ECA - Assignment - 1

19BLA0489
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(1) Explain classification of amplifiers

A. Amplifiers can be classified according to

- frequency range
- Method of operation
- Method of inter stage coupling
- Type of load connected
- Application

Frequency range

1. DC amplifier (from 0 freq)
2. Audio amplifier (20Hz to 20kHz)
3. Vedio (or) pulse amplifier (upto few MHz)
4. Radio frequency amplifier (kHz to 100's of MHz)
5. Ultrahigh- frequency amplifier (100's or 1000's of MHz).

Method of operation: (position of Q point and extent of the characteristics)

1. Class A: Q point and input signal are selected

such that output signal is obtained for a full input cycle.

(2) Class B: Q point and input signal are selected such that o/p signal is obtained for one half cycle

(3) Class C: Q point and i/p signal are selected such that o/p signal is obtained for less than a half cycle for full cycle

(4) Class AB: Q point and i/p signal are selected such that o/p is obtained for more than 180° but less than 360°.

Method of Coupling

(1) RC coupled: Resistors and capacitors are coupling components. They block dc and gives flat response at mid frequencies.

(2) Transformer Coupled: Transformer is coupling component Blocks dc and gives impedance matching

(3) Direct Coupled: o/p of 1st stage connected to i/p of next stage. Doesn't Block dc signal.

Type of load

① Amplifier with resistive load

② with inductive load.

Application

① voltage amplifier

② current amplifier

③ power amplifier

④ Tuned amplifier

(Q) Explain different types of distortion in amplifiers.

(A) In acoustics and electronics, any change in a signal that alters the basic waveform is called distortion.

- amplitude distortion (non-linear)
- frequency distortion
- phase distortion (delay)

① Amplitude distortion

Due to the non-linearity in the dynamic characterstics, the waveform of the o/p voltage differs from that of the i/p signal Such distortion is called non-linear (or) amplitude (or) Harmonic distortion. Harmonic distortion means the presence of the frequency components in the o/p waveform, which are not present in i/p signal. The additional frequency components present in the o/p signal are having components which are integral multiples of the fundamental frequency components. These are known as Harmonics.

out of all the harmonics, the 2nd harmonic has the largest amplitude.

(2) Frequency distortion

This type of distortion exists when the signal components of different frequencies are amplified differently. If the frequency response of an amplifier is not a horizontal straight line over the range of frequencies under consideration, the circuit is said to exhibit frequency distortion

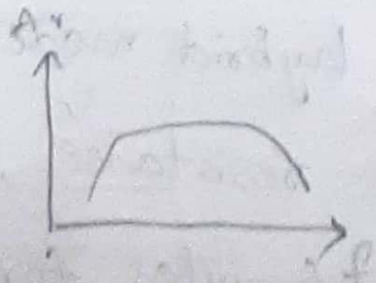
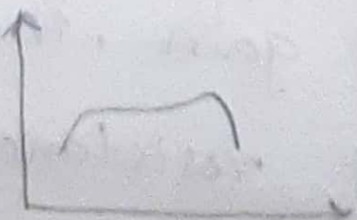
(3) phase distortion:

Also known as delay distortion. when ever there is time delay b/w i/p and occuurance of the signal at o/p, phase distortion occurs.

- It occurs due to electrical reactance.

(3Q) compare different types of coupling schemes used in amplifiers.

(A)

parameter	RC coupled	Transformer coupled	Direct coupled
coupling components	Resistor and capacitor	Impedance matching transformer	—
Block dc	YES	YES	NO
Frequency response	Flat at mid freq's 	Not uniform, high at resonant freq and low at other 	Flat at middle freq and improvement in low freq response 

Impedance matching	Not achieved	Acheieved	Not achieved
DC amplification	NO	NO	YES
weight	Light	Heavy and bulky	—
Application	used in all small signal amplifiers	used in o/p stage of public address system to match the impedance of Loud speaker	used in DC amplification
Signal coupled	ac	ac	ac+dc
Drift	Not present	Not present	present

(HQ) Explain approximate hybrid model. write the current gain, input resistance, voltage gain, output resistance formulas for.

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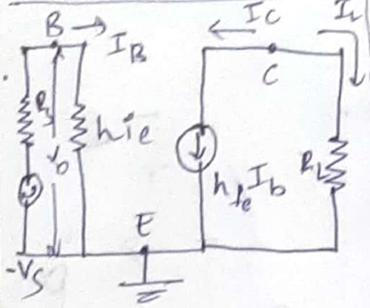
(A) Approximate hybrid models

(1) CE (2) CB (3) CC (4) CE with emitter resistance.

CE



$A_I = -h_{fe}$

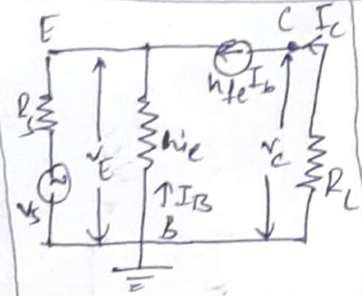
$R_i = h_{ie}$

$A_V = \frac{A_I R_L}{R_i}$

$R_o = \infty$

$R_o' = R_o \| R_L = R_L$

CB



$A_I = \frac{h_{fe}}{1+h_{fe}}$

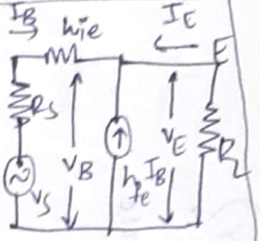
$R_i = \frac{h_{ie}}{1+h_{fe}}$

$A_V = \frac{A_I R_L}{R_i}$

$R_o = \infty$

$R_o' = R_L$

CC



$A_I = 1 + h_{fe}$

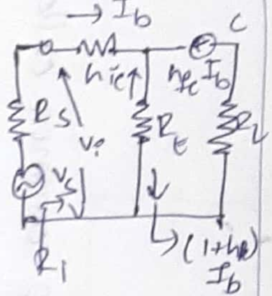
$R_i = h_{ie} + (1+h_{fe}) R_L$

$A_V = \frac{A_I R_L}{R_i}$ ~~1+h_fe~~

$R_o = \frac{R_s + h_{ie}}{1+h_{fe}}$

$R_o' = R_o \| R_L$

CE with RE



$A_I = -h_{fe}$

$R_i = h_{ie} + (1+h_{fe}) R_E$

$A_V = \frac{-h_{fe} R_L}{h_{ie} + (1+h_{fe}) R_E}$

$R_o = \infty$

$R_o' = R_o \| R_L$

$= \infty \| R_L$

$= R_L$

(5Q) write the formulas for overall lower and higher cutoff frequencies of multistage amplifier. Draw the frequency response of single stage and multistage amplifier.

(A) overall lower cutoff frequency of multistage amplifier is

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

overall higher cutoff frequency of multistage amplifier is

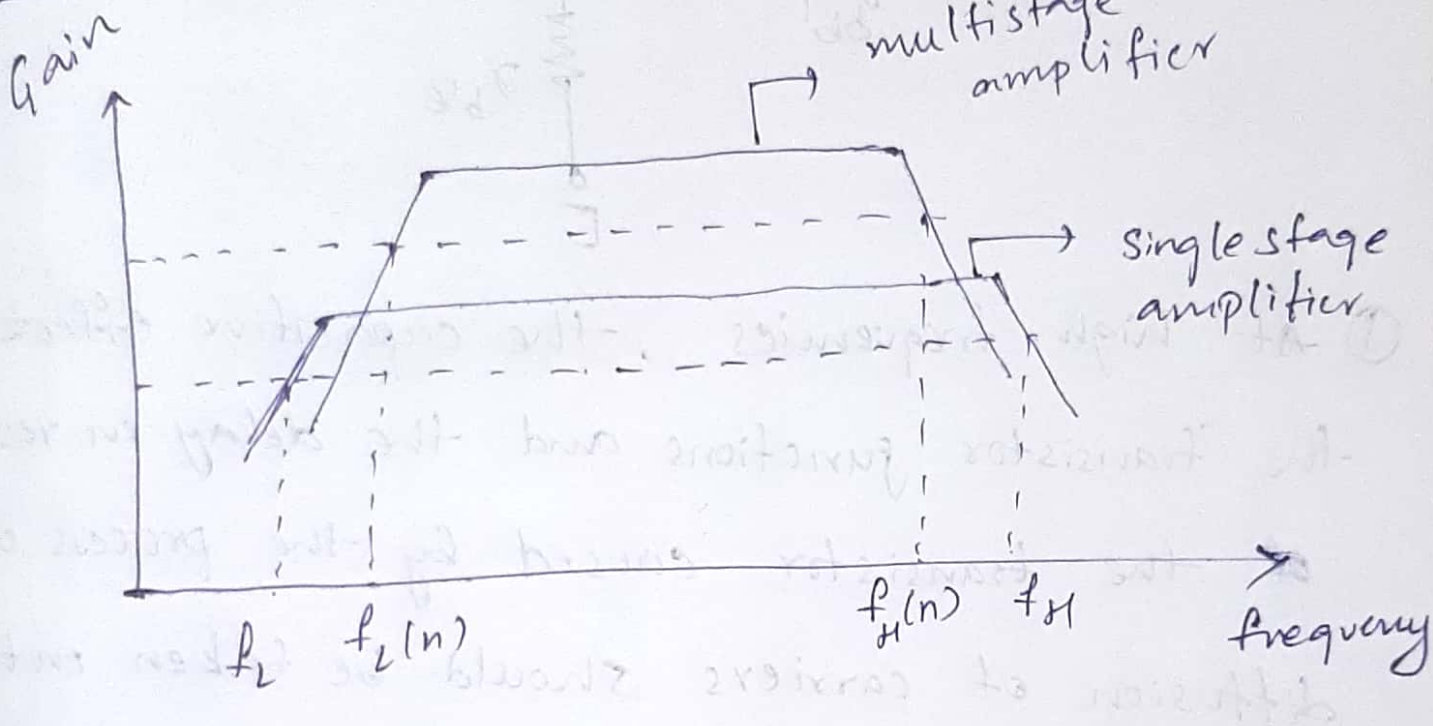
$$f_H(n) = f_H\sqrt{2^{1/n}-1} \quad \text{(identical)}$$

For non-identical stages

$$f_L(n) \approx 1.1\sqrt{f_{L_1}^2 + f_{L_2}^2 + \cdots}$$

$$f_H(n) \approx 1.1\sqrt{\frac{1}{f_{H_1}^2} + \frac{1}{f_{H_2}^2} + \cdots}$$

Frequency response of single stage and multistage amplifier



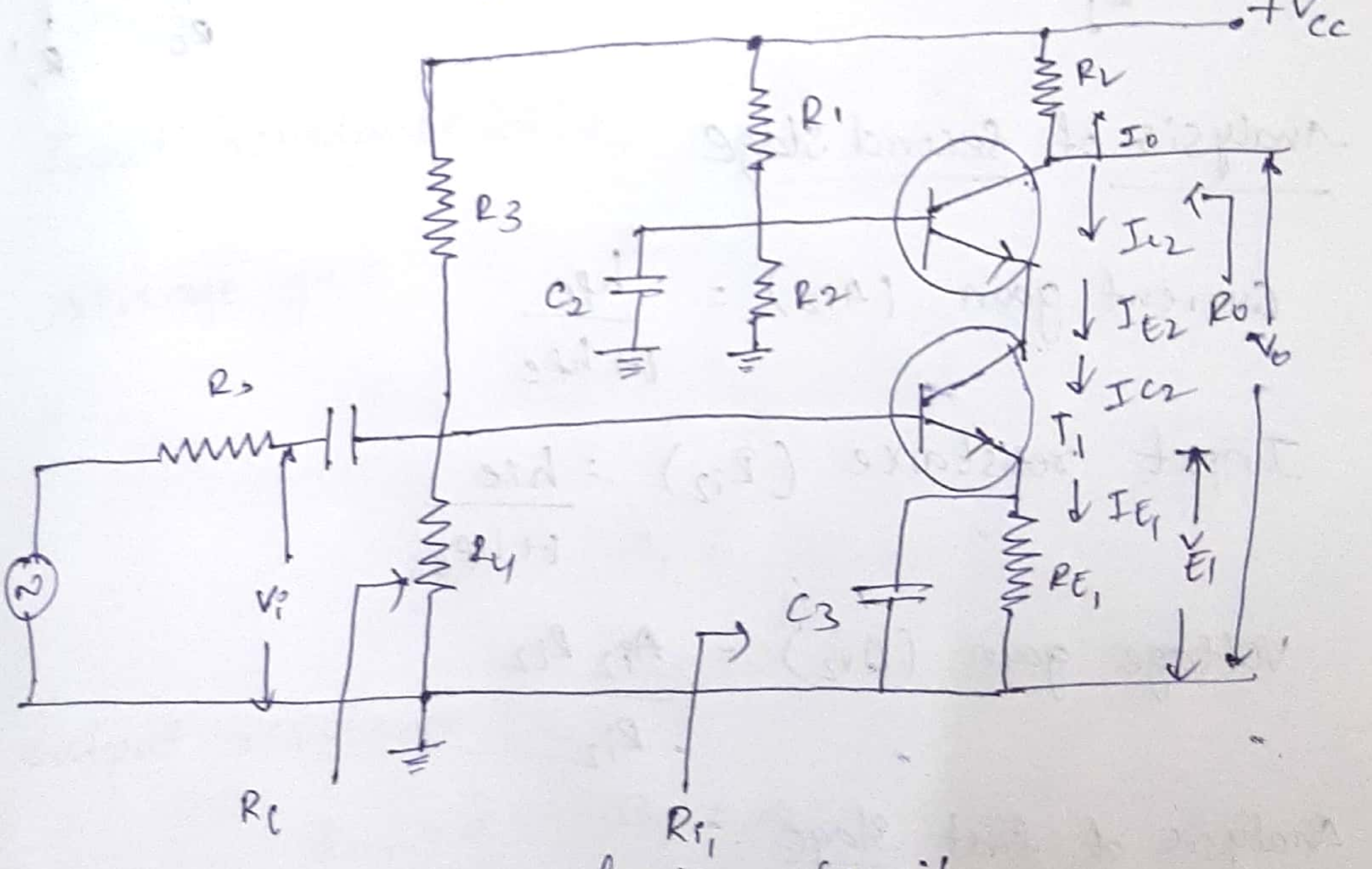
(6Q) Draw circuit diagrams of cascade amplifier, write the current gain, input resistance, voltage gain, output resistance formulas.

(A) (1) It is a cascade of CE and CB amplifier ie, it consist of a CE stage followed by a CB stage directly coupled to each other and combines some of the features of both

② T_1 and its associated components operate as CE, T_2 as a common base o/p stage

Features

① High input impedance
② High voltage gain.
③ very high o/p impedance
④ improved i/p, o/p isolation as there is no direct coupling



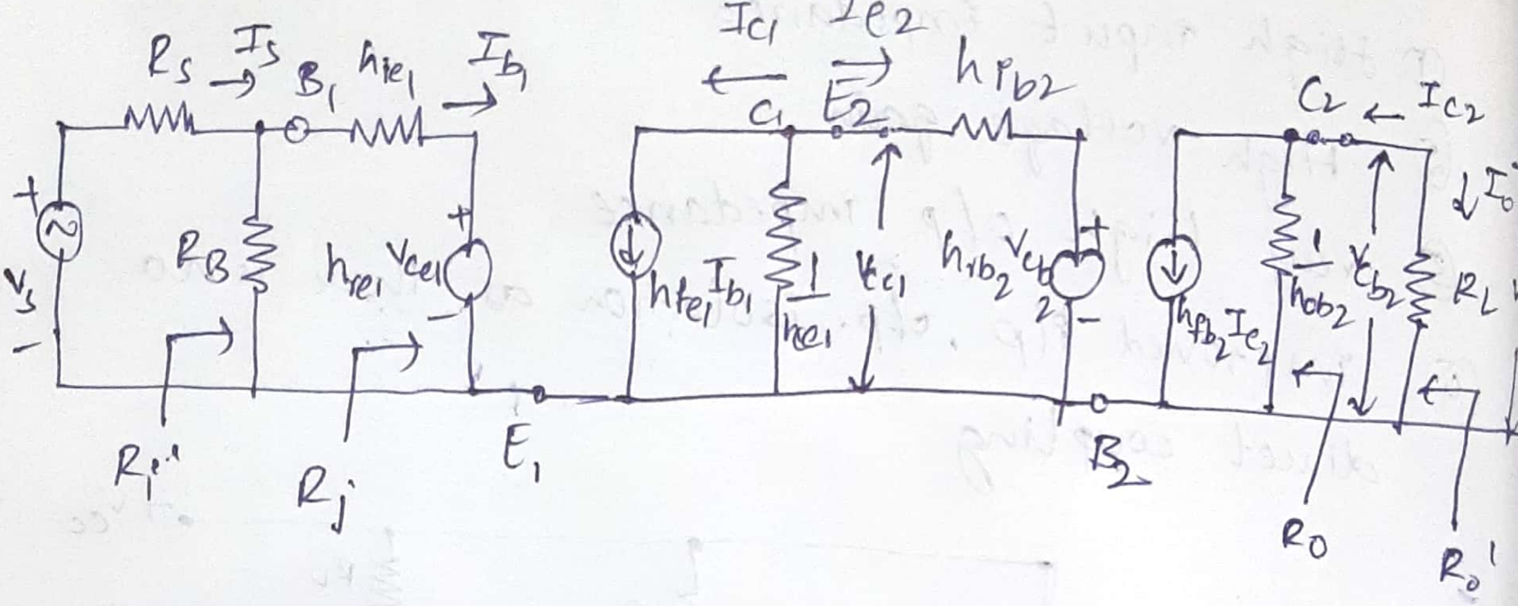
DC bias conditions of the circuit

① Emitter current for T_1 is set by V_{E_1} and R_{E_1}

(2) collector current: $I_{C_1} \approx I_{E_1}$ and

$I_{E_2} \approx I_{C_1}$

AC Analysis



Analysis of Second Stage

Current gain $(A_{i2}) = \dfrac{h_{fe}}{1+h_{fe}}$

Input resistance $(R_{i2}) = \dfrac{h_{ie}}{1+h_{fe}}$

Voltage gain $(A_{v_2}) = \dfrac{A_{i_2} R_{L2}}{R_{i2}}$

Analysis of first stage

current gain $(A_{i_1}) = -h_{fe}$

Input resistance $(R_{i_1}) = h_{ie}$

voltage gain $= \frac{A_{i_1} R_{L_1}}{R_{i_1}}$

overall analysis

current gain $= \frac{I_o}{I_s}$

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

$= \frac{I_o}{I_s}$

Input resistance $(R_i) = R_{i_1} \parallel R_B$

voltage gain $A_v = A_{v_1} \times A_{v_2}$

$A_{vs} = \frac{v_o}{v_s} = \frac{v_o}{v_i} \times \frac{v_i}{v_s}$

$A_{vs} = A_v \times \frac{R_i'}{R_i' + R_s}$

output resistance (R_o)

$R_{o_1} = \infty, \quad R_{o_2} = \infty$

$R_o' = R_{o_2} \parallel R_L$

$= R_L$

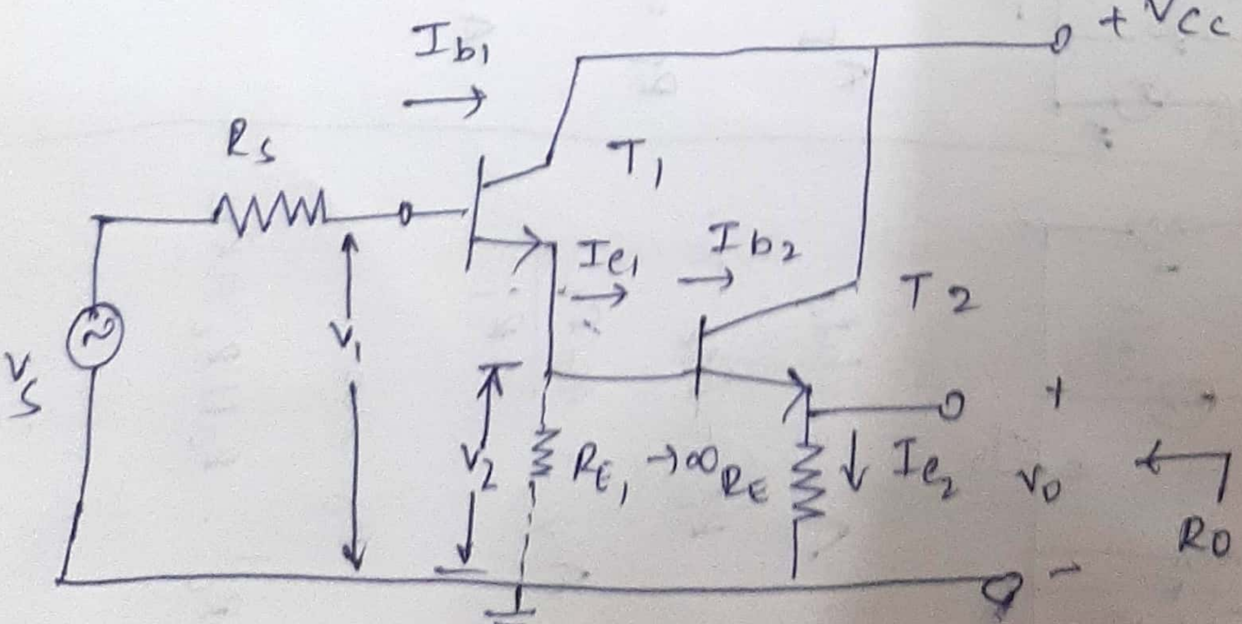
(7) Draw circuit diagrams of darlington pair amplifier. write the current gain, input resistance, voltage gain, output resistance formulas (stage 1, stag 2, overall)

(A) Darlington pair Amplifier

(1) It is a cascade of two common collector amplifier (emitter follower amplifier)

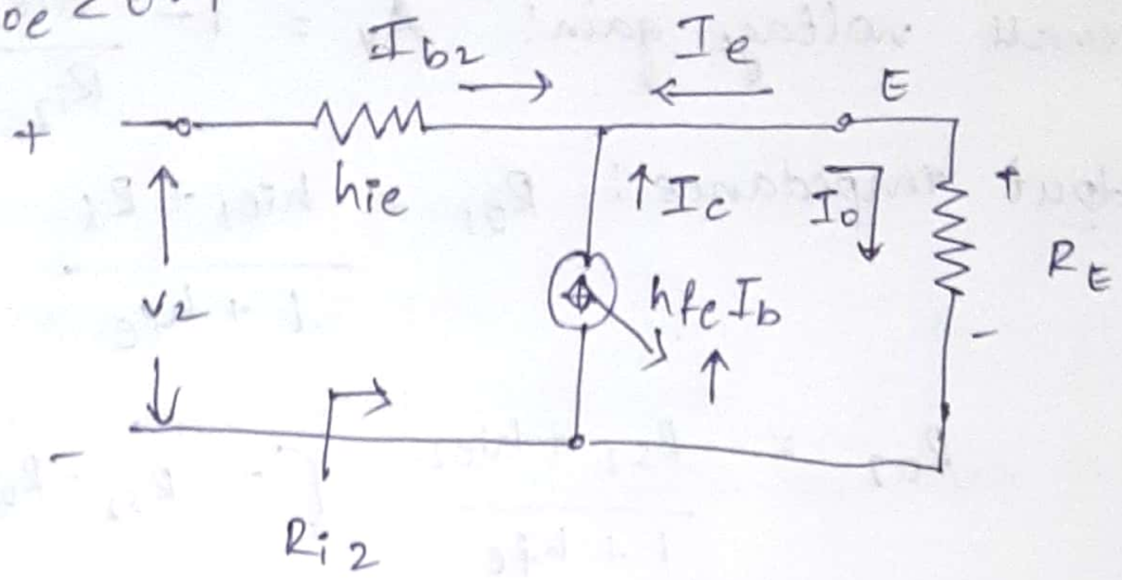
(2) Features: very high i/p resistance
low o/p resistance
unity voltage gain
High current gain

(3) It can be used as Buffer



Second stage

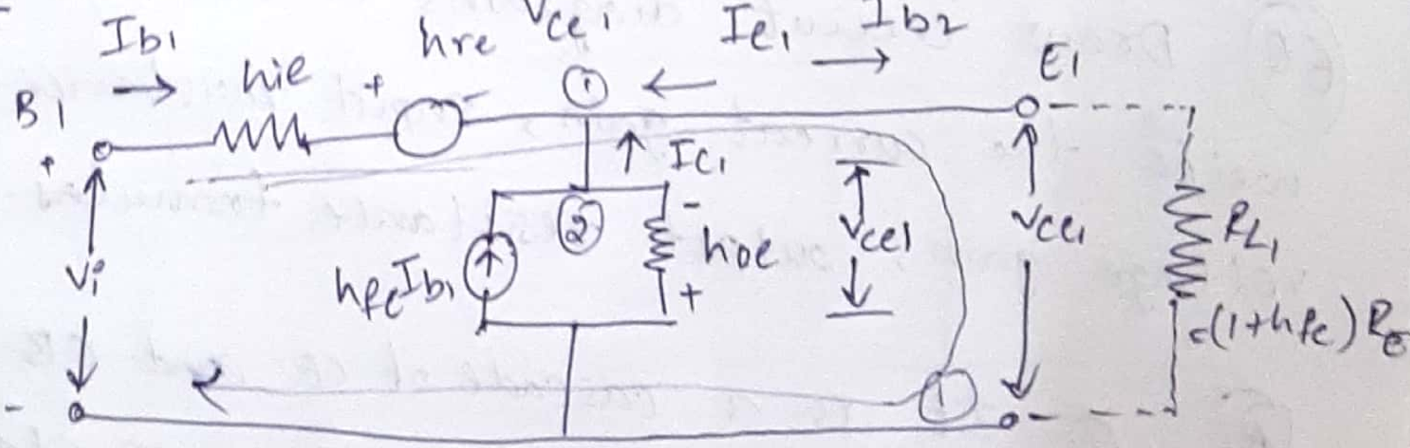
$R_L h_{oe} < 0.1$



$$A_{i2} = 1 + h_{fe}$$

$$R_{i2} = \frac{V_2}{I_{b2}} \Rightarrow R_{i2} = (1+h_{fe}) R_E$$

First stage



$$A_{i1} = \frac{1+h_{fe}}{1+h_{oe} h_{fe} R_E}$$

$$R_{i1} = A_{i1} R_{L1}$$

$$= (1+h_{fe})^2 R_E$$

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Overall Analysis

overall voltage gain: $A_v = 1 - \frac{h_{ie}}{R_{i_2}}$

output impedance: $R_{o1} = \frac{h_{ie_1} + R_s}{1 + h_{fe}}$

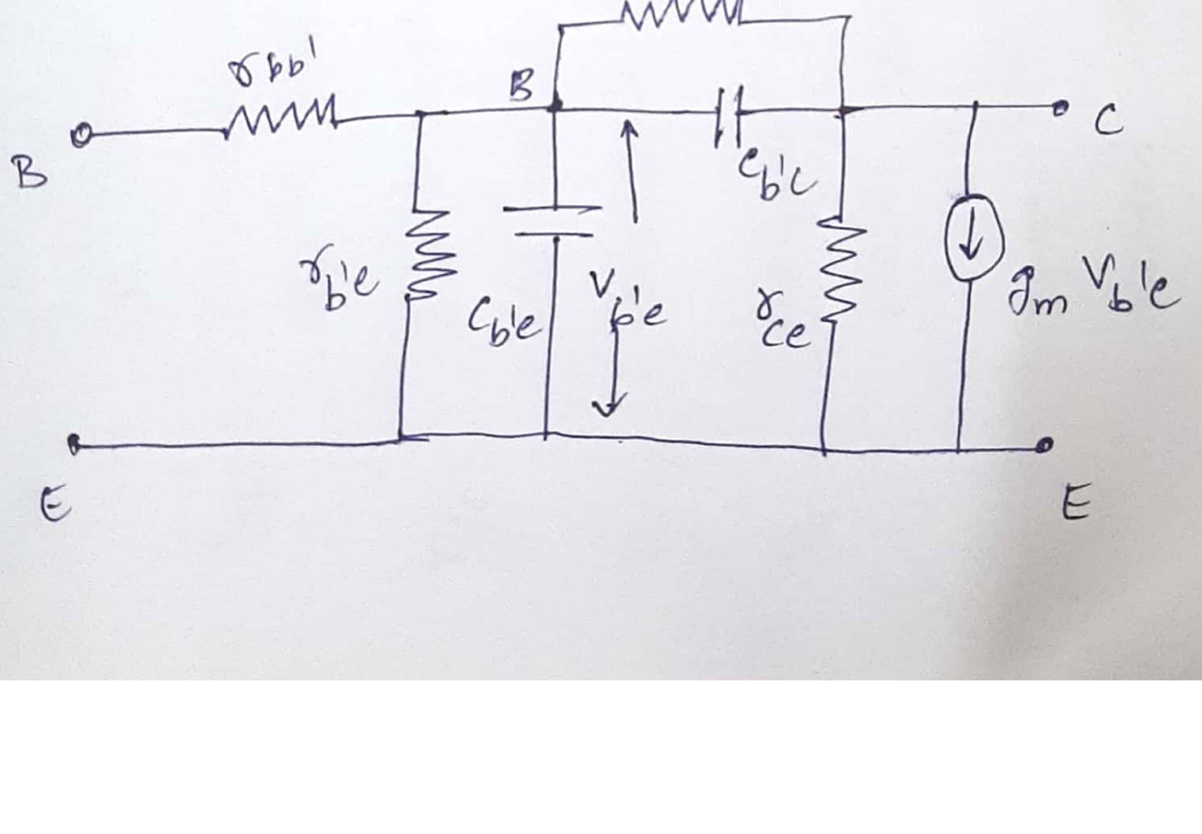
$$R_{o2} = \frac{R_{s2} + h_{ie2}}{1 + h_{fe}} \quad [\because R_{s_2} = R_{o1}]$$

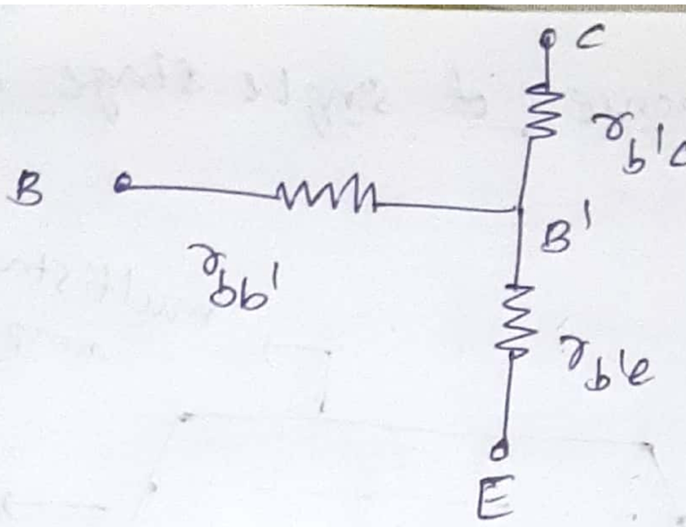
overall current gain:

$$A_i = \frac{(1+h_{fe})^2}{1 + h_{oe}(1+h_{fe})R_E}$$

(8Q) Draw and explain the hybrid pi model for transistor in CE configuration. write the formulas for hybrid pi parameters and write their values.

(A)





① At high frequeneies, the capacitive effects of the transistor junctions and the delay in response of the transistor caused by the process of diffusion of carriers should be taken into account in determining the high frequency model of a transistor.

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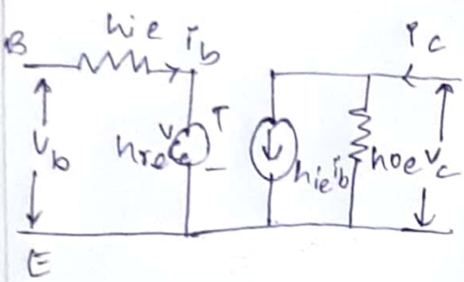
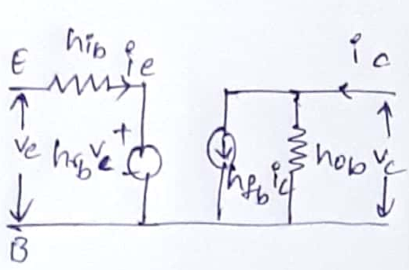
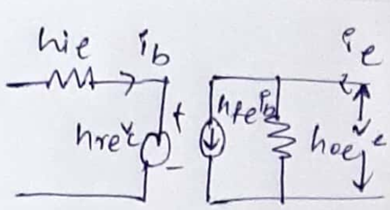
parameter	Meaning	Formulas	values
$r_{bb'}$	Base spreading resistance between base B and virtual base (B')	$r_{bb'} = h_{ie} - r_{b'e}$	100 Ω
$r_{b'e}$	Resistance b/w virtual base (B') and emitter terminal (E)	$r_{b'e} = \frac{h_{ie}}{g_m}$	1KΩ
$r_{b'c}$	Resistance b/w virtual base (B') and collector terminal (C)	$r_{b'c} = \frac{r_{b'e}}{h_{re}}$	4 M Ω
r_{ce}	Resistance b/w collector and emitter	$r_{ce} = \frac{1}{h_{oe} - (1+h_{fe}) g_{b'c}}$	80kΩ
$C_{b'e}$	Diffusion capacitance of normally forward biased base-emitter junction.	–	100 PF
$C_{b'c}$	Transition capacitance of normally reverse biased collector base junction	–	3PF
$g_m V_{b'e}$	output current generators.	$g_m = \frac{\lvert I_c \rvert}{V_T}$	50mA/V

(9Q) Explain Exact hybrid model. Write the current gain, input resistance, voltage gain, output resistance formulas

(i) CE (ii) CB (iii) CC. Define current gain, input resistance, voltage gain, output resistance.

parameter	CE configuration	CB configuration	CC configuration
circuit diagram			
current gain (A_I)	$A_i = \frac{-h_{fe}}{1+h_{oe}R_L}$	$A_i = \frac{-h_{fb}}{1+h_{ob}R_L}$	$A_i = \frac{-h_{fc}}{1+h_{oc}R_L}$
input impedance (R_i)	$R_i = h_{ie} - \frac{h_{fe}h_{re}R_L}{1+h_{oe}R_L}$	$R_i = h_{ie} - \frac{h_{fb}h_{rb}R_L}{1+h_{ob}R_L}$	$R_i = h_{ie} - \frac{h_{fc}h_{rc}R_L}{1+h_{oc}R_L}$
voltage gain (A_V)	$A_V = A_I\frac{R_L}{R_i}$	$A_V = A_I\frac{R_L}{R_i}$	$A_V = A_I\frac{R_L}{R_i}$
output resistance (R_o)	$R_o = \frac{1}{Y_o}$ $Y_o = h_{oe} - \frac{h_{fe}h_{re}}{h_{ie}+R_s}$	$R_o = \frac{1}{Y_o}$ $Y_o = h_{ob} - \frac{h_{fb}h_{rb}}{h_{ib}+R_s}$	$R_o = \frac{1}{Y_o}$ $Y_o = h_{oc} - \frac{h_{fc}h_{rc}}{h_{ie}+R_s}$