

## **Syllabus**

### **1. Feedback Amplifier**

- Classifications of amplifiers
  - Voltage, current, transconductance and transresistance amplifiers
- The feedback concept
- The transfer ratio or gain of feedback amplifier
- Negative feedback amplifier
- Feedback amplifier topologies
  - Voltage series, voltage shunt, current series and current shunt
- General characteristics of –ve feedback amplifier
  - Input impedance of feedback amplifier
  - Output impedance of feedback amplifier
- How to find the feedback topology of an amplifier?
- Outlines of analysis of feedback amplifier

### **2. Differential amplifier**

- Differential amplifier using BJT
  - DC Transfer C/Cs
  - Difference mode input dynamic range
  - Small signal analysis
  - Differential mode gain
  - Common mode gain
  - Common mode rejection ratio (CMRR)
  - Difference mode and common mode input impedances
- Differential amplifier using FET
  - DC Transfer C/Cs
  - Difference mode input dynamic range
  - Small signal analysis
  - Differential mode gain
  - Common mode gain
  - Common mode rejection ratio (CMRR)

- Difference mode and common mode input impedances
- Mismatch analysis
- Biasing Techniques in ICs
  - Constant current source (CCS) and current mirror using BJTs
  - Constant current source using FETs
- Differential amplifiers with active load
- Improved differential amplifier with single ended output

### **3. Output stage**

- Objectives
- Requirements
- Class A output stage
  - Transfer characteristics for small and large loads
  - Power and efficiency
  - Maximum power and maximum efficiency
  - Power dissipation (maximum instantaneous and average power dissipation)
- Class B and AB push pull output stages
  - Disadvantages of class A
  - Advantages of class B
  - Transfer c/cs
  - Crossover distortion
  - Class AB output stage
  - Transfer c/s
  - Power and efficiency
  - Max. Efficiency
  - Maximum output voltage limit

### **4. Operational amplifier architecture**

- Basic stages description
- The analysis of 741 op. amp
- DC analysis
- Ac analysis
- Tutorial and discussion

## 5. Frequency response

- Introduction
- The general voltage gain function
- Low frequency response
  - Low frequency response of CE BJT amplifier
  - Low frequency response of CS FET amplifier
- High frequency response
  - The  $\pi$ -equivalent model at high frequencies
  - High frequency response of CE short circuit current gain
  - Millar theorem
  - High frequency response of CE amplifier
  - High frequency response of Emitter follower amplifier
  - High frequency response of CS amplifier
- Determining the -3dB upper frequency

## 6. Op-Amp applications

- Linear applications
  - Inverting amplifier and non inverting amplifier
  - Inverting and non inverting summers
  - Subtractor
  - Integrator
  - Differentiator
  - Solution of differential equation (analog computer)
- Non linear applications
  - Logarithmic amplifier
  - Anti-log amplifier
  - Temperature compensated logarithmic amplifier
  - Half wave rectifier and full wave rectifier
  - Comparator

## 7. Linear oscillators

- The oscillation criterion
- The Barkhausen conditions

- FET phase shift oscillator
- BJT phase shift oscillator
- Phase shift oscillator using op-amp
- Wien bridge oscillator
- Frequency limitations of an oscillator
- General form oscillator configuration
- Collpits and Hartley oscillators
- Tuned oscillator

## **8. Wave shaping and waveform generators**

- Comparator
- Schmitt trigger (regenerative comparator)
- Square wave generator using op-amp (free running square wave generator)
- Triangular wave generator using op-amp

## **9. Multivibrators**

- Transistor based Bistable Multivibrator
- Transistor based Monostable Multivibrator
- Transistor based Astable Multivibrator
- IC based Multivibrators
- 555 IC timer connected as monostable multivibrator
- 555 IC timer connected as astable multivibrator
- Transistor based Schmitt trigger
- Op- amp based Schmitt trigger
- Tutorial and discussion

## **10. Analog multipliers**

- Variable transconductance multiplier
- Two quadrant multiplier
- Four quadrant multiplier
- Four quadrant multiplier with wide dynamic ranges
- Applications of analog multipliers: amplification, multiplication, division, squaring, square root circuits and in communication circuits (balanced modulator using analog multiplier)

## 11. Phase locked loop (PLL)

- Block diagram and operation
- The voltage controlled oscillator (VCO)
- The phase detector
- PLL applications

## References

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8. *"Design with Operational Amplifiers and Analog Integrated Circuits"* By: S. Franco
9. *"Op-Amps: Design, Application, and Troubleshooting"* By: David L. Terrell