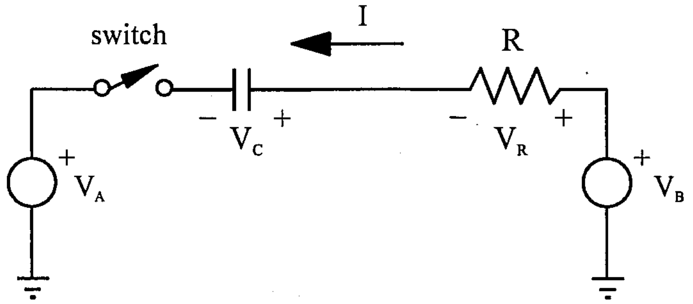
< 60% OF CLASS GOT CORRECT

Questions 9 through 11 deal with the switched RC circuit below. Assume that the capacitor has no charge to begin with, and assume that V_A and V_B are constant dc voltages.



(9) Immediately after the switch is closed (i.e., the circuit is not in steady state yet), what is the correct expression for V_C, given the polarity shown?
- (a) 0
- (b) V_A
- (c) V_B
- (d) $V_A - V_B$
- (e) $V_B - V_A$

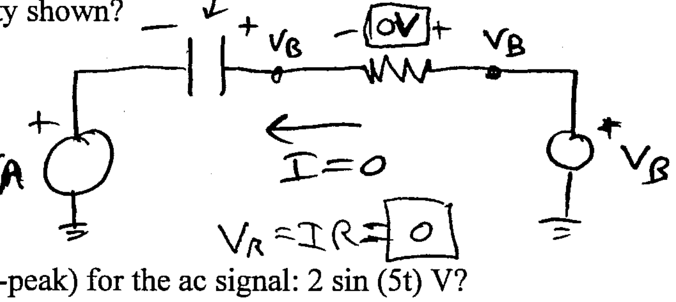
(10) A long time after the switch has been closed (i.e., the circuit is in steady state), what is the correct expression for V_C, given the polarity shown?
- (a) 0
- (b) V_A
- (c) V_B
- (d) $V_A - V_B$
- (e) $V_B - V_A$

FULLY CHARGED

$V_B - V_A$

CAP: OPEN CIRCUIT

(11) A long time after the switch has been closed (i.e., the circuit is in steady state), what is the correct expression for V_R, given the polarity shown?
- (a) 0
- (b) V_A
- (c) V_B
- (d) $V_A - V_B$
- (e) $V_B - V_A$

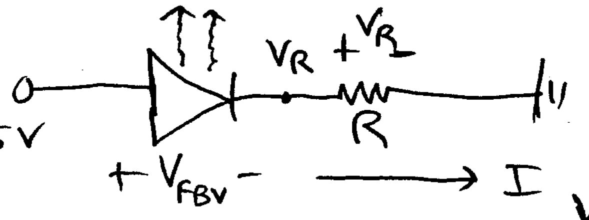


(12) What is the voltage amplitude (not peak-to-peak) for the ac signal: 2 sin (5t) V?
- (a) 1
- (b) 2
- (c) 4
- (d) 5
- (e) 10

(13) What is the frequency, in units of Hertz, of the ac signal: 2 sin (5t) V?
(a) 5
(b) 5π
(c) $5/\pi$
(d) 10π
(e) $5/(2\pi)$

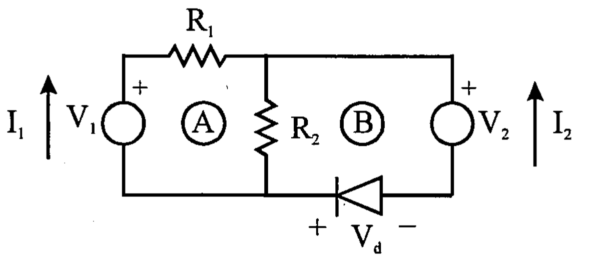
(14) What is the equivalent impedance, in rectangular form, of the series combination of 1<0°> and 1<90°>?
(a) 2 + 2j
(b) 2 −2j
(c) 0
(d) 1 + j
(e) 1 − j

(15) You purchase an LED with a forward bias voltage of 2V. The manufacturer claims the most efficient current for good brightness and low power loss is 30mA. If using a 5V power supply, what resistance value should you put in series with the diode to achieve the recommended current?
(a) 5/30 Ω
(b) 50/3 Ω
(c) 500/3 Ω
(d) 150 Ω
(e) 100 Ω

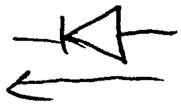


$V_R = 5V - V_{FBV} = IR \Rightarrow R = \frac{V_R}{I} = \frac{3V}{30mA}$
$= 3V$
$= 0.1\ k\Omega = \boxed{100\ \Omega}$

Questions 16 through 18 deal with the circuit shown below. Assume that the diode is ideal (i.e., has a 0V forward bias voltage).

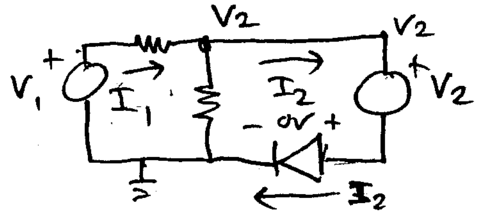


(16) Using a KVL equation in loop A, which expression below is valid?
(a) $V_1 = I_1R_1 + I_2R_2$
(b) $V_1 = -I_1R_1 - I_2R_2$
(c) $V_1 = I_1R_1 + (I_1 - I_2)R_2$
(d) $V_1 = -I_1R_1 - (I_1 - I_2)R_2$
(e) $V_1 = I_1R_1 + (I_1 + I_2)R_2$



(17) What condition is required for the diode to be forward biased? $\Rightarrow I_2 + I_1 > 0$

(a) $V_2 < 0$
(b) $V_1 > 0$
(c) ~~$V_1 + V_2 > 0$~~
(d) $V_1 - V_2 > 0$
(e) $V_2 - V_1 > 0$



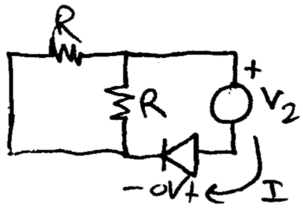
$I_1 = \frac{V_1 - V_2}{R_1}$

$I_1 > 0 \Rightarrow$

$\boxed{V_1 - V_2 > 0}$

(18) If $V_1 = 0V$ (short), $V_2 < 0$, and $R_1 = R_2 = R$, what is V_d?

(a) 0
(b) V_2
(c) $-V_2$
(d) $V_2 / 2$
(e) $-V_2 / 2$



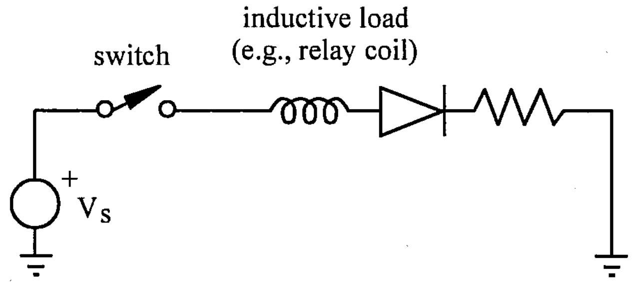
$V_2 < 0$

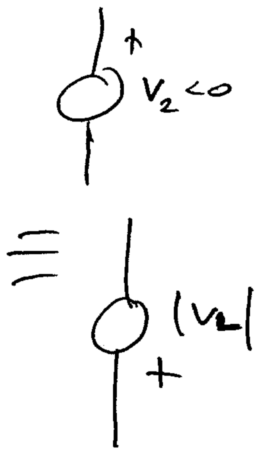
$\Rightarrow$ DIODE FORWARD BIASED

$\Rightarrow \boxed{V_d = 0}$

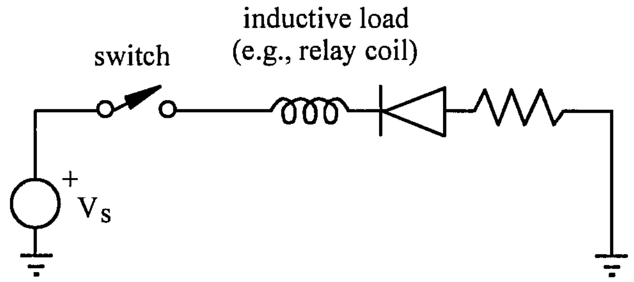
(19) Which circuit below has the diode in the proper place to provide flyback protection for switching the inductive load on and off?

(a)

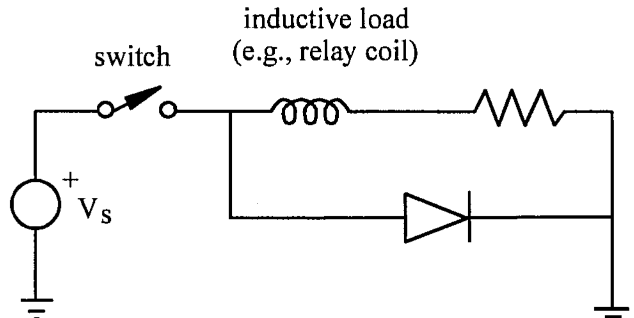




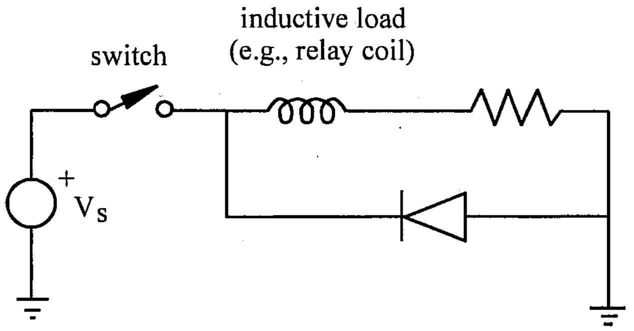
(b)



(c)

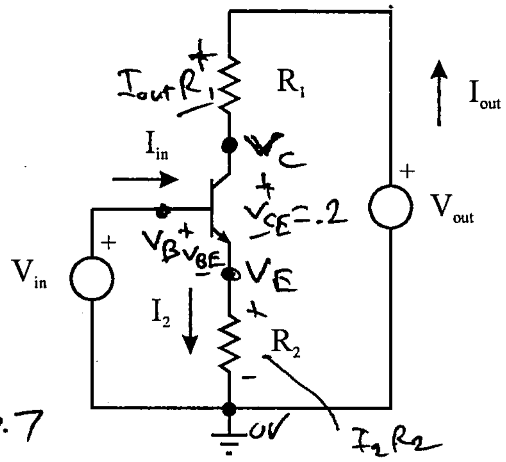


(d)



(e) None of the circuits above is properly set up for flyback protection.

Questions 20 through 22 deal with the circuit below where $R_1 = R_2 = R$.



$V_{BE} = 0.7$

$V_B = V_E + 0.7V$

(20) When the transistor is in saturation the voltage at the base of the transistor (relative to ground) is

(a) 0 V
(b) 0.7 V
(c) I_2R_2
(d) $I_2R_2 + 0.7$ V
(e) $I_2R_2 - 0.7$ V

$V_B = V_E + 0.7V$ OR V_{in} OR $V_{out} - I_{out}R - 0.2 + 0.7$

$\boxed{= I_2R_2 + 0.7V}$

NOT ON LIST

(21) When the transistor is in cutoff the voltage at the collector of the transistor (relative to ground) is

(a) 0 V
(b) 0.2 V
(c) 0.7 V
(d) V_{in}
(e) V_{out}

$\Rightarrow I_{in} = I_{out} = I_2 = 0$

$V_C = V_{out} - I_{out}R_1 = \boxed{V_{out}}$

(28) An all-OR realization of $B(\overline{C} + A)$ is

(a) $B + \overline{C} + A$

(b) $B + \overline{C + \overline{A}}$

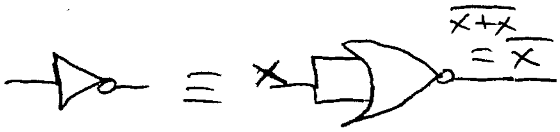
(c) $\overline{B + C + \overline{A}}$

(d) $\overline{\overline{B} + \overline{\overline{C} + A}}$

(e) $\overline{\overline{B} + \overline{C} + A}$

(29) How many AND gates can be packaged on a standard 14-pin DIP, with direct pin access to all inputs and outputs?

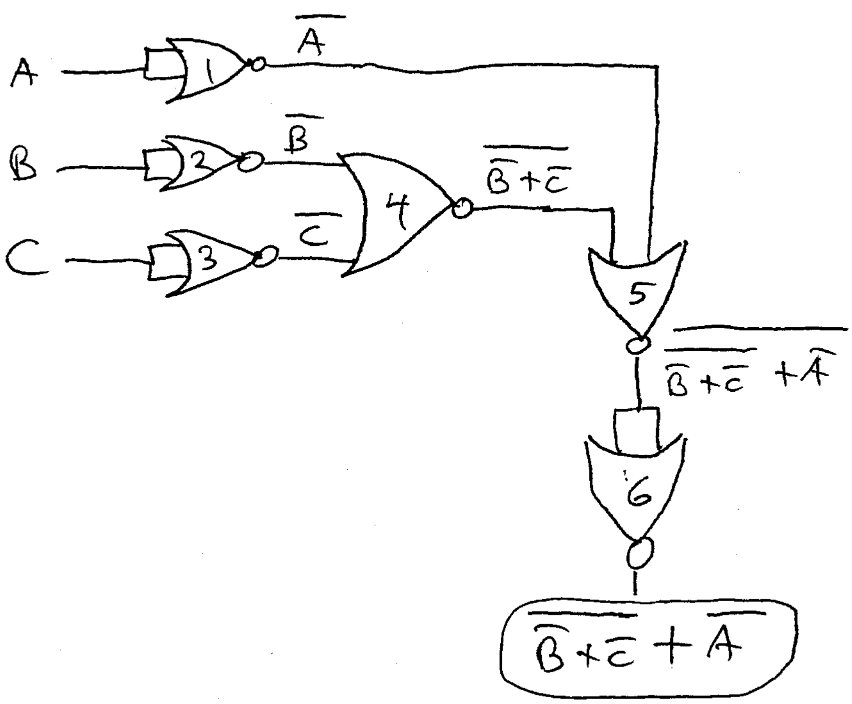
(a) 1
(b) 2
(c) 3
(d) 4
(e) 6



(30) If only NOR gates can be used to build a circuit for the following expression (i.e., no INVERTERS are allowed ... inverters must be built with NOR gates), how many NOR gates would be required? **Note - Do not try to simplify or change the expression ... implement it as is.**

$$\overline{\overline{B} + \overline{C}} + \overline{A}$$

(a) 2
(b) 4
(c) 5
(d) 6
(e) 7



(p. 277)

Table 7.3 Selected PicBasic Pro math operators and functions

Math operator or function	Description
A + B	Add A and B
A − B	Subtract B from A
A * B	Multiply A and B
A / B	Divide A by B
A << n	Shift A n bits to the left
A >> n	Shift A n bits to the right
COS A	Return the cosine of A
A MAX B	Return the maximum of A and B
A MIN B	Return the minimum of A and B
SIN A	Return the sine of A
SQR A	Return the square root of A
A & B	Return the bitwise AND of A and B
A | B	Return the bitwise OR of A and B
A ^ B	Return the bitwise Exclusive OR of A and B
~A	Return the bitwise NOT of A

works for positive 16-bit MAX integers only

MAX VALUE: $2^{16}-1 = 65,535$

(INTEGER DIVISION ⇒ REMAINDER DISCARDED)

** FOR 32-BIT MULTIPLICATION (WORD ** WORD) — SEE PBP BOOK FOR DETAILS

ex) x Var BYTE
y Var BYTE
⇒ y = 0

x = 10
y = x / 20 * 100 ⇒ y = 0
y = x * 100 / 20 ⇒ y = 50 ✓
> 255 BUT OK during calcs

y = 255 + 1 ⇒ y = 0

11111111
+1
100000000

OVERFLOW IS CHOPPED!

Table 7.4 PicBasic Pro logical comparison operators

Operator	Description
= or ==	equal
<> or !=	not equal
<	less than
>	greater than
<=	less than or equal to
>=	greater than or equal to

&& or AND
~ or NOT
\|\| or OR
^^ or XOR

for compound comparisons

FOR IF..THEN..ELSE STATEMENTS

p. 289

SHOW THIS FOR E 7.5

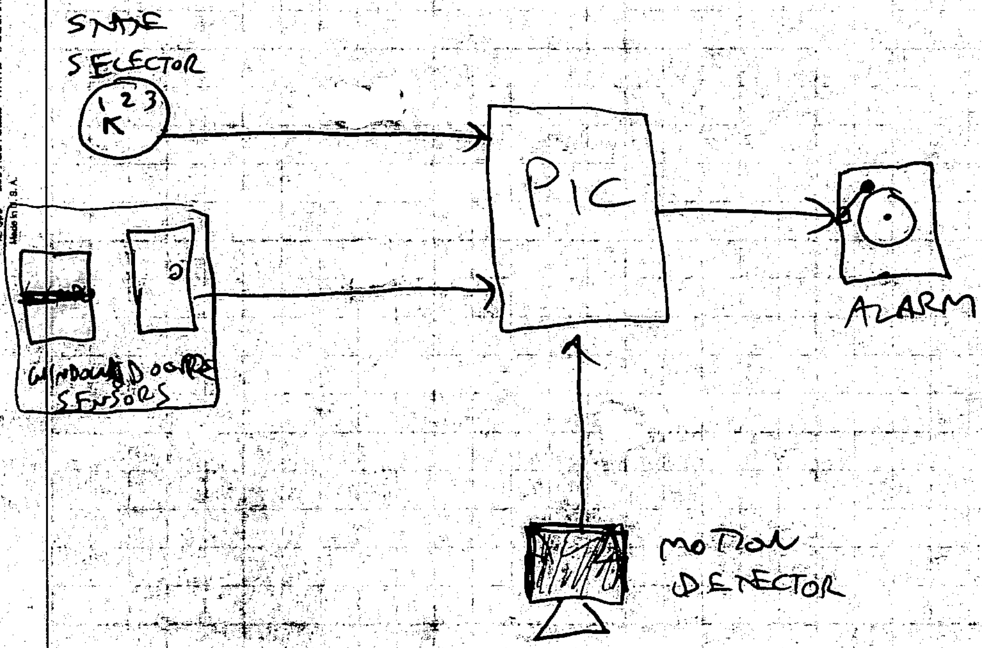
HOME ALARM SYSTEM

p. 264

7.9 METHOD TO DESIGN A MICROCONTROLLER-BASED SYSTEM

1. *Define the problem*
2. *Draw a functional diagram* — attached (typ)
3. *Identify I/O requirements* — attached w/ flowchart
4. *Select appropriate microcontroller models* PIC 16F84
5. *Identify necessary interface circuits*
6. *Decide on a programming language* PICBASIC PRO
7. *Draw the schematic*
8. *Draw a program flowchart*
9. *Write the code*
10. *Build and test the system*

FUNCTIONAL DIAGRAM



See I/O NEXT PAGE

E7.5 (p. 264)

SECURITY SYSTEM FLOWCHART

(POLLING IMPLEMENTATION)

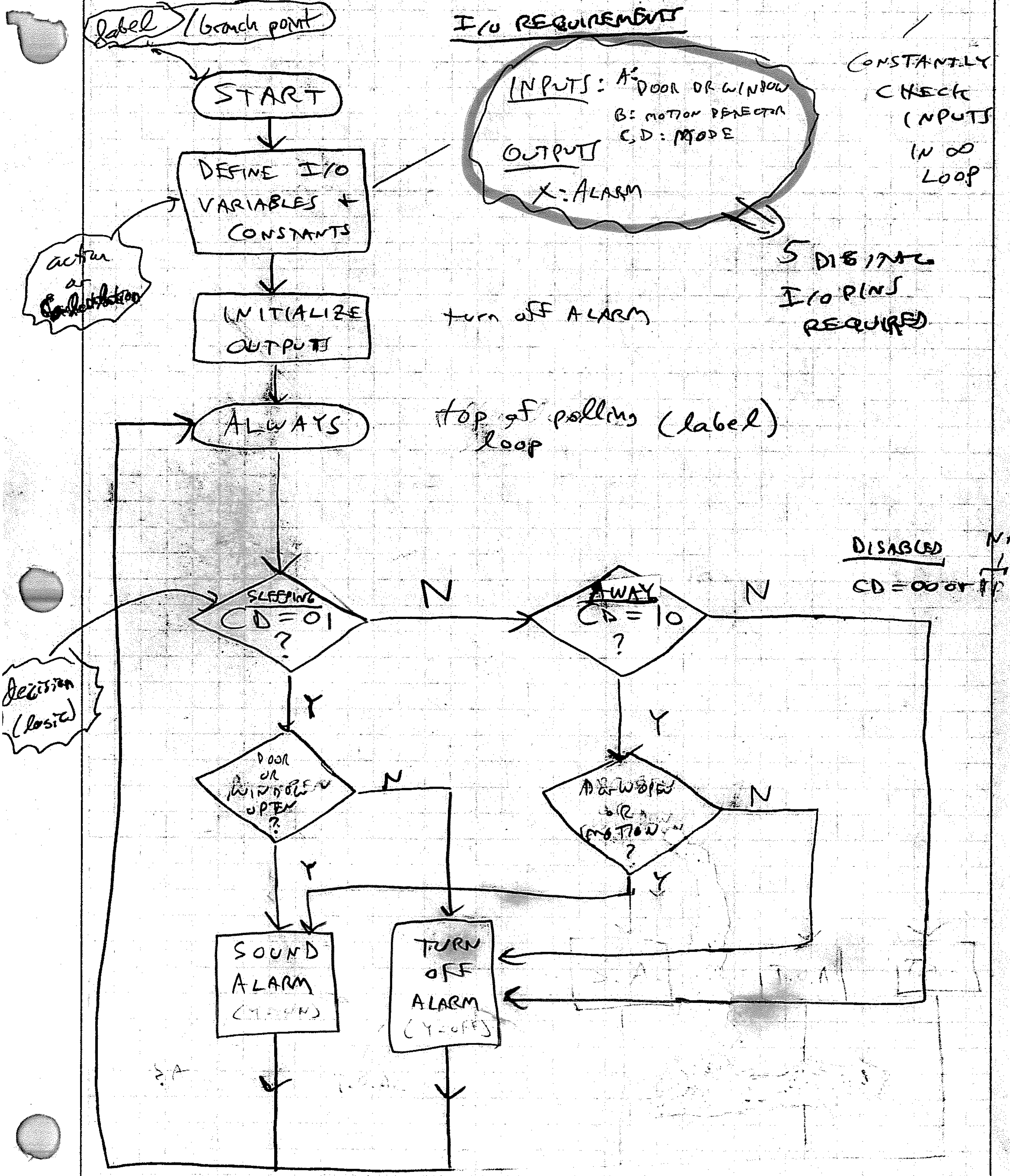
CONSTANTLY CHECK INPUTS IN ∞ LOOP

I/O REQUIREMENTS

INPUTS: A: DOOR OR WINDOW
B: MOTION DETECTOR
C,D: MODE

OUTPUTS
X: ALARM

5 DIGITAL I/O PINS REQUIRED



Ne HANDOUT

EXAMPLE 7.5 PicBasic Pro Program for Security System Example (p. 285)

```
' security.bas

' PicBasic Pro program to perform the control functions of the security
'  system presented in Section 6.6

' Define variables for I/O port pins
door_or_window      Var        PORTB.0     ' signal A
motion              Var        PORTB.1     ' signal B
c                   Var        PORTB.2     ' signal C
d                   Var        PORTB.3     ' signal D
alarm               Var        PORTA.0     ' signal Y

' Define constants for use in IF comparisons
OPEN            Con     1       ' to indicate that a door OR window is open
DETECTED        Con     1       ' to indicate that motion is detected

' Make sure the alarm is off to begin with
Low alarm

' Main polling loop
always:
       If ((c == 0) And (d == 1)) Then      ' operating state 1 (occupants
                                            '  sleeping)
              If (door_or_window == OPEN) Then
                     High alarm
              Else
                     Low alarm
              Endif
       Else
       If ((c == 1) And (d == 0)) Then      ' operating state 2 (occupants away)
              If((door_or_window == OPEN) Or (motion == DETECTED)) Then
                     High alarm
              Else
                     Low alarm
              Endif
       Else                                   ' operating state 3 or NA (alarm
                                              '  disabled)
                     Low alarm
       Endif
     Endif

Goto always                                    ' continue to poll the inputs

End
```

E7.5

closed when door + windows "closed"