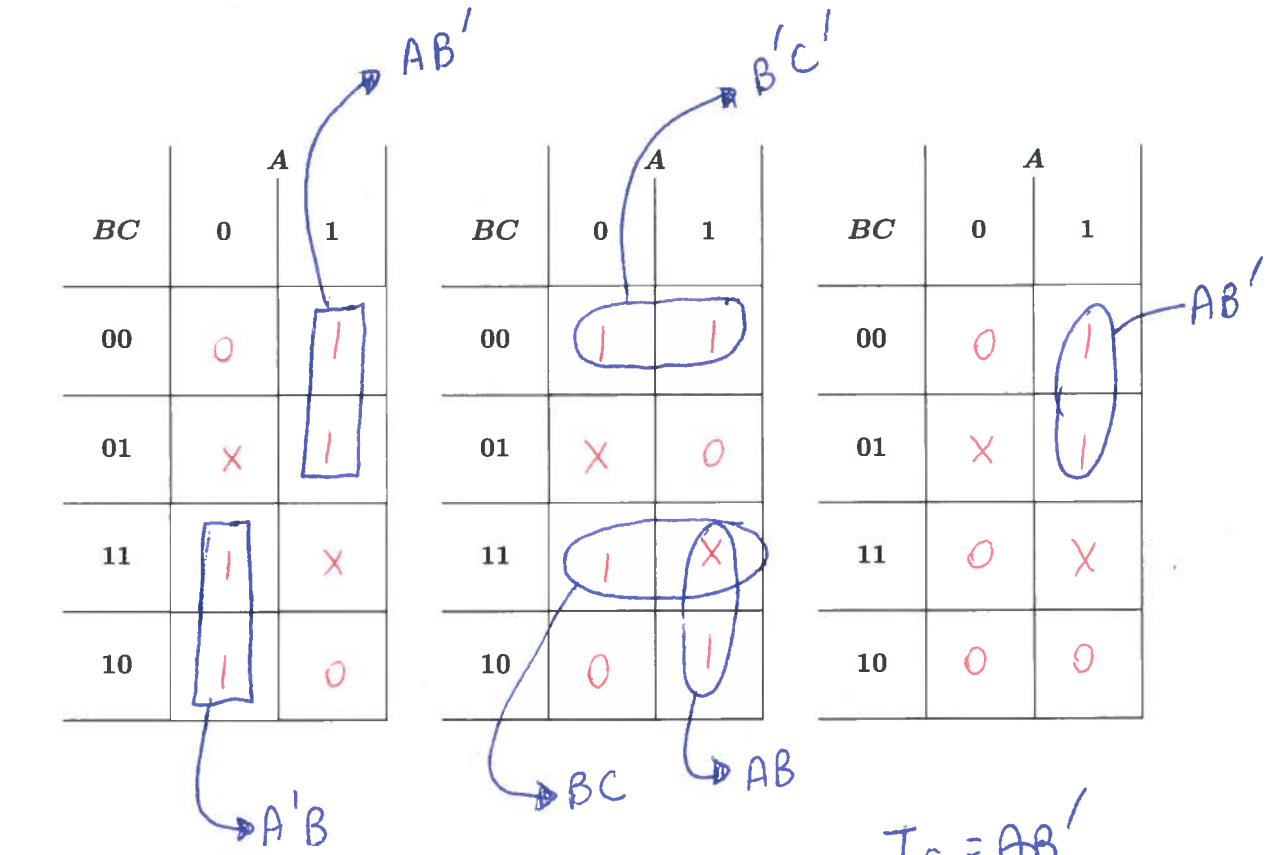
$T_A =$ A ⊕ B

$T_B =$ B' ⊕ C + AB

$T_C =$ AB'

	A	B	C	A^+	B^+	C^+	T_A	T_B	T_C
0	0	0	0	0	1	0	0	1	0
1	0	0	1	X	X	X	X	X	X
3	0	1	1	1	0	1	1	1	0
2	0	1	0	1	1	0	1	0	0
4	1	0	0	0	1	1	1	1	1
5	1	0	1	0	0	0	1	0	1
7	1	1	1	X	X	X	X	X	X
6	1	1	0	1	0	0	0	1	0




AB'
B'C'
A
BC
0
1
00
01
11
10
A'B
BC
AB
AB'
$T_A = A \oplus B$
$T_C = B' \oplus C + AB$
$T_C = AB'$