## EC41-ELECTRONIC CIRCUITS II

### FEEDBACK AMPLIFIERS

Block diagram, Loop gain, Gain with feedback, Effects of negative feedback – Sensitivity and desensitivity of gain, Cut-off frequencies, distortion, noise, input impedance and output impedance with feedback, Four types of negative feedback connections – voltage series feedback, voltage shunt feedback, current series feedback and current shunt feedback, Method of identifying feedback topology and feedback factor, Nyquist criterion for stability of feedback amplifiers.

### OSCILLATORS


### TUNED AMPLIFIERS


### WAVE SHAPING AND MULTIVIBRATOR CIRCUITS


### BLOCKING OSCILLATORS AND TIMEBASE GENERATORS


### REFERENCE

Text Books
Reference Books


Unit-1
Feedback amplifiers

Introduction

- Consists of returning part of the output of a system to the input
- **Negative Feedback**: a portion of the output signal is returned to the input in opposition to the original input signal
- **Positive Feedback**: the feedback signal aids the original input signal
- **Negative Feedback Effects**:
  - Reduces gain
  - Stabilizes gain
  - Reduces non linear distortion
  - Reduces certain types of noise
  - Controls input and output impedances
  - Extends bandwidth

- The disadvantage of reducing the gain can be overcome by adding few more stages of amplification
Feedback amplifier. Note that the signals are denoted as $x_s$, $x_f$, $x_o$, and so on.

The signals can be either currents or voltages

$A_f = \frac{A}{1 + A\beta}$  \hspace{0.5cm} \text{Negative feedback} (A_f < A)

$A_f = \frac{A}{1 - A\beta}$  \hspace{0.5cm} \text{Positive feedback} (A_f > A)

Positive feedback provides an easy way to obtain large gain. It leads to poor gain stability, a slight shift in power supply or temp can change the magnitude of loop gain to unity & cause the Amplifier to break into oscillation.

**Effects of various types of feedback on gain**

$A_f = \frac{x_o}{x_s} = \frac{A}{1 + A\beta}$

Gain Stabilization

> If we design the amplifier so that $A\beta >> 1$, then the closed loop gain $A_f$ is approximately $1/\beta$.

> Under this condition $A_f$ depends only on the stable passive components (resistor or capacitors) used in the feedback network, instead of depending on the open loop gain $A$ which in turn depends on active device parameters ($g_m$) which tend to be highly variable with operating point and temperature.
Types of Feedback

There are 4 basic types of feedback that have different effects:

- Voltage series
- Current series
- Voltage shunt
- Current shunt

The units of $\beta$ are the inverse of the units of the amplifier gain

- For series-voltage feedback $A = Av$ and $\beta$ is unit less
- For series-current feedback $A = Gm$ and $\beta$ is in $\Omega$
- For voltage shunt feedback $A = Rm$ and $\beta$ is in Siemens
- For current shunt feedback $A = Ai$ and $\beta$ is unit less

The four basic feedback topologies: (a) voltage-sampling series-mixing (series-shunt) topology, (b) current-sampling shunt-mixing (shunt-series) topology, (c) current-sampling series-mixing (series-series) topology, (d) voltage-sampling shunt-mixing (shunt-shunt) topology.
Summary (Effects on feedback)

Table 9.1. Effects of Feedback

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th>$x_f$</th>
<th>$x_o$</th>
<th>Gain Stabilized</th>
<th>Input Impedance</th>
<th>Output Impedance</th>
<th>Ideal Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series voltage</td>
<td>$v_i$</td>
<td>$v_o$</td>
<td>$A_{ef} = \frac{A_v}{1 + A_v \beta}$</td>
<td>$R_i(1 + A_v \beta)$</td>
<td>$\frac{R_o}{1 + \beta A_{iso}}$</td>
<td>Voltage</td>
</tr>
<tr>
<td>Series current</td>
<td>$i_i$</td>
<td>$i_o$</td>
<td>$G_{mf} = \frac{G_m}{1 + G_m \beta}$</td>
<td>$R_i(1 + G_m \beta)$</td>
<td>$R_o(1 + \beta G_{moc})$</td>
<td>Transconductance</td>
</tr>
<tr>
<td>Parallel voltage</td>
<td>$i_f$</td>
<td>$v_o$</td>
<td>$R_{mf} = \frac{R_m}{1 + R_m \beta}$</td>
<td>$\frac{R_o}{1 + \beta R_{moc}}$</td>
<td>Transresistance</td>
<td></td>
</tr>
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<td>$\frac{R_i}{1 + A_i \beta}$</td>
<td>$R_o(1 + \beta A_{ioc})$</td>
<td>Current</td>
</tr>
</tbody>
</table>

*Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains $A_v$, $G_m$, $R_m$, and $A_i$ are for the actual load.*

Analysis of feedback amplifiers

Steps

1. **Identify the type of feedback**
2. **Redraw the amplifier circuit without the effect of feedback.**
3. **Use a thevenin’s source at the input for series mixing and use a Norton’s source at the input for shunt mixing.**
4. **After drawing the amplifier circuit without feedback determine the ac parameters of the circuit using the h parameter model.**
5. **Determine the feedback ratio $\beta = x_i / x_o$ from the original circuit.**
6. **Find the desensitivty factor(D).**
7. **Knowing A,D,Ri, and Ro, Find Af, Rif, Ro.**
Nyquist criterion

Criterion Of Nyquist:
The amplifier is unstable if this curve encloses the point -1+j0 and the amplifier is stable if the curve does not enclose this point.

Gain and phase margins
These are a measure of the stability of a circuit.

Unit II
Oscillators

Introduction
- Oscillators are circuits that produce a continuous signal of some type without the need of an input.
- These signals serve a purpose for a variety of purposes. Communications systems, digital systems (including computers), and test equipment make use of oscillators.
- An oscillator is a circuit that produces a repetitive signal from a dc voltage.
- The feedback type oscillator which rely on a positive feedback of the output to maintain the oscillations.
- The relaxation oscillator makes use of an RC timing circuit to generate a non-sinusoidal signal such as square wave.
**Baukhausen criterion:**

- The requirements for oscillation are described by the Baukhausen criterion:

  1. The magnitude of the loop gain $A\beta$ must be 1
  2. The phase shift of the loop gain $A\beta$ must be $0^\circ$ or $360^\circ$ or integer multiple of $2\pi$

**Frequency Stability**

- The frequency stability of an oscillator is defined as

  $$\frac{1}{\omega_p} \left( \frac{d\omega}{dT} \right) \omega = \omega_p \text{ ppm/}^\circ C$$

- Use high stability capacitors, e.g. silver mica, polystyrene, or Teflon capacitors and low temperature coefficient inductors for high stable oscillators.
Amplitude stabilisation

➢ in both the oscillators above, the loop gain is set by component values
➢ in practice the gain of the active components is very variable
  ➢ if the gain of the circuit is too high it will saturate
  ➢ if the gain of the circuit is too low the oscillation will die
➢ real circuits need some means of stabilising the magnitude of the oscillation to cope with variability in the gain of the circuit

Mechanism of start of oscillation:

➢ The starting voltage is provided by noise, which is produced due to random motion of electrons in resistors used in the circuit.
➢ The noise voltage contains almost all the sinusoidal frequencies. This low amplitude noise voltage gets amplified and appears at the output terminals.
➢ The amplified noise drives the feedback network which is the phase shift network. Because of this the feedback voltage is maximum at a particular frequency, which in turn represents the frequency of oscillation.

Application of Oscillators

➢ Oscillators are used to generate signals, e.g.
  – Used as a local oscillator to transform the RF signals to IF signals in a receiver;
  – Used to generate RF carrier in a transmitter
  – Used to generate clocks in digital systems;
  – Used as sweep circuits in TV sets and CRO.

Classification

➢ Three types of RC oscillators that produce sinusoidal outputs will be discussed:
  1. Wienbridge oscillator
  2. phase-shift oscillator
  3. twin-T oscillator.
**RC or phase-shift oscillator**

- one way of producing a phase shift of $180^\circ$ is to use an RC ladder network

- this gives a phase shift of $180^\circ$

- at this frequency the gain of the network is

$$f = \frac{1}{2\pi CR\sqrt{6}}$$

$$\frac{v_o}{v_i} = -\frac{1}{29}$$

**Wien-bridge oscillator**

- uses a Wien-bridge network
- this produces a phase-shift of $0^\circ$ at a single frequency, and is used with an inverting amplifier
- the selected frequency is $$f_r = \frac{1}{2\pi RC}$$

- when the gain is $1/3$
Twin T Oscillator

The twin-T utilizes a bandstop arrangement of RC circuits to block all but the frequency of operation in the negative feedback loop. The only frequency allowed to effectively oscillate is the frequency of resonance.

The *Colpitts oscillator* utilizes a tank circuit (LC) in the feedback loop. Since the input impedance affects the Q, an FET is a better choice for the active device.

\[ f_r = \frac{1}{2\pi \sqrt{LC_T}} \]

The *Clapp* is similar to the Colpitts with exception to the additional capacitor in the tank circuit.
- The Hartley oscillator is similar to the Clapp and Colpitts. The tank circuit has two inductors and one capacitor.
- Frequency of oscillation

\[ f = \frac{1}{2\pi \sqrt{(l_1 + l_2)C}} \]

The Armstrong oscillator uses transformer coupling in the feedback loop. For this reason the Armstrong is not as popular.
Crystal oscillator

- In its heart is a piezoelectric crystal
- Pizo crystal have opposite faces plated with electrodes.
- 3 major advantages:
  - Very high Q (10s to 100s of thousands)
  - Stable with temp. and time
  - Can give freq. upto several MHz
- Q and res. Freq. depends on the size, orientation of faces, and mount

Crystal oscillators

An oscillator in which the frequency is controlled by a piezoelectric crystal. A crystal oscillator may require controlled temperature because its operating frequency is a function of temperature

- frequency stability is determined by the ability of the circuit to select a particular frequency
- in tuned circuits this is described by the quality factor, Q
- piezoelectric crystals act like resonant circuits with a very high Q – as high as 100,000

(a) Circuit symbol

(b) Equivalent circuit
Crystal: A piezoelectric device that vibrates in response to electrical stimulus, can be modeled electrically by a very high $Q (>100,000)$ resonant circuit.

$L$, $C_S$, $R$ represent intrinsic series resonance path through crystal. $C_p$ is package capacitance. Equivalent impedance has series resonance where $C_S$ resonates with $L$ and parallel resonance where $L$ resonates with series combination of $C_S$ and $C_p$.

Below $\omega_S$ and above $\omega_p$, crystal appears capacitive, between $\omega_S$ and $\omega_p$ it exhibits inductive reactance.
Example

- **Problem:** Find equivalent circuit elements for crystal with given parameters.
- **Given data:** $f_s = 5 \text{ MHz}, Q = 20,000, R = 50 \text{ W}, C_P = 5 \text{ pF}$

**Analysis:**

\[
L = \frac{RQ}{\omega_s} = \frac{50(20,000)}{2\pi \times (5 \times 10^6)} = 31.8 \text{ mH}
\]

\[
C_S = \frac{1}{\omega_s^2 L} = \frac{1}{\left(10^7\pi\right)^2 (0.0318)} = 31.8 \text{ pF}
\]

\[
f_P = \frac{1}{2\pi \sqrt{L \frac{C_P C_S}{C_P + C_S} (31.8 \text{ mH})(31.6 \text{ pF})}} = 5.02 \text{ MHz}
\]

**Pierce crystal oscillator configuration**
Unit-3
Tuned Amplifiers

Tuned Circuits

- Frequency selectivity of resonant circuits allows a radio to be tuned to one of a set of transmitting stations.
- Tuning is usually undertaken by varying the capacitance of an adjustable capacitor.
- Resonant circuits are also important for tuning and for transmitting signals.

Tuned amplifiers

- To amplify the selective range of frequencies, the resistive load, $R_c$ is replaced by a tuned circuit.
- The tuned circuit is capable of amplifying a signal over a narrow band of frequencies centered at $f_r$.

\[
f_r = \frac{1}{2 \pi \sqrt{LC}}
\]
\[
Z_r = \frac{L}{CR}
\]
Types Of tuned amplifiers

Single tuned amplifier
➢ one parallel tuned circuit is used as a load
➢ Limitation: Smaller Bandwidth, smaller gain bandwidth product, does not provide flatten response.

Double tuned amplifier
➢ It provides high gain, high selectivity and required bandwidth.
➢ Used in IF in radio and TV receivers.
➢ It gives greater 3db bandwidth having steep sides and flat top. But alignment of double tuned amplifier is difficult

Stagger tuned amplifier
➢ Two single tuned amplifier are connected in cascaded form.
➢ Resonant frequency are displaced.
➢ To have better flat, wideband characteristics with a very sharp rejective, narrow band characteristics.

Synchronously tuned amplifier
➢ To obtain a high over all gain, several identical stages of tuned amplifiers can be used in cascade.
➢ All amplifiers stages are assumed to be identical and to be tuned to the same frequency w0.

Q factor:
➢ Ratio of reactance to resistance.
➢ Measure of efficiency with which inductor can store the energy.

Unloaded Q of tuned circuit
➢ Ratio of stored energy to dissipated energy in a reactor or resonator.

Loaded Q
➢ It is determined by how tightly the resonator is coupled to its terminations.
Instability of tuned circuits

- Transistor are used at the frequencies nearer to their unity gain BW to amplify narrow band of high frequencies.
- At this RF frequencies, inter capacitance between base and collector becomes dominant.
- Some feedback signal manages to reach the input from output, so circuit becomes unstable and generating the oscillation and can stop working as amplifier.

Stabilization techniques:
1. Hazeltine neutralization
2. Neutrodyne neutralization
3. Neutralization using coil
4. Rice neutralization

Class C amplifiers

- Class C amplifiers cannot be used in audio circuitry because of their high distortion.
- Class C amplifiers can be used as tuned rf amplifiers where the undesired harmonic frequencies can be filtered out.
- A class C amplifier is more efficient than either a class A or class B amplifier; its efficiency approaches 100%.

- The input coupling capacitor, base resistor, and base-emitter junction form a negative clamper.
- Because of the clamping action, only the positive peaks of the input signal drive the transistor, Q4, into conduction.
- The \( R_{BC} \) time constant is made long with respect to the period of the input waveform to provide the proper clamping action.
Equivalent input circuit of class c TUNED AMPLIFIER

- At the resonant frequency, $f_r$, the impedance of the tuned LC circuit is maximum.
- The tank impedance, $Z_{tank}$, is purely resistive at $f_r$.

**Application**: used in radio receivers and mixer circuits.

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**Unit IV**

Wave shaping and Multivibrators

**Introduction**

- Linear wave shaping: Process by which the shape of a non-sinusoidal signal is changed by passing the signal through the network consisting of linear elements.
- Diodes can be used in wave shaping circuits.
- Either
  - limit or clip signal portion--- clipper
  - shift the dc voltage level of the signal --- clappers
- Types of non-sinusoidal input
  - step, pulse, square, Ramp input
**RC circuits (Step Response)**

![High-Pass Circuit](image1)

- **High-Pass**
  - $V_{in}$
  - $V_{out}$
  - Voltage on capacitor cannot change instantaneously. So $V_{out} = V_{in}$ initially.

![Low-Pass Circuit](image2)

- **Low-Pass**
  - $V_{in}$
  - $V_{out}$
  - Voltage on capacitor cannot change instantaneously. So $V_{out} = 0$ initially.

**RL circuit**

RL circuit is used for small time constants.

To get a large time constant the inductance value has to be chosen high.

Higher inductance value are provided by iron core inductors which are bigger in size, heavy and costly.

$L = 1 \text{ mH}$

![RL Circuit Diagram](image3)
Fall Time & Time Constant

Storage, delay time of transistors

The Bipolar transistor exhibits a few delay characteristics when turning on and off. Most transistors, and especially power transistors, exhibit long base storage time that limits maximum frequency of operation in switching applications.
• **Calculation of transistor switching times**
  • When a transistor is used as a switch it must be either OFF or fully ON. In the fully ON state the voltage $V_{CE}$ across the transistor is almost zero and the transistor is said to be saturated because it cannot pass any more collector current $I_C$. The output device switched by the transistor is usually called the 'load'. The power developed in a switching transistor is very small:
    • In the OFF state: power $= I_C \times V_{CE}$, but $I_C = 0$, so the power is zero.
    • In the full ON state: power $= I_C \times V_{CE}$, but $V_{CE} = 0$ (almost), so the power is very small.
  • This means that the transistor should not become hot in use and you do not need to consider its maximum power rating. The important ratings in switching circuits are the maximum collector current $I_{C(max)}$ and the minimum current gain $h_{FE(min)}$. The transistor's voltage ratings may be ignored unless you are using a supply voltage of more than about 15V.

![Diagram of transistor and load](image)

**Clippers**

- Clipping removes part of the positive or negative peaks of a signal or both. Silicon diodes do not conduct until the applied voltage exceeds about 0.6 volts and only when the anode is positive with respect to the cathode.
- The circuit is like a potential divider with the diode part being high resistance for voltages below 0.6 volts and low resistance above.

![Diagrams of clipping circuits](images)
During the negative half cycle of the input signal, the diode conducts and acts like a short circuit.

The output voltage $V_o \Rightarrow 0$ volts. The capacitor is charged to the peak value of input voltage $V_m$, and it behaves like a battery.

During the positive half of the input signal, the diode does not conduct and acts as an open circuit.

Hence the output voltage $V_o \Rightarrow V_m + V_m$. This gives a positively clamped voltage.

$V_o \Rightarrow V_m + V_m = 2V_m$

During the positive half cycle the diode conducts and acts like a short circuit. The capacitor charges to peak value of input voltage $V_m$.

During this interval the output $V_o$ which is taken across the short circuit will be zero.

During the negative half cycle, the diode is open. The output voltage can be found by applying KVL.

$-V_m - V_m - V_o = 0 \Rightarrow V_o = -2V_m$
**Bistable Multivibrator**

**Bistable (Flip - Flop) Multivibrator**

![Multivibrator Circuit Diagram]

**Physical Description**
- Multivibrator that functions in one of two stable states as synchronized by an input trigger pulse.

**Operational Characteristics**
- Circuit is turned on.
- One of the two transistors will conduct harder and thereby reach saturation first. (Assume Q2)
- The 0V at the collector of Q2 is coupled to the base of Q1 which drives Q1 into cutoff.
- The \(-V_{cc}\) at the collector of Q1 is coupled to the base of Q2 holding Q2 in saturation.
- An input trigger pulse is applied to the bases of both Q1 and Q2 simultaneously. Since Q2 is already in saturation, there is no effect on Q2.
- The trigger pulse turns on Q1 and drives the transistor into saturation.
- The 0V on the collector of Q1 is coupled to the base of Q2 driving Q2 into cutoff.
- The \(-V_{cc}\) on the collector of Q2 is coupled to the base of Q1 holding Q1 in saturation.
- This process will continue as long as there are trigger pulses applied to the circuit.
- The output frequency of the waveforms will be determined by the frequency of the input trigger pulses.
Astable Multivibrator

Astable (Free - Running) Multivibrator
Physical Description

- Circuit has two outputs but no inputs.
- R1 = R4, R2 = R3, C1 = C2. Q1 & Q2 are as close as is possible in their operating characteristics.

Operational Characteristics

- Circuit is turned on.
- Assume that Q2 conducts harder than Q1 and goes into saturation first.
- The 0V at the collector of Q2 is coupled to the base of Q1 which drives Q1 into cutoff.
- C2 begins to charge. C1 is at $-V_{CC}$ and this voltage is applied to the base of Q2 to hold Q2 in saturation.
- After a finite period of time, (as set by the RC time constant of C2 and R3), C2 reaches a voltage value sufficient to snap Q1 on.
- Q1 quickly goes into saturation. The change in voltage from $-V_{CC}$ to 0V causes C1 to discharge.
- This voltage is coupled to the base of Q2 Placing / holding Q2 in cutoff.
- C1 begins to charge and will snap Q2 on when a sufficient voltage value is reached.
- In Summary, whenever a transistor saturates, its $V_C$ will change from $-V_{CC}$ to 0V. This voltage will then be coupled to the base of the other transistor which will drive the other transistor into cutoff. The frequency of the output waveform will depend on the RC time constants established at C1R2 and C2R3.

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Multivibrators

Monostable (One Shot) Multivibrator

![Monostable Multivibrator Circuit Diagram]

Uses

- Used for pulse stretching
- Used in computer logic systems and Communication / Navigation systems.

Operational Characteristics

- $V_{BB}$ is connected to the base of Q1 which places Q1 in cutoff.
- Q2 is saturated by $-V_{CC}$ applied to its base through R2.
- C1 is fully charged maintaining approximately $-V_{CC}$ on the base of Q2.
- A negative gate signal is applied to the base of transistor Q1 which turns Q1 on and drives it into saturation.
- The voltage at the collector of Q1 is then attached to the base of Q2 which turns Q2 off.
- C1 is discharged to attempt to keep $V_C$ at Q2 constant. This maintains Q2 off.
A Unijunction transistor is a three terminal semiconductor switching device. This device has a unique characteristic that when it is triggered, the emitter current increases regeneratively until it is limited by the emitter power supply. The unijunction transistor can be employed in various applications such as switching, pulse generators, sawtooth generators, etc.

**Construction**

[Diagram of a Unijunction Transistor]

**Unit 5**

**Blocking oscillators & Time base generators**
It consists of an N type silicon bar with an electrical connection on each end the leads to these connection are called base leads. Base 1 B1 Base 2 B2 the bar between the two bases nearer to B2 than B1. A pn junction is formed between a p type emitter and Bar.the lead to the junction is called emitter lead E.

**Operation**

The device has normally B2 positive w.r.t B1

If voltage VBB is applied between B2 and B1 with emitter open. Voltage gradient is established along the n type bar since emitter is located nearer to B2 more than half of VBB appears between the emitter and B1. the voltage V1 between emitter and B1 establishes a reverse bias on the pn junction and the emitter current is cut off. A small leakage current flows from B2 to emitter due to minority carriers

If a positive voltage is applied at the emitter the pn junction will remain reverse biased so long as the input voltage is less than V1 if the input voltage to the emitter exceeds V1 the pn junction becomes forward biased. under these conditions holes are injected from the p type material into the n type bar these holes are repelled by positive B2 terminal and they are attracted towards B1 terminal of the bar. This accumulation of holes in the emitter to B1 region results in the degrees of resistance in this section of the bar the internal voltage drop from emitter to b1 is decreased hence emitter current Ie increases as more holes are injected a condition of saturation will eventually be reached at this point a emitter current limited by emitter power supply only the devices is in on state. If a negative pulse is applied to the emitter, the pn junction is reverse biased and the emitter current is cut off. The device is said to be off state.

**Characteristics of UJT**
The curve between Emitter voltage $V_e$ and emitter current $I_e$ of a UJT at a given voltage $V_{bb}$ between the bases is known as emitter characteristic of UJT. Initially in the cut-off region as $V_e$ increases from zero, slight leakage current flows from terminal B2 to the emitter; the current is due to the minority carriers in the reverse biased diode. Above a certain value of $V_e$ forward $I_e$ begins to flow, increasing until the peak voltage $V_p$ and current $I_p$ are reached at point P. After the peak point P an attempt to increase $V_e$ is followed by a sudden increase in emitter current $I_e$ with decrease in $V_e$ is a negative resistance portion of the curve. The negative portion of the curve lasts until the valley point V is reached with valley point voltage $V_v$ and valley point current $I_v$ after the valley point the device is driven to saturation. The difference $V_p-V_v$ is a measure of a switching efficiency of UJT. Fall of $V_{bb}$ decreases.

**Advantages of UJT**

It is a Low cost device

It has excellent characteristics

It is a low-power absorbing device under normal operating conditions
TRANSFORMER EQUIVALENT CIRCUIT:
The influences of a transformer’s parameters can best be understood by considering the equivalent circuit in below. This circuit shows a typical output pulse waveform. Assuming that this output pulse is the result of injecting an ideal rectangular input pulse, one can see that a number of parameters are distorted. Overshoot, droop, back swing, rise time, etc. appear as unwanted signal distortion on the output pulse. Assuming the pulse transformer is properly matched and the source is delivering an ideal rectangular pulse, the transformer should have low values of leakage inductance and distributed capacitance while having a high open circuit inductance. This will limit the deterioration of the pulse shape. Also, the fact that the source will never produce an ideal rectangular pulse adds to the problems of distortion.

Transformer Equivalent Circuit.
Constant current charging
- A capacitor is charged with constant current source.
- As it charged with constant current, it is charged linearly.

Miller circuit:
- Integrator is used to convert a step waveform to ramp waveform.

Bootstrap circuits
- A constant current source is obtained by maintaining nearly constant voltage across the fixed resistor in series with capacitor.

Compensating network is used to improve the linearity of bootstrap and miller time base generator

- Relaxation oscillators make use of an RC timing and a device that changes states to generate a periodic waveform.
- This triangular-wave oscillator makes use of a comparator and integrator to actually produce both a triangle-wave and square-wave.
- Output levels are set by the ratio of R2 and R3 times the maximum output of the comparator. The frequency of output can be determined by the formula $fr = \frac{1}{4R1C(R2+R3)}$
The **voltage-controlled sawtooth oscillator**'s frequency can be changed by a varied by a given dc control voltage. One possible type uses a programmable unijunction transistor.

A square wave oscillator relaxation oscillator use the charging and discharging of the capacitor to cause the op-amp to switch states rapidly and produce a square wave. The RC time constant determines the frequency.

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**Relaxation Oscillators**

The forward voltage of the PUT ($V_F$) determines the frequency of the output. The formula below shows the relationship. $f = V_{IN}/R/C(1/V_F - V_r)$
TWO MARK QUESTIONS
EC-41-ELECTRONIC CIRCUITS II

1. Define feedback?
A portion of the output signal is taken from the output of the amplifier and is combined with the normal input signal. This is known as feedback.

2. Define positive feedback?
If the feedback signal is in phase with input signal, then the net effect of the feedback will increase the input signal given to the amplifier. This type of feedback is said to be positive or regenerative feedback.

3. Define negative feedback?
If the feedback signal is out of phase with the input signal then the input voltage applied to the basic amplifier is decreased and correspondingly the output is decreased. This type of feedback is known as negative or degenerative feedback.

4. Define sensitivity?
Sensitivity is defined as the ratio of percentage change in voltage gain with feedback to the percentage change in voltage gain without feedback.
\[ \frac{dA}{A} = \frac{dA}{A}(1/1+\beta A) \]

5. What are the types of feedback?
   i. Voltage-series feedback
   ii. Voltage-shunt feedback
   iii. Current-series feedback
   iv. Current-shunt feedback

6. What are the basic amplifiers?
The basic amplifiers are
Voltage amplifier
Current amplifier
Transconductance amplifier
Transresistance amplifier.

7. What are the components of feedback amplifier?

The components are sampling network, Feedback network, and mixer network.

8. What are two types of sampling?

Voltage sampling or node sampling
Current sampling or loop sampling

9. State the two types of mixing?

Series mixing
Shunt mixing

10. What is transfer gain?

It is the ratio of the output signal to the input signal. It is denoted by A.

\[ A = \frac{X_o}{X_i} \]

11. List out the characteristics of feedback amplifier?

Desensitivity
Nonlinear distortion
Noise distortion
Frequency distortion

12. What is the effect of input resistance due to series mixing?

The input resistance increases due to series mixing irrespective of the type of sampling. The feedback signal opposes the source signal and the input current decreases and due to this input resistance increases.
13. **What is the effect of input resistance due to shunt mixing?**

The input resistance decreases due to shunt mixing irrespective of the type of sampling. The feedback signal opposes the source signal and the input current ($I_i$) decreases as a consequence $V_iI_i$ reduces leading to a reduction in input resistance.

\[ R_{if} < R_i \]

Where $R_{if} = \text{input resistance with feedback}$

\[ R_i = \text{input resistance without feedback} \]

14. **What happens to output resistance due to current sampling?**

The output resistance increases due to current sampling.

\[ R_{of} > R_o \]

\[ R_{of} = \text{input resistance with feedback} \]

\[ R_o = \text{input resistance without feedback} \]

15. **What happens to output resistance due to voltage sampling?**

The output resistance decreases due to current sampling.

\[ R_{of} < R_o \]

\[ R_{of} = \text{input resistance with feedback} \]

\[ R_o = \text{input resistance without feedback} \]

16. **What happens to output resistance due to current sampling?**

The output resistance increases due to current sampling.

\[ R_{of} > R_o \]

\[ R_{of} = \text{input resistance with feedback} \]

\[ R_o = \text{input resistance without feedback} \]
17. Write the expression for input and output resistance of voltage series feedback amplifier.

   Input resistance with feedback, \( R_{if} = R_i(1+\beta A) \)
   
   Output resistance with feedback, \( R_{of} = R_o(1+\beta A) \)

18. Give the properties of negative feedback.

   i. Negative feedback reduces the gain
   
   ii. Distortion is very much reduced

19. Give the effect of negative feedback on amplifier characteristics.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Types of feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current-series</td>
</tr>
<tr>
<td>Voltage gain</td>
<td>Decreases</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Increases</td>
</tr>
<tr>
<td>Input resistance</td>
<td>Increases</td>
</tr>
<tr>
<td>Output resistance</td>
<td>Increases</td>
</tr>
</tbody>
</table>

20. What is Oscillator circuit?

A circuit with an active device is used to produce an alternating current is called an oscillator circuit.

21. What is type of feedback used in oscillators?

   Positive feedback
22. Differentiate Oscillators and Feedback Amplifiers.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Feedback Amplifiers</th>
<th>Oscillators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input signal</td>
<td>Needed</td>
<td>Not needed</td>
</tr>
<tr>
<td>Type of feedback</td>
<td>negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Gain</td>
<td>Reduces</td>
<td>Increases leading to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>oscillations</td>
</tr>
<tr>
<td>Example</td>
<td>Voltage series feedback amplifier</td>
<td>Hartley oscillator</td>
</tr>
</tbody>
</table>

23. What are the classifications of Oscillators?

*Based on wave generated:

i. Sinusoidal Oscillator,

ii. Non-sinusoidal Oscillator or Relaxation Oscillator

Ex: Square wave, Triangular wave, Rectangular wave etc.

*According to principle involved:

i. Negative resistance Oscillator,

ii. Feedback Oscillator.

*According to frequency generated:

i. Audio frequency oscillator

20 Hz – 20 kHz

ii. Radio frequency Oscillator

30 kHz – 30 MHz

iii. Ultrahigh frequency Oscillator

30 MHz – 3 GHz

iv. Microwave Oscillator

3 GHz – above.
24. On the basis of circuit components classify oscillators.
   (i) RC Oscillators
   (ii) LC Oscillators

25. Define Barhausen Criterion.
The product $\beta A_v$ is greater than one this is called Barhausen criterion.

   $Avf = A_v / (1 - \beta A_v)$
   $1 - \beta A_v < 0$

$\beta A_v > 1$ this is the condition for feedback Oscillator.

An Oscillator which follows Barkhausen criterion is called the Feedback Oscillator.

26. What are the types of feedback oscillators?
   * RC-Phase shift Oscillator,
   * LC-Oscillators
     i. Tuned collector Oscillator
     ii. Tuned emitter Oscillator
     iii. Tuned collector base Oscillator
     iv. Hartley Oscillator
     v. Colpits Oscillator
     vi. Clap Oscillator

27. What are the conditions for oscillation?
The total phase shift of an oscillator should be 360°. For feedback oscillator it should satisfies Barhausen criterion.

   When applying mechanical energy to some type of crystals called piezoelectric crystals the mechanical energy is converted into electrical energy is called piezoelectric effect.
29. Draw the equivalent circuit of crystal oscillator.

![Equivalent Circuit of Crystal Oscillator]

30. What are the two types of crystal oscillator?

- Pierce crystal oscillator
- Miller crystal oscillator

31. What is Miller crystal oscillator? Explain its operation.

It is nothing but a Hartley oscillator its feedback Network is replaced by a crystal. Crystal normally generate higher frequency reactance due to the miller capacitance are in effect between the transistor terminal.

32. What is Pierce crystal oscillator?

It is nothing but a Colpitts oscillator its feedback Network is replaced by a crystal.

33. State the frequency for RC phase shift oscillator.

The frequency of oscillation of RC-phase shift oscillator is

\[ F = \frac{1}{2\pi RC \sqrt{(4k+6)}} \]

Where \( k = 2.639 \).
34. What is a tuned amplifier?

The amplifier with a circuit that is capable of amplifying a signal over a narrow band of frequencies are called tuned amplifiers.

35. What is the expression for resonant frequency?

\[ f_r = \frac{1}{2\pi \sqrt{LC}} \]

36. What happens to the circuit above and below resonance?

Above resonance the circuit acts as capacitive and below resonance the circuit acts as inductive.

37. What are the different coil losses?

- Hysteresis loss
- Copper loss
- Eddy current loss

38. What is Q factor?

It is the ratio of reactance to resistance.

39. What is dissipation factor?

It is referred as the total loss within a component i.e. \( 1/Q \)

40. What is the classification of tuned amplifiers?

- Single tuned
- Double tuned
- Stagger tuned

41. What is a single tuned amplifier?
An amplifier circuit that uses a single parallel tuned circuit as a load is called single tuned amplifier.

42. What are the advantages of tuned amplifiers?

- They amplify defined frequencies.
- Signal to noise ratio at output is good
- They are suited for radio transmitters and receivers

43. What are the disadvantages of tuned amplifiers?

- The circuit is bulky and costly
- The design is complex.
- They are not suited to amplify audio frequencies.

44. What is neutralization?

The effect of collector to base capacitance of the transistor is neutralized by introducing a signal that cancels the signal coupled through collector base capacitance. This process is called neutralization.

45. What is a stagger tuned amplifier?

It is a circuit in which two single tuned cascaded amplifiers having certain bandwidth are taken and their resonant frequencies are adjusted that they are separated by an amount equal to the bandwidth of each stage. Since resonant frequencies are displaced it is called stagger tuned amplifier.

46. What are the advantages of stagger tuned amplifier?

The advantage of stagger tuned amplifier is to have better flat, wideband characteristics.

47. What are the different types of neutralization?

1. Hazeltine neutralization
2. Rice neutralization

48. What is rice neutralization?
   It uses center tapped coil in the base circuit. The signal voltages at the end of tuned base coil are equal and out of phase.

49. What is unloaded Q?
   It is the ratio of stored energy to the dissipated energy in a reactor or resonator.

50. What are the applications of mixer circuits?
   Used in radio receivers. Used to translate signal frequency to some lower frequency

51. What is up converter?
   When the mixer circuit is used to translate signal to high frequency, then it is called up converter.

52. What is a Multivibrator?
   The electronic circuits which are used to generate nonsinusoidal waveforms are called Multivibrators.

53. Name the types of Multivibrators?
   Bistable Multivibrator, Monostable Multivibrator, Astable Multivibrator

54. How many stable states do bistable Multivibrator have?
   Two stable states.

55. When will the circuit change from stable state in bistable Multivibrator?
When an external trigger pulse is applied, the circuit changes from one stable state to another.

56. What are the different names of bistable Multivibrator?

57. What are the applications of bistable Multivibrator?
   It is used in the performance of many digital operations such as counting and storing of the Binary information. It also finds applications in the generation and processing of pulse – type waveforms.

58. What are the other names of monostable Multivibrator?
   One-shot, Single-shot, a single-cycle, a single swing, a single step Multivibrator, Univibrator.

59. Why is monostable Multivibrator called gating circuit?
   The circuit is used to generate the rectangular waveform and hence can be used to gate other Circuits hence called gating circuit.

60. Why is monostable Multivibrator called delay circuit?
   The time between the transition from quasi-stable state to stable state can be predetermined and hence it can be used to introduce time delays with the help of fast transition. Due to this application is Called delay circuit.

61. What is the main characteristics of Astable Multivibrator
   The Astable Multivibrator automatically makes the successive transitions from one quasi- stable State to other without any external triggering pulse.

62. What is the other name of Astable Multivibrator- why is it called so?
   As it does not require any external pulse for transition, it is called free running
63. What are the two types of transistor bistable Multivibrator?
   i. Fixed bias transistor circuit
   ii. Self bias transistor circuit.

64. Why does one of the transistor start conducting ahead of other?
   The characteristic of both the transistors are never identical hence after giving supply one of the Transistors start conducting ahead of the other.

65. What are the two stable states of bistable Multivibrator?
   i. Q1 OFF (cut off) and Q2 ON (Saturation)
   ii. Q2 OFF (Cut off) and Q1 On (Saturation)

66. What finally decides the shape of the waveform for bistable multivibrator?
   The spacing of the triggering pulses

67. How are the values R1, R2 and VBB chosen in bistable Multivibrator?
   It is chosen in such a way that in one state the base current is large enough to drive the transistor into saturation while in other state the emitter junctions is well below off.

68. What is the self biased Multivibrator?
   The need for the negative power supply in fixed bias bistable Multivibrator can be eliminated by rising a common emitter resistance Re. The resistance previous the necessary bias to keep one transistor or and the other OFF in the stable state such type of biasing is called self biasing and the circuit is called self biased bistable Multivibrator.

69. What are the other names of speed up capacitors.
   i. Commutating Capacitors
ii. Transpose capacitors

70. Define transition time?
   It is defined as the time interval during which conduction transfers from one transistor to other.

71. What is the value of commutating capacitor.
   It lies in the range of tens to some hundreds of Pico farads.

72. Define resolving time.
   The smallest allowable interval between triggers is called resolving time.

73. Give the expression of fmax with respect to resolving time
   Fmax = 1/resolving time.

74. Define gate width
   The pulse width is the time for which the circuit remains in the quasi stable state. It is also called gate width.

75. What are the advantages of monostable Multivibrator.
   - used to introduce time delays as gate width is adjustable
   - used to produce rectangular waveform and hence can be used as gating circuit.

76. What are the applications of astable Multivibrator.
   - used as a clock for binary login signals
   - used as a square wave generator, voltage to frequency converter.

77. What is a complementary Multivibrator
It is turning half the circuit upside down. So one transistor is n-p-n while the other is p-n-p. The circuit is called complementary Multivibrator circuit.

78. What is UTP of the Schmitt trigger

When $V_i$ reaches to $V_{BE1} + V_E$ the Q1 gets driven to active region. This input voltage level is called upper threshold point.

79. What is the other name for UTP

It is also called input turn on threshold level.

80. What is LTP Schmitt trigger.

The level of $V_i$ at which Q1 becomes OFF and Q2 on is called lower threshold point.

81. Define transfer Characteristics

The graph of output voltage against input voltage is called transfer characteristics of Schmitt trigger.

82. What is the important application of Schmitt trigger?

- It is used as an amplitude comparator
- It is used as a squaring circuit.

83. Define Blocking Oscillator?

A special type of wave generator which is used to produce a single narrow pulse or train of pulses.

84. What are the two important elements of Blocking Oscillator?

Transistor and pulse transformer

85. What are the applications of blocking Oscillator?
It is used in frequency dividers, counter circuits and for switching the other circuits.

86. Give the expression for co-efficient of coupling

\[ K = \frac{M}{\sqrt{L_p L_s}} \]

- \( M \) -> Mutual Inductance
- \( L_p \) -> Primary Inductance
- \( L_s \) -> Secondary Inductance

87. Give the formula for transformation ratio

\[ n = \frac{N_s}{N_p} = \text{transformation ratio} \]

- \( N_s \) = Secondary Turns;
- \( N_p \) = Primary turns

88. Define rise time

It is defined by the time required by the pulse to rise from 10% of its amplitude to 90% of its amplitude.

89. Define overshoot.

It is the amount by which the output exceeds its amplitude during first attempt.

90. Define flat top response.

The position of the response between the trailing edge and the leading edge.

91. Define droop or a tilt

The displacement of the pulse amplitude during its flat response is called droop or a tilt.

92. What are the applications of pulse transformer.
i. to invert the polarity of the pulse

ii. to differentiate pulse

93. When do the core saturates?
When L->o as B-> Bm, the core saturates

94. What is the other name of astable Blocking Oscillator
Free running blocking Oscillator

95. What are the two types of astable Blocking Oscillator?
1. Diode controlled Astable Blocking Oscillator.
2. Re controlled Astable Blocking Oscillator.

96. Define Sweeptime in sawtooth generator
The period during which voltage increases linearly is called sweep time.

97. What is the other name of sawtooth generator?
Ramp generator

98. Define Displacement error in the sawtooth generator?
It is defined as the maximum difference between the actual sweep voltage and linear sweep which passes through the beginning and end points of the actual sweep.

99. What is constant current charging?
A capacitor is charged with a constant current source.

100. What is the miller circuit
Integrator is used to convert a step waveform into ramp waveform.
PART B

1. Explain the relevant information, how the negative feedback improves stability reduce noise and increase input impedance?

- Draw the circuit diagram.
- Explain detail the following
- Transfer gain.
- Stability of gain.

The transfer of gain of the amplifier is not constant as it is depends upon the factors such as operating point temperature, etc. This lack of stability can be reduced by introducing negative feedback.

The signal feedback reduces the amount of the noise signal and non linear distortion. The factor \(1 + \beta A\) reduces both input noise and resulting non linear distortion for considerable improvement. Thus, noise and non linear distortion also reduced by same factor.

2. Explain voltage shunt feedback amplifiers?

- Draw the circuit diagram.
- Draw the equivalent circuit.
- Find the input and output impedance after feed back.

3. Explain current series feedback amplifiers?

- Draw the circuit diagram.
- Draw the equivalent circuit.
- Find the input and output impedance after feed back.

4. Explain the classification of amplifiers? Explain the following in detail.

- Voltage amplifier.
- Current amplifier.
- Transconductance amplifier.
- Trans resistance amplifier.

5. Explain current shunt and voltage shunt feedback amplifiers?

- Draw the circuit diagram.
- Draw the equivalent circuit.
- Find the input and output impedance after feed back.

6. With simple diagrams explain the operation of negative resistance oscillator using tunnel diode?

- Draw the circuit diagram and graph.
- Draw the characteristics of tunnel diode.
- Get the expression for time period ‘t’.
7. Explain RC phase shift oscillator?.

- Draw the circuit diagram
- Draw the equivalent circuit.
- Derive the minimum value of $h_{fe}$ for oscillation.

8. Explain Clapp's oscillator and derive the expression for frequency of oscillation.

Also explain how frequency stability can be improved Clapp's oscillator?

- Draw the circuit diagram
- Draw the equivalent circuit.
- Derive the frequency of oscillation.

9. Explain Hartley oscillator and derive the equation for oscillation?

- Draw the circuit diagram
- Draw the equivalent circuit.
- Derive the frequency of oscillation.

10. Explain pierce crystal oscillator and derive the equation for oscillation?

- Draw the circuit diagram
- Draw the equivalent circuit.
- Derive the frequency of oscillation.

11. Explain in detail about single tuned amplifier

- Draw the circuit diagram
- Draw the equivalent circuit.
- Derive the expression for bandwidth

12. Explain in detail about stagger-tuned amplifier

- Draw the circuit diagram
- Draw the equivalent circuit.
- Derive the expression for bandwidth

13. Compare single tuned and stagger tuned amplifier

- Compare the circuit diagram
- Compare the equivalent circuit.
- Compare the expression for bandwidth

14. Explain the different types of neutralization?
- Explain Hazeltine neutralization
- Explain Rice neutralization.
- Explain Neutrodyne neutralization

15. Explain bistable Multivibrator and its types?
   - General form of bistable Multivibrator circuit.
   - fixed Bias transistor bistable Multivibrator circuit
   - self Bias transistor bistable Multivibrator circuit
   - Applications

16. Explain about speedup capacitors or commutating capacitors
   - Practical self biased bistable Multivibrator
   - Explanation about the circuit

17. Explain about Monostable Multivibrator
   - Explanation about the circuit diagram
   - Pulse width of collector coupled Monostable Multivibrator
   - Waveforms
   - Applications

18. Explain about collector coupled astable Multivibrator
   - Explanation about the circuit diagram
   - Waveforms
   - Distraction & its eliminator
   - Applications

19. Explain emitter coupled astable Multivibrator
   - Operation and Mathematical analysis
   - Practical circuit
• Advantages and disadvantages of the Multivibrator

20. Write in detail about Schmitt Trigger circuit?
   • Circuit diagram
   • Operation of the circuit
   • Schmitt trigger waveforms.
   • Hysterisis
   • Applications

21. Explain about pulse transformer?
   • Ideal pulse transformer model
   • Practical equivalent circuit
   • Pulse response characteristics
   • Applications of pulse transformer

22. Explain Monostable blocking oscillator using emitter timing?
   • Circuit Diagram
   • Mathematical analysis
   • Expression for pulse width
   • Triggering circuit for monostable blocking oscillator

23. Write about the core saturation method
   • Circuit diagram
   • Waveforms of ic and iB when core Saturates.

24. Write about astable blocking oscillator.
   • Diode controlled astable blocking Oscillator
25. Write about UJT sawtooth generator
   • Operation
   • Circuit diagram

26. What will happen when a step input voltage is applied to the high pass RC Circuit?
   • Derivation
   • The output Waveform