BME 3512 Bioelectronics   Test Eight (Digital Electronics) Review Notes and Practice Problems

Define and provide examples of *positive* and *negative* logic.

Compare & contrast and list advantages & disadvantages of serial and parallel pulse trains.

Define the terms *combinational logic* and *sequential logic*; and provide examples of each.

Define the terms *synchronous machine* and a*synchronous logic*.

Compare and contrast *synchronous* and a*synchronous* sequential logic circuits.

Compare and contrast *Mealy and Moore* machines.

Describe operation of *Astable*(Free Running), *Mono-Stable*(One Shot), and *Bi-Stable*(Flip Flop) multivibrators.

Describe practical electronic examples/uses for each of the following: Schmitt Trigger, JK Flip Flop, NE 555.

Sketch and describe the operation of a BJT transistor switch; compare the *saturated* and the *cut-off* states to the closed and open positions of a mechanical switch.

State the two DeMorgan's Theorems using Boolean algebraic symbols.

Draw equivalent circuits for the two DeMorgan's Theorems using either NAND gates or NOR gates.

Explain the *Not Allowed* States for RS Flip Flops

Draw a simple NAND gate circuit that prevents the "Not Allowed" state for a NAND RS Flip Flop.

Draw a simple NOR gate circuit that prevents the "Not Allowed" state for a NAND RS Flip Flop.

Explain the operation of and write the Truth Table for a JK Flip Flop.

Calculate the threshold voltages and explain the operation of a Schmitt Trigger Bi-Referenced Comparator.
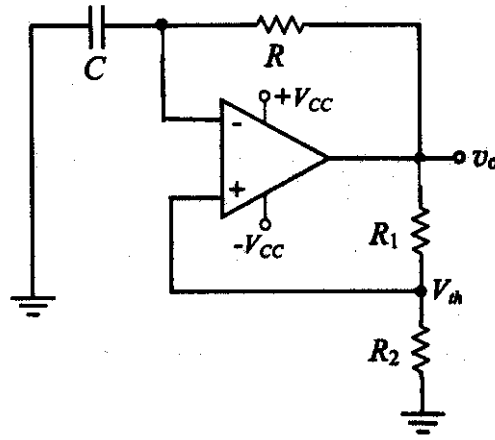
Calculate the operating frequency and period for a Schmitt Trigger Square Wave Generator (page 2).

Calculate the operating frequency, output time periods, and duty cycle of an 555 astable multivibrator (page 3).

Analyze the operation of an Open Loop Op-Amp LED Driver Circuit (page 4).

Calculate the operating frequency and cycle period for Schmitt Trigger Square Wave Oscillator.

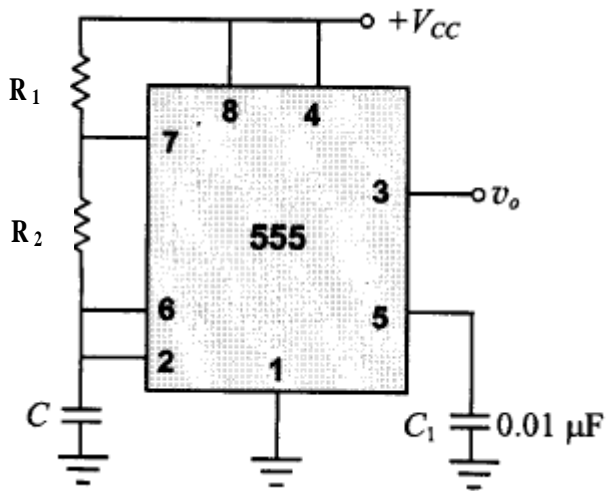Example: $R_1 = 4050\ \Omega$, $R_2 = 3480\ \Omega$, $R = 5000\ \Omega$, $C = 0.01\ \mu F$

Answers:

b. Calculate the Cycle Period   100 μsec

b. Calculate Operating Frequency   10 KHz

Calculate the operating frequency, output time periods, and duty cycle of an 555 astable multivibrator.

Example: $R_1 = 390$ KΩ, $R_2 = 680$ KΩ, and $C = 1$ uf

Answers:

a. Calculate the On & Off Pulse Widths (i.e., t_H & t_L) $t_H = 0.74$ sec $t_L = 0.47$ sec

b. Calculate the Period   1.2 sec

b. Calculate Duty Cycle   61 %

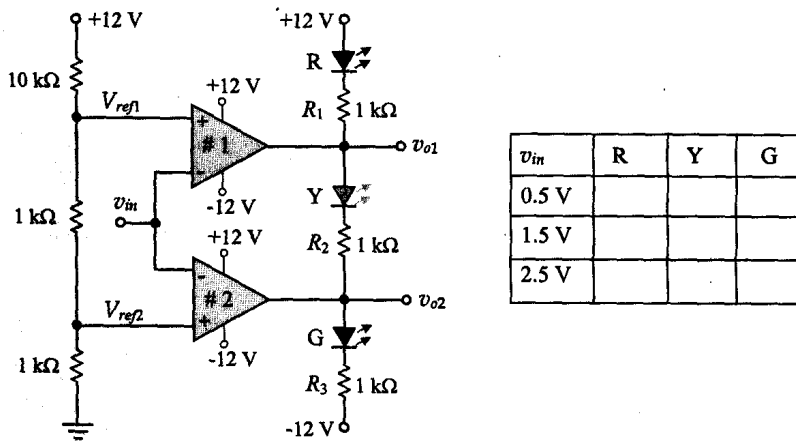c. Calculate the overall Operating Frequency   0.83 Hz

For the LED Driver problem below, assume the following values: $V_{sat} = \pm 10$ V, $V_{LED} = 2.4$ V.

Note:
  $V_{cc} = \pm 12$ V, which also serves as the voltage divider source on the left and the LED sources on the right.

1. Calculate V_{Refs}

  $R_{Total} = 10K + 1K + 1K = 12$ KΩ

  $I = 12$ V $/ 12$ K$\Omega = 1$ mA

  $V_{Ref2} = 1$ mA x 1 K$\Omega = 1$ V

  $V_{Ref1} = 1$ mA x (1 KΩ + 1 KΩ) = 2 V

2. Determine V_{Outs}

  If $V_{in} < V_{Ref2}$ Then $V_{Out2} = + V_{sat}$ that is to say if $V_{in} < 1$ V Then $V_{Out2} = +10$ V
  If $V_{in} > V_{Ref2}$ Then $V_{Out2} = - V_{sat}$ that is to say if $V_{in} > 1$ V Then $V_{Out2} = -10$ V
  If $V_{in} < V_{Ref1}$ Then $V_{Out1} = + V_{sat}$ that is to say if $V_{in} < 2$ V Then $V_{Out1} = +10$ V
  If $V_{in} > V_{Ref1}$ Then $V_{Out1} = - V_{sat}$ that is to say if $V_{in} > 2$ V Then $V_{Out1} = -10$ V

V_{in}	V_{Out1}	V_{Out2}	+ 12V - V_{Out1} Red	V_{Out1} - V_{Out2} Yellow	V_{Out2} - (-12V) Green
0.5 V	+10 V	+10 V	+2 V	0 V	+22 V
1.5 V	+10 V	-10 V	+2 V	+20 V	+2 V
2.5 V	-10 V	-10 V	+22 V	0 V	+2 V

3. Determine LED State: If voltage across LED and its associated 1 KΩ resistor > 2.4 V, then LED is ON.

V_{in}	Red	Yellow	Green
0.5 V	OFF	OFF	ON
1.5 V	OFF	ON	OFF
2.5 V	ON	OFF	OFF