REGULATION: 2017 **ACADEMIC YEAR: 2020-2021**

EC8452 **ELECTRONIC CIRCUITS II** **L T P C**
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OBJECTIVES:

- To give a comprehensive exposure to all types of amplifiers and oscillators constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To study about feedback amplifiers and oscillators principles
- To design oscillators.
- To study about turned amplifier.
- To understand the analysis and design of LC and RC oscillators, amplifiers, multi vibrators, power amplifiers and DC convertors.

UNIT I - FEEDBACK AMPLIFIERS AND STABILITY **9**

Feedback Concepts – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers – analysis of series-series, shunt-shunt and shunt-series feedback amplifiers-stability problem-Gain and Phase-margins-Frequency compensation.

UNIT II - OSCILLATORS **9**

Barkhausen criterion for oscillation – phase shift, Wien bridge - Hartley & Colpitt's oscillators – Clapp oscillator-Ring oscillators and crystal oscillators – oscillator amplitude stabilization.

UNIT III - TUNED AMPLIFIERS **9**

Coil losses, unloaded and loaded Q of tank circuits, small signal tuned amplifiers –Analysis of capacitor coupled single tuned amplifier – double tuned amplifier - effect of cascading single tuned and double tuned amplifiers on bandwidth – Stagger tuned amplifiers - Stability of tuned amplifiers – Neutralization - Hazeltine neutralization method.

UNIT IV WAVE SHAPING AND MULTIVIBRATOR CIRCUITS **9**

Pulse circuits – attenuators – RC integrator and differentiator circuits – diode clampers and clippers –Multivibrators - Schmitt Trigger- UJT Oscillator.

UNIT V POWER AMPLIFIERS AND DC CONVERTERS **9**

Power amplifiers- class A-Class B-Class AB-Class C-Power MOSFET-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design

TOTAL: 45 PERIODS

OUTCOMES:

After studying this course, the student should be able to:

- Analyze different types of amplifier, oscillator and multivibrator circuits
- Design BJT amplifier and oscillator circuits
- Analyze transistorized amplifier and oscillator circuits
- Design and analyze feedback amplifiers
- Design LC and RC oscillators, tuned amplifiers, wave shaping circuits, multivibrators, power amplifier and DC convertors.

TEXT BOOKS:

1. Sedra and Smith, ―Micro Electronic Circuits‖; Sixth Edition, Oxford University Press, 2011. (UNIT I, III, IV, V)
2. Jacob Millman, ‗Microelectronics ', McGraw Hill, 2nd Edition, Reprinted, 2009. (UNIT I, II, IV, V)

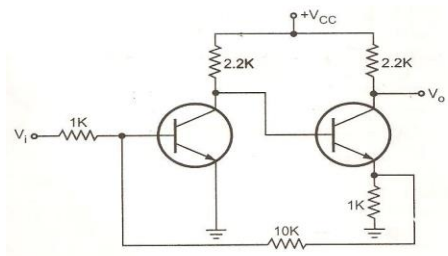
REFERENCES

1. Robert L. Boylestad and Louis Nasheresky, ―Electronic Devices and Circuit Theory‖, 10th Edition, Pearson Education / PHI, 2008.
2. David A. Bell, ―Electronic Devices and Circuits‖, Fifth Edition, Oxford University Press, 2008.
3. Millman J. and Taub H., ―Pulse Digital and Switching Waveforms‖, TMH, 2000.
4. Millman and Halkias. C., Integrated Electronics, TMH, 2007.

Subject Code: EC8452 **Year/Semester: II /04**
Subject Name: ELECTRONIC CIRCUITS II **Subject Handler: Mrs.M.Benisha**

UNIT I-FEEDBACK AMPLIFIERS AND STABILITY	
Feedback Concepts – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers – analysis of series-series, shunt-shunt and shunt-series feedback amplifiers-stability problem-Gain and Phase-margins-Frequency compensation.	
PART * A	
Q.No.	**Questions**
1.	**Define feedback and its types.** BTL1 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. There are two types 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. 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.
2	**List the different types of feedback topologies. (Nov 2011)** BTL1 • Voltage – series feedback topology • Voltage – shunt feedback topology • Current – series feedback topology • Current – shunt feedback topology.
3	**What are the effects of negative feedback? (Or) What are the advantages and disadvantages of negative feedback**? (**Nov 2012, Nov 2016)** BTL1 Advantages: • It improves the stability of the circuit. • It improves the frequency response of the amplifier. • It improves the percentage of harmonic distortion. • It improves the signal to noise ratio (SNR). • It reduces the gain of the circuit. Disadvantages: • Reduced circuit overall gain. • Reduced stability at high frequency.
4	**Define positive feedback.** BTL1 If the feedback signal is in phase with input signals, 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.
5	**What is Node and Loop Sampling?** BTL1 **Node Sampling:**

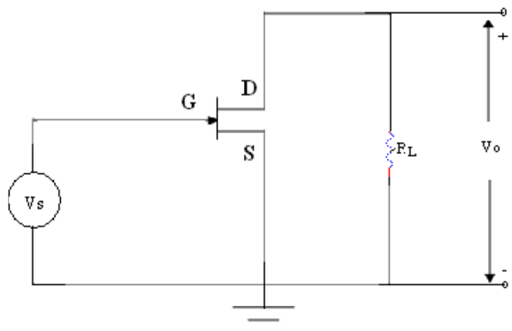
	When the output voltage is sampled by connecting the feedback network in shunt across the output, the connection is referred to as Voltage or Node Sampling. **Loop Sampling:** When the output voltage is sampled by connecting the feedback network in series across the output, the connection is referred to as Current or Loop Sampling.
6	**Define Frequency compensation and its types.** BTL1 If the feedback amplifier has more than two poles, it can be unstable. The technique is used to make unstable feedback amplifier to stable is called Frequency compensation. There are two types, • Dominant pole compensation: In this compensation technique if dominant pole is introduced into the amplifier so that phase shift is less than -1800 when the loop gain is unity. • Miller compensation: It is implemented by connecting a capacitor between input and output of a gain stages of a multistage amplifier.
7	**What is the nature of input and output resistance in negative feedback?** BTL1 Voltage series feedback: Input impedance: Zif = Zi * (1+A β) Output impedance: Zof = Zo / (1+Aβ) Voltage shunt feedback: Input impedance: Rif = Ri * (1+A β) Output impedance: Zof = Zo * (1+ A β) Current series feedback: Input impedance: Rif = Zi / (1+A β) Output impedance: Zof = Zo / (1+A β) Current shunt feedback: Input impedance: Rif = Ri / (1+A β) Output impedance: Rof = Ro * (1+A β)
8	**Mention the three basic networks that are connected around the basic amplifier to implement feedback concept. (NOV/DEC'12)** BTL2 • Mixing Network • Sampling Network • Feedback Network
9	**What is the purpose of mixer network in feedback amplifier?** BTL1 The mixer network is used to combine feedback signal and input at input of an amplifier.
10	**Define Sensitivity and Desensitivity of gain in feedback amplifiers. (April 2011)** BTL1 Sensitivity: The fractional change in amplification with feedback divided by the fractional change in amplification without feedback is called the sensitivity of the transfer gain. Desensitivity: Desensitivity is defined as the reciprocal of sensitivity. It indicates the factor by which the voltage gain has been reduced due to feedback network. Desensitivity factor D = 1+A β β. Where A = Amplifier gain and β = Feedback factor.
11	**State the Nyquist criterion for stability of feedback amplifiers.** BTL1 • The amplifier is unstable if the curve encloses the point -1+j0. The system is called as unstable system. • The amplifier is stable if the curve encloses the point -1+jo. That system is called as stable system.

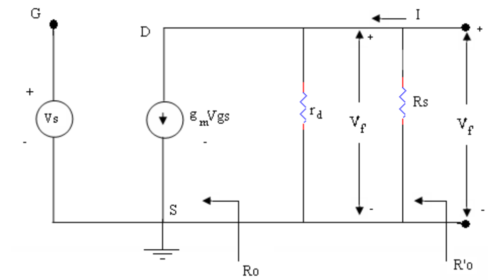
12	**Identify the topology for the circuit drawn in Fig.** BTL3  $V_o = 0$, does not make feedback zero, $I_o = 0$ makes feedback zero; Feedback is fed in shunt with input signal so its **Current shunt feedback.**
13	**The voltage gain of an amplifier without feedback is 60 dB and decreases to 40 dB with feedback. Determine the feedback factor of the feedback network.** BTL5 From $A_{vf} = \frac{A_v}{1+\beta A_v}$ $\beta = \frac{A_v - A_{vf}}{A_v A_{vf}} = \frac{60-40}{60x40} = 8.33x10^{-3}$
14	**Give the expression for gain of an amplifier with feedback.** BTL1 Avf = AV/ 1+ AV β Where, Avf – feedback voltage gain. AV – Voltage gain. β - Feedback factor
15	**What is loop gain or return ratio?** BTL1 A path of a signal from input terminals through basic amplifier, through the feedback network and back to the input terminals forms a loop. The gain of this loop is the product -A β . This gain is known as loop gain or return ratio.
16	**What is the effect of negative feedback on bandwidth?** BTL1 Bandwidth of amplifier with feedback is greater than bandwidth of amplifier without feedback.
17	**Why gain bandwidth product remains constant with the introduction of negative feedback?** BTL1 Since bandwidth with negative feedback increases by factor (1+A β) and gain decreases by same factor, the gain-bandwidth product of an amplifier does not alter, when negative feedback is introduced.
18	**A feedback amplifier has an open loop gain of 600 and feedback factor β = 0.01. Find the closed loop gain with feedback.** BTL1 Avf = AV/ 1+ AV β = 600/ (1+ 600*0.01) = 85.714.
19	**The distortion in an amplifier is found to be 3%, when the feedback ratio of negative feedback amplifier is 0.04. When the feedback is removed, the distortion becomes 15%. Find the open and closed loop gain.** BTL5 Solution: Given: β = 0.04 Distortion with feedback = 3%, Distortion without feedback = 15% D = 15/3 = 5: Where D = 1+A β =5

20	**Voltage gain of an amplifier without feedback is 60dB. It decreases to 40dB with feedback. Calculate the feedback factor.** BTL5 Solution: Given: $A_v = 60dB$ and $A_{vf} = 40$ dB. We know that, $A_{vf} = A_V / 1 + A_V\beta$ $\beta = (A_V - A_{vf}) / (A_V A_{vf})$ $= (60-40) / (60*40)$ $\beta = 0.00833$.
21	**What is Nyquist diagram?** BTL1 The plot which shows the relationship between gain and phase-shift as a function of frequency is called as Nyquist diagram.

22	**Write the steps which are used to identify the method of feedback topology.** BTL1
	• Identify topology (type of feedback)
	    o To find the type of sampling network.
	    o To find the type of mixing network
	• Find the input circuit.
	• Find the output circuit.
	• Replace each active device by its h-parameter model at low frequency.
	• Find the open loop gain (gain without feedback), A of the amplifier.
	• Indicate X_f and X_o on the circuit and evaluate $\beta = X_f.X_O$.
	• Calculate A, and β, find D, Ai, Rif, Rof, and Rof'.

23	**What are the types of distortions in an amplifier?** BTL1 • Frequency • Noise and non-linear
24	**What is the effect of lower cut-off frequency & upper cut-off frequency with negative feedback?** BTL1 Lower cut off frequency with feedback is less than lower cut off frequency without feedback by factor $(1+A_{mid}\,\beta)$ Upper cut off frequency with feedback is greater than upper cut off frequency without feedback by factor $(1+A_{mid}\,\beta)$
25	**Define feedback factor or feedback ratio.** BTL1 The ratio of the feedback voltage to output voltage is known as feedback factor or feedback ratio.
	PART B
1	**Explain with neat diagram, the two stage voltage series feedback amplifier and determine the AV, AVf. (13M) (May 2018)** BTL2 **Answer: Page 545 - S.Salivahanan** **FET Common drain Amplifier: -** (2M) • The feedback signal - voltage Vf across R, • The sampled signal - voltage Vo across R. • To find the input circuit, set Vo= 0, and hence Vs appears directly between G and S. • To find the output circuit, set Ii = 0, and hence R appears only in the output loop. **Low – frequency model Source Follower** (3M)





FET replaced by its Small – Signal Low frequency model.

Vf = Vo ; β = Vf / Vo = 1 (2M)

This topology stabilizes voltage gain.

Without feedback Vi = Vs,

$A_v = \frac{\mu R}{r_d + R}$ (1M)

$A_{vf} = \frac{\mu R}{r_d + (1+\mu)R}$ (1M)

$R_{of} = \frac{r_d}{1+\mu}$ (2M)

$R'_{of} = \frac{r_d R}{r_d + (1+\mu)R}$ (2M)

2

Derive the expression for lower and higher cut off frequency of feedback amplifier. (13M) (Nov 2010, Apr 2010, Nov 2006) BTL3

Answer: Page 539 - S. Salivahanan

Lower cut off frequency of feedback amplifier:

voltage gain at low frequency f L (3M)

$A_L = \frac{A_m}{1 - j\frac{fL}{f}}$

Where,

Amid = Voltage gain in mid frequency range.

f_L = Lower cut off frequency without using feedback.

After the application of feedback, (3M)

$A_{LF} = \frac{A_L}{1 - A\beta}$

$$A_{LF} = \frac{A_{mF}}{1 - j\frac{fL}{f}}$$

Where, f

L = f_L / [1 + Amid β] = Lower cut off frequency using feedback.

A_{mf} = Amid / [1 + A_Lmβ] = Mid band gain with feedback.

FL > fl i.e., the negative feedback decreases the lower cut off frequency by the factor of [1 + Amid β] .

Higher cut off frequency of feedback amplifier:

Voltage gain at high frequency fL is given by (3M)

$A_H = \frac{A_m}{1 - j\frac{f}{fH}}$

Where,

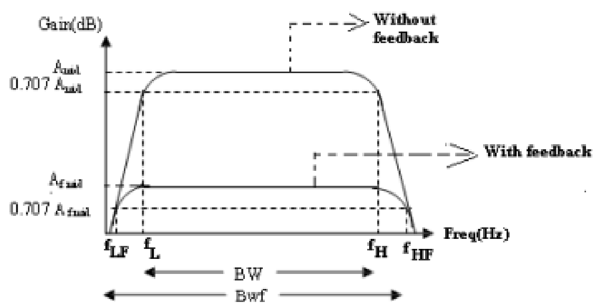
Am id = Voltage gain in mid frequency range.

f_h = upper cut off frequency without using feedback.
After the negative feedback is applied, (3M)

$$A_{HF} = A_H/(1 - A_H\beta)$$

$$A_{HF} = \frac{A_{mF}}{1 - j\frac{f}{fH}}$$

Where,
$F_H = f_h$ [1 + Amid β] = Upper cut off frequency using feedback.
A_{mf} = Amid / [1 + ALmidβ] = Mid band gain with feedback.
$F_H > f_h$ i.e.,
Upper cut off frequency – increased- due to - negative feedback- Band width is increased.
Bandwidth Plot: (1M)



3

An amplifier has a mid-band gain of 125 and a bandwidth of 250 KHZ. (a) If 4%negative feedback is introduced, find the new bandwidth and gain. (b) If the bandwidth is to be restricted to 1 MHZ, find the feedback ratio. (8M) BTL5
Answer: Page 544 - S. Salivahanan
Solution: Given A=125, BW=250KHZ & β=4%=0.04
(a) We know that, BWf = (1+Aβ) BW (4M)
= (1+125 X 0.04) X 250 X 103 = 1.5MHz
Gain with feedback, Af = A / 1+Aβ
=125 / 1+ (125 X 0.04)
Af = 20.83
(b) BWf = (1+Aβ) BW (4M)
$1 * 10^6 = (1+125\beta) * 250 * 10^3$
$= (1+125\beta) = 1 * 106/250 * 10^3$
β = 3/125 = 0.024
β = 2.4%

4

Sketch the block diagram of a feedback amplifier, and derive the expressions for gain with positive feedback and negative feedback. (9M) (May 2017). BTL3
Answer: Page 532 - S. Salivahanan
Introduction: (2M)

- The input signal = Xs
- The output signal = Xo = A Xi
- Feedback signal = Xf = β Xo
- Difference signal = Xd = Xs-X f =Xi
- Gain of the amplifier without feedback A = Xo / Xi
- The feedback factor = β = Xf / Xo

- Input signal applied to the amplifier is, Xi = Output of the mixer or summer.

  Xi = Xs + Xf

Negative feedback: (2M)

Af = Xo / Xs

= A Xi / Xi [1 + A β]

= A / [1 + A β]

'-+ve' sign for positive feedback i.e.,

Positive feedback: (2M)

'- ve' sign for positive feedback i.e.,

Af = A / [1 - A β]

The denominator term '1 - A β' - as "Desensitivity factor".

Negative feedback - '1 + A β'.

Positive feedback - '1 - A β'.

Block Diagram: (3M)

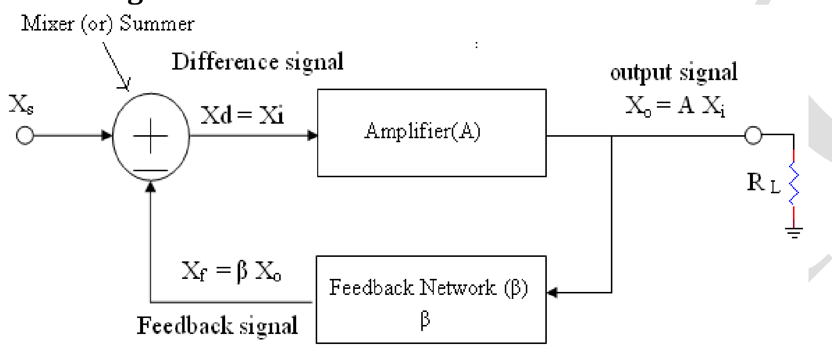


Fig (a)

5

An amplifier has a voltage gain of 400, f1=50HZ, f2=200KHZ and a distortion of 10% without feedback determine the amplifier voltage gain, f1f , f2f and Df when a negative feedback is applied with feedback ratio of 0.01. (8M) BTL5

Answer: Page 544 - S. Salivahanan

Solution: Given: A=400, f1=50HZ, f2=200KHZ, D=10%, β= 0.01

We know that, voltage gain with feedback (2M)

$A_f = A / 1+A\beta = 400 / 1 + 400 X 0.01 = 80$

New lower 3db frequency, (2M)

$F_{1f} = f_1/1+A\beta = 50 / 1+400 X 0.01 = 10Hz$

New upper 3db frequency, (2M)

$F_{2f} = (1+A\beta)f_2 = (1 + 400 X 0.01) X 200 X 10^3$

F_{2f} = 1MHz

Distortion with feedback, $D_f = D / 1+A\beta = 10 / 5 = 2\%$ (2M)

6

Draw the circuit of voltage series and current shunt feedback amplifier and derive the expressions for input impedance Rif. (10M) (May 2017). BTL2

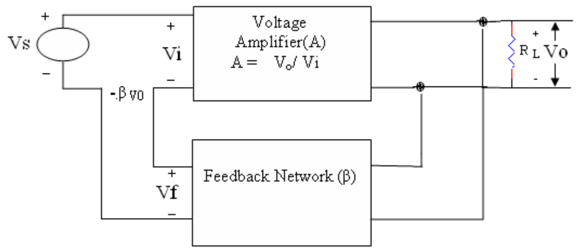
Answer: Page 545 - S. Salivahanan

Voltage series feedback connection. (or) Series – Shunt feedback: -

Output voltage is directly proportional to the input voltage, thus it is used as "Voltage amplifier".

A = Vo / Vi (or) Vo = A Vi.

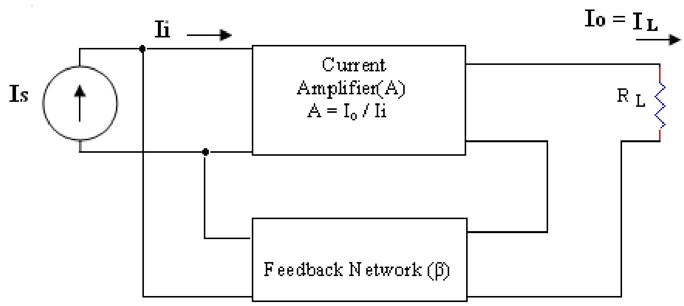
Block Diagram: (2M)



Gain: (1M)
The amplifier has a gain of without feedback,
A = Vo / Vi (or) AVi= Vo.
If feedback is connected then
Vs = Vi + Vf ------------- (1)
(or) Vi = Vs – Vf
AVF = A / (1 + Aβ).
Substituting the Vf value in Eqn (1),
Vs = Vi+ β Vo.
= Vi + β A Vi. (Vo = A Vi)
Vs = (1+A β). Vi
AVF = Vo / Vs
= A Vi / (1+A β). Vi
Input Impedance:- (1M)
=Vs = Vi + Vf
= Vi + β Vo.
= Ri Ii + β Vo. (Vi = Ri Ii)
= Ri Ii + β AVi. (Vo = β Vi)
= Ri Ii + Ri Ii β A
Vs = Zi Ii [1+ A β] (Zi = Ri)
Z if = Vs / Ii
= Zi (1 + A β)
Z if = Zi (1 + A β)
Ouput Impedance:- (1M)
Vo = I Zo + A Vi [Ro = Zo]
Vo = I Zo – A Vf
{ As we know Vi = Vs - Vf ,Vs is transferred to the output side hence Vs = 0 thus
Vi = - Vf = - β Vo }
Vo = I Zo – A β Vo
Vo + A β Vo = I Zo.
Vo [1 + A β] = I Zo
Vo /Io=Zo /1 + A β
ZOF = Zo/ 1 + A β
Zo = output impedance - without feedback.
ZOF = output impedance - with feedback.
Output impedance - reduced by a factor of (1 + A β) - output impedance of the amplifier without feedback.
Current Shunt feedback connection. (Or) Shunt Series feedback:-

Output current - directly proportional - Input current - “Current amplifier “.
i.e., A = Io / Ii (or) Io = A Ii.

Block Diagram: (2M)



Output current - parallel with the input circuit - current shunt feedback configuration.
“Current amplifier” - amplifiers - input current at the output.

G**ain of the amplifier** without feedback is (1M)

A = Io / Ii And β = If / Io

We know,

Is = Ii + If ; If = β Io and Io = A Ii

$$A_F = \frac{A}{1 + A\beta}$$

Input Impedance: - (1M)

$$Rif = \frac{Ri}{1 + A\beta}$$

Where, Rif = Input resistance - with feedback. Input impedance - decreased by the factor (1 + Aβ).

Output Impedance: - (1M)

We know Is = Ii + If (or) Ii = Is - If = - If

Rof = Ro [1 + Aβ] Thus the output impedance increased by (1 + Aβ)

7

Write about the Nyquist criterion for stability of feedback amplifiers. (3M) (May 2017), (Nov2012). BTL1

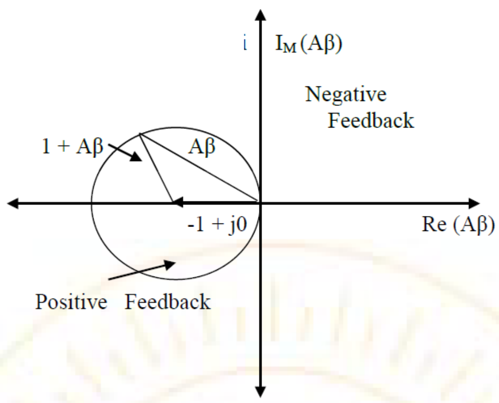
Answer: Page 537 - S. Salivahanan

- Aβ - function of frequency - points in the complex plane – obtained - for the values of Aβ corresponding - ‘f’ from –α to + α .
- Locus - all these points forms - closed curve.
- The criterion of Nyquist - the amplifier - unstable if this curve encloses the points -1 + j 0
- Amplifier - stable - the curve - does not enclose - this point.

Rules for stability: (2M)

- | 1 + Aβ | = 1 represents a circle - unit radius, with its center - point -1 + j0.
- If, for any frequency, Aβ extends outside this circle, - feedback - negative, since then | 1+ Aβ | > 1.
- If Aβ lies within this circle-| 1+ Aβ | < 1, - feedback - positive.
- The system - not oscillate unless Nyquist’s criterion - satisfied.

Nyquist plot: (1M)



8

Sketch the block diagram of a feedback amplifier and derive the expression for gain

(1) With positive feedback and

(2) With negative feedback state the advantages of negative feedback (6M) (Dec 12) BTL2

Answer: Page 532 - S. Salivahana

The Feedback connection has three networks.

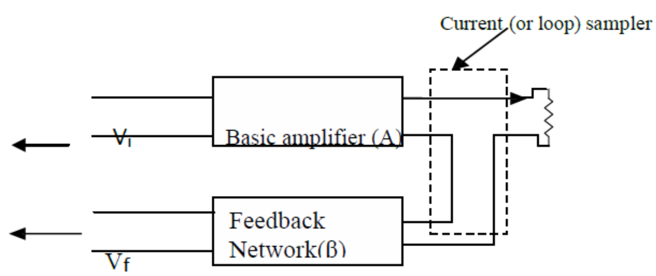
1. Sampling network
2. Feedback network
3. Mixer network

Sampling network: (2M)

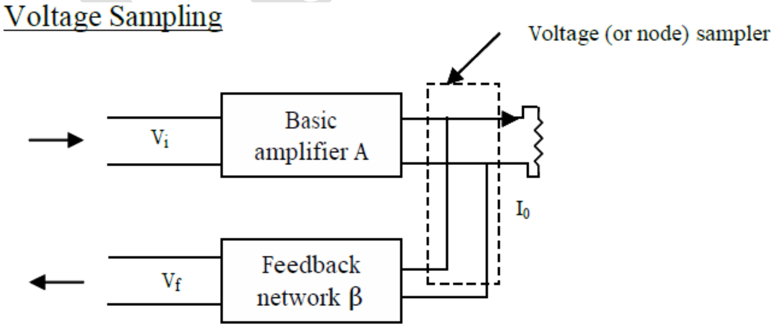
Based on the sampling signal

i. Voltage Sampling or Node sampler

ii. Current Sampling or Loop sampler



Voltage Sampling



Feedback Network : (2M)

Vf = βV0 ; 'β' is a feedback factor or feedback ratio.

The symbol β is always lies between 0 and 1.

- **Negative feedback:**

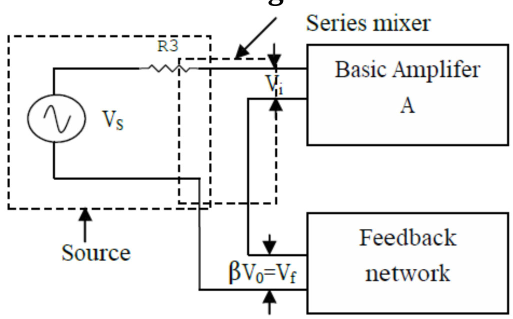
Af = Xo / Xs
= A Xi / Xi [1 + A β]
= A / [1 + A β]
'-+ve' sign for positive feedback i.e.,

- **Positive feedback:**

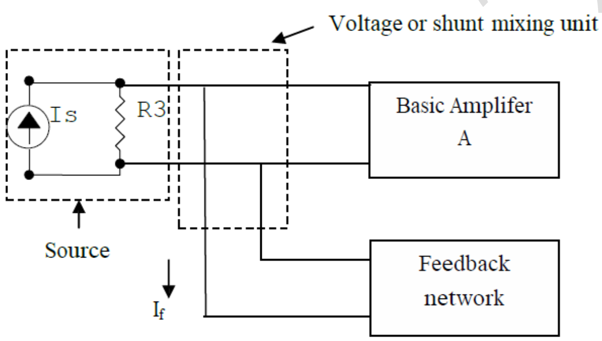
'- ve' sign for positive feedback i.e.,
Af = A / [1 - A β]
The denominator term '1 - A β' - as "desensitivity factor".
If the amplifier uses negative feedback, it is '1 + A β'.
If the amplifier uses positive feedback, it is '1 - A β'.

Mixing Network : (2M)

- **Series Mixing:**



- **Shunt Mixing:**



9 **A single stage transistor amplifier has a voltage gain of 600 without feedback, and 50 with feedback. Calculate the percentage of output which is feedback to the input. (6M)** BTL4

Answer: Page 538 - S. Salivahanan

Solution:

- Voltage Gain without feedback (A) = 600 (2M)
- Voltage Gain with feedback, (Af) =50 (2M)

Af = A / 1+βA
50 = 600 / 1+ (β X 600)
1+ (β X 600) = 600 / 50 = 12
600β = 11
∴β = 0.01833
∴ % of output voltage that is feedback to the input = β X 100=1.833. (2M)

10 **An amplifier with a negative feedback provides an output voltage of 5 volt with an input**

voltage of 0.2volt. On removal of feedback, it needs only 0.1V input to give the same output. Determine a. gain without feedback, b. Gain with feedback, c. Feedback ratio (6M)

Answer: Page 538 - S. Salivahanan

A=50 BTL5

Solution:

a. Gain without feedback, A= output voltage / input voltage = 5 / 0.1 (2M)

b. Gain with feedback, Af = output voltage / input voltage = 5 /0.2 (2M)

∴Af = 25

c. We know that, AF = A /1+βA (2M)

=25 / 1+25β

β=0.02

11

Determine the voltage gain and input impedance with feedback for a voltage series feedback having the following parameters; $A = -100$; $R_i = 10\ k\Omega$; $R_o = 20\ k\Omega$; for (i) $\beta = -0.1$; (ii) $\beta = -0.5$. (13M) BTL5

Answer: Page 552 - S. Salivahanan

$A_{vf} = \frac{A_v}{1+\beta A_v} = \frac{-100}{11} = -9.09$ (2M)

$R_{if} = R_i(1+\beta A_v) = 10x11 = 110\ k\Omega$ (2M)

$R_{of} = \frac{R_o}{1+\beta A_v} = \frac{20}{11} = 1.81\ k$ (2M)

$A_{vf} = \frac{A_v}{1+\beta A_v} = \frac{-100}{51} = -1.96$ (2M)

$R_{if} = R_i(1+\beta A_v) = 10x51 = 510\ k\Omega$ (2M)

$R_{of} = \frac{R_o}{1+\beta A_v} = \frac{20}{51} = 0.392\ k\Omega$ (3M)

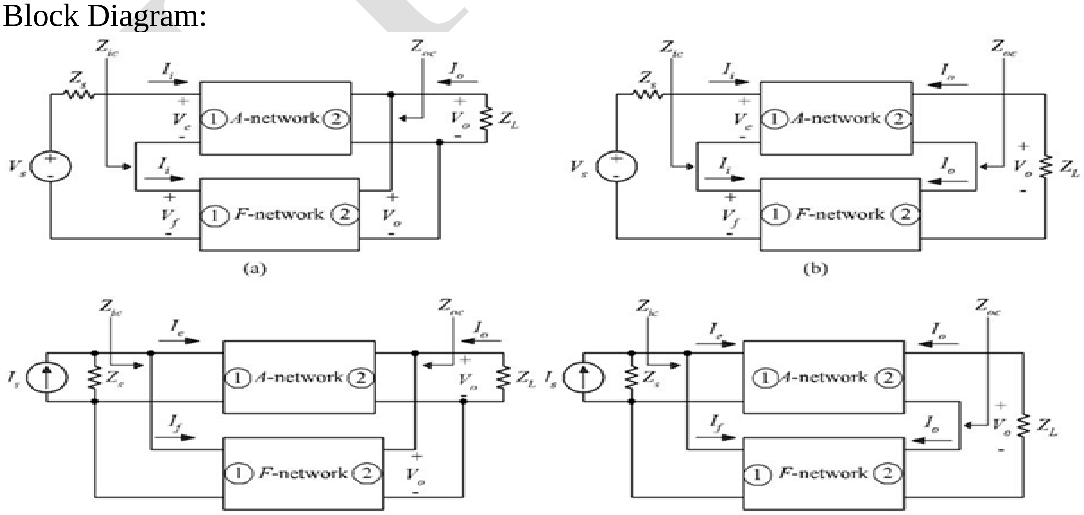
PART * C

1

Compare all the four feedback amplifiers with neat diagrams. (15M) BTL4

Answer: Page 552 - S. Salivahanan

Block Diagram: (8M)



	Parameters Comparison (7M)

Feedback connection	Appropriate Two-port parameter representation	Input Variable (source form)	Output variable	Transfer function stabilized	Z_{ic} Input Impedance	Z_{oc} Output Impedance
Series-Shunt	*h*-parameters	Voltage, V_s (Thevenin)	Voltage, V_o	(V_o/V_s) Voltage transfer function	Increases	Decreases
Series-Series	*z*-parameters	Voltage, V_s (Thevenin)	Current, I_o	(I_o/V_s) Transfer admittance	Increases	Increases
Shunt-Shunt	*y*-parameters	Current, I_s (Norton)	Voltage, V_o	(V_o/I_s) Transfer Impedance	Decreases	Decreases
Shunt-Series	*g*-parameters	Current, I_s (Norton)	Current, I_o	(I_o/I_s) Current transfer function	Decreases	Increases

2

Draw a single stage current series feedback amplifier and draw the basic amplifier without feedback and its equivalent circuit. Also derive for voltage gain without feedback. (13M) (Nov 2017) (or)

What is the effect of current series negative feedback on input resistance and output resistance of a BJT amplifier? Explain the same with necessary circuits, equivalent circuit and equations. (13M), (May 2017) (or)

Draw the equivalent circuit of current series feedback amplifier and explain. Also derive Rif, Rof, Av, Avf .(13M) (May2018) (Nov 2016) BTL2

Answer: Page 551- S. Salivahanan

The Common Emitter Transistor amplifier: (2M)

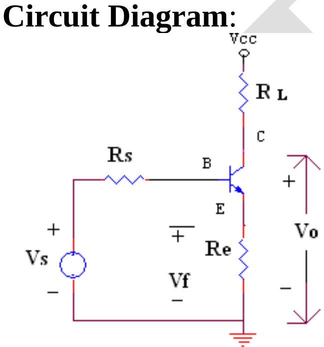
The feedback signal is the voltage Vf across Re, and the sampled signal is the load current Io.

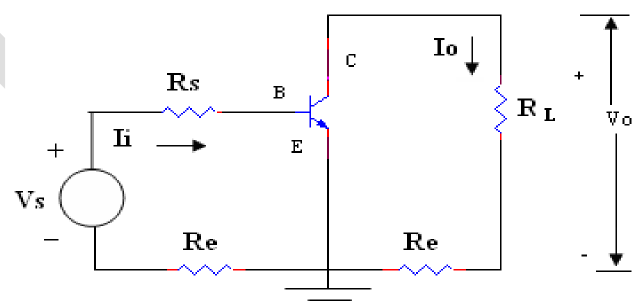
β = Vf/ Vo = -Io Re / Io*RL

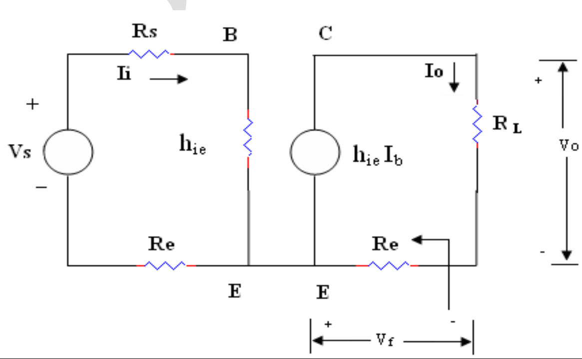
= - Re/ RL

β - function -the load RL.

Circuit Diagram: (3M)







$\beta = V_f / V_o = (-I_o R_e) / I_o$ (2M)

$= - R_e$

Since the input signal Vi without feedback is the Vs, then

$G_m = I_o/V_i = (-h_{fe} . I_b)/ V_s$

$= -h_{fe} /(R_s+h_{ie}+ R_e)$ ----------------------------(A)

$D = 1+\beta * G_m = 1+(h_{fe}*R_e)/(R_s+h_{ie}+R_e)$ (2M)

$D = [R_s + h_{ie} + (1+h_{fe}) R_e] / (R_s + h_{ie} +R_e)$

$G_{mf} = G_m / D$

$G_{mf} = -h_{fe} / [R_s + h_{ie} + (1+h_{fe}) R_e]$

If $(1+h_{fe})*R_e >> R_s+h_{ie}$, and

Since $h_{fe} >> 1$; then $G_{mf} \sim -1/R_e$; $G_{mf} \sim 1/\beta$.

Voltage gain (2M)

$A_{vf} = (I_o*R_L) / V_s = G_{mf} * R_L = (- h_{fe} * R_L) / [R_s + h_{ie}+(1+h_{fe})* R_e]$

$A_{vf} \sim - R_L / R_e$; the voltage gain is stable if RL, Re are stable resistors.

$R_i = R_s + h_{ie} + R_e$.

$R_{if} = R_i *D = R_s+h_{ie}+ (1+h_{fe}) R_e$. (1M)

Since $R_o = \infty$, then $R_{of} = R_o (1+\beta G_m) = \infty$. (1M)

Hence $R'_{of} = R_L \| R_{of} = R_L$.

An alternative derivation is $R'_{of} = R'_o (1+\beta G_m)/ (1+\beta G_M)$

Since Gm represents the short circuit Trans conductance, then $G_m = \lim_{R\to 0} G_M$

From equation (A), GM is independent of RL,

And hence $G_m = G_M$ and $R'_{of} = R'_o = R_L$

3

Draw the circuits of voltage shunt and current series feedback amplifiers and derive the expression for input impedance Rif. (10M) (Dec 12) BTL1

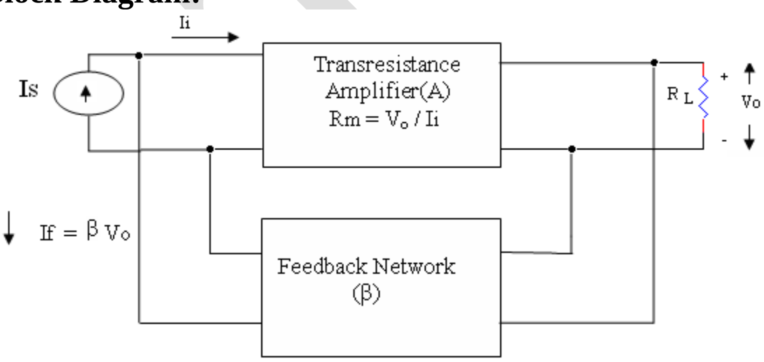
Answer: Page 561 - S. Salivahanan

Voltage shunt feedback connection. (or) Shunt Shunt feedback:-

Output voltage - directly proportional - Input current - "Trans resistance amplifier".

i.e., $A = V_o / I_i$ (or) $V_o = A I_i$.

Block Diagram: (2M)



Voltage Gain: (1M)

$A = V_o / I_i$ = Gain of amplifier without feedback.

$\beta = I_f / V_o$

$I_s = I_i + I_f$

$= I_i + \beta V_o$

$= I_i + \beta A I_i$

$I_s = I_i(1 + A \beta)$

$A_f = V_o / I_s$ = Gain of amplifier with feedback.

$$A_F = \frac{A}{1 + A\beta}$$

Input Impedance: - (1M)

$$Zif = \frac{Zi}{1 + A\beta}$$

Output Impedance: - (1M)

$$Rof = \frac{Ro}{1 + A\beta}$$

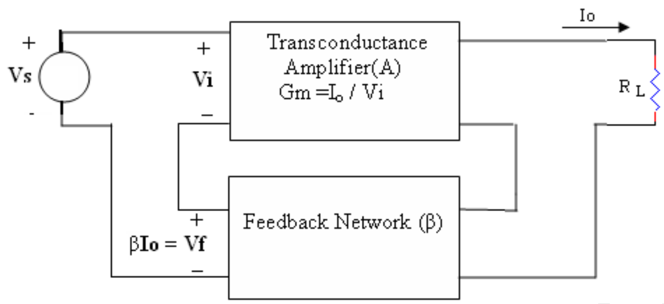
Output impedance of voltage shunt feedback - reduced - the Desensitivity factor of (1 + Aβ) - output impedance of amplifier without feedback Zo = Ro.

Current Series feedback connection. (or) Series Series feedback:-

Output current - directly proportional - Input voltage-"Trans conductance amplifier '".

i.e., A = Io / Vi (or) Io = A Vi.

Block Diagram: (2M)



The property of Trans conductance amplifier

Ri >> Rs ; Ro >> RL thus Io = IL

Voltage Gain: (1M)

Let the gain of amplifier without feedback

A= Io / Vi and β = Vf / Io.

We Know,

Vs = Vi + Vf

The gain of the amplifier with feedback

Af = Io / Vs

$$A_F = \frac{A}{1 + A\beta}$$

Input Impedance: (1M)

Vs = Vi + Vf

= I iRi + Vf

= Ii Ri + β Io

= Ii Ri + A β Vi

Where,

Io = A Vi

Vs = Ii Ri + A β Ii Ri

Vs = Ii Ri [1+ A β]

Rif = Ri [1+ A β]

Input impedance gets increased by the factor (1 + Aβ).

Output Impedance: (1M)

	Assume - source voltage - transferred - output terminals - Vs shorted i.e Vs = 0, resulting - current Io into the circuit. $V_s = V_i + V_f$ $Z_{of} = Z_o[1 + A \beta]$ Output impedance - amplifier with feedback- Output impedance - increased by a factor of $(1 + A \beta)$.

UNIT II – OSCILLATORS	
Barkhausen criterion for oscillation – phase shift, Wien bridge - Hartley & Colpitt's oscillators – Clapp oscillator-Ring oscillators and crystal oscillators – oscillator amplitude stabilization.	
PART * A	
Q.No.	**Questions**
1.	**Define an Oscillator circuit.** BTL1 An Oscillator is a circuit, which basically act as a Generator, generating the output signal which oscillates with a constant amplitude and constant desired frequency.
2.	**Classify Oscillators based on different criterions**. BTL2 Based on waveform generated: • Sinusoidal Oscillator. • Non-Sinusoidal Oscillator or Relaxation Oscillator Example: Square wave, Triangular wave, Rectangular wave etc. According to principle involved: • Negative resistance Oscillator, • Feedback Oscillator. According to frequency generated: • Audio frequency oscillator - 20Hz – 20 KHz • Radio frequency oscillator - 30 KHz – 30 MHz • Ultrahigh frequency oscillator - 30 MHz – 3 GHz • Microwave Oscillator - 3 GHZ above • Crystal oscillator
3.	**Name the various types of feedback oscillators.** BTL1 RC oscillators – Types • RC phase shift oscillator • Wein bridge oscillator LC oscillators – Types • Tuned collector oscillator • Tuned emitter oscillator • Tuned collector base oscillator • Hartley oscillator • Colpitts oscillator • Clapp oscillator.
4.	**Discuss the conditions to be satisfied for oscillation. (Nov 2017)** BTL6 The total phase shift of an oscillator should be 360° for feedback, product of open loop gain & feedback factor should be unity. Oscillator should satisfy Barkhausen criterion.
5.	**Define piezoelectric effect.** BTL1 When applying mechanical energy to some type of crystals called piezoelectric crystals the mechanical energy is converted into electrical energy is called piezoelectric effect.
6.	**What is Miller crystal oscillator? Explain its operation?** BTL1 It is nothing but a Hartley oscillator with its feedback Network is replaced by a crystal. Crystal normally has higher frequency reactance due to the miller capacitance that are in effect between the transistor terminal.

7.	**Define Barkhausen Criteria. (May 2014) (April 2015, April 2017) (Nov 2017)** BTL1 1. The total phase shift around a loop, as the signal proceeds from input through amplifier, feedback network back to input again, completing a loop, is precisely 0^0 or 360^0. 2. The magnitude of the product of the open loop gain of the amplifier (A) and the feedback factor β is unity. i.e., A β = 1.
8.	**Name two low frequency and high frequency oscillators. (Nov 2017)** BTL1 Low frequency oscillators are • RC phase shift oscillator • Wein bridge oscillator High frequency oscillators are • Hartley oscillator • Colpitts oscillator
9.	**List the advantages of crystal oscillators.** BTL1 Frequency stability is greater. Hence,they are used in watches, communication transmitters and receivers.
10.	**List the advantages of the RC phase shift oscillator. (May 2016, Nov 2017).** BTL1 • The circuit is simple to design • Can produce output over AF range • Produces sinusoidal output waveform • It is fixed frequency oscillation.
11.	**Identify which oscillator uses both positive and negative feedback.** BTL3 Wein bridge oscillator
12.	**Discuss about the construction of Armstrong oscillator.** BTL6 It is a type of *LC* oscillator. In this oscillator, a transformer is used, whose primary acts as L in the circuit while the voltage across the secondary is used as a feedback.
13.	**List the factors that affect the frequency stability of an oscillator. (Nov-2016)** BTL1 • Change in temperature • Change in load • Change in power supply
14.	**List the essential parts of an oscillator.** BTL1 • Tank circuits (or) oscillatory circuit. • Amplifier (Transistor amplifier) and • Feedback circuit.
15	**List the disadvantages of crystal oscillator.** BTL1 • It is suitable for only low power circuits. • Large amplitude of vibrations may crack the crystal. The change in frequency is only possible replacing the crystal with another one by different frequency.
16	**Compare an oscillator & an amplifier**. BTL4

Oscillator	Amplifier

They are self-generating circuits. The generate waveforms like sine, square and triangular waveforms of their own, without having input signal.	They are not self-generating circuits. They need a signal at the input and they just increase the level of the input waveform.
It has infinite gain	It has finite gain.
Oscillator uses positive feedback	Amplifier uses negative feedback

17. **List the disadvantages of RC phase shift oscillator. (April 2008)** BTL1

- It is ideal for frequency adjustment over a wide range.
- It requires a high β transistor to overcome losses in the network.

18. **Explain about resonant circuit oscillators.** BTL5

LC oscillators are known as resonant circuit oscillator because the frequency of operation of LC oscillator is nothing but a resonant frequency of tank circuit or LC tank circuit which produces sustained, oscillation at resonant circuit oscillator output.

19. **Justify the need of RC phase shift in a RC phase shift oscillator.** BTL5

The amplifier used causes a phase shift of 180 then the feedback network should create phase shift of 180°, to satisfy the Barkhausen criterion. Hence in phase shift oscillators, three sections of RC circuit are connected in cascade, each introducing a shift of 60, thus introducing a total phase shift 180°, due to feedback network, a phase shift of 180° is introducing providing a total phase shift of 360°.

20. **Wein Bridge oscillator is used for operation at 10 KHz. If the value of resistance R is 100 kΩ, Evaluate the value of C required (Nov 2008).** BTL5

F=1/(2πRC)

C= 159.155PF

21. **Discuss about frequency stability of an oscillator (May 2009)** BTL6

The analysis of the dependence of the oscillating frequency on the various factors like stray capacitance, temperature etc. is called frequency stability analysis.

22. **In a RC phase shift oscillator, if R1 =R2 =R3= 200k and C1=C2=C3=100pf, Estimate the frequency of the oscillator. (April 2010).** BTL5

The frequency of oscillator is F=1/(2πRC) = 7.957 *kHZ*

23. **A crystal has the following parameters L= 0.5 H, C=0.05pf, and mounting capacitance is 2 pf, Estimate its series and parallel resonating frequencies. (Nov 2010)** BTL5

Series resonance frequency:

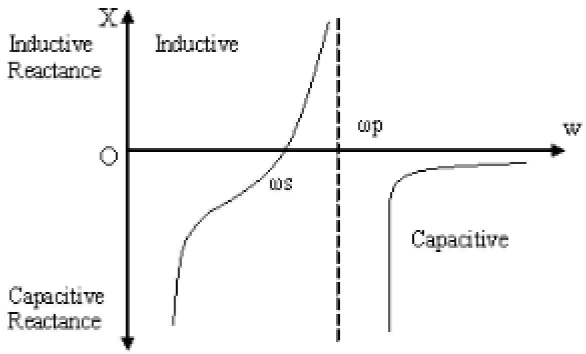
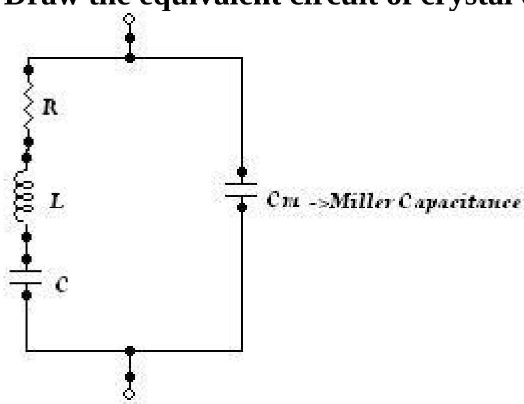
$$f_s = 1/(2\pi\sqrt{LCs})$$

$$= 1/2\pi\sqrt{(0.5 * 0.05 * 10^{-12})}$$

$$fs = 1 \text{ MHz}$$

Parallel resonance frequency:

$$f_p = \frac{1}{2\pi}\sqrt{\frac{Cs+Cp}{LCsCp}}$$

	$$= \frac{\mathbf{1}}{\mathbf{2\pi}}\sqrt{\frac{0.05*10^{-12}+2*10^{-12}}{0.05*10^{-12}*2*10^{-12}*0.5}}$$ = 1MHz
24.	**Draw the frequency V3 reactance curve for a crystal oscillator.** BTL1 
25.	**Draw the equivalent circuit of crystal oscillator.** BTL1 
26.	**Compare between Colpitts's and Clap Oscillator. (April 2015)** BTL4 Colpitts oscillator: An LC Oscillator which uses 2 capacitive reactances and one inductive reactance in the feedback network. Clapp oscillator: • It is similar to that of colpitts oscillator but modification in the tank circuit is that one more capacitor C3 is introduced in series with the inductance. • Good frequency stability. • The stray capacitances have no effect on C3 which decides the frequency.
	PART*B
1.	**A crystal with L=0.4H, C=0.085PF and Cm=1PF, with R=5KΩ,** **Find Series Resonant frequency, (4M)** **Parallel resonant frequency, (3M)** **By what percent does parallel resonant frequency exceeds the series resonant frequency? (3M)** **Find the Q factor (3M) (May2018)** BTL4 **Answer: Page 611- S. Salivahanan**

Series resonance frequency: (4M)

$$f_s = 1/(2\pi\sqrt{LCs})$$

$$= 1/2\pi\sqrt{(0.4 * 0.085 * 10^{-12})}$$

$$fs = 863.13 \text{ KHz}$$

Parallel resonance frequency: (3M)

$$\boldsymbol{f_p = \frac{1}{2\pi}\sqrt{\frac{Cs+Cp}{LCsCp}}}$$

$$= \frac{\mathbf{1}}{\mathbf{2\pi}}\sqrt{\frac{0.085 * 10^{-12} + 1 * 10^{-12}}{0.085 * 10^{-12} * 1 * 10^{-12} * 0.4}}$$

= 899.07 KHz

parallel resonant frequency exceeds the series resonant frequency by 899.07-863.13 KHz = 36 KHz. (3M)

Q Factor: Q =ωL/R = 0.45 (3M)

2.

Illustrate the working principle of Clapp oscillator with neat diagram (7M) (May2018) BTL2

Answer: Page 590- S. Salivahanan

Introduction:

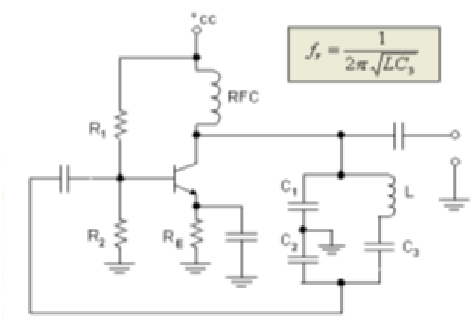
- Modified colpitts oscillator circuit - called clap oscillator. (2M)
- The basic tank circuit with two capacitive reactances --one inductive reactance remains same. Modification -one more capacitor C3 is introduced in series with inductance.
- C3 much smaller than C1 and C2.

Frequency of Oscillation & Condition for Sustained Oscillation: (2M)

$$h_{fe} = \frac{C1}{C2}$$

$$f = \frac{A}{2\pi\sqrt{LC_{eq}}}$$

Circuit Diagram: (3M)



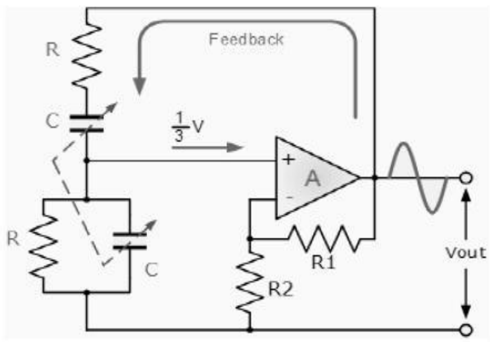
3.

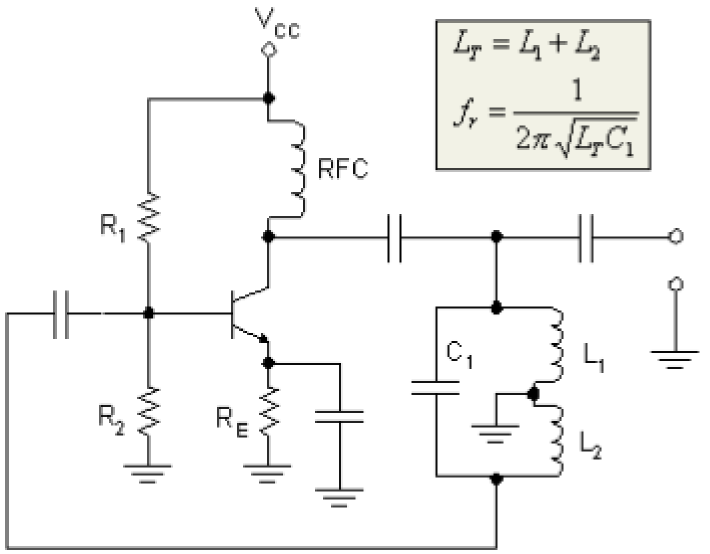
Draw the Wein bridge oscillator using BJT, explain and derive the condition for oscillation. (10M) (Nov 2017) (Nov/Dec- 2003), (Nov/Dec- 2004) (April- 2004) (or)

Draw the circuit of Wein bridge oscillator using BJT. Show that the gain of the amplifier must be at least three for the oscillation to occur (10M) (Nov 12) BTL5

Answer: Page 605- S. Salivahanan

Introduction: (3M)

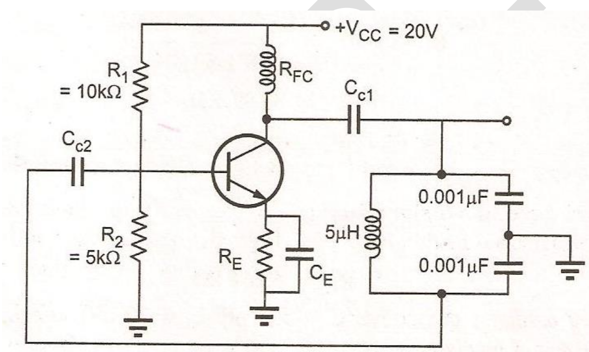
	• Wein bridge oscillator -audio frequency oscillator. • Involves both positive and negative feedback. • Negative feedback – stability. • Positive feedback - oscillations. • Feedback network - not produce - phase shift. • The circuit consists -two transistors- operated - CE configuration. • The transistors- individually -provide - phase shift of 180° - overall phase shift is 360° - fed back - first stage - bridge network. **Circuit Diagram:** (3M)  **The frequency of oscillator** is F=1/(2πRC) (2M) **Advantages of wein bridge oscillator :-** (2M) 1. Good sine wave output. 2. Good frequency stability. 3. Good Amplitude stability.
4.	**In Colpitts oscillator, C1=1µF, C2=0.2µF. If the frequency of oscillation is 10 KHz, find the value of inductor; also find the required gain for sustained oscillation. (3M) (Nov 2017)** BTL2 **Answer: Page 588- S. Salivahanan** **Frequency of Oscillation**: $f = \frac{1}{2\pi\sqrt{LC_{eq}}}$ (1M) $C_{eq} = C_1C_2/(C_1+C_2)$ (1M) L=0.422mH (1M)
5.	**Draw Hartley oscillator using FET, explain and derive the condition for oscillation. (13M) (Nov 2017)** BTL4 **Answer: Page 582- S. Salivahanan** **Introduction:** (2M) • LC Oscillator • Two inductive reactance's - one capacitive reactance - feedback network - Hartley Oscillator. **Frequency of Oscillation:** (3M) $$f = \frac{1}{2\pi\sqrt{L_{eq}C}}$$ $$L_{eq} = L1 + L2$$ **Circuit Diagram** & **Explanation** (4M+4M) 180^0 phase shift – feedback network- another 180^0 phase shift – CE amplifier. Total 360^0 phase shift.



6. **With the help of circuit diagram, explain the principle of operation of Colpitts oscillator. Obtain the frequency of operation of the circuit. (13M) (May 17), (Nov 12), (Nov2014)** BTL4

Answer: Page 585- S. Salivahanan

- **Oscillator**: Generate signal – without input signal. (1M)
- **Components:** $Z_1 = C_1$, $Z_2 = C_2$, $Z_3 = L$ (1M)
- **Circuit Diagram & Explanation**: (4M+4M)
  180^0 phase shift – feedback network- another 180^0 phase shift – CE amplifier. Total 360^0 phase shift.



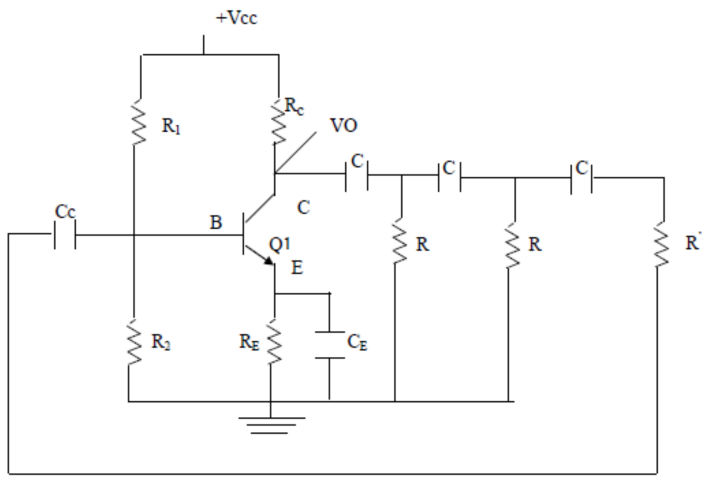
- **Frequency of Oscillation**: $f = \frac{1}{2\pi\sqrt{LC_{eq}}}$ (3M)

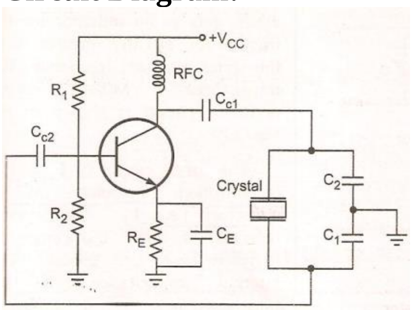
7. **Sketch the circuit of RC phase shift oscillator, and explain its design approach. (10M) (May 2017)(May 2003).** BTL2

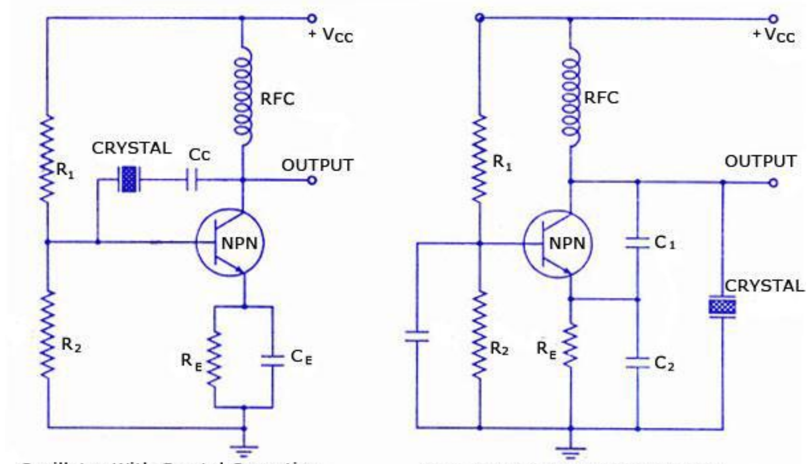
Answer: Page 593- S. Salivahanan

Introduction: (3M)

- RC phase shift oscillator - audio frequency - low frequency oscillator.
- CE amplifier -output - to three RC networks.
- Phase shift- pr
- oduced by the CE amplifier -180^o.
- Oscillator- requires - phase shift - 0^o or 360^o, - additional 180^o -phase shift - obtained -three RC networks - individual shift of 60^o each.

	Circuit Diagram: (3M)  **Barkhausen criterion**, (4M) Aβ = 1 **Condition for Oscillation**: f = 1/2πRC √ 6 Aβ = 1. Sustained oscillations β = - 1/29
9.	**In a colpitts oscillator, inductor and capacitor of the tank circuit are H=40mH, C1=100pF, C2=500pF, Find the frequency of oscillation. (3M) (May 2017).** BTL2 **Answer: Page 589- S. Salivahanan** **Frequency of oscillation:** $f = \frac{1}{2\pi\sqrt{LC_{eq}}}$ (1M) Ceq =C1*C2/C1+C2 = 83.33 pF (1M) F= 87.17KHz (1M)
10.	**Discus thoroughly, the factors affecting frequency stability of oscillators. (6M)** BTL6 **Answer: Page 613- S. Salivahanan** • Change in temperature (6M) • Values of tank circuit components get affected. • Parameters of active device get affected. • Variation in power supply • Change in atmospheric condition, aging. • Changes in load connected. • Stray capacitances
	PART * C
1.	**Design a Hartley oscillator of frequency 100 KHz, and explain its working with neat circuit diagram, Assume L1=L2=4mH. (15M) (May2018)** BTL6 **Answer: Page 584- S. Salivahanan** $f = \frac{1}{2\pi\sqrt{CL_{eq}}}$ (3M) Leq =L1+L2 =8mH (3M) $100*10^3 = \frac{1}{2\pi\sqrt{C*8*10^{-3}}}$

	C=316.6pF (3M) **Diagram**: (6M)
2.	**Using a circuit diagram of a transistorized pierce crystal oscillator, explain its operation. (10M)** BTL2 **Answer: Page 609- S. Salivahanan** **Circuit Diagram:** (4M)  Resonant frequency of the crystal -change in temp- voltage supply- transistor parameter - no effect on frequency stability. (6M) $$f=\frac{1}{2\pi\sqrt{LC_s}}$$
3.	**Explain the working of miller crystal oscillator. (10M)** BTL1 **Answer: Page 612- S. Salivahanan** **Introduction:** (2M) Miller crystal oscillator - modifications -colpitts oscillator- Hartley oscillator. **Circuit Diagram & Explanation:** (4M+4M) • Hartley oscillator circuits- two inductors -one capacitor - required - tank circuit. • One inductor - replaced - crystal, which acts as an inductor - frequencies slightly -greater than - series resonant frequency. • The tuned circuit - 'L1' - 'C' - off tuned - behave - inductor i.e. L1. • The crystal - behaves - other inductance L2 between base - ground. • The internal capacitance - transistor acts - capacitor - to fulfil the elements - tank circuit. • The common emitter - provides a phase shift of 180°. • Tank circuit - additional phase shift of 180° - satisfy oscillation conditions. • Crystal decides - operating frequency - oscillator.

	 Oscillator With Crystal Operating in Series Resonance Oscillator With Crystal Operating in Parallel Resonance

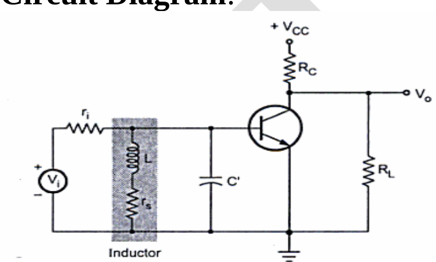
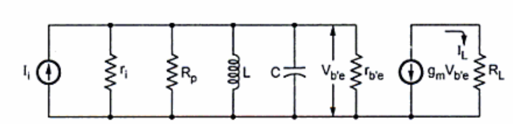
UNIT III – TUNED AMPLIFIERS

Coil losses, unloaded and loaded Q of tank circuits, small signal tuned amplifiers –Analysis of capacitor coupled single tuned amplifier – double tuned amplifier - effect of cascading single tuned and double tuned amplifiers on bandwidth – Stagger tuned amplifiers - Stability of tuned amplifiers – Neutralization - Hazeltine neutralization method.

PART * A

Q.No.	Questions
1.	**What is a tuned amplifier?** BTL1 The amplifier with a circuit that is capable of amplifying a signal over a narrow band of frequencies are called tuned amplifiers.
2	**List the advantages and disadvantages of tuned amplifiers.** BTL1 Advantages: • They amplify defined frequencies. • Signal to Noise ratio at output is good. • They are well suited for radio transmitters and receivers. • The band of frequencies over which amplification is required can be varied. Disadvantages: • Since they use inductors and capacitors as tuning elements, the circuit is bulky and costly. • If the band of frequency is increased, design becomes complex. • They are not suitable to amplify audio frequencies.
3	**What are the different coil losses?** BTL1 • Hysteresis loss • Copper loss • Current loss
4	**What is the classification of tuned amplifiers?** BTL1 • Single tuned • Double tuned • Stagger tuned
5	**What are the advantages of tuned amplifiers?** BTL1 • They amplify defined frequencies.

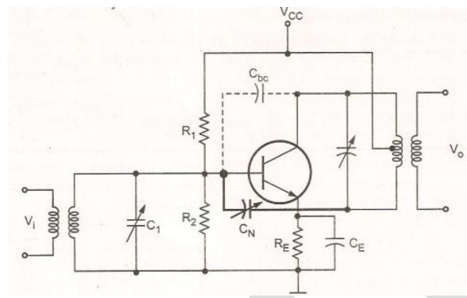
	• Signal to noise ratio at output is good • They are suited for radio transmitters and receivers
6	**What is neutralization?** BTL1 The effect of collector to base capacitance of the transistor is neutralized by introducing a signal that cancels the signal coupled through collector base capacitance. This process is called neutralization.
7	**What are the advantages of double tuned over single tuned?** BTL1 • Possess flatter response having steeper sides • Provides larger 3 dB bandwidth • Provides large gain-bandwidth product.
8	**What are the different types of neutralization?** BTL1 • Hazeltine neutralization • Rice neutralization • Neutrodyne neutralization.
9	**What is rice neutralization?** BTL1 It uses centre tapped coil in the base circuit. The signal voltages at the end of tuned base coil are equal and out of phase.
10	**Define Q factor of resonant circuit.** BTL1 • It is the ratio of reactance to resistance. • It also can be defined as the measure of efficiency with which inductor can store the energy. Q=2π *(Maximum Energy Stored per cycle / Energy dissipated per cycle)
11	**Define unloaded and loaded Q of tuned circuit.** BTL1 The unloaded Q or QU is the ratio of stored energy to dissipated energy in a reactor or resonator. The loaded Q or QL of a resonator is determined by how tightly the resonator is coupled to its terminations.
12	**What is the response of tuned amplifiers?** BTL1 The response of tuned amplifier is maximum at resonant frequency and it falls sharply for frequencies below and above the resonant frequency.
13	**What are stagger tuned amplifiers?** BTL1 Stagger tuned amplifiers use a number of single tuned stages in cascade, the successive tuned circuits being tuned to slightly different frequencies. (OR) 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.
14	**What is the effect of cascading single tuned amplifiers on bandwidth?** BTL1 Bandwidth reduces due to cascading single tuned amplifiers.
15	**What are the advantages of double tuned amplifier over single tuned amplifier?** BTL1 • It provides larger 3 dB bandwidth than the single tuned amplifier and hence provides the larger gain-bandwidth product. • It provides gain versus frequency curve having steeper sides and flatter top.

16	**What is the use of Neutralization?** BTL1 • BJT and FET are potentially unstable over some frequency range due to the feedback parameter presents in them. • If the feedback can be cancelled by an additional feedback signal that is equal in amplitude and opposite in sign, the transistor becomes unilateral from input to output the oscillations completely stop. • This is achieved by Neutralization.
17	**Mention the applications of class C tuned amplifier.** BTL1 • Class C amplifiers are used primarily in high-power, high-frequency applications such as Radio-frequency transmitters. • In these applications, the high frequency pulses handled by the amplifier are not themselves the signal, but constitute what is called the Carrier for the signal
18	**What the advantages are of stagger tuned amplifier?** BTL1 The advantage of stagger tuned amplifier is to have better flat, wideband characteristics.
19	**How single tuned amplifiers are classified?** BTL1 • Capacitance coupled single tuned amplifier. • 2. Transformer coupled or inductively coupled single tuned amplifier.
20	**What is dissipation factor?** BTL1 It is defined as 1/Q. It can be referred to as the total loss within a component.
	PART*B
1.	**Demonstrate on single tuned amplifier and derive for gain and resonant frequency. (13M) (May2018) (Nov 2017)** BTL2 **Answer: Page 497- S. Salivahanan** **Introduction**: (2M) Single tuned amplifier - consists - CE amplifier - which a tuning circuit - included - - input (base terminal) - output (collector terminal). **Circuit Diagram**: (3M)  **Equivalent circuit:** (3M)  $A_i = \frac{-g_m R}{1 + jQ_i(\omega/\omega_o - \omega_o/\omega)}$ (2M) $BW = \frac{1}{2\pi RC}$ (3M)
2	**Explain the stability of tuned amplifiers using Neutralization techniques. (13M) (May2018)**

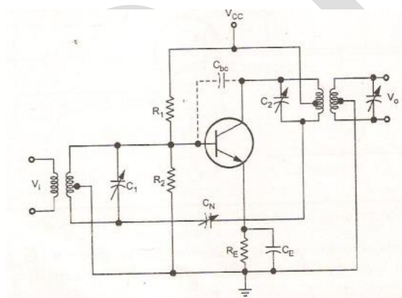
(Nov 2017) BTL1

Answer: Page 521- S. Salivahanan

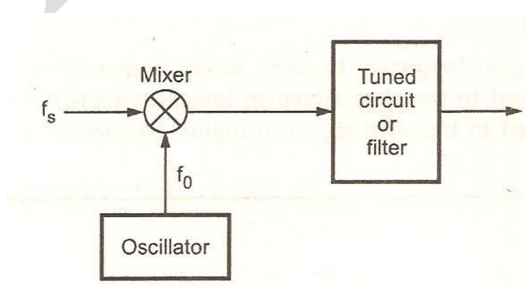
i) Internal capacitance C_{bc} -feeds - signal from top end - coil - neutralization capacitance C_N feeds an equal signal - opposite polarity. (5M)



ii) Uses a center tapped coil - base circuit, - signal voltages - both ends -e tuned base coil -equal -out of phase. (5M)



The mixer accepts two inputs, f_s & f_o -performs mathematical multiplication - produce; f_s ,f_o ,$f_s + f_o$ *and* $f_s - f_o$. (3M)

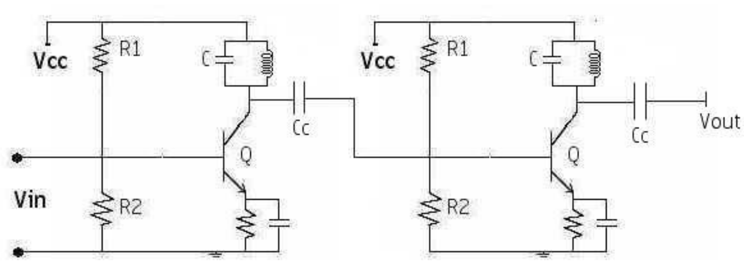
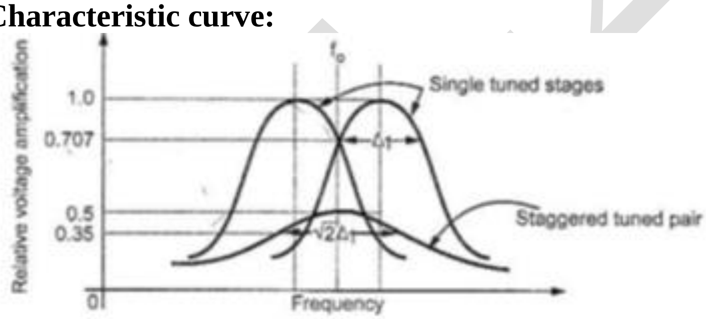


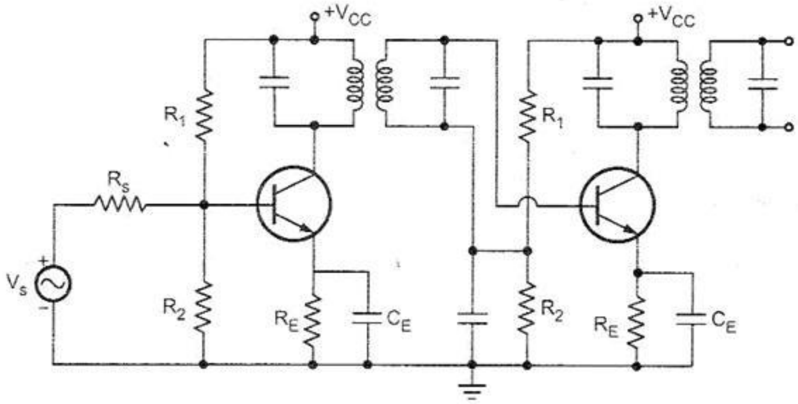
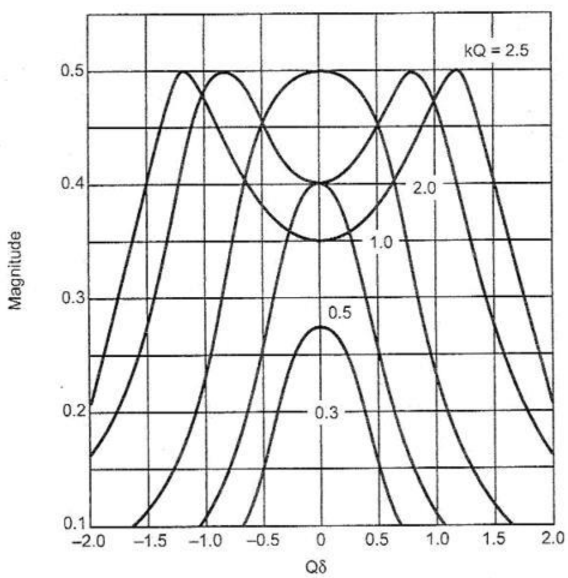
3 **Explain Stagger tuned Amplifiers (4M) (Nov 2017) (Nov 2012)** BTL1

Answer: Page 514- S. Salivahanan

Introduction:

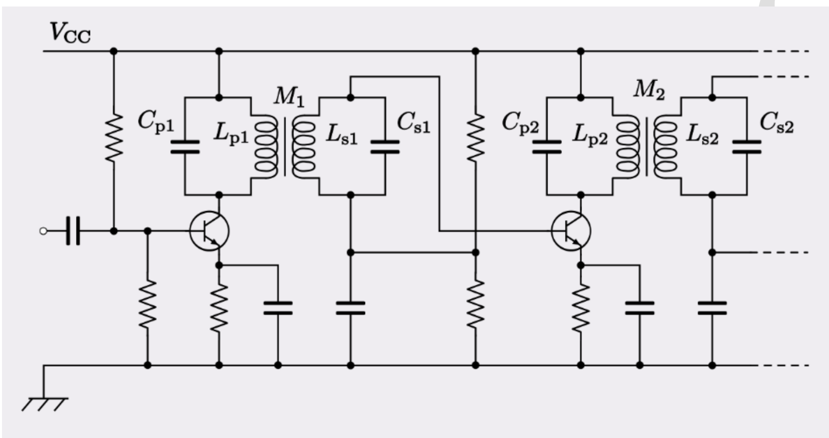
- The double tuned amplifier - greater 3dB bandwidth - steeper sides - flat top.
- Alignment - double tuned amplifier - difficult.

	• To overcome -problem: two single tuned cascaded amplifiers - certain bandwidth - taken - resonant frequencies - adjusted - equal to the bandwidth • Resonant frequencies - displaced or staggered - stagger tuned amplifiers. • Advantage: better flat, wideband characteristic **Circuit Diagram:**  (2M) **Gain**: $\left\|\frac{A_v}{A_v\text{ (at resonance)}}\right\|_{\text{cascaded}} = \frac{1}{\sqrt{4+(2Q_{eff}\delta)^4}} = \frac{1}{\sqrt{4+16Q_{eff}^4\delta^4}}$ $= \frac{1}{2\sqrt{1+4Q_{eff}^4\delta^4}}$ (1M) **Characteristic curve:**  Response of individually tuned and staggered tuned pair (1M)
4	**Draw the circuit of double tuned amplifier and explain its operation. Sketch the nature of frequency-gain characteristics, and write the expression for 3dB bandwidth. (13M) (May 2017) (Nov 2012).** BTL2 **Answer: Page 503- S. Salivahanan** **Introduction:** (2M) • Double tuned RF amplifier in CE configuration. • Voltage developed - tuned circuit - coupled inductively - another tuned circuit. • Both tuned circuits - tuned - same frequency. **Circuit Diagram**: (4M)

	 **Gain:** (3M) $$\|A_v\| = g_m \omega_r \sqrt{L_1 L_2}\, Q \frac{kQ}{\sqrt{1+k^2Q^2-4Q^2\delta^2+16Q^2\delta^2}}$$ **Characteristic Curve:** (4M) 
5	**Draw the circuit diagram of a two-stage synchronously tuned amplifier and also its equivalent circuit. Derive the expression for bandwidth. (8M) (Nov 2012)** BTL2 **Answer: Page 503- S. Salivahanan** **Introduction**: (2M) • Cascaded stage - single tuned amplifiers - tuned same frequency. • Assume - individual amplifier stages - identical. • Overall gain - product of the individual gain. • Gain is high - bandwidth is reduced. **Gain and BW**: (2M) The overall gain of the amplifier is Ai (Overall) = $[Ai]_{\text{I stage}} * [Ai]_{\text{II stage}}$ The resonant frequency $fo = \frac{1}{2\pi\sqrt{L1C1}}$

$$BW = f3 - f1 = \frac{1}{2\pi RC}\sqrt{2^{\frac{1}{2}} - 1}$$

Bandwidth of cascaded stage = 0.643 B.W (individual stage).
Bandwidth decreases on cascading.
Bandwidth of 'n' cascaded stage = $\sqrt{2^n - 1}$* B.W (individual stage). (2M)
Circuit Diagram: (2M)

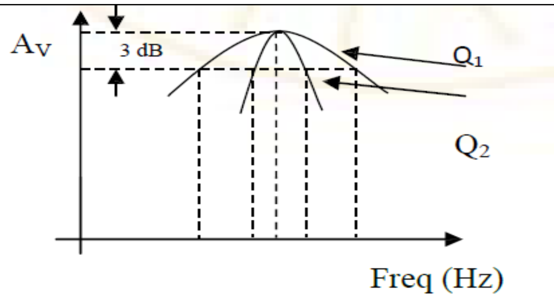


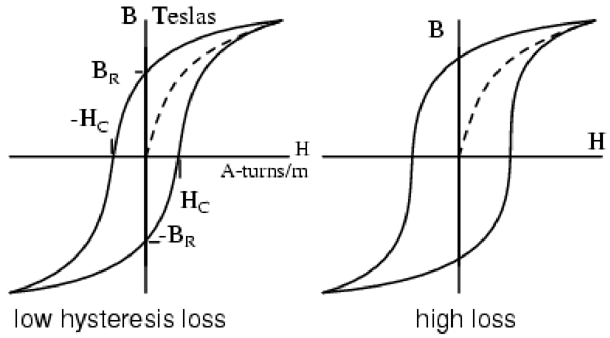
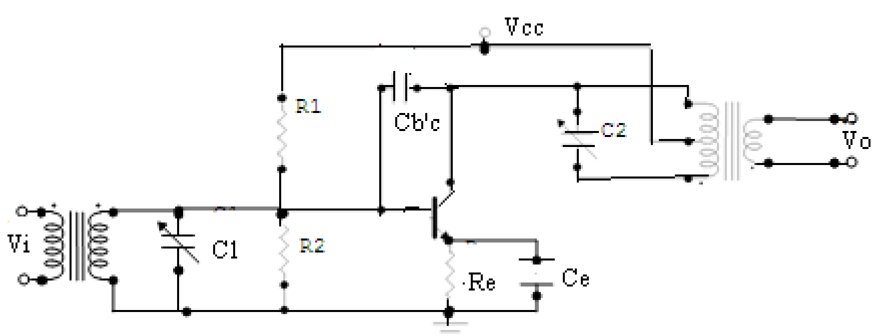
6

Discuss in detail the quality factor of the loaded and unloaded tank Circuits. (8M) BTL6
Answer: Page 494- S. Salivahanan
Q Factor: (2M)
Quality factor (Q) - important characteristics of an inductor.
The Q - ratio - reactance - resistance - unit less.
Measure - how 'Pure' or 'real' an inductor.
Unloaded Q (QU) (2M)
When the tank circuit (parallel LC circuit) - assumed - not connected - any external circuit - load, Q accounts for the internal losses - called unloaded quality factor 'Qu'.
Ro = (ωOL) / QU
Loaded Q (QL): (2M)
RC = (ωO L) / QL.
The circuit efficiency for the above tank circuit.

$$\eta = (I^2 R_C) / [I^2 (R_C + R_O)]$$

The quality factor QL - the 3-db bandwidth - resonant circuit -
B.W = f r / QL fr -represents the centre frequency.
Relation between Bandwidth and Q: (2M)

	
7	**Calculate the resonant frequency of a class c tuned amplifier whose Capacitor=10pf and inductor L=1mH. (8M)** BTL2 **Answer: Page 518- S. Salivahanan** **Solution:** The resonant frequency of class-c tuned amplifier is fr = 1 / 2 π *LC* (4M) fr = 1.59 MHz (4M)
8	**Write a short on coil losses. (8M)** BTL1 **Answer: Page 503- S. Salivahanan** • Tuned circuit consists - coil. • Practically-coil -not purely inductive. • It consists - few losses - represented - leakage resistance - series with the resistor. **Losses in Inductor:** (1M) 1. Copper loss 2. Hysteresis loss 3. Eddy-currents loss **Copper loss** (2M) **Copper loss** -heat produced by electrical currents - conductors - transformer windings, - other electrical devices. Copper Loss=I^2R=Copper Loss = 1/ f **Eddy-currents loss** (2M) • Eddy current loss in iron and copper coil -due to currents flowing within the copper or core- cased by induction. • Loss- due - heating within - inductors copper - core. • Eddy current losses - directly proportional - frequency. **Hysteresis loss** (2M) If - magnetic field applied - magnetic material - increased -then decreased back - original value, t- magnetic field inside the material does not return - original value. The internal field 'lags' behind - external field- behaviour results - loss - energy, called the **hysteresis loss**, when a sample - repeatedly magnetized and demagnetized. (1M)

	
9	**Explain the stabilization techniques used in tuned amplifier. (4M)** BTL2 **Answer: Page 519- S. Salivahanan** **High frequency effects:** (2M) In tuned RF amplifiers, transistors - used at - frequencies nearer - their unity gain bandwidths (i.e fT), - amplify a narrow band - high frequencies cantered around - radio frequency. **Circuit Diagram**: (2M)  The neutralization - achieved - deliberating feeding back a portion - output signal - input -same amplitude - unwanted feedback - opposite phase.
	PART * C
1	**A tank circuit having 5mH coil with resistance 22Ω, and C=1nF, is connected as a load to a single tuned amplifier with R0=10K. Calculate the loaded and unloaded Q factor. (6M) (Nov 2017)** BTL4 **Answer: Page 494- S. Salivahanan** **Unloaded Q (Q_U)** (3M) Ro = (ωOL) / QU **Loaded Q (QL):** (3M) RC = (ωO L) / QL.
2	**Explain the Hazeltine method of neutralization. (8M) (or) What is Hazeltine Method of neutralization? How does a Neutrodyne circuit differ from the Hazeltine Circuit? [APR-**

<table>
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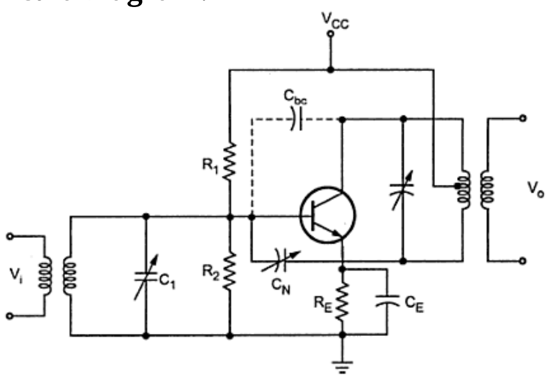
2003] BTL1

Answer: Page 522- S. Salivahanan

Introduction: (2M)

Grid to plate capacitance - tube - neutralized - introducing into the grid circuit a signal - cancelled the signal coupled through the grid to plate capacitance.

Circuit Diagram: (3M)



Tuned RF amplifier with Hazeltine neutralization

Working (3M)

- The primary and secondary windings - Rf transformer must be properly polarized -allow neutralization.
- Primary - frequently inter wound - ground end portion of the secondary coil - tight coupling.

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The bandwidth of a double-tuned amplifier is 10 KHz. Calculate the number of such stages to be connected to obtain the bandwidth of 5.098 KHz. (7M) BTL4

Answer: Page 513- S. Salivahanan

Solution:

BWT = BW1 $(2^{1/n} - 1)^{1/4}$ (2M)

21/n = 1.0676.

Taking log on both sides,

1/n log (2) = log(1.0676)

n = 10 (5M)

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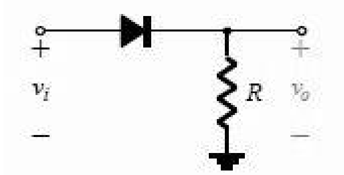
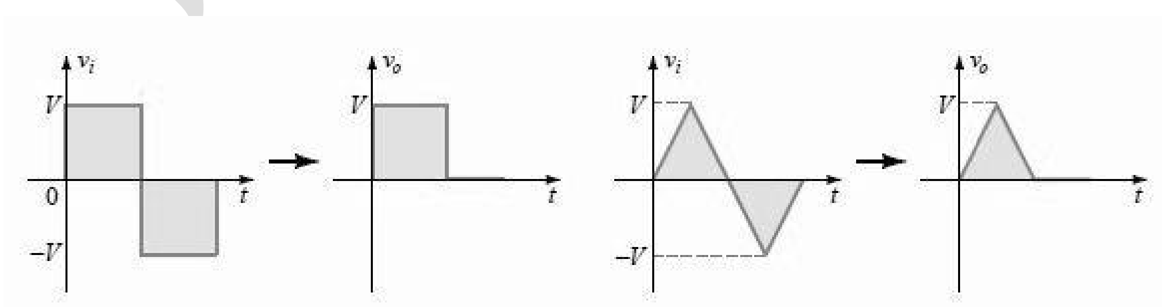
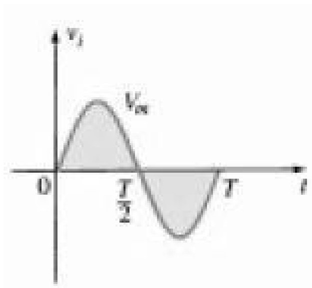
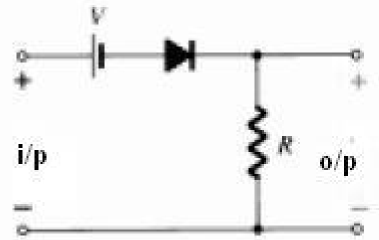
UNIT IV– WAVE SHAPING AND MULTIVIBRATOR CIRCUITS	
Pulse circuits – attenuators – RC integrator and differentiator circuits – diode clampers and clippers –Multivibrators - Schmitt Trigger- UJT Oscillator.	
PART * A	
Q.No.	**Questions**
1	**What is High pass RC circuit? Why it is called high-pass filter?** BTL1 • A simple circuit consisting of a series capacitor and a shunt resistor is called high pass RC circuit. • At very high frequencies the capacitor acts as a short circuit and all the higher frequency components appear at the output with less attenuation than the lower frequency components. Hence this circuit is called high-pass circuit.
2	**Why high-pass RC circuit is called Differentiator?** BTL1 High-pass RC circuit gives an output waveform similar to the first derivative of the input waveform. Hence it is called Differentiator.
3	**What is Low pass RC circuit? Why it is called low-pass filter?** BTL1 • A simple circuit consisting of a series resistor and a shunt capacitor is called Low pass RC circuit. • At very high frequencies the capacitor acts as a virtual short circuit and output falls to zero. Hence this circuit is called low-pass filter
4	**Why low-pass RC circuit is called Integrator?** BTL1 Low pass RC circuit gives an output waveform similar to the time integral of the input waveform. Hence it is called Integrator.
5	**What is High pass RL circuit? Why it is called high-pass filter?** BTL1 • A simple circuit consisting of a series resistor and a shunt inductor is called high-pass RL circuit. • At very high frequencies, the inductor acts as an open circuit and all the higher frequency components appear at the output. Hence this circuit is called high-pass filter.
6	**What is Low pass RL circuit? Why it is called low-pass filter?** BTL1 • A simple circuit consisting of a series inductor and a shunt resistor is called low pass RL circuit. • At very high frequencies, the inductor acts as a virtual open circuit and the output falls to zero. Hence this circuit is called low pass filter.
7	**What is Delay time (td), Rise time (tr) , storage time (ts), fall time (tf) in transistor?** BTL1 The time needed for the collector current to rise to 10% of its maximum (saturation) value i.e. iC(Sat) = VCC/RC is called the delay time. The time required for the collector current to rise from 10% to 90% of the maximum value is called rise time (tr). The time when collector current (iC) dropped to 90% of its maximum value is called the storage time. The time required for the collector current to fall from 90% to 10% of its maximum value is called fall time (tf).
8	**What is Turn-ON time (t_{ON}), Turn-off time (t_{OFF}) in transistor?** BTL1 The sum of the delay time (td) and the rise time (tr) is called the turn-ON time (t_{ON}). t_{ON} = td + tr The sum of the storage time (ts) and the fall time (tf) is called the turn-OFF time (t_{OFF}).

	$(t_{OFF}) = (ts) + (tf)$
9	**List the applications of bistable multivibrator?** BTL1 • It is used as memory elements in shift registers, counters, and so on. • It is used to generate square waves of symmetrical shape by sending regular triggering pulse to the input. By adjusting the frequency of the trigger pulse, the width of the square wave can be altered. • It can also be used as a frequency divider.
10	**What are the two methods of triggering for bistable multivibrators?** BTL1 • Unsymmetrical triggering • Symmetrical triggering
11	**What are the other names of monostable Multivibrator?** BTL1 One-shot, Single-shot, a single-cycle, a single swing, a single step Multivibrator, Univibrator.
12	**What are the different names of bistable Multivibrator?** BTL1 Eccles Jordan circuit, trigger circuit, scale-of-2 toggle circuit, flip-flop and binary.
13	**What is clipper?** BTL1 The circuit with which the waveform is shaped by removing (or clipping) a portion of the input signal without distorting the remaining part of the alternating waveform is called a clipper.
14	**What are the four categories of clippers?** BTL1 • Positive clipper • Negative clipper • Biased clipper • Combination clipper
15	**What is comparator?** BTL1 • The nonlinear circuit which was used to perform the operation of clipping may also be used to perform the operation of comparison is called the comparator. • The comparator circuit compares an input signal with a reference voltage.
16	**What is clamper?** BTL1 A circuit which shifts (clamps) a signal to a different dc level, i.e. which introduces a dc level to an ac signal is called clamper. It is also called dc restorer.
17	**Which circuits are called multivibrators?** BTL1 • The electronic circuits which are used to generate no sinusoidal waveforms are called multivibrators. • They are two stage switching circuits in which the output of the first stage is fed to the input of the second stage and vice-versa.
18	**Which are the various types of multivibrators?** BTL1 • Astable multivibrator • Bistable multivibrator • Monostable multivibrator
19	**What is astable multivibrator?** BTL1 • A multivibrator which generates square wave without any external triggering pulse is called astable multivibrator. • It has both the states as quasi-stable states. None of the states is stable. • Due to this, the multivibrator automatically makes the successive transitions from one quasi-stable state to other, without any external triggering pulse. So, it called Free-running multivibrator.

	• The rate of transition from one quasi-stable state to other is determined by the discharging of a capacitive circuit.
20	**List the applications of Astable multivibrator?** BTL1 • Used as square wave generator, voltage to frequency convertor and in pulse synchronization, as clock for binary logic signals, and so on. • Since it produces square waves, it is a source of production of harmonic frequencies of higher order. • It is used in the construction of digital voltmeter and SMPS. • It can be operated as an oscillator over a wide range of audio and radio frequencies.
21	**State the basic action of monostable multivibrator.** BTL1 • It has only one stable state. The other state is unstable referred as quasi- stable state. • It is also known as one-short multivibrator or univibrator. • After some time, interval, the circuit automatically returns to its stable state. • The circuit does not require any external pulse to change from quasi- stable state. • The time interval for which the circuit remains in the quasi-stable state is determined by the circuit components and can be designed as per the requirement.
22	**Mention the applications of one short multivibrator?** BTL1 • It is used to function as an adjustable pulse width generator. • It is used to generate uniform width pulses from a variable width pulse train. • It is used to generate clean and sharp pulses from the distorted pulses. • It is used as a time delay unit since it produces a transition at a fixed time after the trigger signal.
23	**Which multivibrator would function as a time delay unit? Why?** BTL1 Monostable multivibrator would function as a time delay unit since it produces a transition at a fixed time after the trigger signal.
24	**What is Bistable multivibrator?** BTL1 • The Bistable multivibrator has two stable states. • The multivibrator can exist indefinitely in either of the two stable states. • It requires an external trigger pulse to change from one stable state to another. • The circuit remains in one stable state unless an external trigger pulse is applied.
25	**Why is monostable Multivibrator called gating circuit?** BTL1 The circuit is used to generate the rectangular waveform and hence can be used to gate other Circuits hence called gating circuit.
26	**What are the main characteristics of Astable Multivibrator?** BTL1 The Astable Multivibrator automatically makes the successive transitions from one quasi- stable State to other without any external triggering pulse.
27	**What is the self-biased Multivibrator?** BTL1 The need for the negative power supply in fixed bias bistable Multivibrator can be eliminated by raising a common emitter resistance RE. The resistance provides the necessary bias to keep one transistor ON 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.
28	**What is UTP of the Schmitt Trigger? What is the other name for UTP?** BTL1 The level of Vi at which Q1 becomes ON and Q2 OFF is called Upper Threshold Point. It is also called input turn on threshold level.
29	**What is LTP of the Schmitt trigger?** BTL1 The level of Vi at which Q1 becomes OFF and Q2 on is called Lower Threshold Point.

30	**List the applications of Schmitt trigger.** BTL1 • It is used for wave shaping circuits. • It can be used for generation of rectangular waveforms with sharp edges from a sine wave or any other waveform. • It can be used as a voltage comparator. • The Hysteresis in Schmitt trigger is valuable when conditioning noisy signals for using digital circuits. The noise does not cause false triggering and so the output will be free from noise.
31	**What is meant by Hysteresis voltage in a Schmitt trigger?** BTL1 The difference between UTP (Upper Threshold Point) and LTP (Lower Threshold Point) is called Hysteresis voltage (VH). It is also known as Dead Zone of the Schmitt trigger.
32	**How a Schmitt trigger is different from a multivibrator?** BTL1 A Schmitt trigger has an input and an output; the output is a squared-up version of the input. As long as the input is constant, the output of the Schmitt trigger is also constant. A multivibrator typically has no inputs (other than power), only an output - an oscillating signal.
33	**What is Schmitt trigger?** BTL1 • It is a wave shaping circuit, used for generation of a square wave from a sine wave input. • It is a bistable circuit in which two transistor switches are connected regeneratively.
34	**What is UJT?** BTL1 • UJT is a three terminal semiconductor switching device. • As it has only one PN junction and three leads, it is commonly called as Uni-junction transistor.
	PART*B
1	**Determine and explain a series clipper circuit with clipping above Bias voltage by showing the waveforms of input and output. Draw the transfer characteristics of it. (13M) (May2018)** BTL5 **Answer: Page 648- S. Salivahanan** **Definition**: (2M) **Types**: Positive, Negative (2M) **Circuit Diagram**: (3M)  **Waveforms** (6M) 





2

Draw and explain the operation of Astable multivibrator, and give output waveforms. (13M) (May2018) BTL2

Answer: Page 663- S. Salivahanan

Introduction: (5M)

- A multivibrator - both stage - stable state - switched from one state to another -regular time intervals - any triggering.
- Collector – coupled astable multivibrator - two identical NPN transistors *Q1* and *Q2*.
- Rc1= Rc2 = Rc , R1 = R 2 = R and C1 = C2 = C- symmetrical astable multivibrator.
- The transistor *Q1* - forward biased by the Vcc supply through resistor R1.
- Transistor *Q2* - forward biased by the Vcc supply through resistor R2..
- Output of the transistor *Q1* - coupled - input of transistor *Q2* through the capacitor C1- Output of transistor *Q2* is coupled - input of transistor *Q1* through the capacitor C2.
- Both transistors - switch and connected back to back each other.
- R1C1 and R2C2 forms - charging - discharging network i.e., time constant network.
- RC1 and RC2 - load resistors - connected - biasing voltage VCC.
- Two outputs - 180^o out of phase.

Calculation of Time period: (3M)

- If Q1 is ON, then T1= R1C1ln2 = 0.693 R1C1
- If Q2 is ON, then T2= R2C2ln2 = 0.693 R2C2 Therefore, total Time period T=T1+ T2
- T= 0.693 (R1C1 + R2C2) ---- When R1 and R2 similarly C1 and C2 are not equal
  If both are equal then total time period is given as,

T= 1.386 RC
F = 1 / T

Circuit Diagram: (5M)

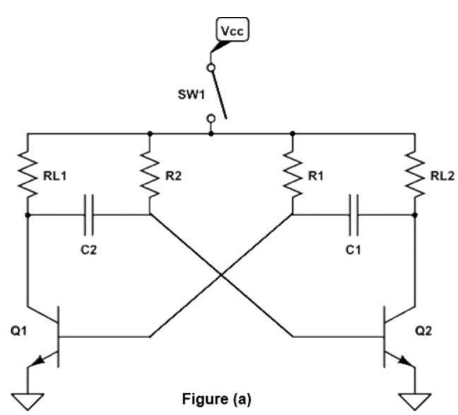


Figure (a)

3

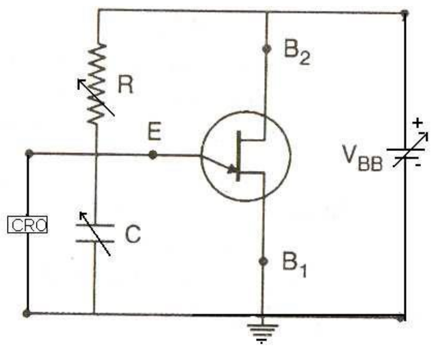
Explain the operation of UJT Sawtooth oscillator. (7M) (May2018) (Nov 2017) (May 2017) BTL2

Answer: Page 690- S. Salivahanan

Introduction: (1M)

- The UJT negative resistance characteristic,
- Because -character the UJT - trigger pulse.
- Any one - three terminals - triggering pulse.
- The UJT - used - relaxation oscillator - produces non-sinusoidal waves.

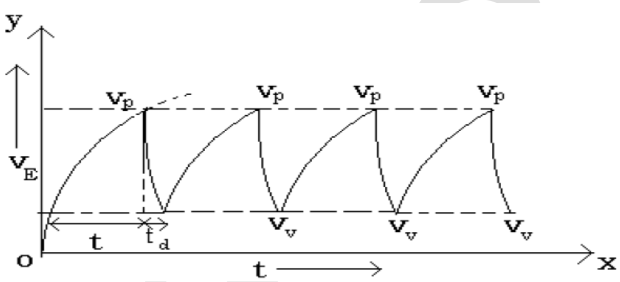
Circuit Diagram: (2M)



Frequency of oscillation: (2M)

$$f = 1/(2.303RClog_{10}\frac{1}{1-\eta})$$

Graph: (2M)



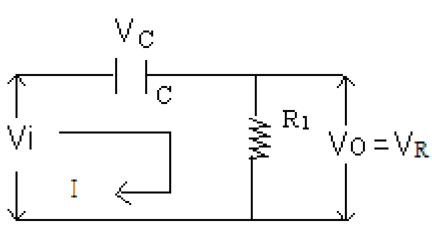
4

Prove an HPF is a differentiator and also prove a LPF is a integrator. (8M) (Nov 2003, April 2005, April 2004) BTL5

Answer: Page 633- S. Salivahanan

High Pass RC network as a differentiator: - (4M)

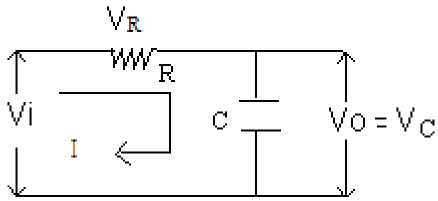
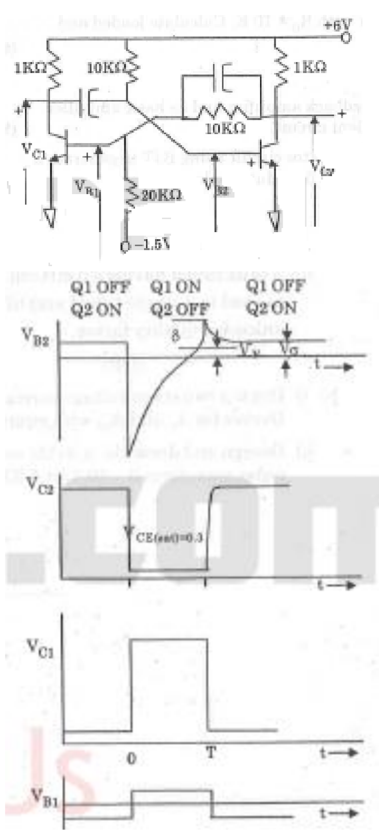
If the high pass RC network - very low time constant - circuit - differentiator. Under such conditions - drop across R is zero - the entire drop is across C.



$$V_0 = RC\frac{dv_i}{dt}$$

This proves the output is the differential of the input.

Low Pass RC circuit as a integrator:- (4M)

	If the resistor - capacitor of a high pass circuit - interchanged the circuit functions as a low pass circuit.  $V_o = \frac{1}{RC}\int V_i dt$ This implies that the output voltage is an integral of the input voltage.
5	**Consider a collector coupled Monostable multivibrator, whose components and supply voltages are indicated in fig. Calculate the voltage levels (V_{B2}, V_{C1}, V_{C2}, V_{B1}) of the waveform during ($t=0^-$, 0, T) period in fig. Also find the overshoot voltage δ. Assume silicon transistor having hfe=50, V0=0.7V, V_γ=0.5V and input Resistance = 200Ω. (13M) (Nov 2017)** BTL2  **Answer: Page 674- S. Salivahanan** $V_{B2} = Vcc-(Vcc-V_\sigma+IcRc)e^{-t/Rc}$ (4M) V_{B1}& V_{C1} Calculation (5M) V_{C2}=Vce(Sat) (4M)
6	**With neat circuit diagram and necessary waveforms, explain the operation of a monostable multivibrator. (13M)** BTL2 **Answer: Page 670- S. Salivahanan**

Multivibrator:- (3M)

- Multivibrator -electronic circuit - used - generate a non-sinusoidal waveform.
- Multivibrators - connected back to back - coupling circuits.i.e; output of first stage - connected with input of second stage - vice versa.

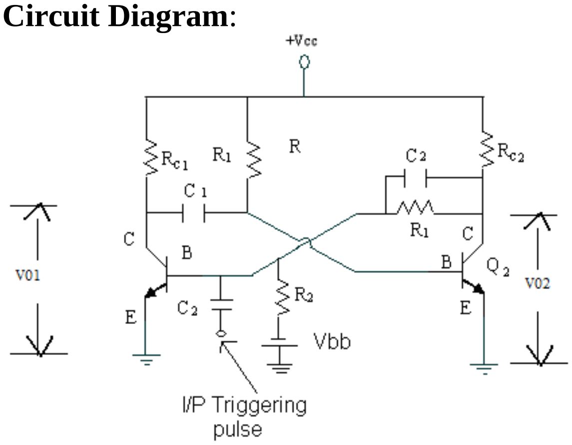
Multivibrators are classified into three major types.
1. Astable multivibrator.
2. Monostable multivibrator.
3. Bistable multivibrator.

Monostable Multivibrator:- (3M)

Construction: -

- It contains one stable state - one quasi stable state.
- It needs - external pulse - change their permanent state to quasi-stable state - return back to permanent state - completing RC time constant.
- Also called One short, single short, one swing multivibrator.
- Two transistors Q1 and Q2 used - both - connected back to back.
- R1C1 acts - a timing circuit.
- RB Base resistance - biasing –VBB.
- Trigger pulse applied - base of transistor Q1 - change the state.

Circuit Diagram: (3M)



Conditions: (2M)

Stable state:

Q_1 = OFF; With $V_{C1} \sim V_{CC}$.

Q_2 = ON; With $V_{C2} \sim V_{CE(sat)}$

Quasi stable state:

Q_1 = ON; With $V_{C1} \sim V_{CE(sat)} \sim 0.2V$.

. Q_2 = OFF; With $V_{C2} \sim V_{CC}$

Time constant: (2M)

T1 = R1C1ln2 = 0.693 R1C1

T2 = R2C2ln2 = 0.693 R2C2

7 **With a neat circuit diagram and waveform, explain Bistable multivibrator operation. (13M) (May 2017)** BTL2

Answer: Page 677- S. Salivahanan

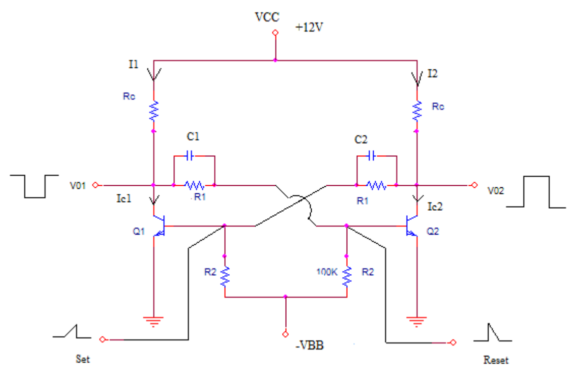
Introduction: (6M)

- It contains - two stable states - none of the quasi stable stable.
- It needs two clock pulse change the states.It stays - one stable state - next trigger pulse

appears.

- Two transistors Q1 - Q2 - connected back - back - feedback resistors R1 - R2 similar to asable multivibrator - no capacitors.
- Two transistor base - biased with –VBB.
- RC1 and RC2 acts - load resistor.
- Two trigger pulses(+ve) applied - change the states from 1 state - another in base of transistor
- R_E- used - emitter circuit - provide bias - keep one transistor ON and another OFF.

Circuit Diagram: (7M)



If a positive pulse - applied at S or R, drives Q_1- saturation - Q_2goes - cut-off.

8

Explain Clipper circuits. (10M) BTL2
Answer: Page 648- S. Salivahanan

Clipper: (2M)

- A circuit - removes the peak of a waveform - *clipper*.
- Clipper- device -to prevent the output - circuit - exceeding - predetermined voltage level - distorting - remaining part - applied waveform.
- The basic components - ideal diode - resistor.
- To fix - clipping level - the desired amount, a dc battery - included.

Types: (2M)

Depending - features - diode, the positive or negative region of the input signal is “clipped” off and accordingly the diode clippers may be ,

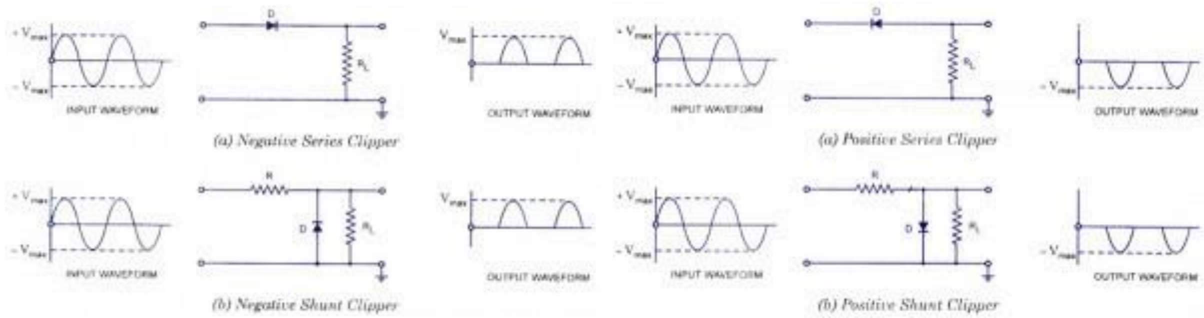
- Positive clippers.
- Negative clippers.

There are two general categories of clippers:

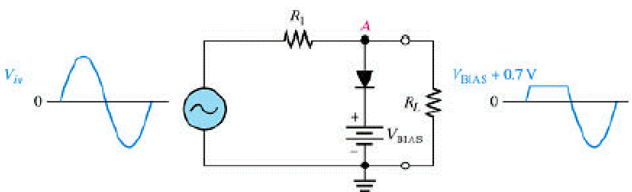
- Series clippers
- Parallel (or shunt) clippers.

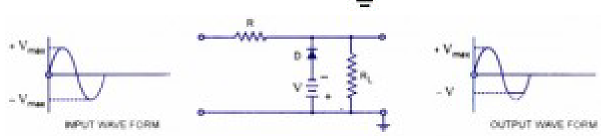
The series configuration is defined - diode - series - load,
Shunt clipper - diode - branch parallel to the load.

Positive & Negative Clipper: (4M)



Biased Positive & Negative Clipper: (2M)





Biased Negative Clipper

9

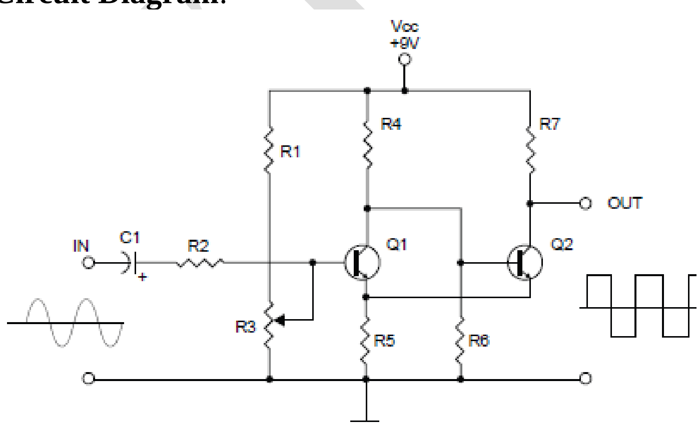
Explain Schmitt trigger circuit. (6M) BTL2

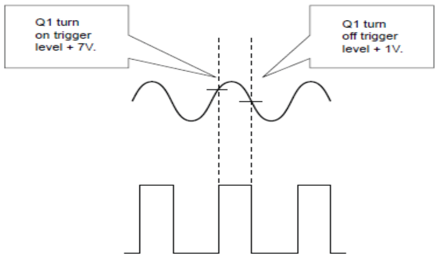
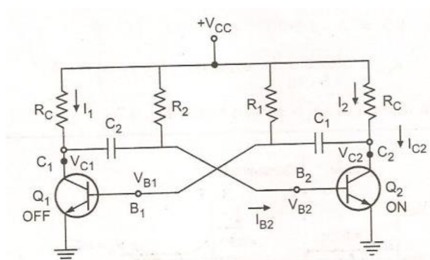
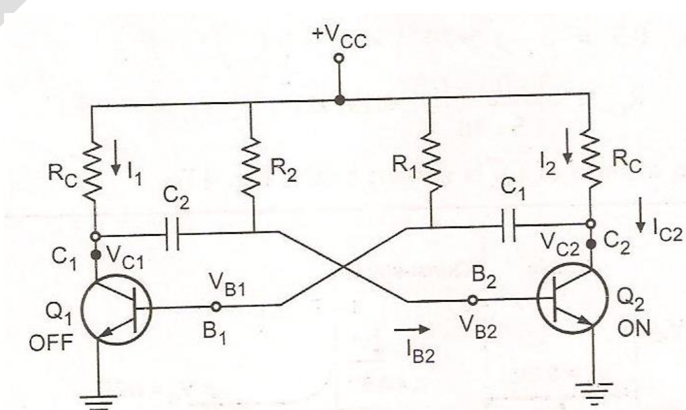
Answer: Page 682- S. Salivahanan

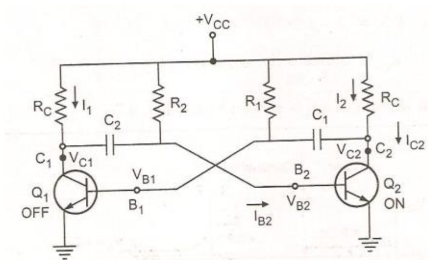
Schmitt trigger: (2M)

- Wave squaring circuit - to convert - sinusoidal - irregular input wave - square or rectangular output wave.
- Two-stage electronic gate.
- Gate is comprised - two dc coupled transistors - employ regenerative feedback - a common emitter resistor (R5).
- Regenerative feedback - necessary - produce - positive switching action.

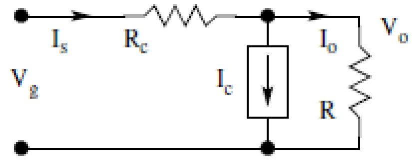
Circuit Diagram: (2M)



	Graph: (2M) 
	PART *C
1	**Design and draw the Astable multivibrator circuit using BJT, to generate a pulse waveform 0-10V at 5KHz, with 50% duty cycle. (6M) (Nov 2017)** BTL6 **Answer: Page 668- S. Salivahanan** $I_2 = \frac{V_{CC}-V_{C2}}{R_C} \approx I_{C2}$ (3M) $I_{B2} = \frac{V_{CC} - V_{B2}}{R_2}$ $T_2 = 0.69R_2C_2$ $T_1 = 0.69R_1\,C_1$ (3M) 
2	**Design and draw the Astable multivibrator circuit to generate a pulse wave format 40% duty cycle, at 20KHz, using Vα=10V, hfe=220, I, sat=2mA. (15M) (May 2017)** BTL6 **Answer: Page 668- S. Salivahanan** $I_2 = \frac{V_{CC}-V_{C2}}{R_C} \approx I_{C2}$ (10M) $I_{B2} = \frac{V_{CC} - V_{B2}}{R_2}$ $T_2 = 0.69R_2C_2$ $T_1 = 0.69R_1C_1$ **Diagram:** (5M) 

3	**Illustrate an astable multivibrator to meet the following specifications;** $V_{cc} = 10\,V$; $I_c = 2\,mA$; $h_{fe} = 30$ **. (The output should be a square-wave of frequency 1 kHz with 60 % duty cycle). (15M)** BTL2 **Answer: Page 668- S. Salivahanan** $I_2 = \frac{V_{CC} - V_{C2}}{R_C} \approx I_{C2}\ \therefore\ R_C = 4.85\ k\Omega$ (10M) $$I_{B2} = \frac{V_{CC} - V_{B2}}{R_2}\ \therefore\ R_2 = 93\ k\Omega$$ $T_2 = 0.69 R_2 C_2 \ \rightarrow C_2 = 9.39\ nF$; but $C_2 = C_1$ $T_1 = 0.69 R_1 C_1 \ \rightarrow R_1 = 62\ k\Omega$  (5M)

UNIT V–POWER AMPLIFIERS AND DC CONVERTERS	
Power amplifiers- class A-Class B-Class AB-Class C-Power MOSFET-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design	
PART * A	
Q.No.	**Questions**
1.	**State the difference between voltage and power amplifier.** BTL1 Voltage Amplifier: The input given to the transistor is in millivolts. The transistor used is a small signal transistor. Power Amplifier: The input given to the transistor is in volts. The transistor used is a power transistor.
2	**Why power amplifier is also known as large signal amplifier?** BTL1 Since the output obtained from the power amplifier is very large, it is known as large signal amplifier.
3	**Define class A power amplifier. How do you bias class A amplifier?** BTL1 It is an amplifier in which the input signal and the biasing is such that the output current flows for full cycle of the input signal. The Q point should be kept at the center of the DC load line to bias the Class A amplifier.
4	**Define class B power amplifier.** BTL1 It is an amplifier in which the input signal and the biasing is such that the output current flows for half cycle of the input signal.
5	**Define class C power amplifier.** BTL1 It is an amplifier in which the input signal and the biasing is such that the output current flows for less than half cycle of the input signal
6	**Define class AB power amplifier.** BTL1 It is an amplifier in which the input signal and the biasing is such that the output current flows for more than half cycle but less than full cycle of the input signal
7	**What is a push pull amplifier?** BTL1 Class B amplifier is used as a push pull amplifier which uses two transistors. Both the transistors work as a push pull arrangement. i.e one transistor will be on at a time.
8	**What is cross over distortion? How it can be eliminated?** BTL1 There is a 0.7V delay in between every half cycle. Due to this the sine wave will not be a continues wave. This is called cross over distortion. It can be eliminated by class AB amplifier.
9	**An amplifier has an efficiency of 32% and a collector dissipation of 0.8W. Calculate the d.c. power input and a.c.power output of the circuit.** BTL1 Pin(d.c) = 2Pc(d.c) + Po(a.c) = 2.35W Po(a.c) = Pin(d.c)(.32) 0.752W
10	**Define DC DC Converters.** BTL1 DC-to-DC converters convert electrical power provided from a source at a certain voltage to electrical power at a different dc voltage.
11	**List the features of DC DC Converters.** BTL1 • DC-to-DC power converters form a subset of electrical power converters. • Both the output and input power specifications of dc-to-dc converters are in dc. Most dc loads require a well-stabilized dc voltage capable of supplying a range of required current, or

	a variable dc current or pulsating dc current rich in harmonics. • The dc-to-dc converter has to provide a stable dc voltage with low output impedance over a wide frequency range.
12	**Draw the simple DC DC Converter.** BTL1 
13	**List the different types of simple DC DC Converters.** BTL1 • Series controlled • Shunt Controlled • Switch Mode Converters
14	**What are the different modes of DC Converters in Switch mode?** BTL1 • Buck Converter • Boost Converter • Buck-Boost Converter
15	**Give the important features of Buck Converters.** BTL1 • Gain less than unity • Gain is independent of switching frequency as long as Ts<To • Output voltage ripple percentage of independent of the load on the converter • Output ripple have second order roll off with the switching frequency. • Ideal efficiency is unity. • The input current is discontinuous and pulsating.
16	**Write the important features of Boost Converters.** BTL1 • Gain more than unity • Gain is independent of switching frequency as long as Ts<RC • Output voltage ripple percentage of dependent of the load on the converter • Parasitic resistance degrades the gain • Ideal efficiency is unity. • The input current is continuous.
17	**List the important features of Buck-Boost Converters.** BTL1 • Gain can be set below or above unity. • Gain is independent of switching frequency as long as Ts<RC • Output voltage ripple percentage of independent of the load on the converter & Output ripple have second order roll off with the switching frequency. • Parasitic resistance degrades the gain • Ideal efficiency is unity. • The input current is discontinuous and pulsating.
18	**What is theoretical maximum conversion efficiency of class A power amplifier? (Nov 2009)** BTL1 25% and it can be increased to 50% by using inductors or transformers.
19	**What is 'distortion' in power amplifiers? (Nov 2009)** BTL1 It is non-linear or harmonic distortion and is caused by the non-linear characteristic curve of an active devices.

20

A BJT has a maximum power dissipation of 2W at ambient temperature of 25°C and maximum junction temperature of 150°C, find its thermal resistance. (Nov 2010) BTL1

Thermal resistance = (TJ - TA)/ PD

= (150-25)/2

= 62.5 °C/W

21

List the disadvantages of push pull amplifier. (Nov 2011) BTL1

- The circuit needs two separate voltage suppliers
- The ouput is distorted due o the crss over distortion

22

Define Harmonic distortion and intermodulation distortion. (Nov 2011) BTL1

Harmonic distortion is caused by the nonlinear dynamic characteristics curve of an active device. Here new frequencies are produced in the output which are not present in the input. Intermodulation distortion is also a nonlinear distortion which occurs when the input signal consists of more than one frequency

23

Define thermal resistance in the context of power amplifier? BTL1

The resistance offered by the bipolar junction transistor to the flow of heat is called thermal resistance. The thermal resistance measured in °C/W = (TJ - TA)/ PD

24

What is meant by second order harmonic distortion? (Nov 2012) BTL1

The second harmonic distortion is defined as |B2|/|B1| X100 % Where B1-amplitude of the desired signal the fundamental frequency ω B2- amplitude of the second harmonic frequency 2ω

25

List the applications of MOSFET power amplifier. (Nov 2012) BTL1

- Large switches
- Line drivers for digital switching circuits
- Switched mode voltage regulators

26

Distinguish between class A and class B operation. (April 2011) BTL2

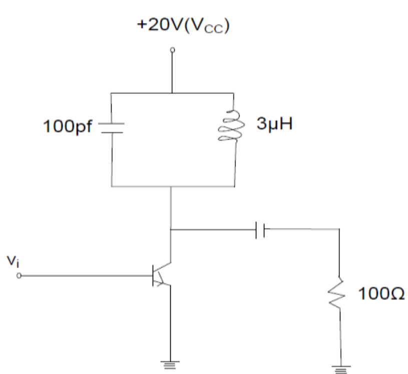
Parameter	Class A	Class B
Conduction angle	100 % of the input signal	50 % of the input signal
Theoretical efficiency	25%	78.5%

PART *B

1

In fig. a basic Class C-amplifier is shown. It uses supply voltage of + 20V and load resistance of 100Ω. The operating frequency is 3MHZ and VCE(sat) = 0.3 V. Calculate and efficiency. If peak current is 500 mA, find the conduction angle also. (13M) BTL2

Answer: Page 484- S. Salivahanan



Solution:

$V_p = V_{CC} - V_{CE(sat)} = 20 - 0.3$

Or, $V_p = 19.7V$

(2M)

$$P_0 = \frac{V_p^2}{2R_L} = \frac{1.97^{\ 2}}{2 \times 100}$$

$or,\ P_0 = 1.69W$

$P_{dc} = 20 \text{ X } 0.0857$

or, $P_{dc} = 1.714$ W

(2M)

$$P_{dc} = V_{CC} \times I_{dc}$$

Where,

$$I_{dc} = \frac{P_0}{V_p} = \frac{1.69W}{19.7V} = 0.0857A$$

(2M)

$$\eta = \frac{P_0}{P_{dc}} = \frac{1.69W}{1.714W} \times 100 = 98.5\%$$

For the frequency of 3MHz, the period of the wave, T, is

$$T = \frac{1}{3 \times 10^6} = 0.33\mu s$$

(2M)

$$t = \frac{P_0 \times T}{I_p \times V_p}$$

$$= \frac{1.69W \times 0.33 \times 10^{-6}}{500 \times 10^{-3} \times 19.7V}$$

$or,\ t = 56.6 \times 10^{-9}\ s$

$or,\ t = 56.6\ ns$

And, the conduction angle, θ, is

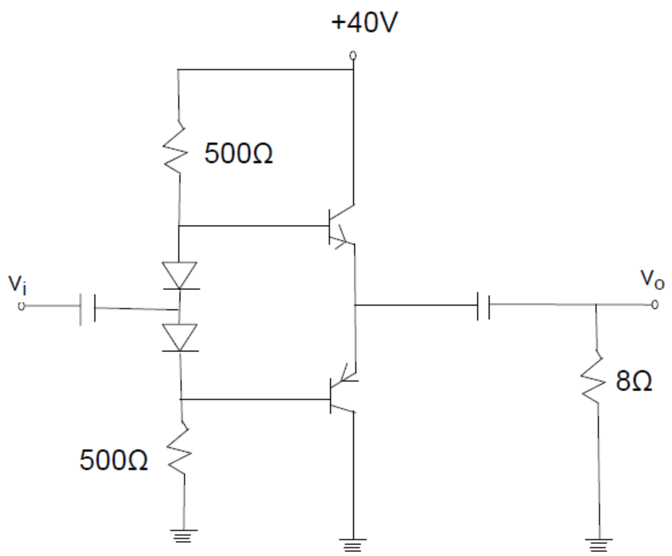
$$\theta = \frac{t}{T} \times 360 = \frac{56.6 \times 10^{-9}}{0.33 \times 10^{-6}} \times 360$$

$or, \theta = 61.7^{\circ}$

(5M)

2 **Calculate maximum ac output power and the minimum power rating of the transistors in the push-pull amplifier shown in fig.(10M)** BTL2

Answer: Page 682- S. Salivahanan



$$P_{0(\max)} = \frac{V_{CEQ} \times i_{c(sat)}}{2}$$ (2M)

$$V_{CEQ} = \frac{1}{2}V_{CC} = \frac{1}{2} \times 40V = 20V$$ (2M)

$$i_{c(sat)} = \frac{V_{CEQ}}{r_C + r_E} = \frac{20V}{0 + 8\Omega} = 2.5A$$ (2M)

$$P_{0(\max)} \frac{V_{CEQ} \times i_{C(sat)}}{2} = \frac{20 \times 2.5}{2} = 25\ W$$ (2M)

$$P_{D(\max)} = \frac{1}{5} \cdot P_{0(\max)} = \frac{25W}{5}$$
$$or,\ P_{D(\max)} = 5W$$ (2M)

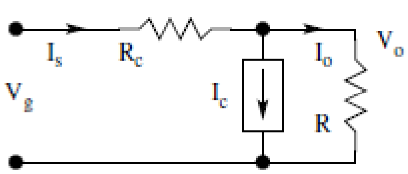
3

Explain DC DC Converter and its basic types. (13M) BTL2

Answer: Page 119- Notes

DC-to-DC converters : convert electrical power - provided - source - certain voltage - electrical power - different dc voltage. (2M)

General Dc Dc Converetr. (3M)

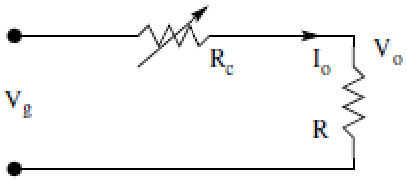


Types (2M)

- Series controlled
- Shunt Controlled

- Switch Mode Converters

Series controlled (2M)

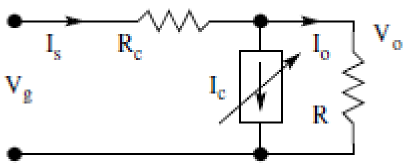


$$V_o = \frac{V_g R}{R + R_c}$$

$$P_l = \frac{V_g^2 R_c}{(R + R_c)^2}$$

$$\eta = \frac{V_o}{V_g}$$

Shunt controlled (2M)

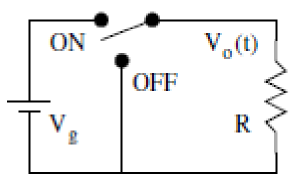


$$V_o = \frac{V_g R}{R + R_c} - \frac{I_c R R_c}{R + R_c}$$

$$P_l = V_o I_c + (I_c + I_o)^2 R_c$$

$$\eta = \frac{V_o}{V_g} \frac{I_o}{I_o + I_c}$$

Switch Mode Converter (2M)



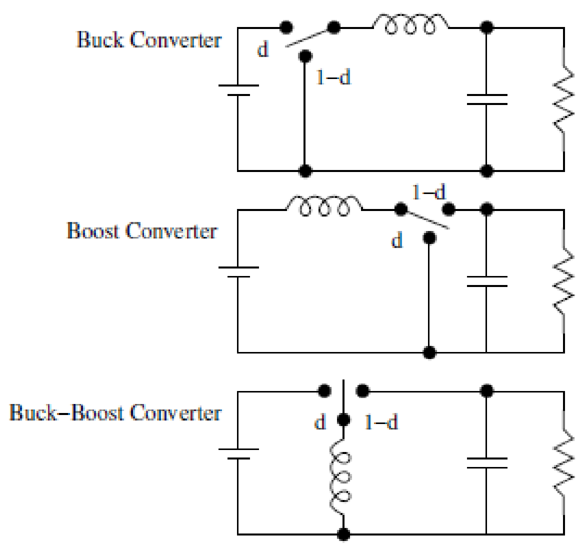
$$V_o = \frac{1}{T_s} \int_0^{T_s} V_o(t)\, dt \;=\; d\, V_g$$

4

Compare various modes of Switch mode DC DC Converters in details. (10M) BTL2

Answer: Page 119-notes

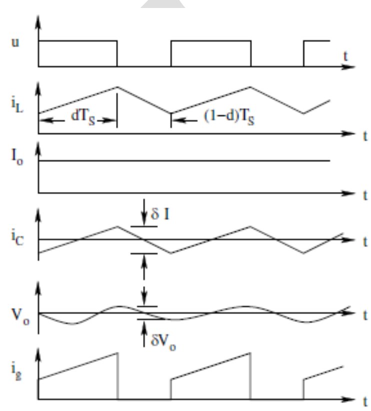
Circuit Diagram: (3M)



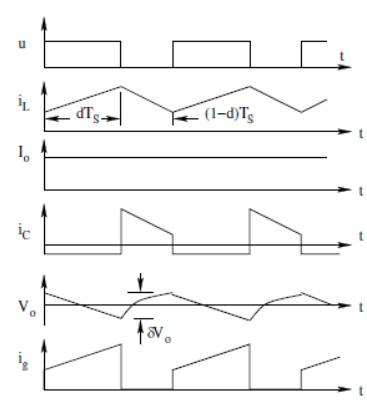
General Parameters: (4M)

	Buck	Boost	Buck-Boost
Ideal Gain	d	$\frac{1}{1-d}$	$-\frac{d}{1-d}$
Current Ripple	$\frac{(1-d)RT_S}{L}$	$\frac{d(1-d)^2RT_S}{L}$	$\frac{(1-d)^2RT_S}{L}$
Voltage Ripple	$\frac{(1-d)T_S^2}{8LC}$	$\frac{dT_S}{RC}$	$\frac{dT_S}{RC}$
Duty Ratio	$\frac{2}{3} \leq d \leq 1$	$0 \leq d \leq \frac{2}{3}$	$0 \leq d \leq \frac{2}{3}$
Efficiency degradation on account of different non-idealities Note: $\alpha = \frac{R_l}{R}; \beta = \frac{R_g}{R};$			
R_l and R_g	$\frac{1}{1+\alpha+\beta d}$	$\frac{1}{1+\frac{\alpha+\beta}{(1-d)^2}}$	$\frac{1}{1+\frac{\alpha+\beta d}{(1-d)^2}}$
V_{sn} and V_{sf}	$1-\frac{V_{sf}}{V_g}-\frac{V_{sf}}{dV_g}$	$1-\frac{V_{sn}}{V_g}-\frac{(1-d)V_{sf}}{V_g}$	$1-\frac{V_{sn}}{V_g}-\frac{(1-d)V_{sf}}{dV_g}$

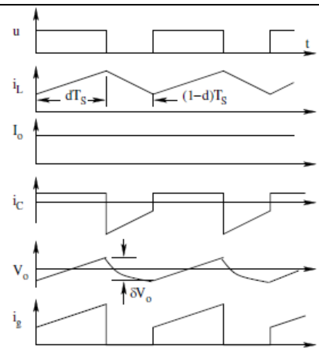
Wave form Comparison: (3M)



Steady State Waveforms of the Buck Converter



Steady State Waveforms of the Boost Converter



Steady State Waveforms of the Boost Converter

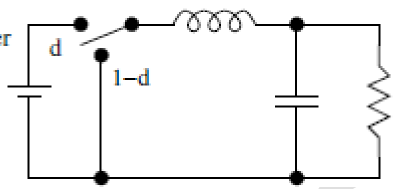
5

Derive the efficiency of Buck Converter with neat sketch. (10M) BTL4

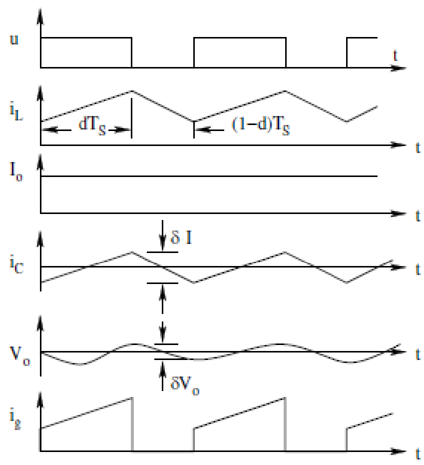
Answer: Page 119- Notes

Diagram: (2M)

Buck Converter



Waveform: (2M)



Steady State Waveforms of the Buck Converter

Voltage Gain: (4M)

$V_o = dV_g$

Current Ripple:

$$\delta I_o = \frac{V_g d(1-d)T_S}{L} = \frac{V_o(1-d)T_S}{L}$$

$$\frac{\delta I_o}{I_o} = \delta_i = \frac{(1-d)RT_S}{L}$$

Voltage Ripple:

$$\delta V_o = \frac{\delta Q}{C} = \frac{1}{C}\frac{1}{2}\frac{\delta I_o}{2}\frac{T_S}{2}$$

$$\delta V_o = \frac{V_o(1-d)T_S^2}{8LC}$$

$$\frac{\delta V_o}{V_o} = \delta_v = \frac{(1-d)T_S^2}{8LC}$$

Input Current:

$$I_g = dI_o$$

Validity of Results:

$$\frac{\delta V_o}{V_o} = \delta_v = \frac{5(1-d)T_S^2}{T_o^2} << 1$$

Efficiency:

$$\eta = \left[1 - \frac{V_{sn}}{V_g} - \frac{V_{sf}(1-d)}{dV_g}\right]\left[\frac{R}{R+R_l+dR_g}\right]$$

Features: (2M)

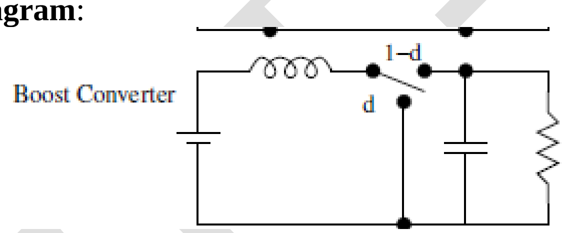
- Gain less than unity
- Gain is independent of switching frequency as long as Ts<To
- Output voltage ripple percentage of independent of the load on the converter
- Output ripple have second order roll off with the switching frequency.
- Ideal efficiency is unity.
- The input current is discontinuous and pulsating.

6

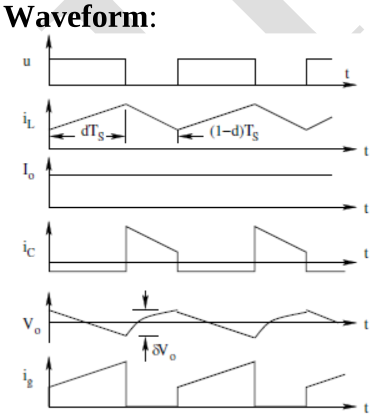
Explain the operation of Boost Converter with neat sketch. (10M) BTL2

Answer: Page 119- Notes

Diagram: (2M)



Waveform: (2M)



Steady State Waveforms of the Boost Converter

Voltage Gain: (4M)

$$V_o = \frac{V_g}{1-d}$$

Current Ripple:

$$\delta I_L = \frac{V_g d T_S}{L}$$

$$\frac{\delta I_L}{I_L} = \delta_i = \frac{d(1-d)^2 R T_S}{L}$$

Voltage Ripple:

$$\delta V_o = \frac{\delta Q}{C} = \frac{I_o d T_S}{C}$$

$$\frac{\delta V_o}{V_o} = \delta_v = \frac{d T_S}{RC}$$

Input Current:

$$I_g = \frac{I_o}{1-d}$$

Validity of Results:

$$\frac{\delta V_o}{V_o} = \delta_v = \frac{d T_S}{RC} << 1$$

Efficiency:

$$\eta = \left[1 - \frac{d V_{sn}}{V_g} - \frac{V_{sf}(1-d)}{V_g}\right]\left[\frac{1}{1+\frac{\alpha}{(1-d)^2}}\right]$$

Features: (2M)

- Gain more than unity
- Gain is independent of switching frequency as long as Ts<RC
- Output voltage ripple percentage of dependent of the load on the converter
- Parasitic resistance degrades the gain
- Ideal efficiency is unity.
- The input current is continuous.

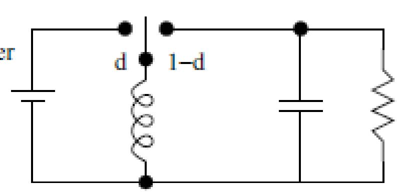
7

Derive and draw the steady state waveform of Buck- Boost Converters. (10M) BTL2

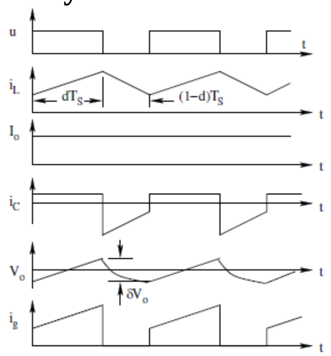
Answer: Page 119- Notes

Diagram: (2M)

Buck–Boost Converter



Steady state waveform: (2M)



Steady State Waveforms of the Boost Converter

Voltage Gain: (4M)

$$V_o = -\frac{dV_g}{1-d}$$

Current Ripple:

$$\delta I_L = \frac{V_g dT_S}{L}$$

$$\frac{\delta I_L}{I_L} = \delta_i = \frac{(1-d)^2 RT_S}{L}$$

Voltage Ripple:

$$\delta V_o = \frac{\delta Q}{C} = \frac{I_o dT_S}{C}$$

$$\frac{\delta V_o}{V_o} = \delta_v = \frac{dT_S}{RC}$$

Input Current:

$$I_g = \frac{dI_o}{1-d}$$

Validity of Results:

$$\frac{\delta V_o}{V_o} = \delta_v = \frac{dT_S}{RC} << 1$$

Efficiency:

$$\eta = \left[1 - \frac{V_{sn}}{V_g} - \frac{V_{sf}(1-d)}{dV_g}\right]\left[\frac{1}{1 + \frac{\alpha + \beta d}{(1-d)^2}}\right]$$

Features: (2M)

- Gain can be set below or above unity.
- Gain is independent of switching frequency as long as Ts<RC
- Output voltage ripple percentage of independent of the load on the converter & Output ripple have second order roll off with the switching frequency.
- Parasitic resistance degrades the gain
- Ideal efficiency is unity.
- The input current is discontinuous and pulsating.

8

Describe the distortion in power amplifier and the methods to eliminate the same. (6M) (NOV/DEC 2009) BTL1

Answer: Page 479- S. Salivahanan

Amplifier Distortion: (2M)

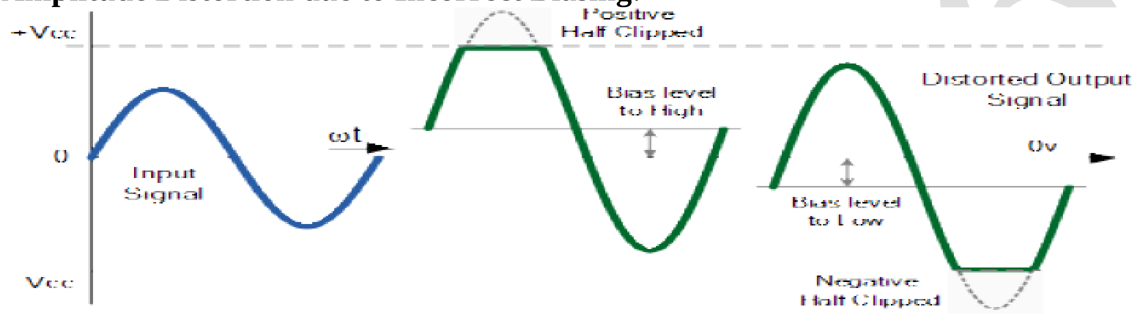
Distortion - output signal waveform may occur because:

1. Amplification may not be taking place over - whole signal cycle due - incorrect biasing levels.
2. The input signal - too large, causing - amplifiers transistors - limited by the supply voltage.
3. The amplification - not - a linear signal over - entire frequency range of inputs.

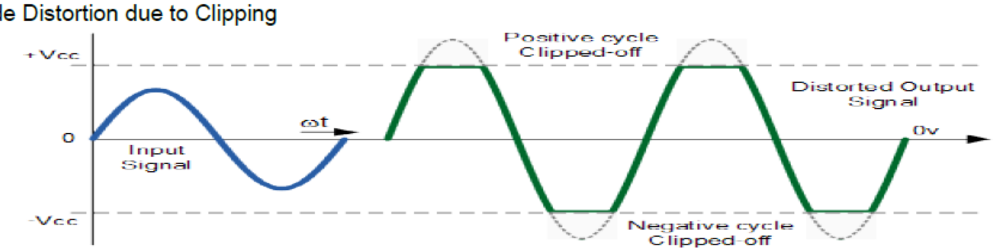
Amplitude Distortion

Amplitude distortion occurs - peak values of the frequency waveform - attenuated causing distortion - shift - Q-point and amplification may not take place over the whole signal cycle.

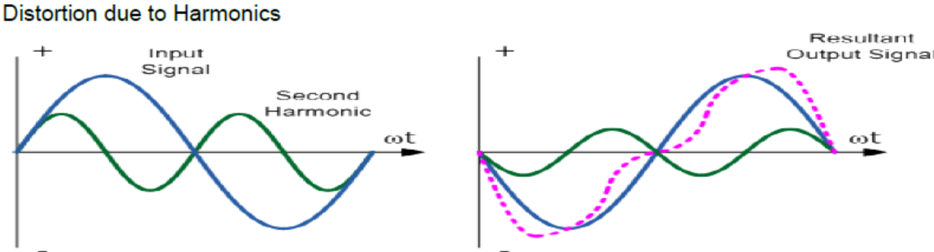
Amplitude Distortion due to Incorrect Biasing: (4M)



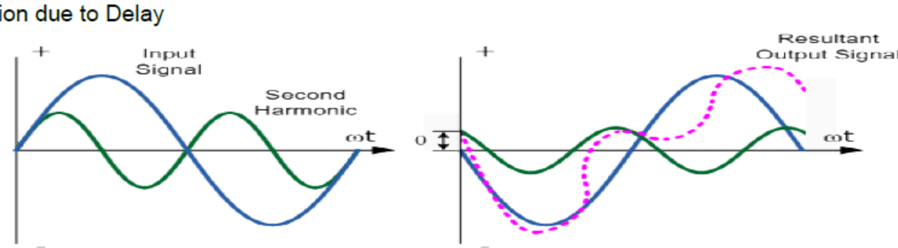
Amplitude Distortion due to Clipping



Frequency Distortion due to Harmonics



Phase Distortion due to Delay



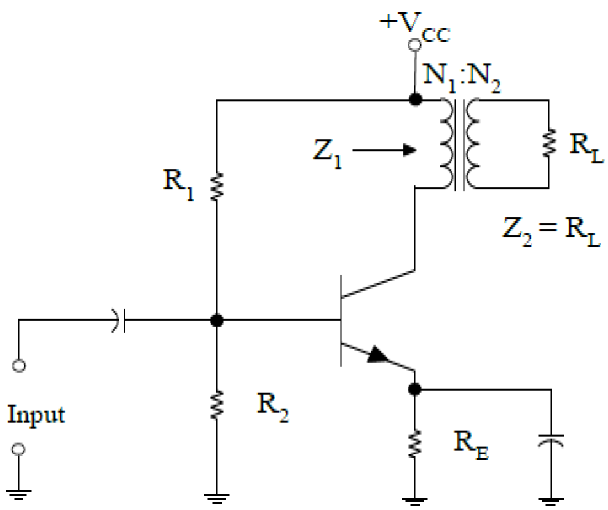
9

Explain the operation of the transformer coupled class A audio power amplifier. (8M) (April 2010) or Explain class A power amplifier with circuit diagram and derive for its efficiency. (8M) (Nov 2010)(Nov 12) BTL2

Answer: Page 671- S. Salivahanan

Introduction: (2M)

Circuit Diagram: (2M)



Operation; (2M)

N1, N2 = the number of turns in the primary and secondary

V1, V2 = the primary and secondary voltages

I1, I2 = the primary and secondary currents

Z1, Z2 = the primary and seconadary impedance (Z2 = RL)

Ptot = P1 + P2 + PC + PT + PE (2M)

$$\eta_{(max)} = \frac{P_{ac}}{P_{dc}} = \frac{2V_{CC}\,2I_C}{8V_{CC}I_C} \times 100\%$$

10

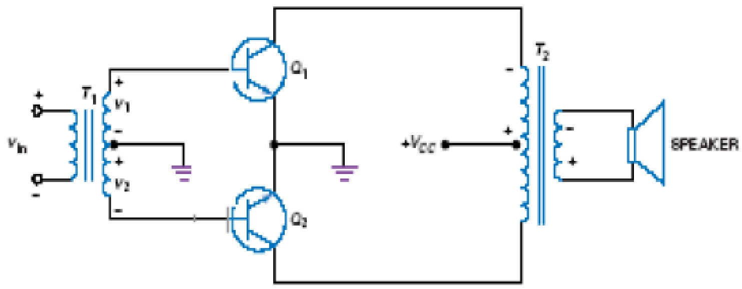
Draw the circuit diagram of class B push pull amplifier and discuss its merits. (13M) (NOV/DEC 2011) (APR/MAY 2010)(NOV/DEC'12) BTL2

Answer: Page 478- S. Salivahanan

Introduction: (2M)

- Push-pull - one transistor conducts - half a cycle - other -off, and vice versa.
- On - positive half cycle - input voltage, the secondary winding of T1 has voltage v1 and v2, as shown.
- The upper transistor conducts - lower one cuts off.
- The collector current through Q1flows - upper half of the output primary winding.
- This produces - amplified - inverted voltage, - transformer-coupled - loud speaker.
- On - next half cycle - input voltage, - polarities reverse. -lower transistor turns on - upper transistor turns off - lower transistor amplifies - signal, - alternate half cycle appears across the loudspeaker.
- Since each transistor amplifies one-half of the input cycle, the loud speaker receives - complete cycle - amplified signal.

Circuit Diagram: (4M)

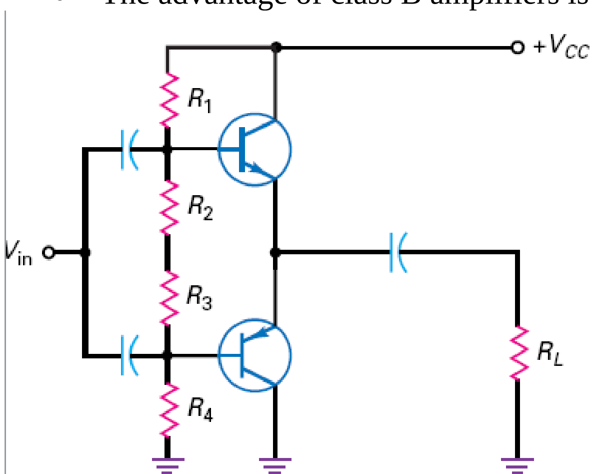


Class B advantages: (3M)

1. Much higher power conversion efficiency - class A - large signal amplitudes.
2. Zero power dissipation with zero input.

Class B Push-Pull Emitter Follower: (4M)

- Class B operation - collector current flows - only 180° -cycle.
- Q point - located - cutoff on both the dc and the ac load lines.
- The advantage of class B amplifiers is lower current drain – higher stage efficiency.



11

Compare class A, class B and class C power amplifier in their performance and efficiency. (10M) BTL2

Answer: Page 471- S. Salivahanan

Class A (4M)

- The Class A topology - one of the transistors - dc current source.
- capable of supplying the maximum audio current required by the speaker.
- Good sound quality - possible - Class A output stage
- power dissipation - excessive

Class B (4M)

- The Class B topology eliminates - dc bias current
- dissipates significantly less power.
- Its output transistors - individually controlled - push-pull manner
- This reduces -output stage power dissipation,
- The Class B circuit - inferior sound quality (2M)

Class	A	B	C
Conduction Angle in degrees	360	180	Less than 90
Position of Q point	Middle of DC load line	On X axis	Below X axis
Overall Efficiency	25 to 30%	70 to 80%	>80%
Signal Distortion	None if correctly biased	At X axis cross over point	Large amounts

12

Describe the operation of class c amplifier and derive the efficiency. (13M) BTL1

Answer: Page 484- S. Salivahanan

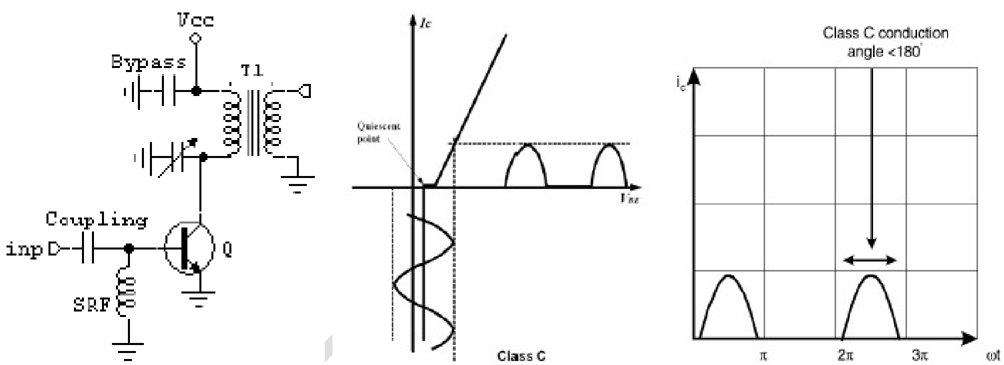
Introduction: (3M)

Less than 90-Conduction angle

Q point – On X axis

Efficiency - >80%

Circuit Diagram: (4M)



It is an amplifier - conduction angle for the transistor is significantly less than 180°.

Operation: (6M)

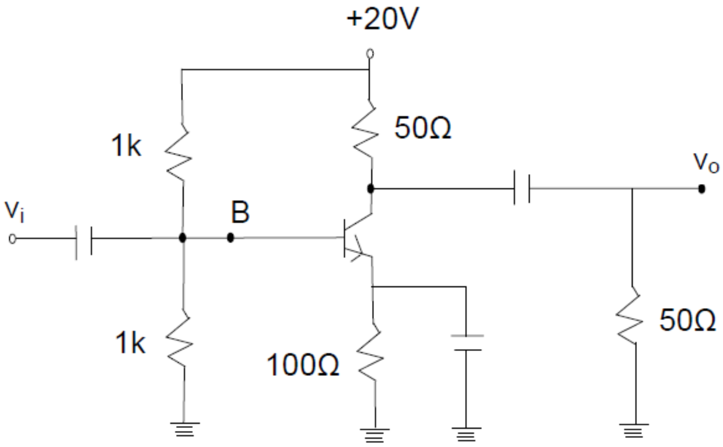
- The transistor - biased - under steady-state conditions - no collector current flows.
- The transistor idles - cut-off.
- linearity of the Class-C amplifier - poorest of the classes of amplifiers.
- The Efficiency of Class-C can approach 85 %, - much better - either the Class-B or the Class-A amplifier.
- To bias a transistor for Class-C operation, - necessary to reverse bias of base-emitter
- junction.
- External biasing - not needed

PART *C

1

Calculate maximum ac output power in the amplifier shown in fig. (Assume VBE = 0) (10M) BTL4

Answer: Page 474- S. Salivahanan



The ac power in class A-operation, P0 is given by the relation, (2M)

$$P_0 = \frac{V_{CEQ} \cdot I_{CQ}}{2} \qquad I_{CQ} = I_E = \frac{V_{BB} - V_{BE}}{R_E} = \frac{V_{BB}}{R_E} = \frac{10V}{100\Omega} = 100\,mA$$

(3M)

$V_{CC} = V_{CEQ} + I_E(R_C + R_E)$

Or, $V_{CEQ} = V_{CC} - I_E(R_C + R_E)$

$= 20 - 100mA\,(50 + 100)\Omega$

$= 20 - 15$

Or, $V_{CEQ} = 5V$

(3M)

Therefore, maximum ac power, P_O,

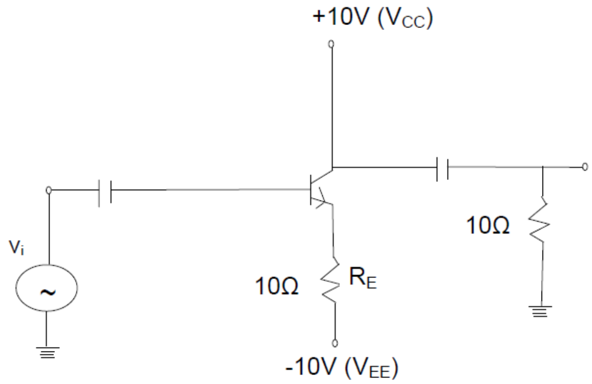
$$P_0 = \frac{V_{CEQ} \cdot I_{CQ}}{2} = \frac{5 \times 100\,mA}{2}$$

$$or \quad P_0 = 250\,mW$$

(2M)

2

Calculate maximum ac output power and efficiency of the amplifier shown in fig. VBE may be assumed negligibly small. (8M) BTL4
Answer: Page 474- S. Salivahanan



$$I_{CQ} = I_E = \frac{|V_{EE}|}{R_E} = \frac{10V}{10\Omega} = 1A$$

(2M)

$V_{CEQ} = V_{CC} = 10V$

$$P_{0(max)} = \frac{V_{CEQ} \cdot I_{CQ}}{2} = \frac{10 \times 1}{2} = 5W$$

(2M)

$$P_{DC} = \left[|V_{CC}| + |V_{EE}|\right] I_{CQ}$$
$$= (10+10) \times 1 = 20W$$

(2M)

$$\eta = \frac{P_{0(max)}}{P_{DC}} = \frac{5W}{20W} \times 100$$
$$or\ \eta = 25\%$$

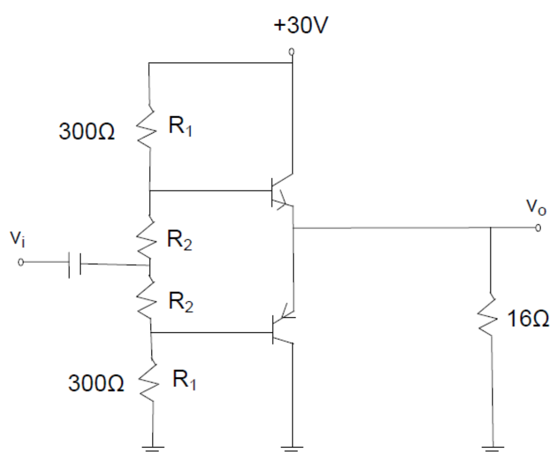
(2M)

3

Find out the value of resistor R2 to provide trickle current for distortion free output in the push pull amplifier shown in fig. VBE for each transistor is 0.7V. (8M) BTL4

Answer: Page 474- S. Salivahanan

Circuit Diagram: (2M)



Trickle current which flows through resistors R2 - produces a voltage drop of 0.7 V across base –

	emitter junction over comes cross – over distortion in push – pull amplifier. For analysis purposes, - sufficient - consider only half of the circuit for reasons of symmetry, and VCC of half (= VCC/2 = 30/2 = 15V) is to be taken for one transistor. (2M) The current through resistors R1 and R2 is, $I = \frac{15V}{R_1 + R_2} = \frac{15V}{300\Omega + R_2}$ ....(A) (2M) $I \times R_2 = 0.7V$ (desired voltage) $or, I = 0.7V / R_2$ ....(B) (1M) $\frac{0.7V}{R_2} = \frac{15V}{300\Omega + R_2}$ $or, R_2 = 14.7\Omega$ (1M)