Unit - 2

WAVESHAPING CIRCUITS

Introduction

Waveshaping circuits are quite often used in signal processing in which signals of one form are required to be converted into other forms. Resistors, capacitors, inductors and diodes are used for waveshaping. Clipping, clamping, differentiation and integration are examples of waveshaping. In this chapter we discuss above operation with simple RC networks as well as with op-amp circuits. We use general discussion, mathematical derivations, chart making and experimental setup to transact the content.

Unit frame

Concept/Process Skills	Process/Activities with Assessment	Learning outcomes
Clipping and different types of clipping. • Communicating • Experimenting • Observing	General discussion Demonstration of the circuits Analysis of the waveform on CRO Involvement in general discussion Skill in circuit making	Explains different types of clipping circuits
Different types of clamping • Communicating • Experimenting • Interpreting	• General discussion on clamping • ICT simulation of different types of clamping • Circuit implementation and observation of the output. *Assessment* • Skill in circuit making • Involvement in discussion	Demonstrates the working of clamping circuits.
Principle of differentiating and integrating circuits. • Analysing • Observing • Interpreting	• Discussion • Mathematical derivation • Experimental set up • Observing output on CRO • Sketching waveforms *Assessment* • Involvement in experimenting • Quality of the prepared chart • Skill in practical experimenting	Explains RC differentiator and integrator.
Filter circuits and their classification • Observing • Comparing • Experimenting	• General discussion • Preparation of chart on types of filters • Sketching frequency response of ideal and practical filters. • Setting up simple filter circuits and draw their frequency response.	Identifies different types of RC filter circuits.

	Assessment	
	• Quality of the sketches	
	• Skill in experimenting	
	• Participation in discussion	
Various op-amp circuits	• General discussion	Sketches the circuit diagrams and explains the operation of buffer, adder and subtractor.
• Communicating	• Sketching circuit diagram	
• Observing	• Circuit implementation and output verification	
• Sketching	*Assessment*	
• Measuring	• Correctness of the circuit diagram	
	• Skill in implementing practical circuit	

Clamping circuits

Suggested activity 2.1

Experimental set up and general discussion.

Discussion points

- What is the average value of a sine wave?
- What happens to the average value when a DC voltage is added to this signal?
- What happens to this signal when polarity of the DC voltage is changed?
- Can we use a capacitor as a DC voltage source?

Now set up a clamper circuit and observe its output on a CRO. Ask the students to press AC/DC switch of the CRO and see the variation in the output. In AC position, clamping can't be observed as the added DC in the output is removed by the CRO.

Then set up a biased clamper by connecting a DC voltage source to the circuit and observe the level shift in the output signals as the value of this voltage source is varied.

Finally the teacher consolidates that the clamping is done by adding a d/c voltage of required polarity and value to the signal.

Worksheet I

- Match the following

Circuit	Function
A) Differentiator	Selects a particular frequency
B) Integrator	Impedance matching
C) Buffer	Converts square wave into triangular wave
D) Clamper	Converts square wave into spikes
E) Filter	Shifts the average of a signal up or down

Worksheet II

- Draw the output waveform for the following circuit for a square wave input.

    a) Integrator

    b) Differentiator

    c) Buffer

    d) Positive clamper

    e) Combinational clipper with Zero bias.

Sample TE Questions

1. A Clipper is equivalent to

    a) Buffer   b) Rectifier   c) Clamper   d) Integrator

2. In a clipper circuit, the capacitor used of

    a) Small value   b) large value   c) any value

3. In an integrator circuit, relatively ……………… value capacitor is used

    a) Small   b) large   c) any

4. The operation of which of the following circuit is frequency dependant?

    a) Buffer   b) Clipper   c) clamper   d) Differentiator

5. An integrator is a RC circuit whose output is the integral of the input.

    a) Show mathematically that the output of the integrator is the integral of the input

    b) What condition should be satisfied for the circuit perform better integration

6. In a buffer circuit, output voltage follows the input voltage.

a) What is the voltage gain of a buffer

b) Give one application of buffer

7. An analog comparator compares two voltages given to its inputs.

   a) Draw a comparator circuit for which a sine wave of 5V (p-p) is given to positive input and a 2V DC is given to the negative input.

   b) Draw the output waveform in this case

8. Filters are classified based on the pass band they allow.

   a) Identify different types of filters

   b) Draw their ideal frequency response

   c) How will you find out the cut off frequency of a filter from its frequency response.

   d) Suppose you have a signal with frequencies ranging from 0Hz to 25 kHz . You are required to filter out the following bands from the above signal.

   (i) 0 – 5 kHz (ii) 8 kHz – 12 kHz (iii) 5 kHz – 25 kHz

What type of filters will you choose in each of the above case and mention their cut off frequencies.

PE Items

1) Set up different types of clippers and observe their output values.

2) Implement integrator and differentiator circuits and observe output when frequency of the input signal is varied.

3) Design and implement LPF and HPF for a given cut-off frequency and draw their frequency response curve. Calculate the cut off frequency from this graph and verify it.

Unit 3
DIGITAL ELECTRONICS

Introduction

Digital systems are spreading everywhere in the field of electronics. The digital circuits can be classified into combinational circuits and sequential circuits. The sequential circuits are having memory. The logic gates are the basic building units of the digital circuits. With these gates adder, subtractor, encoder, decoder flip-flops, shift registers, counters etc. are designed. The circuit diagram of each of these circuits is sketched and they are assembled in the laboratory and their operation is observed. The truth table of various flip flops is verified. The students may be asked to draw the logic circuit for a given digital logic. ICT can be used to obtain the working simulations of the above digital circuits.

Concept/Process Skills	Process/Activities with Assessment	Learning outcomes
Combinational and sequential circuits. • Communicating • Interpreting • Organizing • Distinguishing	• General discussion • Chart preparation identifying combinational and sequential circuits. • Preparation of table citing examples for combinational and sequential circuits. *Assessment* • Content and quality of the chart and table. • Participation in the discussion • Correctness of the table prepared.	Explains the difference between combinational and sequential circuits.
Multiplexer and de multiplexer. • Analyzing • Sketching • communicating	• General discussion on multiplexing and demultiplexing. • Sketching their circuits and explaining the operation. • Identifying their application areas. *Assessment* • Points of discussion • Involvement in activities	Demonstrates the operation of multiplexer and demultiplexer
Comparator and its application. • Communicating • Reasoning • Organising	• Discussion on the need of comparator. • Drawing and explaining the circuit of one bit comparator. • Discussion on expanding one bit to two –bit comparator.	Designs and sets one bit comparator
Flip flops and their types • Interpreting • Analysing • Communicating	• General discussion on flip flops and their types. • Sketching the circuit diagram of each.	Explains the operation of basic flip flops.

	• Group discussion and presentation of their operation. • Verifying the truth table • Discussion on the application	
Operation of counter and shift register. • Analysing • Reasoning • Sketching •	• Discussion on the need of a counter and shift register • Sketching the circuit diagram and explains the operation. • Develop and draw the output waveform of a counter	Explains the operation of counters and shift register

Counter Circuits

Suggested Activity 3.1

Discussion Points:

- How an event or thing can be counted electronically?
- Why it is to be converted into electrical pulses?
- T-flip flops can be arranged to form a counter.
- The change of state of T-flip flops can be used to represent a binary count.

A 3 stage asynchronous binary counter is formed using three T-flips. Ask the students to record the state (HIGH or LOW) of output of each flip flop when a clock pulse is given as input. Repeat this for successive clock pulses. Prepare a table to show the number of clock pulses and output of each flip flop (As given in the textbook). Now observe that each output state is the binary equivalent of the number of clock pulses then applied. The automatic resetting of the counter can also be verified for the eighth clock pulse.

Then draw a four stage counter and find out the state of each flip flop for successive clock pulses. A table mentioned in the previous case can be developed here for the 4 bit counter.

The teacher finally consolidates the operation of the counter and mentions various applications of it. The student may be asked to find out situations around them where a counter can be used.

WORKSHEET 1

- It is said that S = R = 1 input is invalid in a SR flip flop

  a) why it is called invalid?

  b) Draw a SR flip flop using NOR gates.

  c) Write the truth table of SR flip flop

  d) How this invalid input problem is overcome?

WORKSHEET 2

- D and T flip flops are the modifications of JK flip flop

  a) Draw D and T flip flops using JK flip flop

  b) Write their truth table

  c) How they got their name?

WORKSHEET 3

- A counter circuit is used to count any event or thing electronically.

  a) Which flip flop is used as the building block of the counter?

  b) Draw a 3 stage counter circuit and explain its operation.

  c) Design a decade counter using four T- flip flops.

WORKSHEET 4

- A shit register can store data bits and the bits can be shifted left or right to perform numerical operations.

  a) Draw a 8 – bit SISO shift register.

  b) Explain the Write/Read operation of this register.

1. **Fill in the blanks**

Flip flop	Application
T flip flop	
	Shift register
	Latch

2. **Match the following**

SR flip flop	Master – Slave configuration
D flip flop	Toggling output
T flip flop	Forbidden state
JK flip flop	One clock pulse delay

3. A multiplexer is used to save the number of data lines required for communication.

    a) Draw the circuit of a 4 : 1 multiplexer using gates

    b) How will you set up a 8 : 1 multiplexer using two 4 : 1 multiplexers.

4. Draw the circuit of a 3 to 8 decoder

5. A digital comparator is used to compare two binary numbers.

    a) Draw the circuit of a one bit comparator

    b) Which gate is used to say that the bits are equal?

6. The sequential circuits are made up of flip flops.

    a) What do you mean by a sequential circuit?

    b) Flip flop is a one – bit memory. Why do you think so?

    c) What are the different types of flip flops?

PE ITEMS

1) Familiarizes with 4 : 1 and 8 : 1 multiplexer ICs.

2) Familiarise with SR, JK flip flops and counter and shift register ICs.