ROLL NUMBER – 47

DIVISION - A

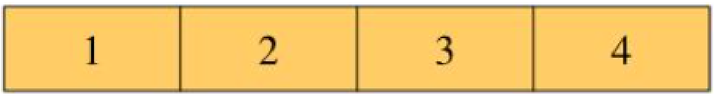
HOMEWORK 2 (SUBJECT - MPMC)

Question: Short note on: Clock generator for Digital system and details of Quartz Crystal Oscillator.

Answer:

Combinational logic circuit

A combinational logic circuit is one whose outputs depend only its current inputs.



Combinational Circuit

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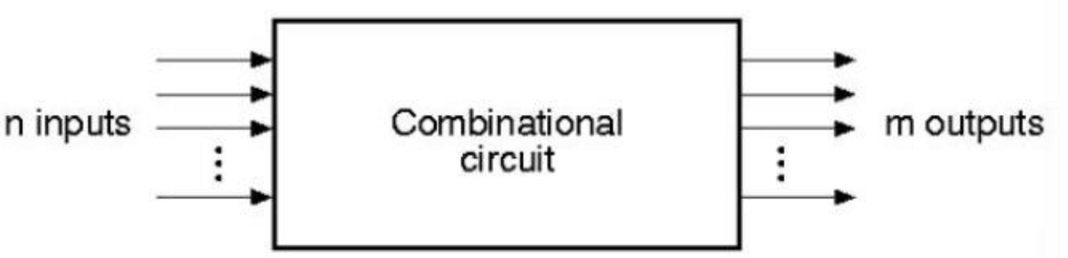
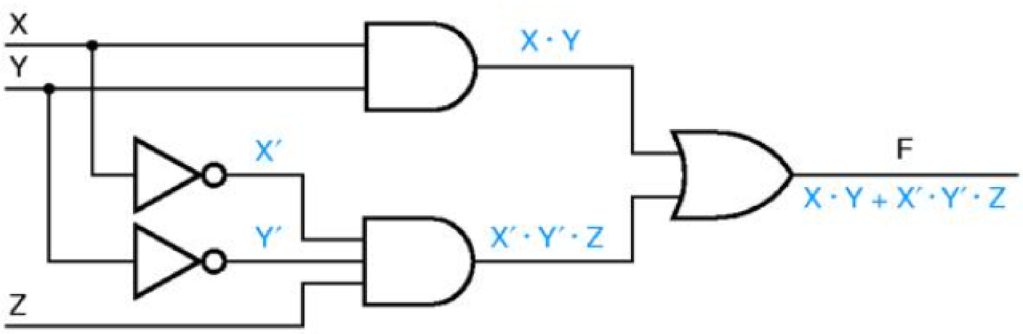


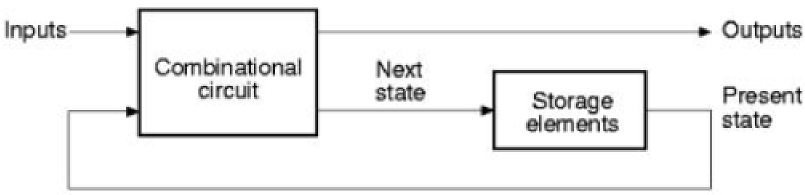
Logic circuit using AND, OR and NOT gates:



Sequential Logic Circuits

A Sequential Logic Circuit is one whose outputs depend not only on its current inputs, but also on the past sequence of inputs.

- The circuit controlled by the channel-up and channel-down pushbuttons on a TV is a sequential circuit.
- The channel selection depends on the past sequence of up/down pushes and the current push.
- Outputs depend on the sequence of past inputs.
- As a result, the circuit must "remember" something about the past.
- A circuit with memory, whose outputs depends on the current input and the sequence of past inputs, is called a sequential circuit.
- The behaviour of such a circuit may be described by a state table that specifies its output and next state as functions of its current state and input.



- There are two main types of sequential circuits:

  - synchronous

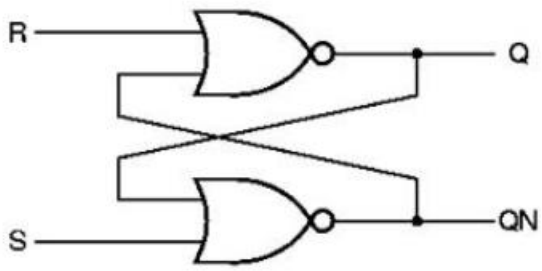
  - asynchronous

- This classification depends on the timing of their signals.
- A synchronous sequential circuit is a system whose behaviour can be defined from the knowledge of its signals at discrete instants of time.
- The behaviour of an asynchronous sequential circuit depends upon the order in which its input signals change and can be affected at any instant of time.

Asynchronous Sequential Logic Circuit

- An asynchronous sequential circuit uses ordinary gates and feedback loops. Propagation delay of these gates provide the needed memory, thereby creating sequential-circuit building blocks such as latches and flip-flops that are used in higher-level.

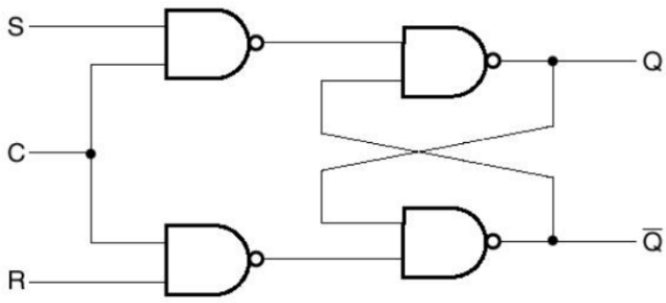
(a)



(b)

S	R	Q	QN
0	0	last Q	last QN
0	1	0	1
1	0	1	0
1	1	0	0

SR Flip-flop with Control Input



(a) Logic diagram

C	S	R	Next state of Q
0	X	X	No change
1	0	0	No change
1	0	1	Q = 0; Reset state
1	1	0	Q = 1; Set state
1	1	1	Undefined

(b) Function table

SR Flip-flop with Clock input

- Q is an abbreviation of Q(t), referred to as the present state.
- Q(t+1), referred to as the next state after application of a single pulse at the clock input.

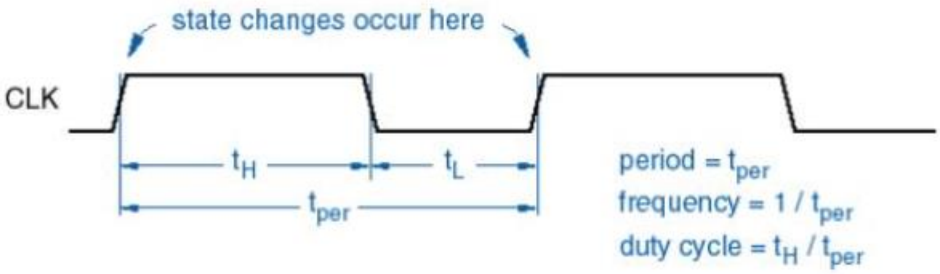
Synchronous Sequential Logic Circuit

- A synchronous sequential circuit, by definition, must employ signals that affect the memory elements only at discrete instants of time.
- One way of achieving this goal is to use pulses of limited duration throughout the system.
- The device that generates these pulses are called clock and the train of pulses are called clock pulses.

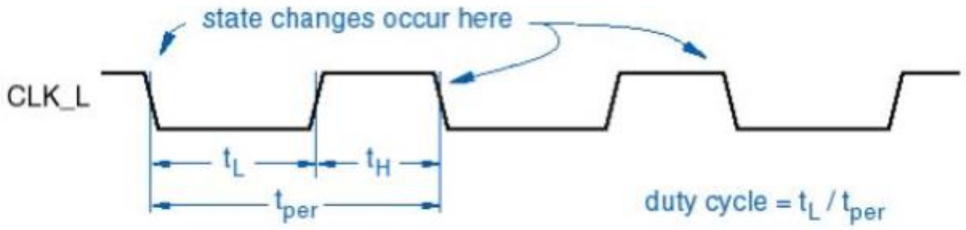
Clock

- The state changes of most sequential circuits occur at times specified by a free-running clock signal.

Active high clock signal:



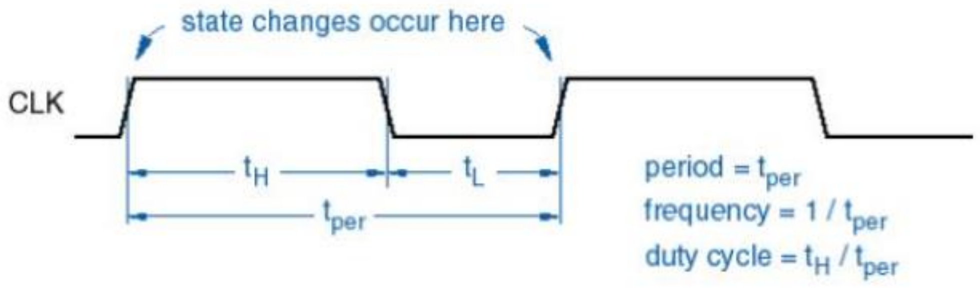
Active low clock signal:



Clock period and frequency

- The clock period is the time between successive transitions in the same direction.
- The clock frequency is the reciprocal of the period i.e., the number of clock pulses per second.

  f=1/T



Duty Cycle

Duty cycle is the percentage of time that the clock signal is at its asserted level.

Pentium4 (Launched in 2000 and discontinued in 2008)

Q. What is the clock frequency of the latest Pentium 4 processor?

Answer. Intel® Pentium® 4 Processor 2.80 GHz, 512K Cache, 533 MHz FSB

Q. What is the clock period of the latest Pentium 4 processor?

Answer. Max. CPU clock rate is 1.3 GHz to 3.8 GHz

DEFINTION

A clock generator is an electronic oscillator that produces a clock signal for use in synchronizing a circuit's operation. The signal can range from a simple symmetrical square wave to more complex arrangements. The basic parts that all clock generators share are a resonant circuit and an amplifier.

Clock Generator Functions

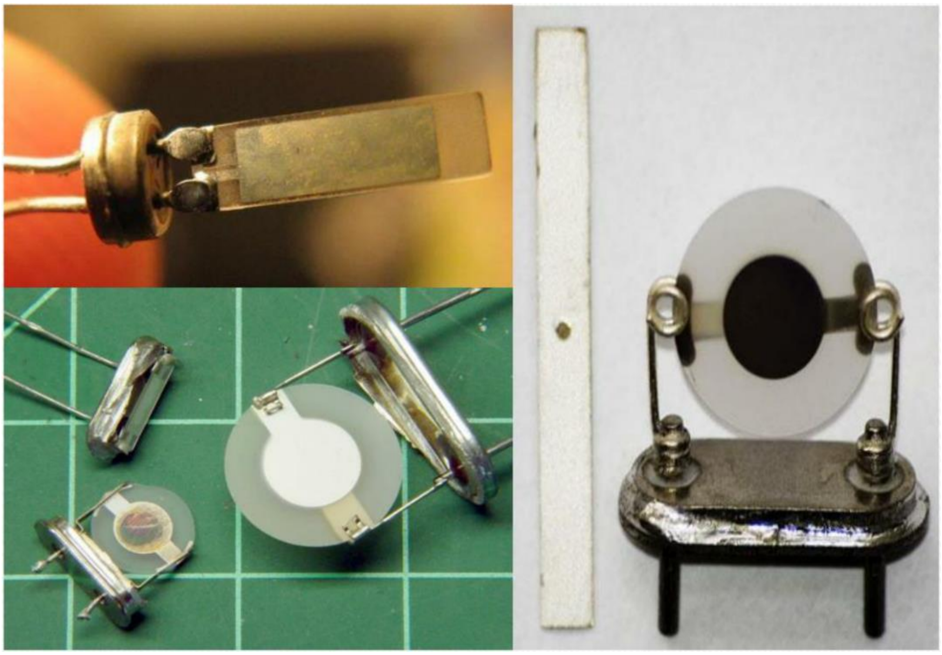
- The 8086 CPU has 16 data lines and 20 address lines.
- The CPU uses time multiplexing for the Address, data, and some status lines.
- The clock generator and driver 8284 is a device capable of providing the CPU with
  - Clock
  - Reset Logic, and
  - Ready Logic.
- The 8284 Clock generator uses a crystal oscillator that must be 3 times the frequency of the CPU (15 MHz Crystal).
- A crystal oscillator (See Figure 1) is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency.
- The most common type of piezoelectric resonator used is the quartz crystal (See Figure 2), so oscillator circuits incorporating them became known as crystal oscillators.

- Figure 1: Two types of crystal oscillator

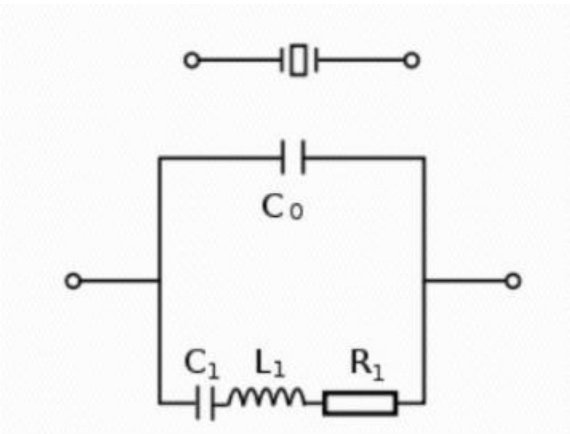
- Figure 2: Cluster of natural quartz crystals

Operation

- When a crystal of quartz is properly cut and mounted (See Figure 3), it can be made to distort in an electric field by applying a voltage to an electrode near or on the crystal.
- The property is known as electrostriction or inverse piezoelectricity.
- When the field is removed, the quartz will generate an electric field as it returns to its previous shape, and this can generate a voltage.
- The result is that a quartz crystal behaves like a circuit composed of an inductor, capacitor, and resistor, with a precise resonant frequency (See RLC circuit in Figure 4).



- Figure 3: Internal construction of quartz crystal oscillators.



- Figure 4: Schematic symbol and equivalent circuit for a quartz crystal in an oscillator.

Clock Generator (8284A) Pins

X1 & X2 (Crystal In):

- X1 & X2 are the pins to which a crystal is attached.
- The crystal frequency is 3 times the desired processor clock frequency.

F/C (Frequency/Crystal Select):

- When LOW -> CLK is generated by the crystal.
- When HIGH -> CLK is generated by the EFI input.

EFI (External Frequency Input):

- When F/C is HIGH, CLK is generated from the input frequency appearing on this pin.
- The input signal is a square wave 3 times the frequency of the desired CLK output.

CLK (Processor Clock):

- CLK is the clock output used by the processor and all devices which directly connect to the processor’s local bus.
- CLK has an output frequency which is 1/3 of the crystal or EFI input frequency and a 1/3 duty cycle.

PCLK (Peripheral Clock):

- PCLK is a peripheral clock signal whose output frequency is ½ that of CLK and has a 50 % duty cycle.

OSC (Oscillator Output):

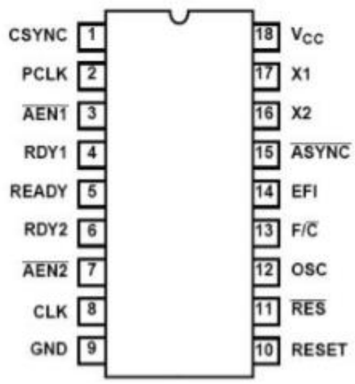
- OSC is the output of the internal oscillator circuitry.
- Its frequency is equal to that of the crystal.

$\overline{\text{RES}}$ (Reset In):

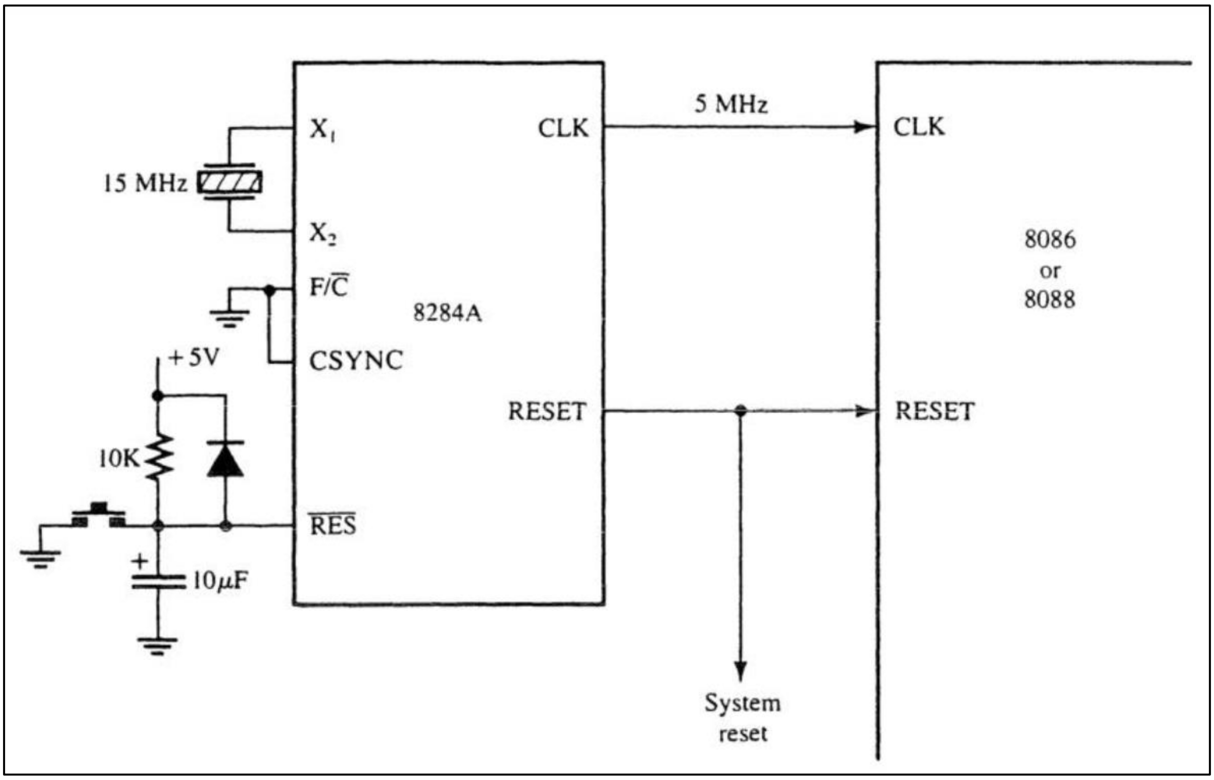
- It is an active LOW signal which is used to generate RESET.
- The 82C84A provides a trigger input so that an RC connection can be used to establish the power-up reset of proper duration.

RESET:

- It is an active HIGH signal which is used to reset the 80C86 family processors.
- Its timing characteristics are determined by RES.



Interfacing the 8284A to 8086



➢ **Reset Logic**:

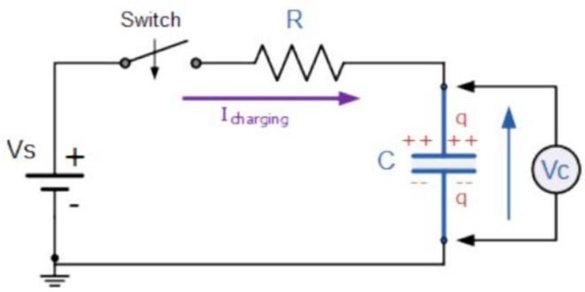
- Initially the capacitor is uncharged.
- When power is switched on, the RES signal is at logic 0 (RESET signal is at logic 1).
- The capacitor starts charging with time constant (RC=10Kx10uF)
- When the voltage across the capacitor becomes equal to the minimum High voltage of the 8284 (2V), the RES signal goes to logic 1 (RESET signal goes to logic 0).
- If the Reset button is pressed, the capacitor is discharged through the switch.
- When the Button is released, the capacitor starts charging as before.
- The diode is used to short circuit the resistor during switch off, thus discharge the capacitor fast.

RC Charging Circuit

- A capacitor is charged in an RC circuit according to the following equation:

  $Vc = Vs\ (1-e^{-t/RC})$

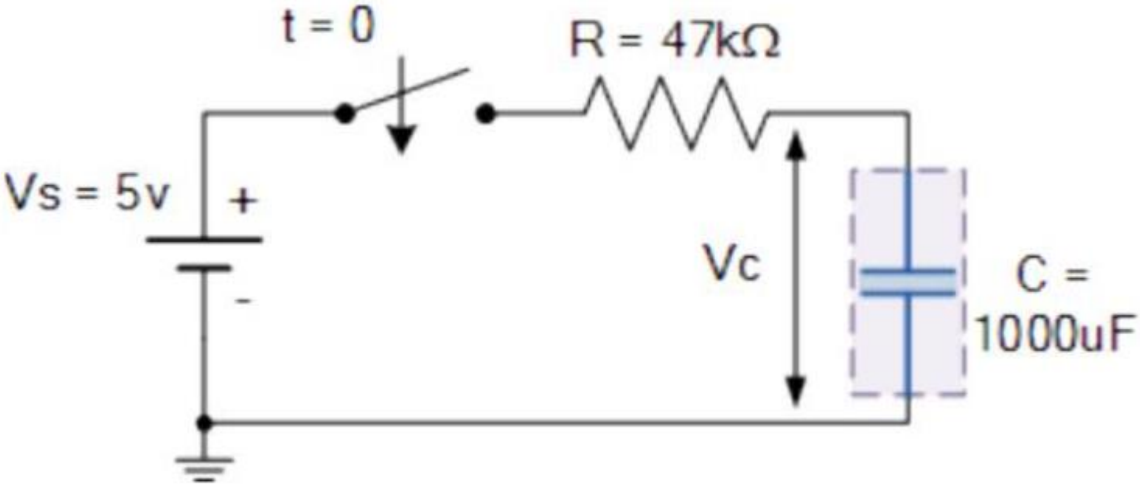
- Vc is the voltage across the capacitor
- Vs is the supply voltage
- t is the elapsed time since the application Vs
- RC is the time constant of the RC charging circuit



Example

Consider the RC circuit shown in the figure and answer the following questions:

(a) What is the time constant of the circuit?
(b) How long will it take charge the capacitor to 2.5 V?
(c) What is the voltage across the capacitor after 100 seconds?



<u>Answer</u>:

a. What is the time constant of the circuit?

   $T = R \times C = 47 \times 10^{3} \times 1000 \times 10^{-6} = 47$ seconds

b. How long will it take charge the capacitor to 2.5 V?

   $Vc = Vs\ (1 - e^{-t/RC})$
   - ⇨ $2.5 = 5\ (1 - e^{-t/47})$
   - ⇨ $0.5 = 1 - e^{-t/47}$
   - ⇨ $e^{-t/47} = 0.5$
   - ⇨ $\ln e^{-t/47} = \ln 0.5$
   - ⇨ $-t/47 = -0.693147$
   - ⇨ $t = 32.578$ seconds

c. What is the voltage across the capacitor after 100 seconds?

   $Vc = Vs\ (1 - e^{-t/RC})$
   - ⇨ $Vc = 5\ (1 - e^{-100/47})$
   - ⇨ $Vc = 4.404$ volts