		UNIT-IV			
8	a)	Draw the circuit diagram and explain the working of Hartley oscillator. Also derive the expression for frequency of oscillation and condition for sustained oscillations.	L4	CO4	5 M
	b)	Explain the concept of stability of Oscillators.	L4	CO4	5 M
		OR			
9	a)	In a Colpitts oscillator, $C_1 = C_2 = C$ and $L = 100\ \mu H$. The frequency of oscillation is 500 kHz. Calculate C.	L3	CO4	5 M
	b)	Illustrate working principle of Wein bridge oscillator.	L3	CO4	5 M
		UNIT-V			
10	a)	Illustrate with diagram, Transformer coupled Class A Power Amplifier and derive its maximum efficiency.	L3	CO3	5 M
	b)	Illustrate Complementary Symmetry Class B Power Amplifier with diagram and write about crossover distortion in class B power amplifiers.	L3	CO3	5 M
		OR			
11	a)	A class B push pull amplifier supplies power to a resistive load of 12Ω. The output transformer has a turns ratio of 3:1 and efficiency of 78.5%. Calculate (i) Maximum power output, (ii) Maximum power dissipation in each transistor and (iii) Maximum base and collector current. For each transistor, assume $h_{fe} = 25$ and $V_{CC} = 20V$.	L3	CO3	5 M
	b)	Derive the general expression for the output power in the case of a class A power amplifier. Draw the circuit and explain the movement of operating point on the load line for a given input signal.	L3	CO3	5 M

Code: 23EC3402

II B.Tech - II Semester – Regular Examinations - MAY 2025

ELECTRONIC CIRCUIT ANALYSIS
(ELECTRONICS & COMMUNICATION ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

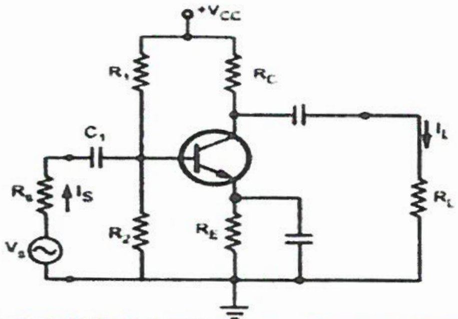
BL – Blooms Level CO – Course Outcome

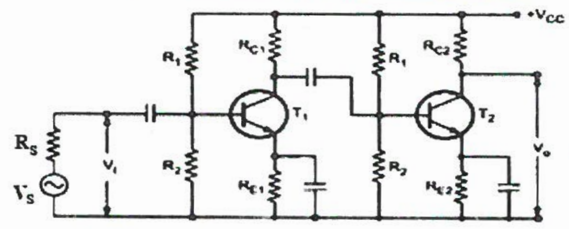
PART – A

		BL	CO
1.a)	Express h_f, h_r, h_i and h_o in terms of CE Two port network.	L2	CO1
1.b)	Describe Source Resistance in CS amplifier also called as "Source degeneration" resistance.	L2	CO1
1.c)	Discuss the methods of coupling in multi stage amplifiers.	L2	CO1
1.d)	What are the classifications of multistage amplifiers? Explain the purpose of multistage amplifiers.	L2	CO1
1.e)	'Negative feedback stabilizes the gain'-justify the statement.	L2	CO1
1.f)	A feedback amplifier has an open loop gain of 600 and feedback factor β= 0.01 Express the closed loop gain with negative feedback.	L2	CO1
1.g)	Explain the conditions for Barkhausen criterion.	L2	CO1
1.h)	Describe why LC oscillators are preferred over RC oscillators at radio frequencies?	L2	CO1
1.i)	Explain the applications of power amplifiers?	L2	CO1
1.j)	Summarize the classification of power amplifiers.	L2	CO1

40x5 = 280
235
330
195

PART – B

			BL	CO	Max. Marks
		UNIT-I			
2	a)	Compare the CE, CB and CC transistor amplifier parameters.	L2	CO1	5 M
	b)	Consider a single stage CE amplifier with $R_s = 1k\Omega$, $R_1 = 50k\Omega$, $R_2 = 2k\Omega$, $R_c = 1k\Omega$, $R_L = 1.2k\Omega$, $h_{fe}=50$, $h_{ie}=1.1k\Omega$, $h_{oe} = 25\mu A/V$ and $h_{re} = 2.5 \times 10^{-4}$, as shown in Fig. Calculate A_i, R_i, A_v, A_{vs}, A_{is} and R_0. 	L3	CO2	5 M
		OR			
3	a)	Determine the CE short circuit current Gain parameters.	L3	CO2	5 M
	b)	Derive an expression for voltage gain, input and output impedance of a common drain amplifier.	L3	CO2	5 M
		UNIT-II			
4	a)	The following figure shows CE-CE cascade amplifier with their biasing arrangements. Calculate R_i, A_i, A_v, R_i', A_{vs} and A_{is} if circuit parameters are: $R_s=1$ kΩ, $R_{c1} = 15k\Omega$, $R_{E1}= 100\Omega$, $R_{C2} = 4$ kΩ, $R_{E2} = 330\Omega$ with $R_1 = 200K$ and $R_2 = 20K$ for first stage and $R_1 = 47K$ and $R_2 = 4.7$ kΩ for second stage. Assume that $h_{ie} = 1.2k\Omega$, $h_{fe} = 50$, $h_{re} = 2.5 \times 10^{-4}$ and $h_{oe} = 25 \times 10^{-6}$ A/V.	L3	CO2	5 M

		 Fig. CE-CE Cascade amplifier			
	b)	Illustrate how the input impedance is increased by Bootstrap Emitter Follower with neat diagram.	L3	CO2	5 M
		OR			
5	a)	An amplifier consists of 3 identical stages in cascade, the bandwidth of overall amplifier extends from 20 Hz to 20 kHz. Calculate the bandwidth of the individual stage.	L3	CO2	5 M
	b)	With diagram, derive the expression for current gain and input resistance of Darlington amplifier.	L3	CO3	5 M
		UNIT-III			
6	a)	A voltage series negative feedback amplifier has a voltage gain without feedback of A = 500, input resistance $R_i = 3k\Omega$, output resistance $R_0 = 20k\Omega$ and feedback ratio $\beta = 0.01$. Calculate the voltage gain A_f, input resistance R_{if}, and output resistance R_{of} of the amplifier with feedback.	L3	CO2	5 M
	b)	Articulate current series and current shunt feedback configurations.	L3	CO2	5 M
		OR			
7	a)	An amplifier has an open loop gain of 1000 and a feedback ratio of 0.04. If the open loop gain changes by 10% due to temperature, solve the percentage change in gain of the amplifier with feedback.	L3	CO2	5 M
	b)	Illustrate different types of feedback amplifiers? Give their equivalent circuits.	L3	CO2	5 M

Prasad V Potluri Siddhartha Institute of Technology
Kanuru, Vijayawada.
II BTech - II Sem Reg. May 2025. ECE.
Electronic Circuit Analysis - 23EC3402

PART - A

Max-Marks-7

1.a → each expression - 0.5M - 4×0.5 = 2M

1.b → Proper Answer as per key. = 2M.

1.c → Three methods = 2M

1.d → classification - 1, Purpose - 1 = 2M

1.e → statment - 2M

1.f. → formula - 1, Answer - 1 - 2M

1.g → statment & condition - 2M

1.h. → Proper Answer as per key - 2M.

1.i → Any four Applications - 2M

1.j → Any four types - 2M.

PART - B

2.a. Any 5 differences - 5M.

b. Any 5 Parameters - 5M

3 a. Ckt - 1M, explanation - 1M, Derivation - 3M = 5M

b. Ckt - 1M, explanation - 1M, Derivation - 3M = 5M

4-a. Any 5 Parameters - 5M.

b. CKT - 2M, explanation - 1M, Derivation - 2M = 5M

5 a. formula - 1M, Data - 1M, Solution - 3M = 5M

b. CKT - 2M, explanation - 1M, Derivation - 2M = 5M.

6 a. Data - 1M, formula - 1M, Solution - 3M = 5M

b. Any 5 Points about current Series & Current Shunt - 5M

7-a Data - 1M, formula - 1M, Solution - 3M - 5M

b. Provided two types of eqn ckt, consider any one, for all four types - 5M

8 a. CKT - 2, explanation - 2M, formula - 1 = 5M

b. Complete Concept as Per key - 5M.

9. a Data - 1M, formula - 1, Solution - 3M = 5M

b. CKT - 2M, Explanation - 2M, formula - 1M = 5M

10 a. CKT - 2M, explanation - 1M, Derivation - 2M = 5M

b. CKT & graph - 3M, explanation - 2M, - 5M.

11. a. Data - 1M, Solution - 4M - 5M

b. CKT - 1M, loadline graph - 1M, explanation - 1M, Derivation - 2M - 5M

Prasad V Potluri Siddhartha Institute of Technology Kanuru (1)

II BTech - II Semester - Regular examination - May 2025

Electronic circuit Analysis - 23EC3402

Electronics & communication Engineering

(1)

PART - A

1.a Express hf, hr, hi and ho in terms of CE Two Port N/w

Ans

$$h_{fe} = \left.\frac{\Delta I_C}{\Delta I_B}\right|_{V_{CE}\ \text{constant}}, \quad h_{re} = \left.\frac{\Delta V_{BE}}{\Delta V_{CE}}\right|_{I_B\ \text{constant}}$$

$$h_{ie} = \left.\frac{\Delta V_{BE}}{\Delta I_B}\right|_{V_{CE}\ \text{constant}} \quad h_{oe} = \left.\frac{\Delta I_C}{\Delta V_C}\right|_{I_B\ \text{constant}}$$

1.b Describe Source Resistance in CS amplifier also called as " Source degeneration" resistance.

Ans In Common Source Amplifier Source degeneration resistance, typically denoted as Rs, It is a Resistor Placed in the Source of the FET. It acts as a negative feedback, reducing the gain.

1.c Discuss the Methods of coupling in Multistage Amplifiers.

→ RC Coupling - Connecting two Transistors Using R & C

→ Direct Coupling → The o/p of Ist stage is Directly connected to the Base of IInd stage.

→ Transformer coupling → o/p of Ist stage is connected to Primary of Transformer, Secondary

Transformer is connected to the Base of the 2nd stage.

1. What are the classifications of Multistage Amplifiers? Explain the purpose of Multistage amplifiers.

Ans → Resistance & capacitance coupled Amplifier (RC coupl
→ Transformer coupled Amplifiers
→ Direct coupled Amplifiers
→ Tuned circuit Amplifiers.

The Purpose of Multistage amplifier is, to achieve greater over all gain or amplification than a Single stage Amplifi

2. 'Negative feedback stabilizes the gain' - Justify the statement.

Ans An Important advantage of negative feedback is that the resultant gain of the amplifier can be made independent of transistor Parameters or the Supply voltage variations

$$A_f = A/(1+A\beta.)$$

for -ve voltage feedback in an amplifier to be effective, the designer deliberately makes the Product 'Aβ' much greater than Unity. Therefore, in the above relation, '1' can be neglected as compared to Aβ, then

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

Gain now depends only upon feedback fraction β, then the gain of the amplifier is extremely stable

f. A feedback Amplifier has an open loop gain of 600 and feedback factor $\beta = 0.01$ Express the closed loop gain wit negative feedback.

Ans

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

$$A = 600, \quad \beta = 0.01$$

$$A_f = \frac{600}{1+0.01\times 600} = \frac{600}{1+6} = \frac{600}{7} = 8$$

g. Explain the conditions for Barkhausen Criterion.

Ans. Barkhausen Criterion states that the frequency of a Sinusoidal oscillator determined by the condition that the loop-gain phase shift is zero.

Hence $-A\beta = 1$

It implies that (i) $|A\beta| = 1$ i.e magnitude of feedback factor = unity

(ii) $\phi = 0$ or multiple of 2π.

Another interpretation of Barkhausen Criterion is

$$A_{fb} = \frac{A}{1+A\beta} = \frac{A}{1-1} = \alpha.$$

Since the gain is infinity we will get fainter o/p with no I/P.

h.) Describe why LC Oscillators are Preferred over RC Oscillators at Radio frequencies.

Ans LC oscillators can operate at high frequencies typically from 200KHz to few GHz. They are not suitable for low operating frequencies b'cos the values of L & C will be large at low frequencies.

i) Explain the Applications of Power Amplifiers?

Ans
- → Audio systems
- → Head phone Amplifiers,
- → PA systems
- → Consumer Electronics.
- → Radio & wireless Communications
- → Satellite Communications
- → Radar Systems

J. Summarize the classification of Power Amplifiers:

Ans

Class A → If the Q Point and the Input Signals are Selected that the o/p signal is obtained for a full I/p ~~cycle~~ Signal

Class B → o/p current flows only for one half cycle of the I/p ~~cy~~ Signal.

Class C → o/p current flows for less than half cycle of the I/p Signal.

Class AB → characteristics lies between class A & class B.

PART-B

UNIT-I

2a) Compare the CE, CB and CC transistor amplifier Parameters.

Ans

Parameter	CE	CB	CC
I/P Impedance	Moderate	low	High
o/P Impedance	Moderate to high	High	low
Voltage Gain (A_v)	High	High	$\simeq 1$
current Gain (A_i)	High	$\simeq 1$	High
Power Gain	High	Moderate	Moderate
Applications	General Application	High fq. Applications	Buffer

2b) Given Data $R_S = 1K\Omega$, $R_1 = 50K\Omega$, $R_2 = 2K\Omega$, $R_C = 1K\Omega$, $R_L = 1.2K\Omega$, $h_{fe} = 50$, $h_{ie} = 1.1K\Omega$, $h_{oe} = 25\mu A/V$ and $h_{re} = 2.5\times10^{-4}$.

a) Current Gain $A_i = \frac{-I_c}{I_b} = \frac{-h_{fe}}{1+h_{oe}R_L'}$

$$R_L' = R_C \parallel R_L = 545.45\Omega$$

$$A_i = \frac{-50}{1+25\mu A/V(545.45)} = -49.32$$

b) $R_i = h_{ie} + h_{re} A_i R_L' = 1.1K + 2.5\times10^{-4}\times(-49.32)\times 545.45$

$$= 1093\Omega$$

$$\frac{\quad}{V_b} = \frac{\quad}{R_i} = \frac{-49.32 \times 545.45}{1093} = -$$

d) $$A_{vs} = \frac{V_c}{V_s} = \frac{V_c}{V_b} \times \frac{V_b}{V_s} = A_v \times \frac{R_i'}{R_S + R_i'}$$

where $$R_i' = R_i \| R_1 \| R_2 = 1093 \| 50K \| 2K$$
$$= 696.9\Omega$$

$$A_{vs} = 24.61 \times \frac{696.9}{1K + 696.9} = 10.1$$

e) $$A_{is} = \frac{-R_C}{R_C + R_L} \times \frac{I_c}{I_b} \times \frac{I_b}{I_s}$$

$$= \frac{-R_C}{R_C + R_L} \times 49.32 \times \frac{R_B}{R_B + R_i}$$

$$= \frac{-1K}{1K + 1.2K} \times 49.32 \times \frac{1.923K}{1.923K + 1.093K}$$

$$= -14.29.$$

f). $$R_o = \frac{R_s + h_{ie}}{R_s \cdot h_o + \Delta h}$$

where $$\Delta h = h_{ie} \cdot h_{oe} - h_{re} \cdot h_{fe}$$
$$= 1.1K\Omega \times 25\mu A/V - 2.5 \times 10^{-4} \times 50$$

$$R_o = \frac{1K\Omega + 1.1K\Omega}{1K\Omega \times 25\mu A/V + 1.1K\Omega \times 25\mu A/V - 2.5 \times 10^{-4} \times 50}$$

$$\simeq 56K\Omega.$$

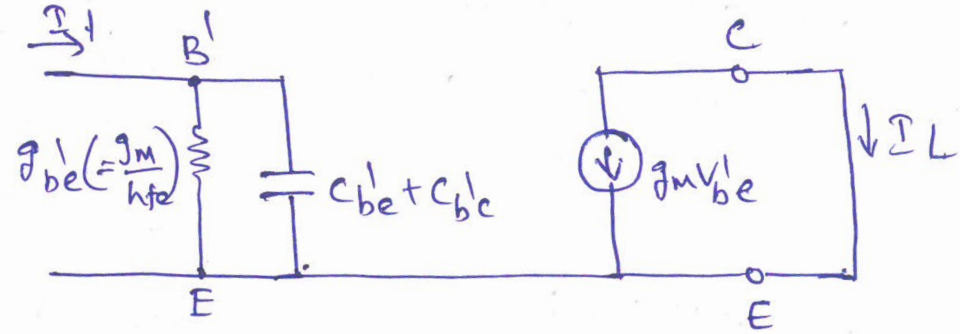
3 a) Determine the CE short circuit Gain Parameters

Ans

Let us consider a Single stage CE Transistor Ampli[fier]. The load resistor R_L on this stage is the collec[tor] circuit resistor. So that $R_C = R_L$.

Assume $R_L = 0$, ~~whereas the circuit with R_L~~

The Approximate equivalent ckt for the calculat[ion] of the short-circuit CE current gain is given below.



$I_i \rightarrow$ I/p current, $I_L \rightarrow$ load current.

we have neglected $g_{b'c}$, which should appear across terminals $B'C$. b'cos $g_{b'c} << g_{b'e}$.

from ckt

$$I_L = -g_m V_{b'e} \quad \text{--- (1)}$$

where

$$V_{b'e} = \frac{I_i}{g_{b'e} + j\omega\left(C_{b'e} + C_{b'c}\right)} \quad \text{--- (2)}$$

The current Amplification under short-ckted conditions is given by

$$A_i = \frac{I_L}{I_i} = \frac{-g_m}{g_{b'e} + j\omega(C_{b'e}+C_{b'c})} \quad \text{--- (3)}$$

$$A_i = \frac{-h_{fe}}{1+j(f/f_\beta)} \Rightarrow |A_i| = \frac{h_{fe}}{\left[1+(f/f_\beta)^2\right]^{1/2}}$$

where $f_\beta = \dfrac{g_{b'e}}{2\pi(C_{b'e}+C_{b'c})}$

$$f_\beta = \frac{1}{h_{fe}} \cdot \frac{g_m}{2\pi(C_{b'e}+C_{b'c})}$$

$$f_\beta = \frac{1}{2\pi r_{b'e}(C_{b'e}+C_{b'c})}$$

At $f = f_\beta$, $|A_i|$ is equal to $1/\sqrt{2} = 0.707$.

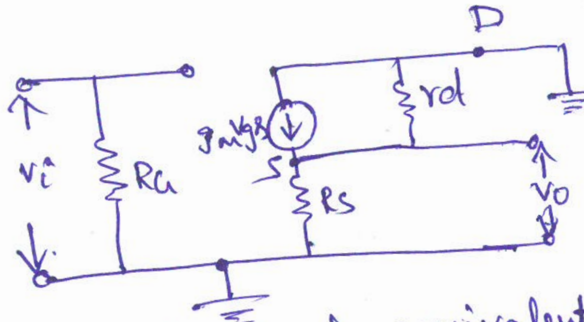
It may also be noted that the value of A_i at $\omega = 0$ is $-h_{fe}$, as the low-fq short-ckt CE current gain

3b Derive an expression for voltage gain, I/P & O/P Impedances of Common Drain amplifier.

Ans.

I/P Impedance Z_i:

$$Z_i = R_G$$



Simplified low fq. equivalent model for CD ckt.

O/P Impedance Z_o:

$$Z_o = Z_o' \,||\, R_S$$

where $Z_o' = \left.\dfrac{V_o}{I_d}\right|_{V_i=0}$

Apply KVL to the outer loop

$$V_i + V_{gs} - V_o = 0$$

As $V_i = 0$ then $V_{gs} = V_o$

$$I_d = g_m V_{gs}.$$

Substitute the value of V_{gs}.

$$I_d = g_m V_o$$

$$Z_o' = \frac{V_o}{I_d} = \frac{1}{g_m} \Rightarrow Z_o = \frac{1}{g_m} \,||\, R_S$$

Voltage gain $A_v = \frac{V_o}{V_i}$ 5

from ckt $V_o = -I_d (r_d \| R_s)$

$I_d = g_m V_{gs}$

$V_o = -g_m V_{gs} (r_d \| R_s)$

we know that $V_i = -V_{gs} + V_o$

$V_i = -V_{gs} + [-g_m V_{gs} (r_d \| R_s)]$

Substitute V_i & V_o in the eqn $A_v = \frac{V_o}{V_i}$

$$A_v = \frac{-g_m V_{gs} (r_d \| R_s)}{-V_{gs} + [1 + g_m (r_d \| R_s)]} = \frac{g_m (r_d \| R_s)}{1 + g_m (r_d \| R_s)}$$

If $r_d >> R_s$ $\boxed{A_v = \frac{g_m R_s}{1 + g_m R_s}}$

UNIT - II

4a)

Ans Analysis of 2nd stage (CE)

current gain $(A_{i2}) = -h_{fe} = -50$

I/P Resistance $(R_{i2}) = h_{ie} = 1.2 K\Omega$

voltage gain $(A_{v2}) = \frac{A_{i2} R_L}{R_{i2}} = \frac{-50 \times 4 \times 10^3}{1.2 \times 10^3}$

$= -166.67$

Analysis of first stage :-

$R_L' = R_{C1} \| R_1 \| R_2 \| R_{i2}$

$= 15K \| 47K \| 4.7K \| 1.2K = 881.8\Omega$

$h_{oe} R_L' = \frac{1}{40} \times 10^{-3} \times 881.8 = 0.022$

As $h_{oe} R_L < 0.1$, use Approximate analysis

current Gain $A_{i_1} = -h_{fe} = -50$

I/P resistance $R_{i_1} = h_{ie} = 1.2 K\Omega$

voltage Gain $(A_{V_1}) = \frac{A_{i_1} R_L'}{R_{i_1}} = \frac{-50 \times 881.8}{1.2 \times 10^3}$

$= -36.74$

overall ~~current~~ Gain $(A_V) = A_{V_1} \times A_{V_2}$

$= -166.67 \times -36.74$

$= 6123.45$

overall voltage gain $(A_{VS}) = \frac{A_V \times R_{i_1}'}{R_{i_1}' + R_S}$

$R_{i_1}' = R_1 \| R_2 \| R_{i_1} = 200K \| 20K \| 1.2K$

$= 1.13 K.$

$A_{VS} = \frac{6123.45 \times 1.13 \times 10^3}{1.13 \times 10^3 + 1 \times 10^3} = 3248.6$

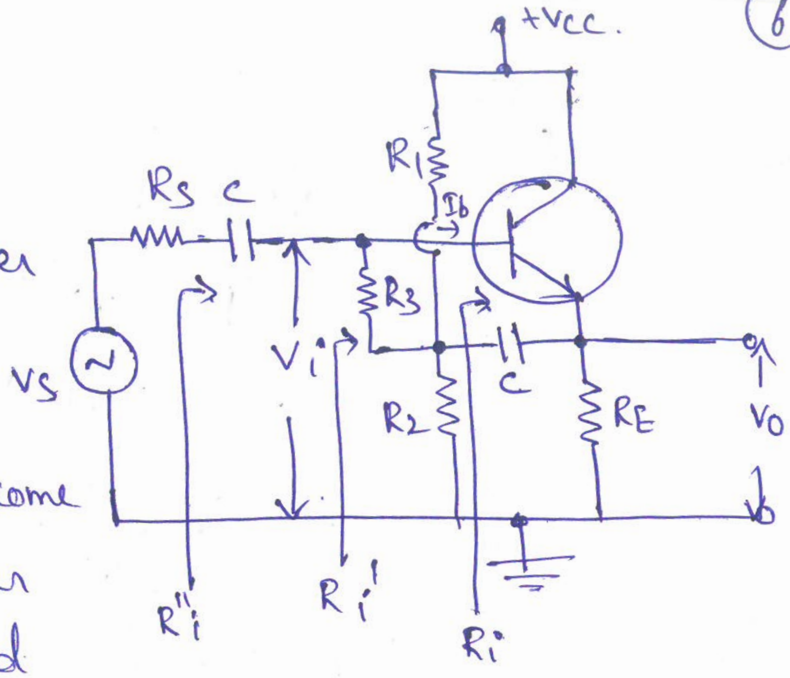
$A_{is} = \frac{I_o}{I_s} = \frac{I_o}{I_{c2}} \times \frac{I_{c2}}{I_{e2}} \times \frac{I_{e2}}{I_{c1}} \times \frac{I_{c1}}{I_{b1}} \times \frac{I_{b1}}{I_s}$

$\frac{I_o}{I_{c2}} = -1$, $\frac{I_{c2}}{I_{e2}} = -A_{i2}$, $\frac{I_{e2}}{I_{c1}} = -1$, $\frac{I_{c1}}{I_{b1}} = -A_{i_1}$, $\frac{I_{b1}}{I_s} = \frac{R_B}{R_B + R_i}$

$A_{is} = -43.9$

Illustrate how the I/P Impedance is Increase by Bootstrap Emitter follower with neat diagram (6)

Ans



In emitter follower, the I/P resistance of the amplifier is reduced because of the shunting effect of the biasing resistors. To overcome this problem, the emitter follower ckt is modified as shown in fig.

Here two additional components are used, resistance 'R_3' and capacitor 'C'. The capacitor is connected between the emitter and the junction of R_1, R_2 & R_3.

for dc signal, capacitor 'C' acts as a open ckt and therefore resistance R_1, R_2 & R_3 provides necessary biasing to keep the transistor in the active region.

for ac signal, the capacitor acts as a short ckt & provides very low reactance nearly short ckt at lowest operation fq. Resistor R_3 is connected between I/P & O/P node. For such connection effective I/P resistance is given by the Miller's theorem. The theorem says that the Impedance between the two nodes can be resolved into two components, one from each node to ground.

$$R_{M1} = \frac{R_3}{1-A_V} \quad \& \quad R_{M2} = \frac{R_3 A_V}{A_V - 1}$$

$A_V = 1$, then R_{M2} becomes extremely large

5 a) Ans

Given $f_L^{(n)} = 20 Hz$, $f_H^{(n)} = 20 KHz$

$$f_L^{(n)} = \frac{f_L}{\sqrt{2^{1/n}-1}}$$

$$f_L = f_L(n)\sqrt{2^{1/n}-1} = 20 \times \sqrt{2^{1/3}-1}$$

$$= 10.196 Hz$$

$$f_H^{(n)} = f_H\sqrt{2^{1/n}-1}$$

$$f_L = \frac{f_H^{(n)}}{\sqrt{2^{1/n}-1}} = \frac{20\times10^3}{\sqrt{2^{1/3}-1}} = 39.23KH$$

Bandwidth $= f_H - f_L$

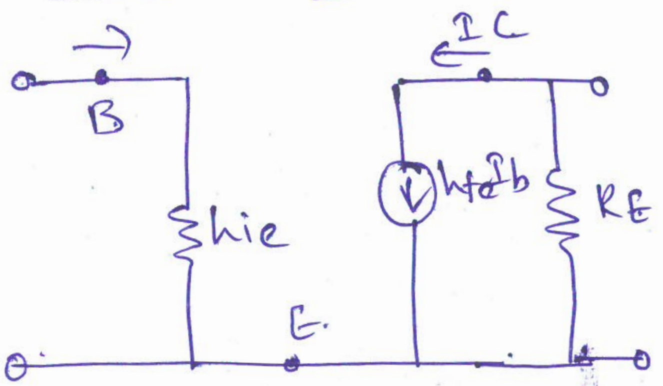
$= 39.23 \times 10^3 - 10.196$

$= 39.218 KHz$

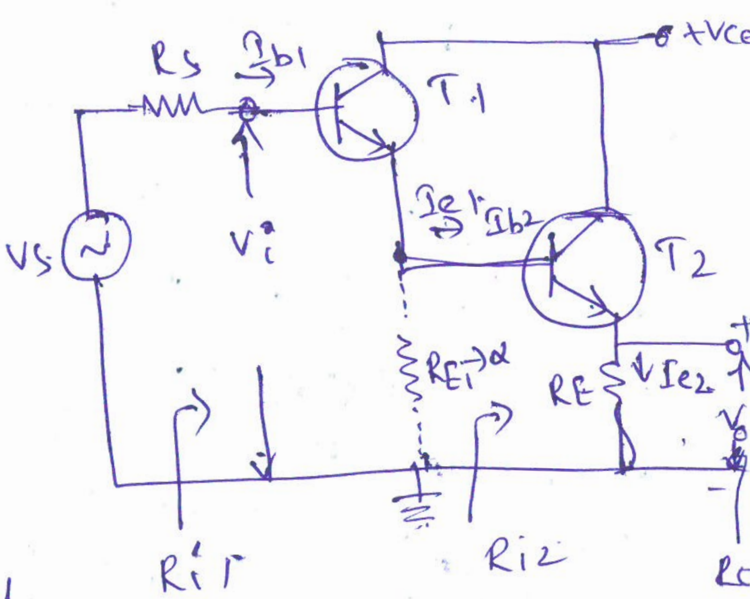
5b with diagram, Derive the expression for current Gain and I/P Resistance of Darlington Amplifier

Ans

AC equivalent ckt



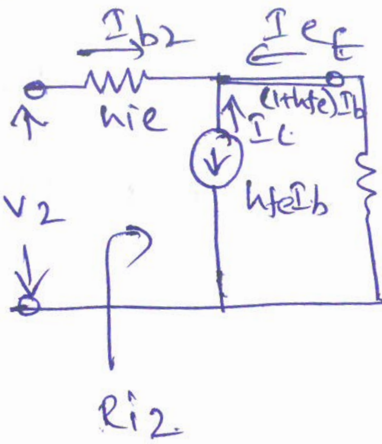
Approximate h-parameter



Analysis of 2nd stage:-

$A_{i2} \rightarrow$ current gain $= \dfrac{I_o}{I_b} = \dfrac{-I_e}{I_b} = \underline{1+h_{fe}}$

I/P Resistance $R_{i2} = \dfrac{V_2}{I_{b2}}$



Apply KVL to outer loop we get

$V_2 - I_{b2} h_{ie} - I_o R_E = 0$

$V_2 = I_{b2} h_{ie} + I_o R_E$

$R_{i2} = h_{ie} + A_{i2} R_E = \underline{(1+h_{fe}) R_E}$

Analysis of 1st stage:-

current Gain $(A_{i1}) = \dfrac{I_{b2}}{I_{b1}}$

$A_{i1} = \dfrac{I_{e1}}{I_{b1}}$

$I_{e1} = -(I_{b1} + I_{c1})$

$I_{c1} = h_{fe} I_{b1} + h_{oe} I_{e1} R_{L1}$

$I_{e1} = -(I_{b1} + h_{fe} I_{b1} + h_{oe} I_{e1} R_{L1})$

$\dfrac{-I_{e1}}{I_{b1}} = \dfrac{1+h_{fe}}{1+h_{oe} R_{L1}}$

$R_{L1} = (1+h_{fe}) R_E$

$A_{i1} = \dfrac{-I_{e1}}{I_{b1}} = \dfrac{1+h_{fe}}{1+h_{oe}(1+h_{fe}) R_E}$

$R_{i1} = h_{ie} + A_{i1}(1+h_{fe}) R_E$

Sol Ans Given that $A = 500$, $R_i = 3K\Omega$, $R_o = 20K\Omega$, $\beta = 0.0$

for Voltage - Series feedback Amplifier, the voltage gain is given by

$$A_f = \frac{A}{1+A\beta} = \frac{500}{1+500\times0.01} = 83.33$$

Input Resistance with feedback is given by

$$R_{if} = R_i(1+A\beta) = 3\times10^3\times(1+500\times0.01)$$

$$R_{if} = 18K\Omega$$

O/P Resistance with feedback is given by

$$R_{of} = \frac{R_o}{1+A\beta} = \frac{20\times10^3}{1+500\times0.01} = 3.33K\Omega$$

6b Articulate current Series & current shunt feedback configurations.

Ans current Series feedback is also called as Series-Series feedback. In this the feedback signal is Proportional to o/p current.

The feedback is connected in Series with the I/P. The current is Sampled from o/P. I/P Impedance Increases, o/p Impedance decreases. Improves linearity & Bandwidth.

current Shunt feedback → feedback Signal Proportional to o/p current. The feedback is connected in Parallel. I/p is connected in Shunt. o/P current is Sampled. Input Impedance Decreases, o/P Impedance Decreases. Improves Stability & Bandwidth.

7a Ans

Given open loop Gain $A = 1000$

feedback factor $\beta = 0.04$

change in open-loop Gain 10% $\rightarrow \Delta A = 0.10 A$
$= 100$

$$A_f = \frac{A}{1+A\beta} = \frac{1000}{1+1000 \times 0.04} = \frac{1000}{1+40} = 24.39$$

New open loop Gain after 10% Increases

$$A' = A + \Delta A = 1000 + 100 = 1100$$

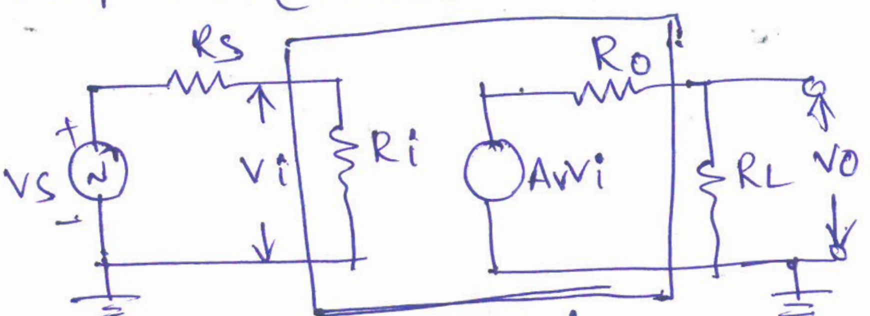
$$A_f' = \frac{A'}{1+A'\beta} = \frac{1100}{1+1100 \times 0.04} = \frac{1100}{45} = 24.44$$

$$\% \text{ change} = \frac{A_f' - A_f}{A_f} \times 100 = \frac{24.44 - 24.39}{24.39} \times 100$$

$$= \frac{0.05}{24.39} \times 100 = 0.205\%$$

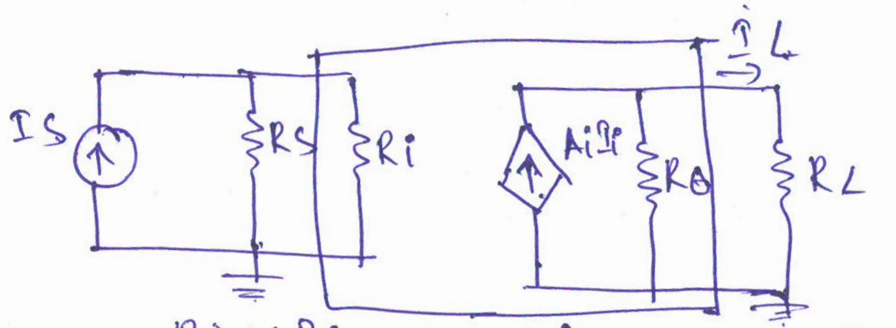
7b Illustrate Different types of feedback amplifiers? Give their equivalent ckts.

Ans 1) Voltage Amplifier (Series-shunt feed back.)



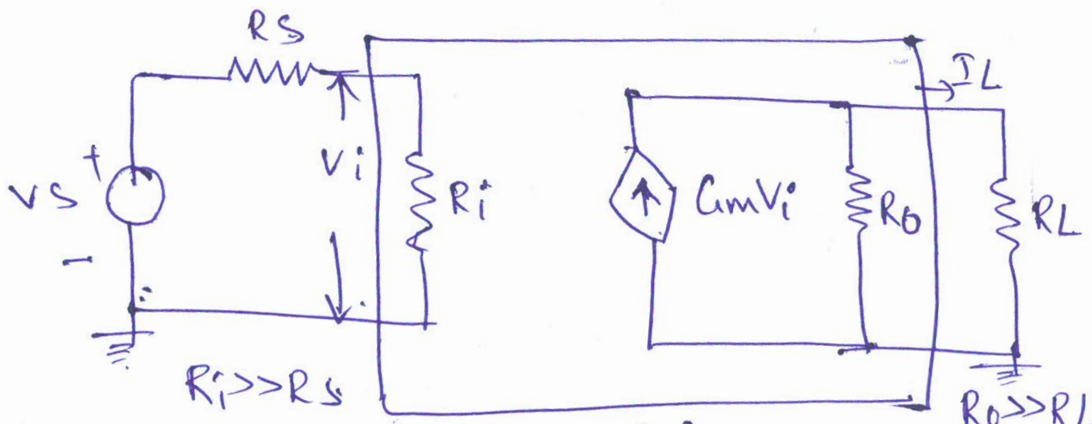
Ri>>Rs Amplifier Ro<<RL

…feedback.)



$R_i << R_S$ Amplifier. $R_o >> R_L$

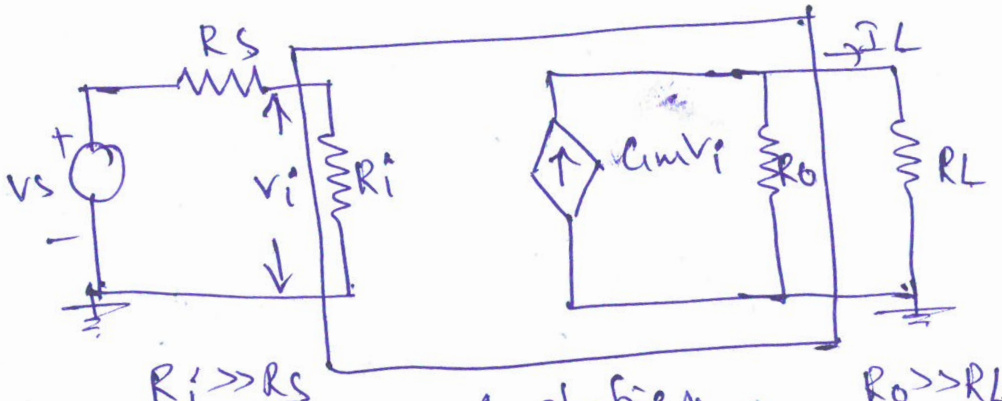
3. Transconductance Amplifier (Series-Series feedback



$R_i >> R_S$ $R_o >> R_L$

Amplifier.

4. Transresistance Amplifier (Shunt-Shunt feedback)



$R_i >> R_S$ Amplifier. $R_o >> R_L$

(Or)

9

6

Thus we have the four basic feedback arrangements :

(1) Voltage-series feedback [Fig. 11.3-1(a)]

(2) Voltage-shunt feedback [Fig. 11.3-1(b)]

(3) Current-series feedback [Fig. 11.3-1(c)]

(4) Current-shunt feedback [Fig. 11.3-1(d)]

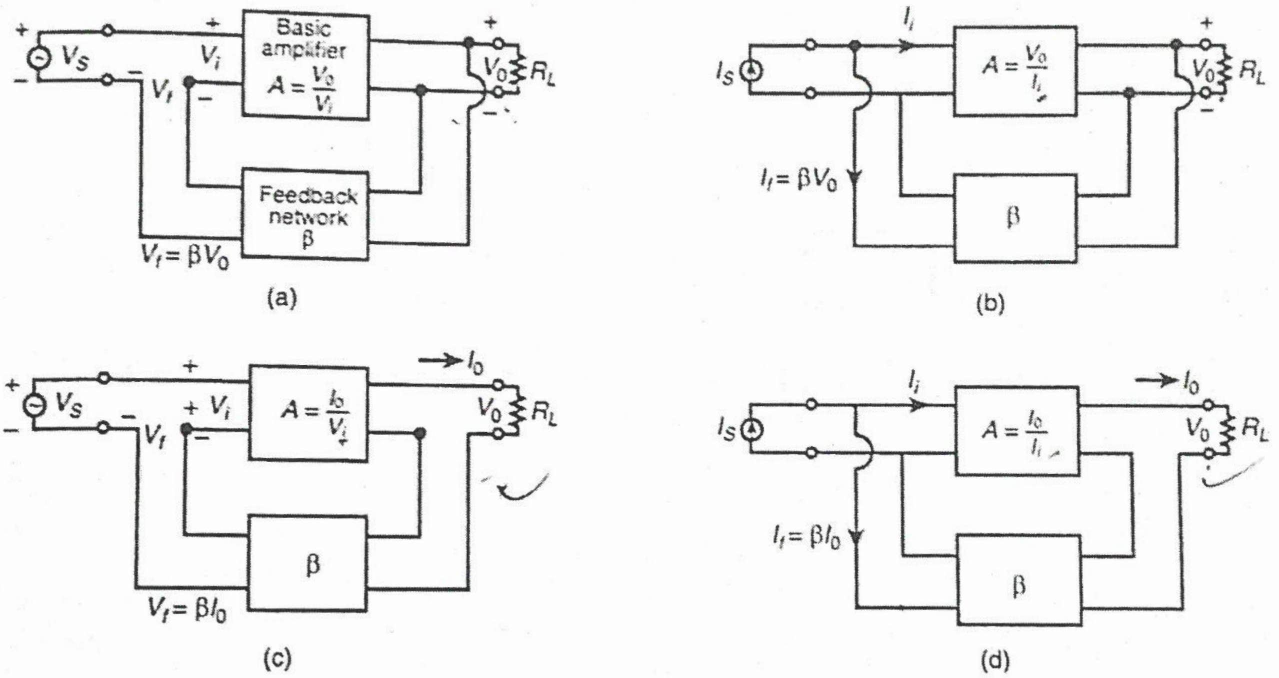


Fig. 11.3-1: Feedback amplifier types (a) voltage-series feedback (b) voltage-shunt feedback (c) current-series feedback (d) current-shunt feedback

In Fig. 11.3-1(a) the basic amplifier is a voltage amplifier. Here the output voltage v_0 is sampled by connecting the feedback network in *parallel* with the load. This makes feedback signal proportional to the output voltage. The feedback voltage v_f is added in series with an input voltage source. Thus it is an example of voltage-series feedback. Here the feedback network forms a series circuit with the input and a parallel circuit with the output. For this the arrangement is also called *series-shunt feedback*.

In Fig. 11.3-1(b) the basic amplifier is a current amplifier. Here the feedback current i_f is proportional to the output voltage and this feedback current is fed in parallel with the input current source. Thus it represents a voltage-shunt feedback. Here feedback network is in parallel to both input and output ports, so it is a *shunt-shunt feedback*.

In Fig. 11.3-1(c) the feedback network is connected in *series* with the load and it produces a feedback signal proportional to the output current i_0. So it is a current feedback. Since the feedback voltage is applied in series with an input voltage source it is a current-series feedback. The arrangement is also called *series-series* feedback.

10

8 a). ~~11.10~~ Hartley Oscillator

The circuit diagram of a Hartley oscillator using a transistor and LC network is shown in Fig. 11.10-1. The resistors R_1, R_2, $R_E - C_E$ combination and collector supply V_{CC} provide stabilized self-bias. C_i and C_o act as blocking/coupling capacitors. R_{fc}, the *radio frequency choke*, prevents RF current from reaching the collector supply; it also provides d.c. load to the collector. The capacitor C and the inductors L_1, L_2 form the frequency determining tank circuit. As soon as the supply is switched on a transient flows in the tank circuit. Voltage across L_2 is the output and that across L_1 is fed back to the input of the CE amplifier. Since the point O is grounded the points A and B are 180° out of phase. The CE amplifier provides additional phase shift of 180°. Thus the Barkhausen phase shift requirement of 360° around the loop for oscillation is fulfilled. Now if the amplifier provides sufficient gain the condition of unity loop gain i.e., $|A\beta| = 1$ may be satisfied and sustained oscillation will be obtained.

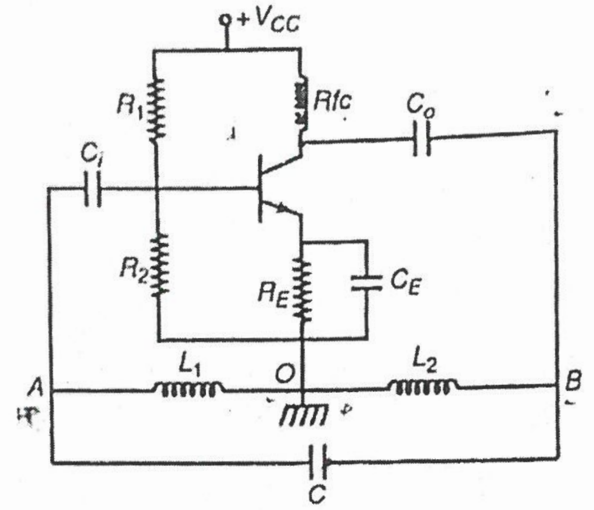


Fig. 11.10-1: A BJT Harley Oscillator

To analyse the performance of the circuit we consider, for simplicity, the approximate h-parameter equivalent circuit of Fig. 11.10-2 where we have represented the inductive and capacitive reactances by Z_1, Z_2 and Z_3. Let $Z_1 = jX_1$, $Z_2 = jX_2$ and $Z_3 = jX_3$ where $X_1 = \omega L_1$, $X_2 = \omega L_2$ and $X_3 = -\frac{1}{\omega C}$, ω being the angular frequency of oscillation.

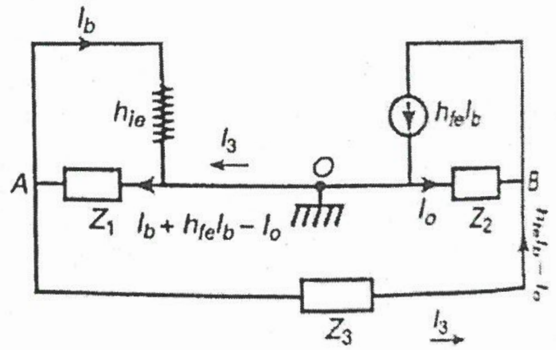


Fig. 11.10-2: Simplified h-parameter equivalent circuit of Hartley oscillator

Applying Kirchhoff's voltage law to the input and output circuits we get

$$I_b \cdot h_{ie} + (I_b + h_{fe} I_b - I_o) Z_1 = 0$$

$$\text{or,} \quad I_b[h_{ie} + (1 + h_{fe}) Z_1] = I_o \cdot Z_1 \qquad (11.10\text{-}1)$$

$$\text{and} \quad I_o \cdot Z_2 - (h_{fe} I_b - I_o) Z_3 - (I_b + h_{fe} I_b - I_o) Z_1 = 0$$

$$\text{or,} \quad I_b[(1 + h_{fe}) Z_1 + h_{fe} Z_3] = I_o (Z_1 + Z_2 + Z_3) \qquad (11.10\text{-}2)$$

Assuming non-zero values of I_b and I_o and dividing Eq. (11.10-2) by Eq. (11.10-1).

we get

$$\frac{Z_1 + Z_2 + Z_3}{Z_1} = \frac{(1 + h_{fe})Z_1 + h_{fe}Z_3}{(1 + h_{fe})Z_1 + h_{ie}}$$

Rearranging we get,

$$h_{ie}(Z_1 + Z_2 + Z_3) + (1 + h_{fe})Z_1 Z_2 + Z_1 Z_3 = 0 \tag{11.10-3}$$

An alternative derivation of Eq. (11.10-3)

Equation (11.10-3) can also be established by considering the Barkhausen criterion for oscillation i.e., $A\beta = 1$. The voltage gain of the amplifier in the absence of feedback is given by

$$A = -\frac{h_{fe}Z_L}{h_{ie}}$$

where $Z_L = Z_2 \| (Z_3 + Z_1')$, is $Z_1' = Z_1 \| h_{ie}$.

Now feedback voltage between the points A and O is

V_f = voltage across $Z_1 = I_3 Z_1'$ and the output voltage between the points B and O is

$$\begin{aligned} V_0 &= \text{voltage across } Z_2 = \text{voltage across } (Z_3 + Z_1') \\ &= I_3(Z_3 + Z_1') \end{aligned}$$

where I_3 is the current through Z_3.

Therefore, feedback ratio $\beta = \dfrac{Z_1'}{Z_3 + Z_1'}$.

Now $A\beta = 1$ requires that

$$-\frac{h_{fe}}{h_{ie}} \cdot \frac{Z_2(Z_3 + Z_1')}{Z_1' + Z_2 + Z_3} \times \frac{Z_1'}{Z_3 + Z_1'} = 1$$

which, on simplification, gives Eq. (11.10-3)

Now putting $Z_1 = jX_1$, $Z_2 = jX_2$ and $Z_3 = jX_3$ in Eq. (11.10-3) and equating real and imaginary parts separately to zero we get

$$(1 + h_{fe})X_2 + X_3 = 0 \tag{11.10-4}$$

$$\text{and} \quad X_1 + X_2 + X_3 = 0 \tag{11.10-5}$$

From Eq. (11.10-5),

$$\omega L_1 + \omega L_2 - \frac{1}{\omega C} = 0$$

$$\text{or} \quad \omega^2 = \frac{1}{C(L_1 + L_2)} \tag{11.10-6}$$

Therefore, the frequency of oscillation is

$$f = \frac{1}{2\pi\sqrt{C(L_1 + L_2)}} \tag{11.10-7}$$

11

From Eq. (11.10-4) we get the condition of sustained oscillation as

$$(1+h_{fe})\omega L_2 - \frac{1}{\omega C} = 0$$

$$\text{or,}\quad \omega^2 \cdot L_2(1+h_{fe}) = \frac{1}{C}$$

Using Eq. (11.10-6),

$$h_{fe} = \frac{L_1}{L_2} \qquad (11.10\text{-}8)$$

Thus $h_{fe} \geq \frac{L_1}{L_2}$ is the condition for sustained oscillation. If we include the mutual inductive effect (M) between the coils L_1 and L_2 then the frequency of oscillation and the condition of oscillation are slightly modified as follows:

$$f = \frac{1}{2\pi\sqrt{C(L_1+L_2+2M)}} \qquad (11.10\text{-}9)$$

$$\text{and}\quad h_{fe} \geq \frac{L_1+M}{L_2+M} \qquad (11.10\text{-}10)$$

Hartley oscillators are primarily used for the generation of RF oscillations, for example in transistorized radios and other entertainment receivers. The frequency of oscillation is changed conveniently by varying the capacitor C.

FET Hartley Oscillator

Hartley oscillator may also be designed by using a FET. Fig. 11.10-3 shows the circuit of a FET Hartley oscillator. The frequency of oscillation is given by the Eq. (11.10-9).

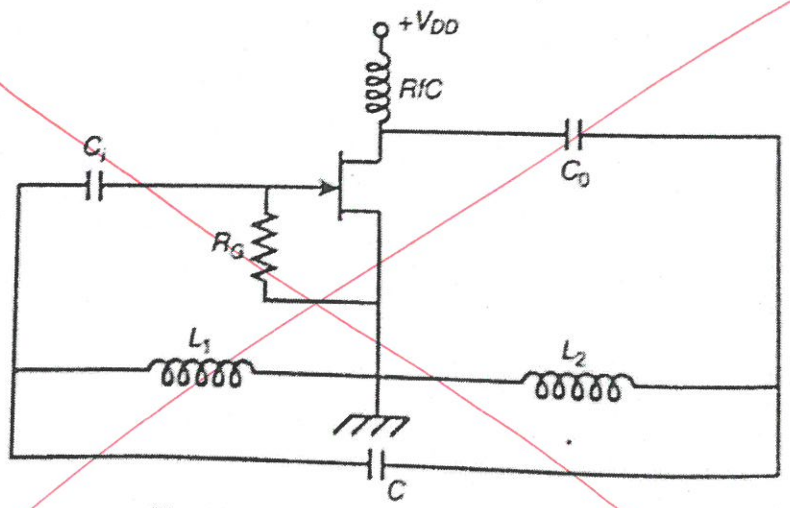


Fig. 11.10-3: A FET Hartley Oscillator

11.11 Colpitts Oscillator

The circuit diagram of a Colpitts oscillator using a transistor and a LC network is shown in Fig. 11.11-1. Note that the circuit is similar to that of Hartley oscillator

8b. Explain the concept of stability Oscillators. (12)

Ans The frequency stability of an oscillator is a measure of its ability to maintain the required frequency as precisely as possible over as long a time interval as possible. The accuracy of fq. calibration required may be anywhere between 10^{-2} & 10^{-10}. The main drawback in transistor Oscillators is that the frequency of oscillation is not stable during a long time operation.

The following are the factors which contribute to the change in frequency:-

→ Due to change in temperature, the values of the frequency determining components viz., resistor, capacitor & Inductor.

→ Due to variation in the Power Supply, unstable transistor parameters, change in climatic conditions & aging

→ The effective resistance of the tank ckt is changed when the load is connected.

→ Due to variations in biasing conditions & load conditions

→ The variation of fq. ~~with~~ with temperature is given by

$$S_{\omega,T} = \frac{\Delta\omega/\omega_0}{\Delta T/T_0} \text{ PPMC}$$

where $\omega_0 T_0$ are the desired fq. of osillation and the operating Temperature.

9(a)

Ans $C_1 = C_2 = C$, $L = 100\,\mu H$ (13)

$f = 500\,KHz$.

$$f = \frac{1}{2\pi\sqrt{LC}} \Rightarrow f^2 = \frac{1}{4\pi^2 LC}$$

$$LC = \frac{1}{4\pi^2 f^2} = \frac{1}{4\pi^2 (500\times10^3)^2} = 1.013\times10^{-13}$$

$L = 100\,\mu H$

$$C = \frac{1.013\times10^{-13}}{100\times10^{-6}} = \frac{1.013\times10^{-13}}{10^{-4}}$$

$$= 1.013\times10^{-9} \Rightarrow 101.32\,PF$$

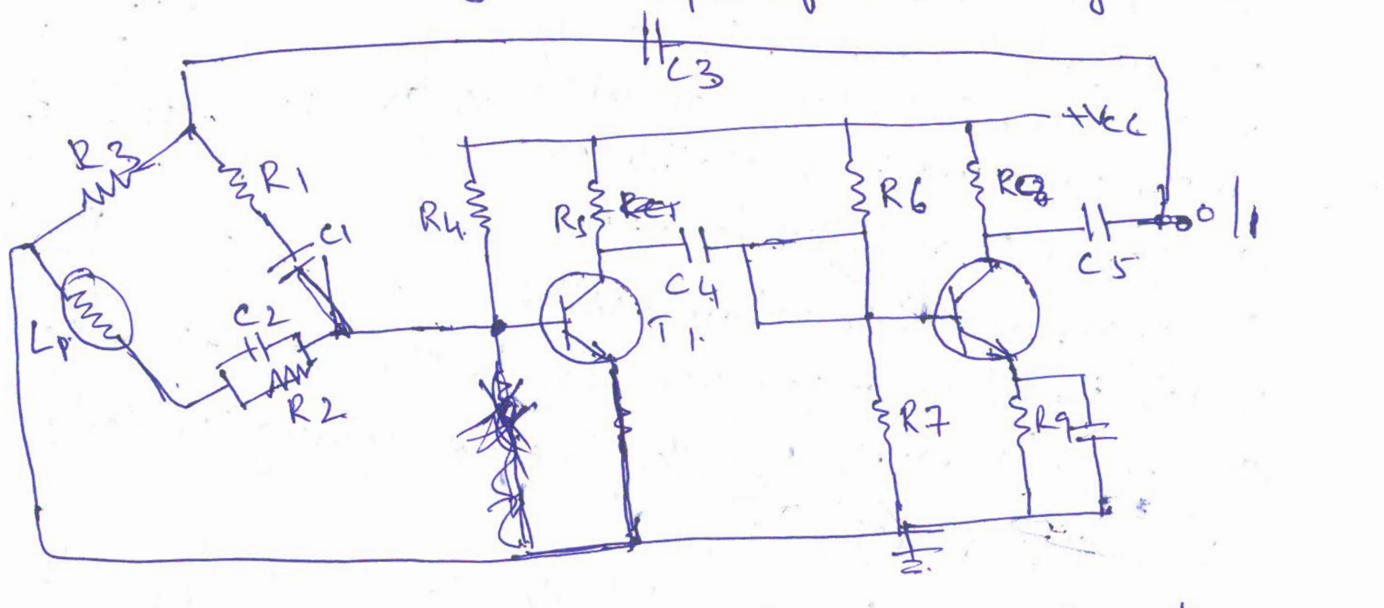
$$C = \frac{C_1C_2}{C_1+C_2}, \quad C_1 = C_2 = C$$

$$101.32 = \frac{C'^2}{2C'}$$

$$C_1 = C_2 = \underline{202.6\,PF}$$

9b Illustrate working Principle of wien bridge oscillator.

Ans



ckt shows a wien bridge Oscillator using two stage transistor amplifier. note that two Common emitter amplifiers are being connected in Cascade so that the Phase Shift introduced by the amplifier is zero. The wien bridge ckt has been shown in a bridge Model. The I/P to this feedback N/W is the o/P voltage Vo coupled from the collector of transistore.

The voltage developed across the ||el RC is used as feedback voltage.

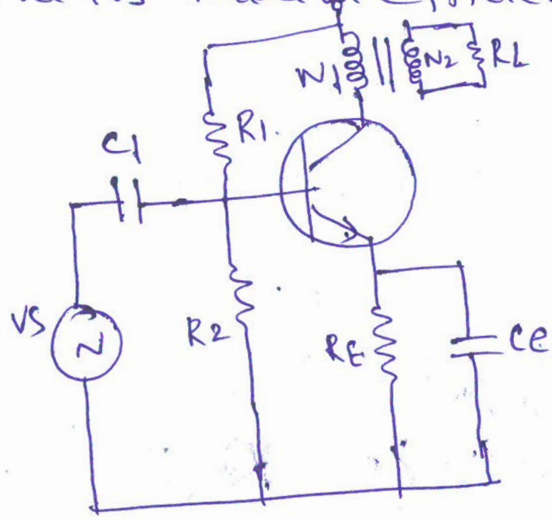
The fq. Can be varied by varying either both resistors or both capacitors connected in the fq. Sensitive arms of the wienbridge.

The expression for the oscillation fq. is given by

$$f = \frac{1}{2\pi RC}$$

10 A Illustrate with diagram, Transformer coupled Class A Power Amplifier and derive its maxim efficiency.

Ans fig shows the Transformer coupled Class A power Amplifier. The Primary winding of transformer has a low resistance. So the Power absorbed in the winding is negigible as Compared to resistive load. The function of the transformer is to



match the low impedance load to the high o/P Impedance of Amplifier. The Impedance matching Property follow from the relation

$$V_1 = \frac{N1}{N2} \cdot V_2 \quad \& \quad I_1 = \frac{N2}{N1} \cdot I_2$$

Power Relations :-

The Average Power applied to the ckt $= P_{in(dc)} = V_{cc} \cdot I_{C}$

Power developed in Transistor $P_{tr(dc)} = V_{CEQ} \cdot I_{CQ}$
$= V_{cc} \cdot I_{CQ}$

Peak value of o/p volt across load $= V_p = V_{CEQ}$.

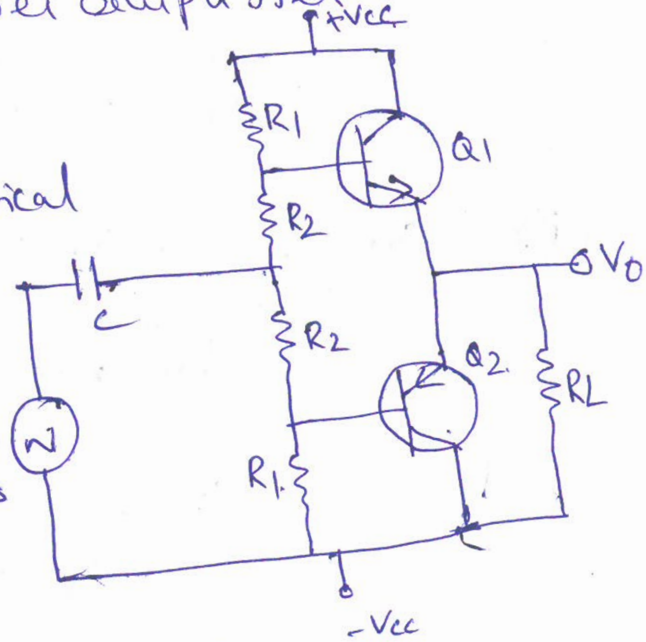
and Peak value of load current $I_P = I_{CQ}$

Maximum efficiency $\eta_o = \frac{P_{o(ac)}}{P_{in(dc)}} = \frac{V_p I_p / 2}{V_{ce} I_{CQ}} = \frac{V_m I_m}{2 V_{ce} I_C}$

b'cos of Transformer coupling $V_{cc} = V_{ceQ} = V_m$

% efficiency $\eta_o = \frac{V_{CEQ} \cdot I_{CQ}}{2 V_{CEQ} \cdot I_{CQ}} \times 100 = \frac{1}{2} \times 100 = 50\%$.

10 b Illustrate complimentary symmetry class B Power Amplifier with diagram and write about crossover distortion in class B Power amplifier.



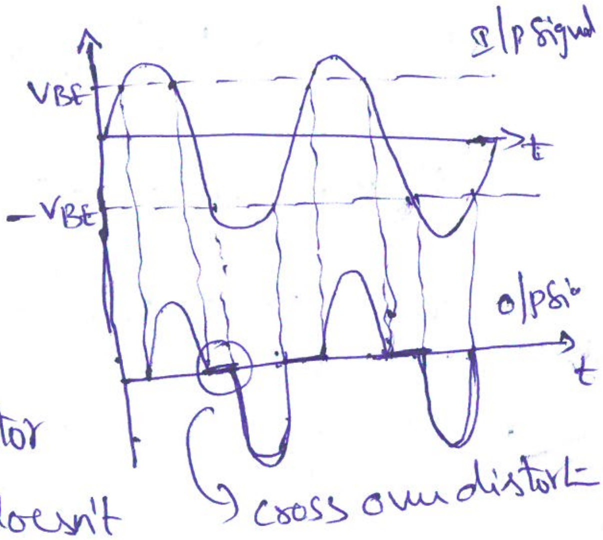
Ans. In this ckt Complimentary means the ckt uses two Identical Transistors but one is NPN and the other is PNP.

The symmetry means the biasing resistors connected in both transistors are equal.

During the +ve half cycle of ac input the base emitter voltage of both transistor becomes Positive. Under these Conditions, only the NPN transistor conducts, while the PNP Transistor is cutoff.

During the -ve half cycle of ac input only PNP conducts and NPN is OFF and -ve half cycle current flows through R_1.

In class B mode, both Transistors are biased at cut off region b'cos dc bias voltage is zero. So I/P signal should exceed the barrier voltage to make the transistor conduct otherwise a transistor doesn't conduct. So there is a time Interval between the 2 -ve alterations of the O/P signal when neither transistor is conducting. The resulting distortion in the o/p signal is "Cross over distortion".



11a Ans

Assume $h_{fe} = 25$ & $V_{cc} = 20V$.

$R_L = 12\Omega$, $n = \frac{N_2}{N_1} = \frac{1}{3} = 0.333$, $\eta_{trans} = 78.5\%$

$$R_L' = \frac{R_L}{(n)^2} = 108\Omega$$

(i) for P_{max}, $V_m = V_{cc}$

$$(P_{ac})_{max} = \frac{1}{2}\frac{(V_{cc})^2}{R_L'} = \frac{1}{2}\frac{(20)^2}{108} = 1.8518W$$

$\eta_{trans} = 78.5\%$.

$$P_L = \eta_{trans} \times (P_{ac})_{max}.$$

$$= 0.785 \times 1.8518 = 1.4537W.$$

(ii) Condition for $(P_d)_{max}$ is $V_m = \frac{2}{\pi} V_{cc} = 12.7323V$ (15)

$$(P_d)_{max} = \frac{2}{\pi^2}\frac{V_{cc}^2}{R_L'} = \frac{2}{\pi^2}\frac{(20)^2}{108} = 0.7505W$$

$$(P_d)_{max} \text{ Per Transistor} = \frac{0.7505}{2} = 0.3752W$$

(iii) $$(P_{ac})_{max} = V_{rms} I_{rms} = \frac{V_m}{\sqrt{2}}\frac{I_m}{\sqrt{2}} = \frac{V_m I_m}{2}$$

$$1.8518 = \frac{20 I_m}{2}$$

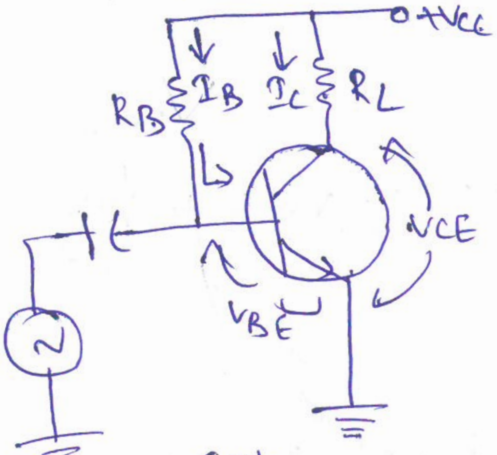
$$I_m = 0.1851A$$

11b. Derive the general expression for the o/p power in the case of a Class A Power Amplifier. Draw the ckt & explain the movement of operating Point on the load line for a given I/P signal.

Apply KVL to the ckt.

$V_{cc} = I_C R_L + V_{CE}$

$I_C R_L = -V_{CE} + V_{CC}$



Ckt

DC Power I/P

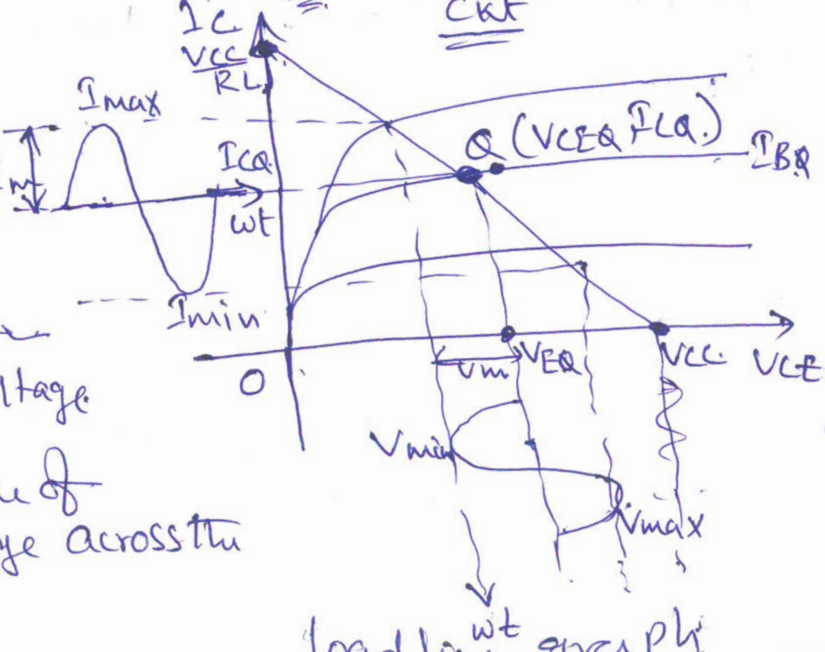
$P_{dc} = V_{cc} I_{CQ}$

AC Power O/P

V_{min} → Minimum Instant value of the o/p voltage

V_{max} → maximum Instant value of the o/p voltage

V_{PP} → Peak to Peak value of a.c o/p voltage across the load.



loadline graph

$$V_{pp} = V_{max} - V_{min}$$

$$V_m = \frac{V_{pp}}{2} = \frac{V_{max} - V_{min}}{2}$$

$I_{min} \rightarrow$ Minimum Instantaneous value of the o/p current

$I_{max} \rightarrow$ Maximum " " "

I_{pp} = Peak to Peak value of a.c o/p current

$$I_{pp} = I_{max} - I_{min}$$

$$I_m = \frac{I_{pp}}{2} = \frac{I_{max} - I_{min}}{2}$$

rms value of o/p voltage & current.

$$V_{rms} = \frac{V_m}{\sqrt{2}}, \quad I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = I_{rms} R_L, \quad V_m = I_m R_L$$

using rms values

$$P_{ac} = V_{rms} I_{rms}$$

$$P_{ac} = I^2_{rms} R_L \Rightarrow \frac{V^2_{rms}}{R_L}$$

using Peak values

$$P_{ac} = \frac{V_m I_m}{2} = \frac{I^2_m R_L}{2}$$

$$P_{ac} = \frac{V^2_m}{2R_L}$$