7. **SUBJECT DETAILS**

7.6 **ELECTRONIC CIRCUITS**

7.6.1 Objective and Relevance

7.6.2 Scope

7.6.3 Prerequisites

7.6.4 Syllabus

i. JNTU

ii. GATE

iii. IES

7.6.5 Suggested Books

7.6.6 Websites

7.6.7 Experts’ Details

7.6.8 Journals

7.6.9 Findings and Developments

7.6.10 Session Plan

7.6.11 Students Seminar Topics

7.6.12 Question Bank

i. JNTU

ii. GATE

iii. IES

7.6.13 Assignment Questions
7.6.1 OBJECTIVES AND RELEVANCE

In this subject, a major emphasis is laid on various types of amplifiers (single stage amplifier, multistage amplifier, feedback amplifier, power amplifier and tuned amplifier) and oscillators.

Almost all electronic equipments must include means for amplifying electrical signals. The subject of “Electronic Circuits” explains in detail how electrical signal is amplified. The various amplifiers that are going to be discussed include Single stage amplifiers, multistage amplifiers, Feedback amplifiers, power amplifiers and tuned amplifiers. The design of these amplifiers and its analysis will also be discussed.

7.6.2 SCOPE

The student will gain knowledge on various amplifiers i.e Designing amplifiers for the required specifications (single stage amplifier, multistage amplifier, feedback amplifier, power amplifier and tuned amplifier) and their analysis.

7.6.3 PREREQUISITES

Knowledge on semiconductor devices and network analysis is required.

7.6.4.1 JNTU SYLLABUS

UNIT-I

OBJECTIVE
It deals with Analysis of single stage amplifiers using simplified Hybrid model.

It also deals with the Effect of feedback and Analysis of the Feedback amplifier in all Topologies.

SYLLABUS


UNIT- II

OBJECTIVE
It deals with the design of various multistage amplifiers of BJT, the determination of the frequency response and the bandwidth of various multistage amplifiers.

SYLLABUS
BJT & FET Frequency Response Logarithms-Decibels-General frequency consideration-Low frequency analysis-Low frequency response of BJT amplifiers-Low frequency response of FET amplifier-Miller effect capacitance-High frequency response of BJT amplifier-Square wave testing.

UNIT-III

OBJECTIVE
In this chapter we learn the operations and design of multivibrators and also we study diode clippers; transistor clippers and comparators.

SYLLABUS

CLIPPERS AND CLAMPERS: Diode clippers, Transistor clippers, clipping at two independent levels, Transfer characteristics of clippers, Emitter coupled clipper, Comparators, Applications of voltage comparators, Clamping operation, Clamping circuits using diode with different inputs, Clamping circuit theorem, Practical clamping circuits, Effect of diode characteristics on clamping voltage, Transfer characteristics of clamps.

UNIT- IV

OBJECTIVE
It deals with the design of various power amplifiers, determining efficiency, power output of various classes of power amplifiers and distortion resulted in power amplifiers. It also deals with the response of RC high pass and low pass circuits for non-sinusoidal waveforms

SYLLABUS

Linear wave shaping: High pass, low pass RC circuits, their response for sinusoidal, step, pulse, square and ramp inputs.
UNIT- V
OBJECTIVE

In this chapter we study transistor switching and switching times

SYLLABUS
SWITCHING CHARACTERISTICS OF DEVICES: Diode as a switch, piecewise linear diode characteristics, Transistor as a switch, Break down voltage consideration of transistor, saturation parameters of Transistor and their variation with temperature, Design of transistor switch, transistor-switching times.

7.6.4.2 GATE SYLLABUS

UNIT- I
Single stage Amplifier, Feed back Amplifiers

UNIT- II
Frequency Response of BJT Amplifier, Analysis at low and high frequencies.

UNIT- III
Clipplers and Clampers

UNIT- IV
Large signal Amplifiers, Linear wave shaping.

UNIT- V
Not Applicable

7.6.4.3 IES SYLLABUS

UNIT- I
Not Applicable

UNIT- II
Not Applicable

UNIT- III
Not Applicable

UNIT- IV
Not Applicable

UNIT- V
Not Applicable

UNIT- VI
Not Applicable
UNIT VII
Not Applicable

UNIT VIII
Not Applicable

7.6.5 SUGGESTED BOOKS

Text Books


Reference Books


7.6.6 WEBSITES

1. Nptel.iitm.ac.in

2. www.amiestudy.com

3. www.eetasia.com

4. forum.jntuworld.com

5. www.scribd.edu
7.6.7 EXPERTS’ DETAILS

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7.6.8 JOURNALS

INTERNATIONAL

2. Circuits and systems Magazine IEEE
3. Power Electronics IEEE
7.6.9 FINDINGS AND DEVELOPMENTS


7.2.10 SESSION PLAN

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|   | 12 | To study the analysis of negative feedback amplifiers | Effect of feedback on amplifier characteristics - Current Series | T1: 11.10 |
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|   | 15 | To study the low frequency responses | Low frequency analysis of BJT amplifiers  
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**CLIPPERS AND CLAMPERS**

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**LINEAR WAVE SHAPING**

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**7.6.11 STUDENTS SEMINAR TOPICS**

1. Designing of Single Stage Amplifiers
2. Advantages and Disadvantages of Cascaded Amplifiers
3. Analysis of Tuned Amplifiers
4. Applications of Power Amplifiers
5. Pspice programming
6. Applications of multi vibrators

7.6.12 QUESTION BANK

UNIT-I

1. Compare the transistor(BJT) amplifier circuits in the three configurations with the help of h-parameters values. (DEC2014)

2. a) What are the causes of the following distortions in BJT amplifiers?
   - Non-linear Distortion
   - ii) Phase Distortion
   - iii) Frequency Distortion.

   b) For the transistor amplifier shown below, calculate $A_V, A_I, A_{VS}, R_i$ and $R_o$.

   Assume all capacitors to be arbitrarily large and the following h-parameter values.
   $h_ie=1.1\,\text{Kohm}$; $h_{fe}=50$; $h_re = 2.5 \times 10^{-4}$; $hoe=24\,\mu\text{A/V}$. (MAY2013)

   ![Transistor Amplifier Circuit](image)

3. (a) Compare BJT amplifier configurations based on $A_i$, $A_v$, $R_i$ and $R_o$.
   (b) The h-parameters of CE amplifier with $R_s=1\,\text{k}$, $R_L=10\,\text{k}$, $h_ie=1.1\,\text{K}$, $h_re=2.5 \times 10^{-4}$, $h_{fe}=50$ and $hoe=24\,\mu\text{A/V}$. Find out current and voltage gain with and without source resistance, input and output impedances? (MAY2012)

4. (a) Explain the effect of coupling capacitor CC on low frequency range.
(b) How does the emitter bypass capacitor CE determines a lower 3 dB frequency? Derive the required results. 

(MAY2012)

5. (a) Draw the Circuit Diagram of CC Amplifier and explain its working.
(b) Describe the basic BJT Amplifier in CE Configuration. Derive the expressions for current gain, voltage gain, input impedance, output impedance and Power Gain.

(MAY2012)

6. (a) Draw the Circuit Diagram of Emitter Follower and explain its working.
(b) The h-parameters of a transistor connected as CE amplifier are  \( h_{ic}=1100 \), \( h_{re}=2.54 \times 10^{-4} \), \( h_{fe}=50 \) and \( h_{oe}=25 \mu A/V \). Find various gains and Input and out Impedances (if \( R_s=R_L=1k \)). 

(MAY2012)

FEEDBACK AMPLIFIERS

1. a) Classify different type of fee back amplifiers.
   b) Compare voltage series and voltage shunt amplifiers. 

   (DEC2014)

2. a) Describe the four negative feedback configurations in BJT amplifiers with suitable block schematics.
b) If the gain of the amplifier reduces to 1% of its open loop gain of 120 with negative feedback, compute the feedback factor and loop gain.

c) Identify the type of feedback provided in i) CC amplifier ii) CE amplifier with un bypassed \( R_E \). 

   (MAY2013)

3. (a) The gain of an amplifier is decreased to 1000 with negative feedback from its gain of 5000. Calculate the feedback factor and amount of negative feedback in dB.
   (b) Classify types of feedback amplifiers based on the parameters sampled and feedback. 

   (MAY2012)

4. (a) Classify amplifiers based on feedback topology. Explain the topologies based on block diagram and equivalent circuit.
(b) An amplifier has a value of \( R_{in}=4.2 \text{ k} \), \( A_v=220 \) and \( A_i=0.01 \), determine the value of input resistance with feedback? 

   (MAY2012)

5. (a) How does negative feedback effect the input and output resistances? Justify your statement with required derivations for any feedback configuration.
   (b) For an amplifier of 60dB gain it has an output impedance, \( z_0 = 10 \text{ k} \) it is required to modify its output impedance to 500 by applying negative feedback, calculate the value of feedback factor, also find the percentage change in the overall gain for 10% change in the gain of the internal amplifier. 

   (MAY2012)

6. (a) Briefly discuss about the effect of feedback on amplifier band width and input impedance. Is the effect same for all feedback configurations? Justify.
   (b) The gain of an amplifier is decreased to 10,000 with negative feedback from its gain of 60,000. Calculate the feedback factor, express the amount of negative feedback in dB. 

   (MAY2012)
UNIT-II

1. a) Draw the high frequency equivalent circuit of a BJT and explain the same. 
   b) Explain about miller effect capacitance. \[ \text{(DEC2014)} \]

2. a) What are the circuit components which determine the low frequency cut-off of a small signal BJT amplifier in Common Emitter configuration? Discuss. 
   b) If two JFET CS amplifiers each with a lower cut-off frequency of 500Hz are cascaded, what is the resultant lower cut-off frequency? 
   c) State and explain Miller’s theorem. Apply the theorem for determining the equivalent capacitances at input and output of a BJT CE amplifier. \[ \text{(MAY2013)} \]

3. a) Write short notes on the importance of square wave testing. 
    b) Derive an expression for decibel gain of cascaded systems. \[ \text{(MAY2012)} \]

4. (a) Using the approximate model derive expressions for current gain, voltage gain, input impedance and output impedance of CC Amplifier. \[ \text{(MAY2012)} \]
   (b) Explain the operation of Common Source FET Amplifier.

5. (a) Show that the decibel gain of cascaded system is \( G_v = G_{v1} + G_{v2} + G_{v3} + \ldots + G_{vn} \) where \( G_{v1}, G_{v2}, \ldots, G_{vn} \) are gains of individual stages. 
   (b) Show that for low frequency response of CE amplifier the gain in dB is given by, \( A_v(dB) = -20 \log_{10}(f/f_1) \) where \( f_1 \) is the lower cut of frequency. \[ \text{(MAY2012)} \]

6. (a) With the help of neat sketches explain the Gain - versus - frequency for RC coupled amplifier, transformer coupled amplifier and direct coupled amplifier by showing the effects of parasitic capacitance of active devices and circuit Capacitors. 
   (b) The input power to a device is 10,000 watt at a voltage of 1000V the output Impedance is 20. 
      i. Find power gain in decibels. 
      ii. Find voltage gain in decibels. \[ \text{(MAY2012)} \]

UNIT-III

MULTIVIBRATORS

1. With the help of a neat circuit diagram and waveforms explain the working of an Astable multivibrator. \[ \text{(DEC2014)} \]

2. With relevant transistor based circuit diagrams explain the operation of following: 
   a) Astable multivibrator 
   b) Schmitt Trigger. \[ \text{(MAY2013)} \]

3. a) With necessary transfer characteristics, explain how an emitter coupled transistor clipper functions. Can it be used as a comparator? Use suitable circuit diagrams to explain. 
   b) Design a diode based clamper for the following specifications 
      i) Input is a symmetrical square wave of -5V to +5V swing and output has DC such that the –ve peak shifts to 0V. 
      ii) Input is a symmetrical square wave of -8V to +2V swing and output has DC such that the output swing is from -8V to +2V. \[ \text{(MAY2013)} \]
4. (a) Explain various methods to improve the resolution of a binary.
   (b) A collector-coupled ONE-SHOT is designed using silicon npn transistors with\(h_{FE}(\text{min})=20\).
   Assume \(V_{BE}=-1\text{V}\) for the transistor in cut-off and \(I_{B}=1.5I_{B}(\text{min})\) for the transistor in saturation,
   \(V_{CC}=8\text{V}\), \(I_{C}(\text{sat})=2\text{mA}\), \(T=2\text{ms}\) & \(R_1=R_2\). Find \(R_C\), \(R\), \(R_1\), \(C\) and \(V_{BB}\). \(\text{(MAY2012)}\)

5. (a) What do you mean by collector catching diodes? Explain the need of these diodes in a bistable multivibrator.
   (b) Silicon transistors with \(h_{FE}(\text{min})=40\), \(V_{BE}(\text{sat})=0.7\text{V}\), \(V_{CE}(\text{sat})=0.3\text{V}\), \(I_{C}(\text{sat})=10\text{mA}\) are available. Design an astable multivibrator to generate a square wave of 1 kHz frequency with a duty cycle of 25% . \(\text{(MAY2012)}\)

6. A self-biased binary uses n-p-n transistors having worst-case (max.) values of \(V_{CE}(\text{sat})=0.4\text{V}\) and \(V_{BE}(\text{sat})=0.8\text{V}\) and \(V_{BE}\) cutoff = 0V. Given: \(V_{cc}=15\text{V}\), \(R_C=390\) , find the stable-state currents and voltages. Also find the minimum value of \(h_{FE}\) required of BJT to provide the above stable state values. Also determine \(I_{CBO}(\text{max})\) to which \(I_{CBO}\) raises as temperature rises where neither BJTs is off. \(\text{(MAY2012)}\)

7. (a) Discuss the different methods of triggering a i/p-o/p.
   (b) Explain the operation of emitter coupled bistable multivibrator. \(\text{(MAY2012)}\)

**CLIPPERS AND CLAMPERS**

1. a) Write the procedure for designing a clipping circuits.
   b) Draw a circuit, to transmit that part of a sine wave which lies between -3V and +6V. \(\text{(DEC2014)}\)

2. (a) Give the circuits of different types of shunt clippers and explain their operation with the help of their transfer characteristics.
   (b) Draw the diode differentiator comparator circuit and explain the operation of it when ramp input signal is applied. \(\text{(MAY2012)}\)

3. (a) For the clipper circuit shown in Figure , write the transfer characteristic equations & draw the transfer characteristic plot, indicating all intercepts slopes & voltage levels.(Assume diodes as ideal).
   (b) Explain about effect of diode characteristics on clamping voltage.
4. (a) Draw and explain circuit of two diode clipper, also draw necessary waveforms.
(b) For the circuit shown in Figure , an input voltage Vi, varies linearly from 0 to 50V is applied. Sketch the output waveform VO to the same time scale. Assume ideal diodes.

5.(a) Give the circuits of series & shunt clippers and explain their operation with the help of transfer characteristics.
(b) For the circuit shown in the Figure, sketch the input and output waveforms if R = 1 K, VR = 10 V, Vi = 20 Sin ωt, Rf = 100 Rr = 1, V = 0.
UNIT-IV

1. a) Classify amplifiers based on the location of the operating point on the output curves for large signal input.
   b) Show that the maximum conversion efficiency of a class B amplifier in push-pull configuration is about 78.5%.
   c) What is cross over distortion? How can it be eliminated effectively? (MAY2013)

2. (a) Determine the power dissipation capability of a transistor, which has been mounted with a heat-sink having thermal resistance of \(_{HS}\_A\) (Heat Sink-to-Ambience) = 80°C/W, \(_{JC}\_C\) (Junction-to-Case) = 50°C/W, \(_{CA}\_A\) (Case-to-Ambience) = 850°C/W at a junction temperature of 1600°C and ambient temperature of 400°C.
   (b) When are two transistors said to be configured in Complementary Symmetry? Draw the circuit of a complementary symmetry Push-Pull Class-B Power Amplifier and explain its operation together with characteristics of amplifier. (MAY2012)

3. Derive the expression, with necessary diagrams, to calculate the total harmonic distortion \(D\) in power amplifiers using the \(-\)ve-point method of analysis. (MAY2012)

4. Calculate the power dissipated in the individual transistors of a class B push-pull power amplifier, if \(VCC = 20V\) and \(RL = 4\). Assume the circuit parameters necessary. (MAY2012)

5. (a) Explain about heat sinks. Explain the term Thermal Resistance. Give the sketches of heat-sinks.
   (b) What is the Junction to ambient Thermal Resistance for a device dissipating 600mw into an ambient temperature of 50°C and operating at a junction temperature of 110°C? (MAY2012)
LINEAR WAVESHAPING:

1. a) With the help of circuit diagram, explain the working of RC and RL low-pass circuit.
   
   b) Why are RC circuit commonly used compared to RL circuit? (DEC2014)

2. Obtain expressions for the output voltage of an RC low pass filter for sinusoidal, step, ramp and square wave inputs. Under what conditions, a triangular wave can be obtained with a square wave input to an RC network? Explain. (MAY2013)

UNIT-V

1. A rectangular pulse of voltage is applied to the base of a transistor driving it from cut-off to saturation discuss the changes in output potential explain the various times involved in the switching process. (DEC2014)

2. (a) Explain in detail the junction diode switching times.
   
   (b) Give a brief note on piece-wise linear diode characteristics. (MAY2012)

3. Design a common-emitter transistor switch shown in Figure 2, operated with Vcc= 18V and -Vbb = -12V. The transistor is expected to operate at IC = 8mA, IB =0.75mA. Assume hFE = 25, VBE(sat) = VCE(sat) = 0V and R2 = 6 R1. (MAY2012)

4. (a) A rectangular pulse of voltage is applied to the base of a transistor driving it from cut-off to saturation. Discuss the changes in the output potential. Also explain various times involved in the switching process.
   
   (b) Calculate the maximum operating frequency of a diode with storage time of 1ns and transition time of 8ns. (MAY2012)

5. The circuit shown in Figure uses a silicon transistor with hFE = 100 and VBE =0.7V. Find the value of R which saturates the transistor, when input voltage is +5V. Given RC = 1K & VCC = +5V.
Assignment Questions

UNIT 1


2. Draw the circuit diagram of Emitter follower and derive the equation for voltage gain, input resistance, output resistance and current gains.

3. State Miller’s theorem. Specify its relevance in the analysis of a BJT amplifier

4. i. Reason out the causes and results of Amplitude, Phase & Frequency distortions in transistor amplifiers.

   ii. Write short notes on Classification of Amplifiers.

FEEDBACK AMPLIFIERS
1. i. Draw the Generalized block diagram of negative feedback amplifier and calculate transfer gain.
   ii. Write the advantages of negative Feedback amplifiers.
2. Mention about different types of basic amplifiers used in feedback amplifiers.
3. What are the different feedback topologies? Derive gain, input and output resistance in all topologies.
4. Explain with equations stability of amplifiers with and without feedback.
5. i. Compare different feedback amplifiers.
   ii. Write the procedural steps to carry out the analysis in different topologies.

UNIT II
1. Draw the hybrid – π Model of BJT. Describe each component in the model in detail. Also derive the expressions for input conductance, feedback conductance, output conductance and base spreading resistance in the hybrid –π model.
2. With the help of neat diagrams and necessary equations, explain the effect of bypass, coupling capacitor on the performance of an amplifier at low frequencies. Also derive the expression for lower 3-db frequency established by the coupling capacitor.
3. Derive the expression for the CE short circuit current gain as a function of frequency.
4. i. Define $f_p$ and $f_T$ and also establish the relationship between $f_p$ and $f_T$
   ii. write short notes on Gain bandwidth product.
5. Describe how an emitter follower behaves at high frequencies.

UNIT III
MULTIVIBRATORS
1. Explain the operation of emitter coupled bistable multivibrator.
2. Draw the circuit diagram of a Schmitt trigger circuit and explain its operation. Derive the Expressions for its UTP and LTP.
3. Draw and explain the circuit of Astable Multivibrator with necessary waveforms and also derive the expression for its frequency of oscillations.
4. What is a monostable multivibrator? Explain with help of a neat circuit diagram the principle of operation of a monostable multivibrator, and derive an expression for pulse width. Draw the wave forms at collector and base of both transistors.
5. Explain asymmetrical triggering in a binary and mention its uses.
CLIPPERS AND CLAMPERS

1. State and prove clamping circuit theorem

2. Explain the response of the clamping circuit when a square wave input is applied under steady state conditions

3. Draw the basic circuit diagram of negative peak clamper circuit and explain its operation

4. What is meant by comparator and explain diode differentiator comparator operation with the help of ramp input signal is applied.

5. Determine Vo for the network shown in figure 1 for the given waveform. Assume ideal Diodes.

UNIT IV

1. Derive the expression, with necessary diagrams, to calculate the total harmonic distortion ‘D’ in power amplifiers using the three-point method of analysis.

2. Define conversion efficiency. Determine the maximum value of conversion efficiency for a series fed and transformer coupled class A power amplifier.

3. i. With the help of a suitable circuit diagram, show that the maximum conversion efficiency of a class B power amplifier is 78.5%.
   ii. Explain how Total harmonic distortion can be reduced in a Class B push-pull configured amplifier.

4. i. A single stage class A amplifier $V_{cc}=20V$, $V_{CEQ} =10V$, $I_{CQ} =600mA$, $RL=16$.
   The ac output current varies by $\pm 300mA$, with the ac input signal. Find
   a. The power supplied by the dc source to the amplifier circuit.
   b. AC power consumed by the load resistor.
   c. AC power developed across the load resistor.
   d. DC power wasted in transistor collector.
   e. Overall efficiency
f. Collector efficiency.
ii. List the advantages of complementary-symmetry configuration over push pull configuration.

5. Write short notes on Classification of power amplifiers.

UNIT V

1. Explain Piecewise linear characteristics of diode
2. Explain Zener & Avalanche breakdown mechanisms in diodes.
3. Define rise time and fall time of a transistor switch. Derive expressions for these in terms of the transistor parameters and operating currents.
4. List the disadvantages of using transistor as a switch
5. Compare mechanical switch with a diode switch and transistor switch