4:30
↓
8:00 pm

E029
+
G012

ELECTRICAL SYSTEM (POWER)

ELECTRICAL SYSTEM (ELECTRONICS)

+E029

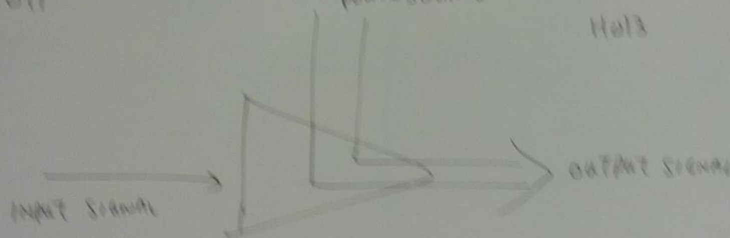
POWER SUPPLY

H011

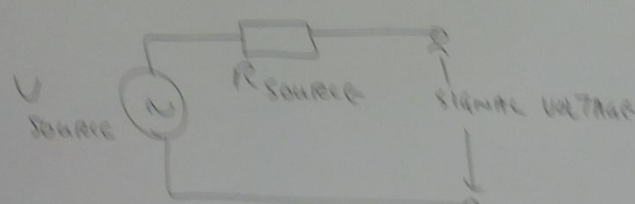
ANALOG ELECTRONICS
AMPLIFIER
H013

DIGITAL ELECTRONICS
H012

+
MECHANICAL
PRINCIPLE

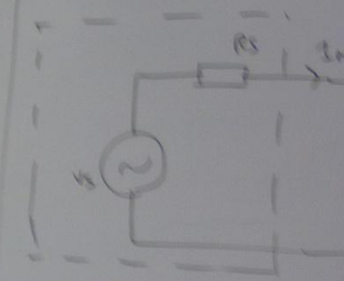


THE INPUT SIGNAL IS AMPLIFIED BY AMPLIFIER



EQUIVALENT CIRCUIT OF SIGNAL SOURCE

EQUIVALENT C



SIGNAL SOURCE

V_S = SOURCE VOLTAG

R_S = SOURCE RESIST

r_{in} = INPUT RESIST

A_V = VOLTAGE GAIN

V_{in} = INPUT VOLTAG

r_{out} = OUTPUT R

R_{load} = LOAD RES

SYSTEM (POWER)

SYSTEM (ELECTRONICS)

ICS

IER

3

DIGITAL ELECTRONICS

H012

+ MECHANICAL PRINCIPLE

UT SIGNAL

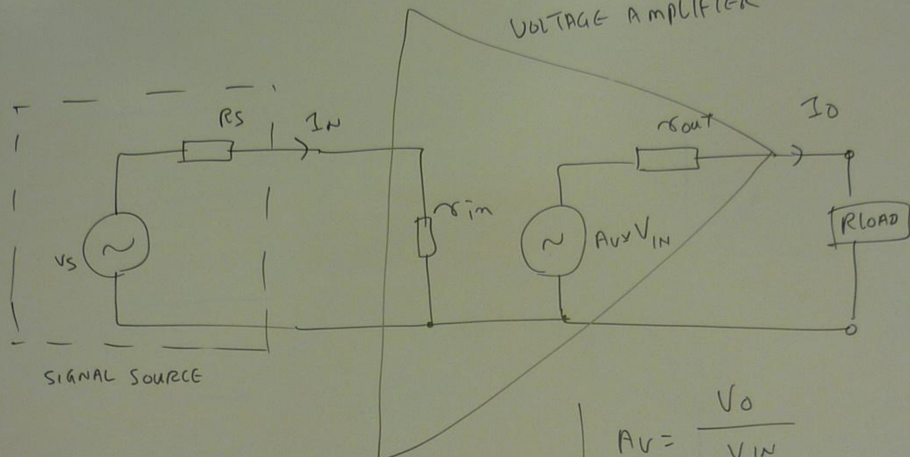
D BY AMPLIFIER

VOLTAGE

GNAL SOURCE

+E029

EQUIVALENT CIRCUIT OF AMPLIFIER



V_S = SOURCE VOLTAGE

R_S = SOURCE RESISTANCE

r_{in} = INPUT RESISTANCE

A_V = VOLTAGE GAIN

U_{IN} = INPUT VOLTAGE

r_{out} = OUTPUT RESISTANCE

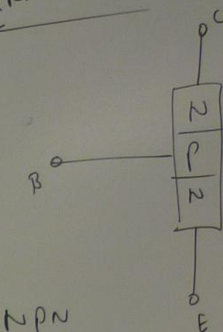
R_{load} = LOAD RESISTANCE

$$A_V = \frac{V_O}{V_{IN}}$$

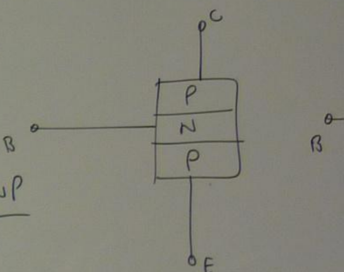
$$A_I = \frac{I_O}{I_{IN}}$$ (CURRENT GAIN)

$$A_P = \frac{P_O}{P_{IN}}$$ (POWER GAIN)

TRANSISTOR

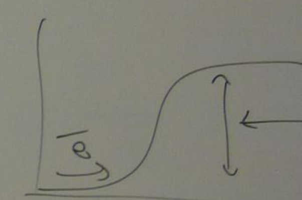


NPN



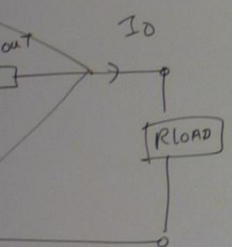
PNP

CONSTRUCTION



...ORIES

...LIFIER

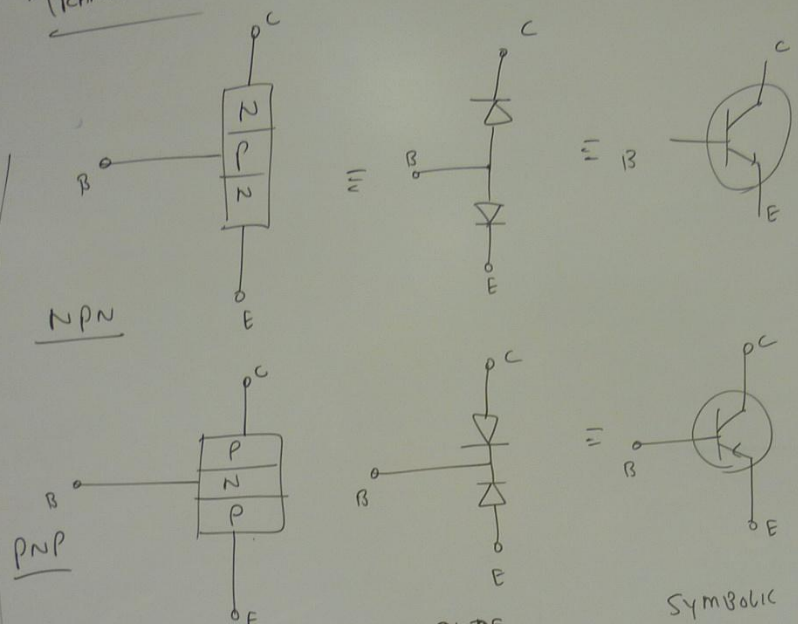


$$\frac{V_O}{V_{IN}}$$

$$= \frac{I_O}{I_{IN}}$$ (CURRENT GAIN)

$$p = \frac{P_O}{P_{IN}}$$ (POWER GAIN)

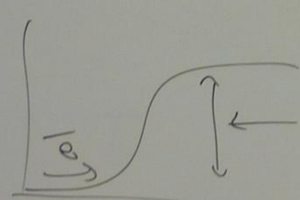
TRANSISTOR



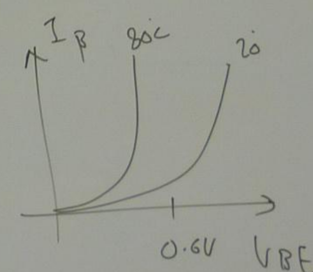
CONSTRUCTION

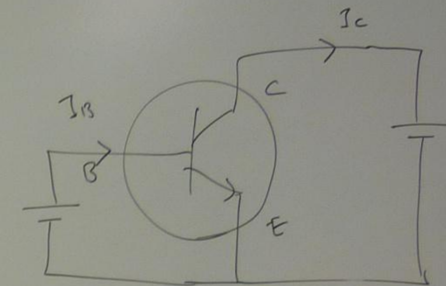
DIODE EQUIVALENCE

SYMBOLIC SYMBOL



VBE IS APPLIED TO REDUCE THE POTENTIAL BARRIER





$$\beta = \frac{I_C}{I_B}$$

I_C = COLLECTOR CURRENT

I_B = BASE CURRENT

β = CURRENT GAIN

(h_{fe})

V_{CE} =

THE

T

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POWER

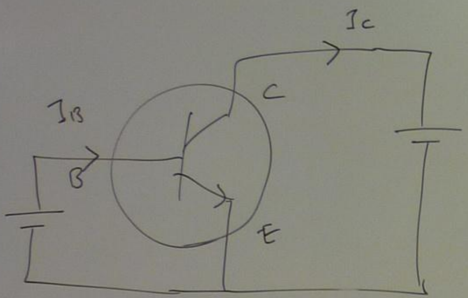
THE

THE

USE

- E

ORIES



$$\beta = \frac{I_C}{I_B}$$

I_C = COLLECTOR CURRENT

$I_B \rightarrow$ BASE CURRENT

β = CURRENT GAIN

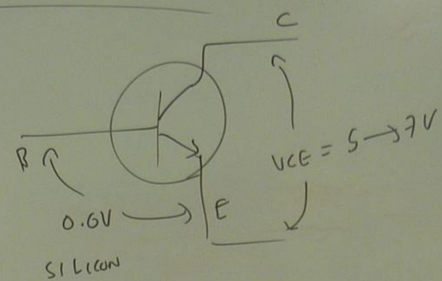
(h_{fe})

20

$\rightarrow$

V_{BE}

V_{CE} = COLLECTOR VOLTAGE



THE CASE OUTLINE

TYPE OF PACKAGE USED TO CONTAIN THE TRANSISTOR ELEMENT.

POWER RATING

THE POWER RATING OF A TRANSISTOR DETERMINES THE MAXIMUM COLLECTOR CURRENT THAT CAN BE USED FOR THAT TRANSTOR FOR A GIVEN COLLECTOR-EMITTER VOLTAGE.

300mW $\longrightarrow$ SEVERAL HUNDRED WATTS.

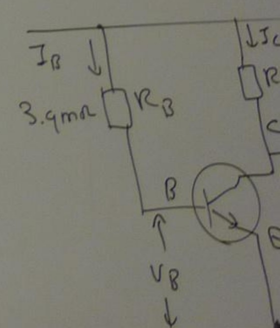
AMPLIFICATION

AN IDEAL AMPLIFIER WIL
THE SAME SHAPE AS IN

TRANSIS

WHEN USED AS AMPL
FORWARD BIASED.
A VOLTAGE ACROSS
THIS VOLTAGE NEEDS
SUPPLY AND VARIOU

BASIC TRANSISTOR



C

$V_{CE} = 5 \rightarrow 7V$

TO CONTAIN THE TRANSISTOR

TRANSISTOR DETERMINES
R CURRENT THAT CAN BE
NSTOR FOR A GIVEN COLLECTOR-

SEVERAL HUNDRED WATTS.

AMPLIFICATION

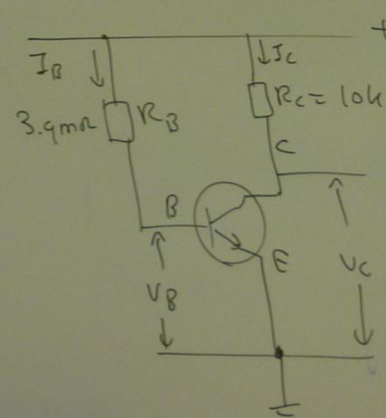
AN IDEAL AMPLIFIER WILL PRODUCE AN OUTPUT SIGNAL THAT HAS EXACTLY THE SAME SHAPE AS INPUT EXCEPT IT WILL BE LARGER

TRANSISTOR BIASING

WHEN USED AS AMPLIFIER, A TRANSISTOR NEEDS TO BE FORWARD BIASED. IT'S BASE-EMITTER JUNCTION MUST HAVE A VOLTAGE ACROSS IT OF 0.6V.

THIS VOLTAGE NEEDS TO BE SUPPLIED FROM DC POWER SUPPLY AND VARIOUS METHODS ARE USED TO ACHIEVE IT.

BASIC TRANSISTOR - AMPLIFIER CIRCUIT



I_B = BASE CURRENT

I_C = COLLECTOR CURRENT

V_B = BASE VOLTAGE

V_C = COLLECTOR VOLTAGE

V_{CC} = SUPPLY VOLTAGE

DC CONDITION

WHEN AN AMPLIFIER
AROUND THE CIRCUIT

Pb IN GIVEN D
V_C. $\beta =$

$I_B = \frac{V_{CC} - V_B}{R_E}$

$I_C = \beta I_B$

$V_C = V_{CC} - I_C R$

FACTORS INFLUENC

TEMPERATURE
THE OPERATION

Pb CALCULATE
IF THE CALCU

$I_B = 5\mu A$

$V_C = V_{CC} - I$

... AN OUTPUT SIGNAL THAT HAS EXACTLY
... T IT WILL BE LARGER

...SING

... TRANSISTOR NEEDS TO BE
...E-EMITTER JUNCTION MUST HAVE
... 0.6V.
... SUPPLIED FROM DC POWER
...S ARE USED TO ACHIEVE IT
...ER CIRCUIT

...c = 20V

I_B = BASE CURRENT

I_C = COLLECTOR CURRENT

V_B = BASE VOLTAGE

V_C = COLLECTOR VOLTAGE

V_{CC} = SUPPLY VOLTAGE

DC CONDITION

WHEN AN AMPLIFIER HAS NO INPUT SIGNAL, THE DC VOLTAGE AROUND THE CIRCUIT IS REFERRED AS DC QUIESCENT VOLTAGE

Pb IN GIVEN DIAGRAM, CALCULATE I_B, I_C AND V_C. $\beta = 200$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{20 - 0.6}{3.9\,M\Omega} = \frac{19.4}{3.9 \times 10^6} = 5\,\mu A$$

$$I_C = \beta I_B = 200 \times 5\,\mu A = 1000\,\mu A = 1\,mA$$

$$V_C = V_{CC} - I_C R_C = 20 - 1 \times 10^{-3} \times 10 \times 10^3 = 10V$$

FACTORS INFLUENCING THE PERFORMANCE OF TRANSISTOR

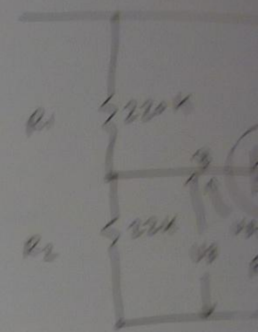
TEMPERATURE CHANGE AND CHANGE IN β EFFECTS THE OPERATIONS OF ELECTRONICS CIRCUIT.

Pb CALCULATE THE VALUE OF V_C FOR GIVEN CIRCUIT IF THE VALUE OF β INCREASES FROM 200 TO 300.

$I_B = 5\,\mu A$ $\quad \beta = 300 \rightarrow I_C = \beta I_B = 300 \times 5\,\mu A = 1.5\,mA$

$$V_C = V_{CC} - I_C R_C = 20 - 1.5 \times 10^{-3} \times 10 \times 10^3 = 5V$$

POTENTIAL DIVIDER ...



$V_B = \frac{V_{CC} \times ...}{R_1 ...}$

$V_E = V_B - ...$

$I_E = I_C ...$

$V_{CE} = V_{CC} ...$

...C CONDITION

... AN AMPLIFIER HAS NO INPUT SIGNAL, THE DC VOLTAGE ...ND THE CIRCUIT IS REFERRED AS DC QUIESCENT VOLTAGE.

... IN GIVEN DIAGRAM, CALCULATE I_B, I_C AND V_C. $\beta = 200$

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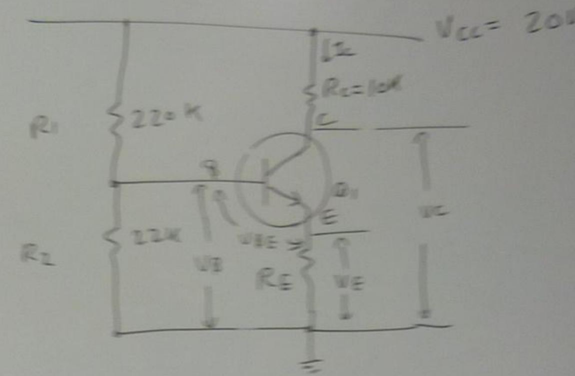
POTENTIAL DIVIDER BIASING



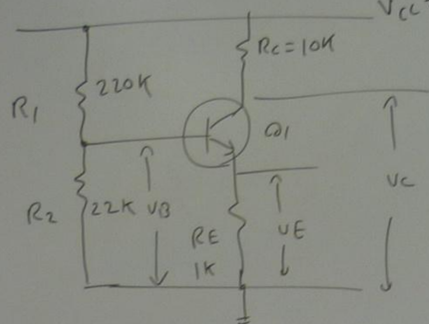
$$V_B = \frac{V_{CC} \times R_2}{R_1 + R_2}$$

$$V_E = V_B - V_{BE}$$

$$I_E = I_C = \frac{V_E}{R_E}$$

$$V_C = V_{CC} - I_C R_C$$

pb CALCULATE V_B, V_E, I_E AND V_{CC} FOR THE GIVEN CIRCUIT.



$$V_B = \frac{V_{CC} R_2}{R_1 + R_2} = \frac{20 \times 22k}{(220+22)k} = 1.8V$$

$$V_E = V_B - V_{BE} = 1.8 - 0.6 = 1.2V$$

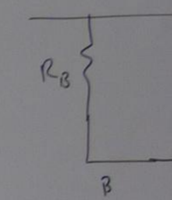
$$I_E = I_C = \frac{V_E}{R_E} = \frac{1.2}{1k} = 1.2mA$$

$$V_C = V_{CC} - I_C R_C = 20 - 1.2 \times 10^{-3} \times 10 \times 10^3$$
$$= 8V$$

pb FOR THE

TO GIVE

VOLTAGE.



$V_C = V_{CC}$

$10 = 20$

$3.3 \times 10^3 I_C$

$I_C = \beta$

$R_B =$

AND V_{cc} FOR THE GIVEN CIRCUIT.

$$\frac{2k}{(\ldots 22)k} = 1.8V$$

$$6 = 1.2\,V$$

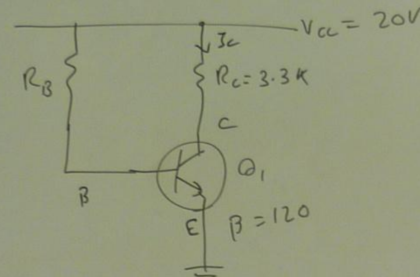
$$= 1.2\,mA$$

$$1.2\times10^{-3} \times 10\times10^{3}$$

V

pb

FOR THE GIVEN CIRCUIT, DETERMINE THE VALUE OF R_B REQUIRED TO GIVE A VALUE OF COLLECTOR VOLTAGE EQUAL TO HALF THE SUPPLY VOLTAGE.



$V_c = 10V$

$$R_B = \frac{V_{cc} - V_{BE}}{I_B}$$

$$I_c = \beta I_B$$

$$V_c = V_{cc} - I_c R_c \longrightarrow$$

$$10 = 20 - I_c \times 3.3\times10^{3}$$

$$3.3\times10^{3}\, I_c = 20 - 10 = 10 \Rightarrow I_c = \frac{10}{3.3\times10^{3}} = 3.3\times10^{-3}\,A$$

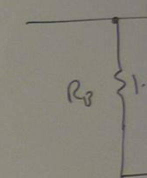
$$I_c = \beta I_B \Rightarrow I_B = \frac{I_c}{\beta} = \frac{3.3\times10^{-3}}{120} = 2.75\times10^{-6}\,A$$

$$R_B = \frac{V_{cc} - V_{BE}}{I_B} = \frac{20 - 0.6}{2.75\times10^{-6}} = 7.05\times10^{6}\,\Omega$$

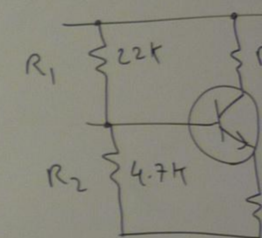
$$= 7.05\,M\Omega$$

EXERCISES

1. FOR THE GIVEN



2. CALCULATE THE B... VOLTAGE V_c FOR ...



...ETERMINE THE VALUE OF R_B REQUIRED
...CTOR VOLTAGE EQUAL TO HALF THE SUPPLY

...V $\quad V_C = 10V$

$$R_B = \frac{V_{CC} - V_{BE}}{I_B}$$

$$I_C = \beta I_B$$

$$\Rightarrow I_C = \frac{10}{3.3\times10^{3}} = 3.3\times10^{-3} A$$

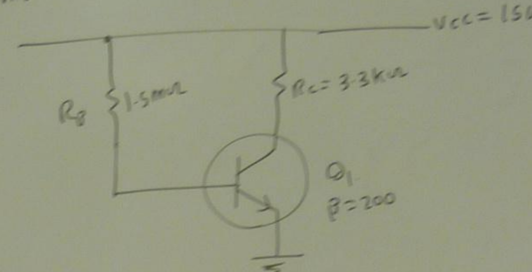
$$\frac{I_C}{\beta} = \frac{3.3\times10^{-3}}{120} = 2.75\times10^{-6} A$$

$$\frac{20 - 0.6}{2.75\times10^{-6}} = 7.05\times10^{6}\ \Omega$$

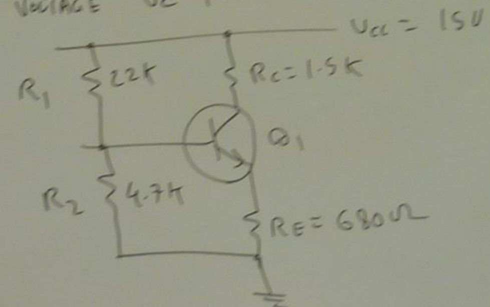
$$= 7.05\ M\Omega$$

EXERCISES

1. FOR THE GIVEN CIRCUIT, CALCULATE (a) I_B (b) I_C (c) V_C



2. CALCULATE THE BASE VOLTAGE V_B, EMITTER VOLTAGE V_E AND COLLECTOR VOLTAGE V_C FOR GIVEN CIRCUIT



...ORIES

V_{CE} =

THE

POWE...

THE

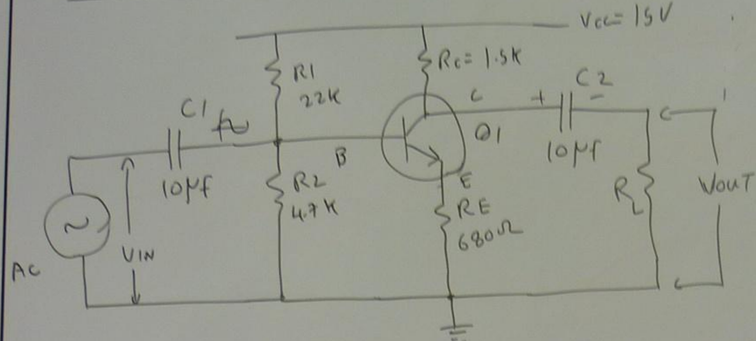
TH...

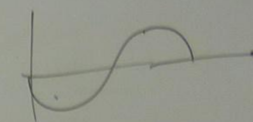
(c) V_c

E VE AND COLLECTOR

TRANSISTOR - AMPLIFIER (PART 1) AC CONDITIONS OF A TRANSISTOR AMPLIFIER

COMMON EMITTER AMPLIFIER





THE ABOVE DIAGRAM SHOWS A COMMON EMITTER AMPLIFIER THAT USES POTENTIAL DIVIDER BIASING AND EMITTER STABLISING.

C_1 = INPUT COUPLING CAPACITOR, C_2 = OUTPUT COUPLING CAPACITOR

TO PREVENT DC VOLTAGE.

AC CONDITIONS

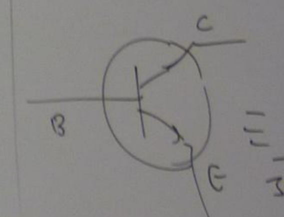
THE AC CHARACTERISTICS OF CE - TRANSISTOR AMPLIFIER

- VOLTAGE GAIN, INPUT RESISTANCE, OUTPUT RESISTANCE.

CHARACTERISTICS

- THE INPUT
- THE VOLTAGE
- THE OUTPUT
- THE OUTPU
- THE WAVE
  THE BASE.

VOLTAGE GAIN



$r_e = \frac{30m}{I_c(}$

...DITIONS OF A TRANSISTOR AMPLIFIER

...TER AMPLIFIER THAT USES
...BLISING.
...OUT PUT COUPLING CAPACITOR

...TRANSISTOR AMPLIFIER

...CE, OUT PUT RESISTANCE.

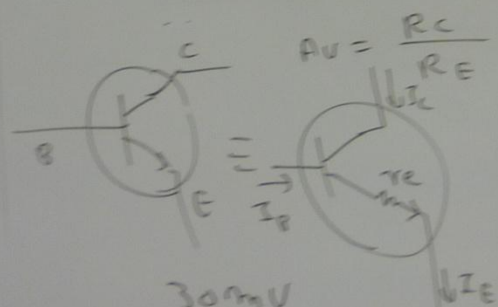
CHARACTERISTICS OF C E AMPLIFIER

- THE INPUT SIGNAL HAS NO DC COMPONENT
- THE VOLTAGE AT BASE HAS BOTH DC & AC COMPONENT
- THE OUTPUT TERMINAL HAS NO DC COMPONENT
- THE OUTPUT SIGNAL IS 180 OUT OF PHASE WITH INPUT SIGNAL
- THE WAVE FORM AT EMITTER IS IDENTICAL TO THAT AT THE BASE.

VOLTAGE GAIN AV

$$A_V = \frac{V_o}{V_{in}}$$

$$A_V = \frac{R_C}{R_E}$$

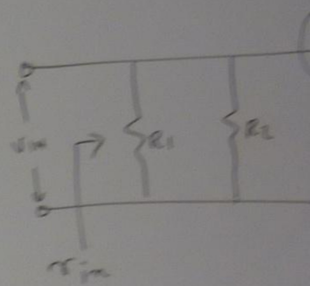


$$r_e = \frac{30\,mV}{I_C\,(mA)}$$

$$A_V = \frac{R_C}{R_E + r_e}$$

$$A_V = \frac{R_C \,||\, R_L}{R_E + r_e}$$

IN PUT AND OUT PUT ...

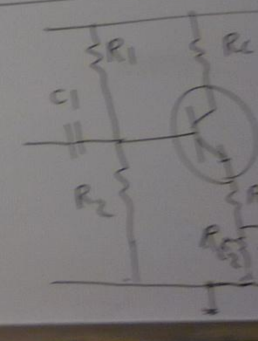


$$r_{in} = R_1 \,||\, R_2$$

OUT PUT RESISTANCE

$$r_o = R_C$$

ADDING THE EMI...



AMPLIFIER

O DC COMPONENT

S BOTH DC & AC COMPONENT

NO DC COMPONENT

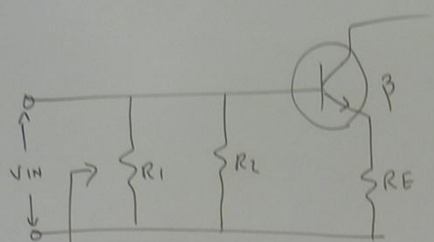
180 OUT OF PHASE WITH INPUT SIGNAL

TTER IS IDENTICAL TO THAT AT

$$A_V = \frac{R_C}{R_E + r_e}$$

$$A_V = \frac{R_C \parallel R_L}{R_E + r_e}$$

INPUT AND OUTPUT RESISTANCE OF CE AMPLIFIER



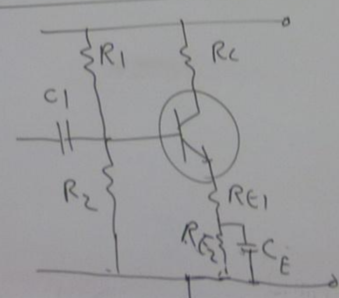
r_{in}

$$r_{in} = R_1 \parallel R_2 \parallel \beta(r_e + R_E)$$

OUTPUT RESISTANCE

$$r_o = R_C$$

ADDING THE EMITTER BY PASS CAPACITOR



C_E = EMITTER BY PASS CAPACITOR

TO PROVIDE DC STABILITY

T

AC COMPONENT

NENT

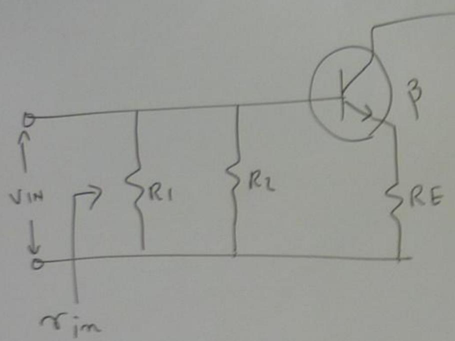
HASE WITH INPUT SIGNAL

TICAL TO THAT AT

$$\frac{RC}{RE + re}$$

$$= \frac{Rc \,||\, RL}{R_E + re}$$

INPUT AND OUTPUT RESISTANCE OF CE AMPLIFIER

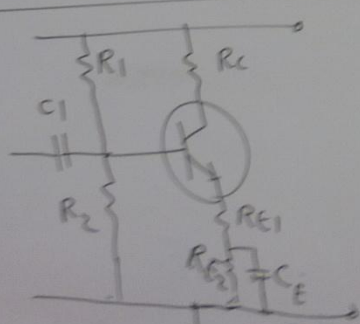


$$r_{in} = R_1 \,||\, R_2 \,||\, \beta(re + RE)$$

OUTPUT RESISTANCE

$$r_o = R_C$$

ADDING THE EMITTER BY PASS CAPACITOR



C_E = EMITTER BY PASS CAPACITOR

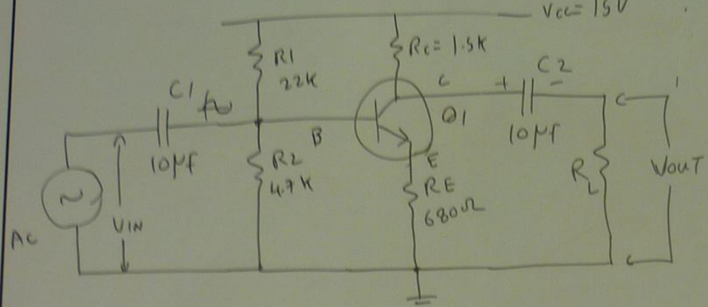
TO PROVIDE DC STABILITY

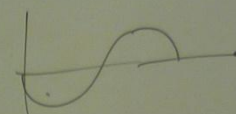
$$\frac{1}{\;} \quad + \frac{1}{4.7\times10^{3}} + \frac{1}{100(10+80+600)}$$

Ω

TRANSISTOR - AMPLIFIER (PART 1) AC CONDITIONS OF A TRANSISTOR AMPLIFIER

COMMON EMITTER AMPLIFIER





THE ABOVE DIAGRAM SHOWS A COMMON EMITTER AMPLIFIER THAT USES POTENTIAL DIVIDER BIASING AND EMITTER STABLISING.

C_1 = INPUT COUPLING CAPACITOR, C_2 = OUTPUT COUPLING CAPACITOR TO PREVENT DC VOLTAGE.

AC CONDITIONS

THE AC CHARACTERISTICS OF CE - TRANSISTOR AMPLIFIER

- VOLTAGE GAIN, INPUT RESISTANCE, OUTPUT RESISTANCE.

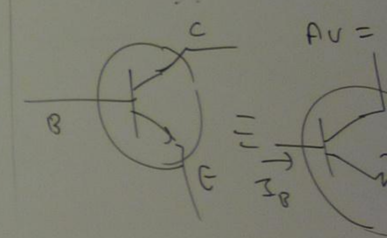
CHARACTERISTICS OF

- THE INPUT SIGNAL
- THE VOLTAGE AT B
- THE OUTPUT TERMIN
- THE OUTPUT SIGNA
- THE WAVE FORM A THE BASE.

VOLTAGE GAIN AV

AV =

AV =



$$r_e = \frac{30\,mV}{I_C\,(mA)}$$

...TIONS OF A TRANSISTOR AMPLIFIER

... AMPLIFIER THAT USES
...SING.
...PUT COUPLING CAPACITOR

...ANSISTOR AMPLIFIER

..., OUTPUT RESISTANCE.

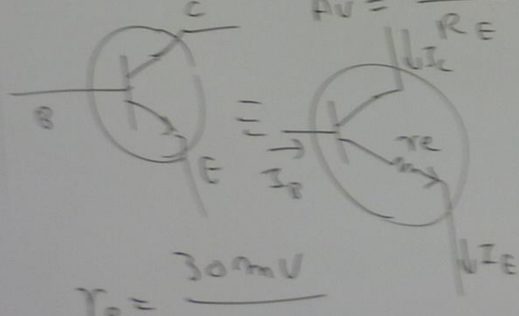
CHARACTERISTICS OF CE AMPLIFIER

- THE INPUT SIGNAL HAS NO DC COMPONENT
- THE VOLTAGE AT BASE HAS BOTH DC & AC COMPONENT
- THE OUTPUT TERMINAL HAS NO DC COMPONENT
- THE OUTPUT SIGNAL IS 180 OUT OF PHASE WITH INPUT SIGNAL
- THE WAVE FORM AT EMITTER IS IDENTICAL TO THAT AT THE BASE.

VOLTAGE GAIN AV

$$A_V = \frac{V_o}{V_{in}}$$

$$A_V = \frac{R_C}{R_E}$$

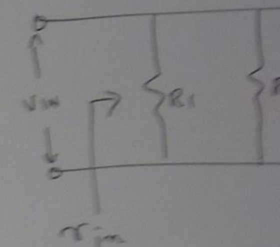


$$r_e = \frac{30\,mV}{I_C\,(mA)}$$

$$A_V = \frac{R_C}{R_E + r_e}$$

$$A_V = \frac{R_C \| R_L}{R_E + r_e}$$

INPUT AND OUT...

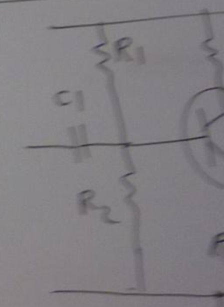


$r_{in} = R_1 \|$

OUTPUT RESISTA...

$r_o = R_C$

ADDING THE E...



ponent

DC & AC component

component

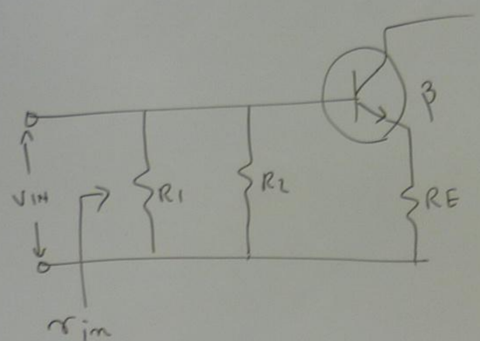
of PHASE WITH INPUT SIGNAL

S IDENTICAL TO THAT AT

$$A_v = \frac{R_C}{R_E + r_e}$$

$$A_v = \frac{R_C \| R_L}{R_E + r_e}$$

INPUT AND OUTPUT RESISTANCE OF CE AMPLIFIER

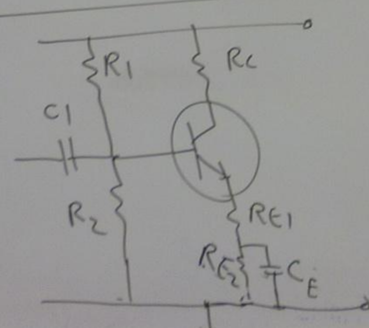


$$r_{in} = R_1 \| R_2 \| \beta(r_e + R_E)$$

OUTPUT RESISTANCE

$$r_o = R_C$$

ADDING THE EMITTER BYPASS CAPACITOR



C_E = EMITTER BYPASS CAPACITOR

TO PROVIDE DC STABILITY

pb

FOR THE GIVEN CIRCUIT, CALCULATE THE FOLLOWINGS.

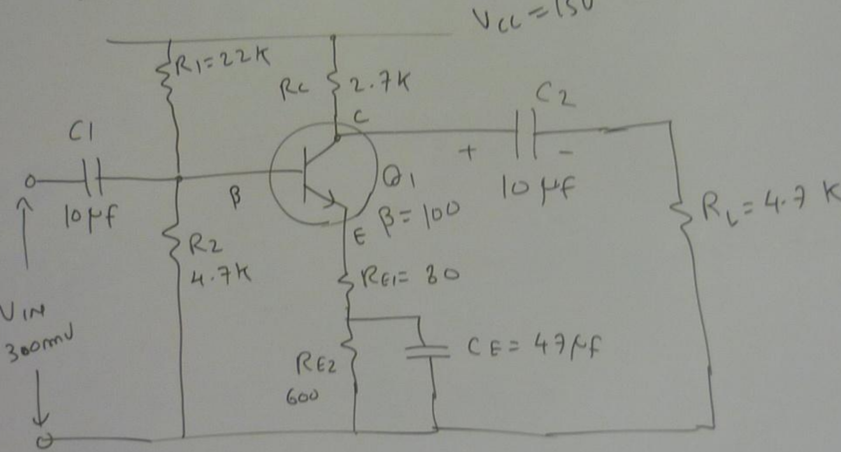
(a) THE DC VOLTAGE PRESENT AT BASE, EMITTER AND COLLECTOR OF Q_1

(b) THE GAIN OF THE CIRCUIT

(c) THE INPUT RESISTANCE

(d) THE OUTPUT RESISTANCE

(e) THE GAIN AND INPUT RESISTANCE IF C_E IS DISCONNECTED.



(a) $$V_B = \frac{V_{CC} R_2}{R_1 + R_2} = \frac{15 \times 4.7}{22 + 4.7} = 2.6V$$

$$V_E = V_B - V_{BE} = 2.6 - 0.6 = 2\ V$$

$$V_C = V_{CC} - I_C R_C \ , \ I_C = I_E = \frac{V_E}{R_E}$$

$$I_C = I_E = \frac{2}{80+600}$$

$$V_C = V_{CC} - I_C$$

$$= 15 - 3\times10$$

$$r_e = \frac{30\,mV}{I_C(mA)} =$$

(b) $$A_V = \frac{R_c}{r}$$

$$= \frac{2.}{}$$

$$=$$

$$=$$

$$=$$

$= Q_1$

$$I_C = I_E = \frac{2}{80+600} = 3\ mA$$

$$V_C = V_{CC} - I_C R_C$$

$$= 15 - 3\times10^{-3} \times 2.7\times10^{3} = 6.9V$$

$$r_e = \frac{30\,mV}{I_C(mA)} = \frac{30\,mV}{3\,mA} = 10\,\Omega$$

(b) $$A_V = \frac{R_C \,||\, R_L}{r_e + R_{E_1}}$$

$$= \frac{2.7k \,||\, 4.7k}{10 + 80}$$

$$= \frac{\frac{2.7\times4.7}{2.7+4.7}}{90}$$

$$= \frac{1.715\,k\Omega}{90}$$

$$= \frac{1715\,\Omega}{90} = 19$$

(c) $r_{in} = R_1 \,||\, R_2 \,||\, \beta(r_e + R_{E1})$

$$\frac{1}{r_{in}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}$$

$$r_{in} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}}$$

$$= \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+80)}}$$

$$= 2710\,\Omega = 2.71\,k\Omega$$

(d) $R_o = R_C = 2.7K$

(e) $$r_{in} = \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10 + R_{E_1} + R_{E_2})}}$$

C_E REMOVED

r_{in} WITHOUT C_E

(c) $r_{in} = R_1 \,||\, R_2 \,||\, \beta(r_e + R_{E1})$

$$\frac{1}{r_{in}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}$$

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$$= 2710\,\Omega = 2.71\,k\Omega$$

(d) $R_o = R_C = 2.7K$

(e) $r_{in} = \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10 + R_{E1} + R_{E2})}}$

C_E REMOVED

r_{in} WITHOUT C_E $= \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+80+600)}}$

$= 3.7\,k\Omega$

AC

$$r_{in} = R_1 \,||\, R_2 \,||\, \beta(r_e + R_{E1})$$

$$\frac{1}{r_{in}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}$$

$$= \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}}$$

$$= \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+80)}}$$

$$= 2710\,\Omega = 2.71\,k\Omega$$

$$= R_C = 2.7K$$

$$r_{in} = \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+R_{E1}+R_{E2})}}$$

r_{in} without C_E

$$r_{in} = \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+80+600)}}$$

$$= 3.7\,k\Omega$$

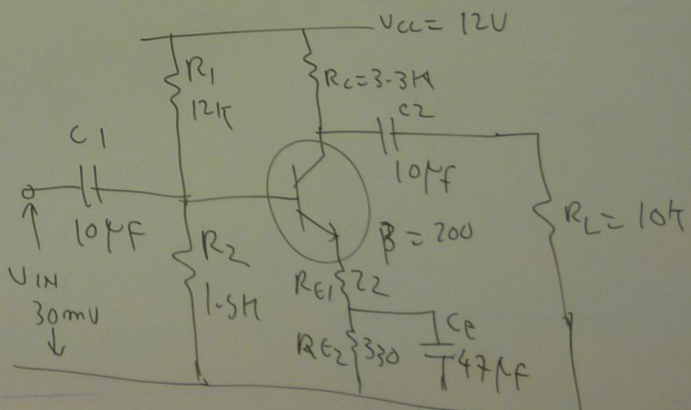
EXERCISE

FOR THE GIVEN CIRCUIT, CALCULATE THE FOLLOWINGS.

(a) V_B AND V_E (b) I_c (c) V_c (d) r_e

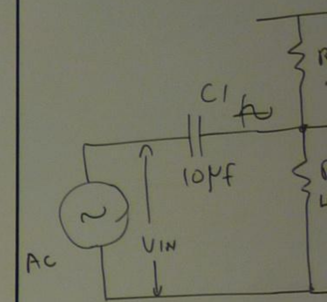
(e) VOLTAGE GAIN A_v (f) INPUT RESISTANCE r_{in}

(g) OUTPUT RESISTANCE r_o (h) OUTPUT VOLTAGE V_o



TRANSISTOR -

COMMON EMITTER



THE ABOVE DIAG

POTENTIAL DIVID

C_1 = INPUT

TO

AC CONDIT

THE AC

- VOLTAG

$\| \beta(r_e + R_{E1})$

$$\cdots + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}$$

$$\frac{1}{\cdots + \frac{1}{R_2} + \frac{1}{\beta(r_e + R_{E1})}}$$

$$\frac{1}{\cdots + \frac{1}{4.7\times10^3} + \frac{1}{100(10+80)}}$$

$+10\,\Omega = 2.71\,k\Omega$

$= 2.7\,k$

$$\frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+R_{E_1}+R_{E_2})}}$$

r_{in} WITHOUT C_E

$$r_{in} = \frac{1}{\frac{1}{22\times10^3} + \frac{1}{4.7\times10^3} + \frac{1}{100(10+80+600)}}$$

$$= 3.7\,k\Omega$$

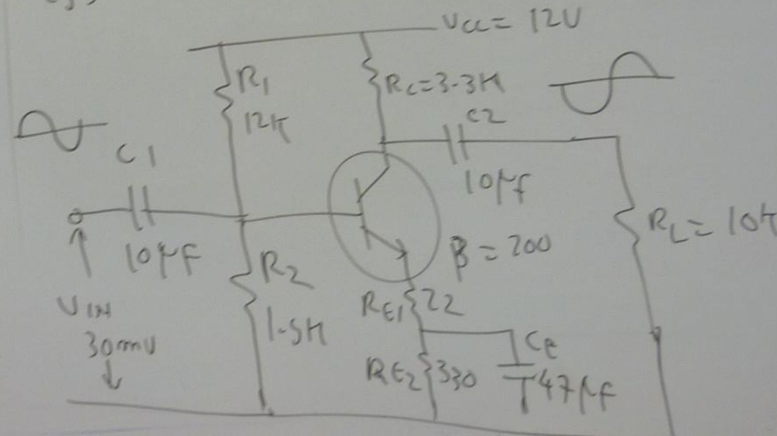
EXERCISE

FOR THE GIVEN CIRCUIT, CALCULATE THE FOLLOWINGS.

(a) V_B AND V_E (b) I_C (c) V_C (d) r_e

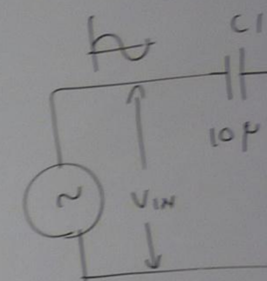
(e) VOLTAGE GAIN A_V (f) INPUT RESISTANCE r_{in}

(g) OUTPUT RESISTANCE r_o (h) OUTPUT VOLTAGE V_o



C E – AMPLIF

C C – AMPLI FI



$V_B = \frac{V}{\ }$

$V_E = V$

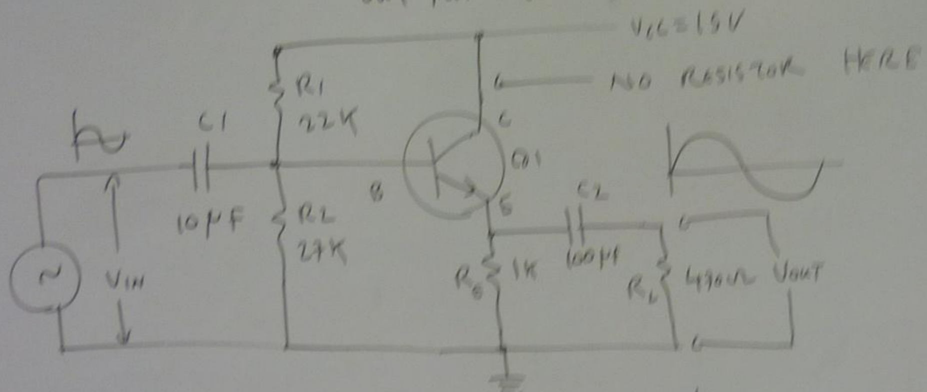
$I_E = I$

TRANSISTOR AMPLIFIER (PART - 2) - COMMON COLLECTOR (C.C) AMPLIFIER
& COMMON BASE (C.B) AMPLIFIER

CE - AMPLIFIER → IN PUT & OUT PUT SIGNALS ARE 180 OUT OF PHASE

CC - AMPLIFIER → IN PUT & OUT PUT SIGNALS ARE IN PHASE

OUT PUT TERMINAL HAS NO DC VOLTAGE



$$V_B = \frac{V_{CC} R_2}{R_1 + R_2}$$

$$V_E = V_B - V_{BE}$$

$$I_E = I_C = \frac{V_E}{R_E}$$

$$V_C = V_{CC}$$

$$r_e = \frac{30mV}{I_C}$$

VOLTAGE GAIN

$$A_V = 1$$

$$r_{in} = R_1 || R_2 || [\beta (r_e + R_E || R_L))$$

$$r_o = r_e$$

AMPLIFIER
) AMPLIFIER

180 OUT OF PHASE

PHASE

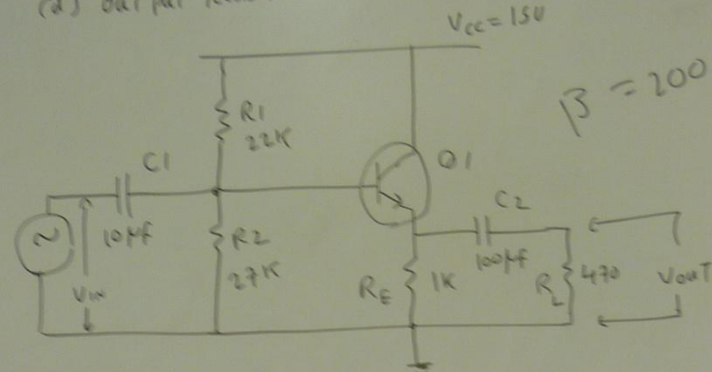
OLTAGE

$|| [\beta(r_e + R_E || R_L))$

P1 FOR THE GIVEN CIRCUIT, CALCULATE

(a) r_e (b) THE GAIN OF THE CIRCUIT (c) INPUT RESISTANCE

(d) OUTPUT RESISTANCE



(a) $r_e = \dfrac{30\,mV}{I_c}$

$I_c = I_E = \dfrac{V_E}{R_E}$

$V_E = V_B - V_{BE}$

$V_B = \dfrac{V_{cc} R_2}{R_1 + R_2}$

$V_B = \dfrac{15 \times 27}{22 + 27} = 8.3V$

$V_E = V_B - V_{BE}$

$= 8.3 - 0.6 = 7.7V$

$I_E = I_C = \dfrac{V_E}{R_E} = \dfrac{7.7}{1k} = 7.7mA$

$r_e = \dfrac{30\,mV}{I_c} = \dfrac{30\,mV}{7.7\,mA} = 3.9\Omega$

(b) GAIN = $A_v =$

(c) $r_{in} = R_1 ||$

$r_{in} = \dfrac{1}{\frac{1}{R_1} + \cdots}$

$= \dfrac{1}{\frac{1}{22 \times 10^3} \cdots}$

$= 10$

(d) $r_o =$

INPUT RESISTANCE

00

7

Vout

$\frac{27}{27} = 8.3V$

BE

$0.6 = 7.7V$

$\frac{E}{R_E} = \frac{7.7}{1k} = 7.7mA$

$\frac{mV}{C} = \frac{30mV}{7.7mA} = 3.9\Omega$

(b) GAIN = $A_v = 1$

(c) $r_{in} = R_1 \| R_2 \| \beta(r_e + R_E \| R_L)$

$$r_{in} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta\left(r_e + \frac{R_e R_L}{R_e + R_L}\right)}}$$

$$= \frac{1}{\frac{1}{22\times10^3} + \frac{1}{27\times10^3} + \frac{1}{200\left(3.9 + \frac{1\times10^3 \times 470}{1\times10^3 + 470}\right)}}$$

$$= 10.2\,k\Omega$$

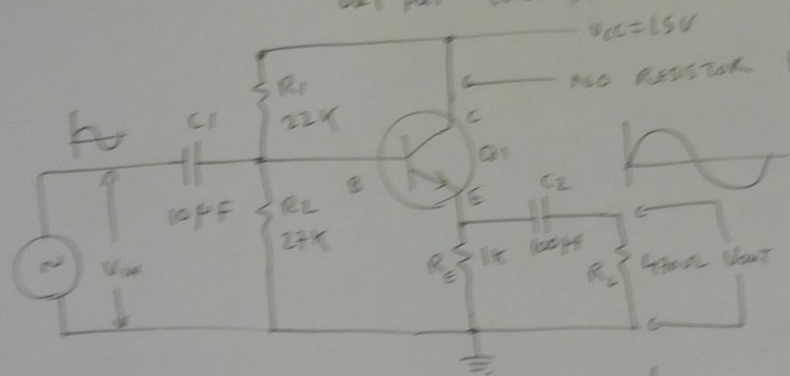
(d) $r_o = r_e = 3.9\Omega$

TRANSISTOR AMPLIFIER (PART - 2) - COMMON COLLECTOR (C.C) AMPLIFIER & COMMON BASE (C.B) AMPLIFIER

CE - AMPLIFIER → INPUT & OUTPUT SIGNALS ARE 180 OUT OF PHASE

CC - AMPLIFIER → INPUT & OUTPUT SIGNALS ARE IN PHASE

OUTPUT TERMINAL HAS NO DC VOLTAGE



$$V_B = \frac{V_{CC} R_2}{R_1 + R_2}$$

$$V_E = V_B - V_{BE}$$

$$I_E = I_C = \frac{V_E}{R_E}$$

$$V_C = V_{CC}$$

$$r_e = \frac{30mV}{I_C}$$

VOLTAGE GAIN

$$A_V = 1$$

$$r_{in} = R_1 \| R_2 \| [\beta(r_e + R_E \| R_L))$$

$$r_o = r_e$$

P1 / FOR THE ...

(a) r_e (b) ...

(c) OUTPUT ...

(a) $r_e = \frac{30...}{I...}$

$I_C = I...$

$V_E = V_B ...$

$V_B = \frac{V_C...}{R...}$

.C) AMPLIFIER
C.B) AMPLIFIER

180 OUT OF PHASE

IN PHASE

VOLTAGE

E

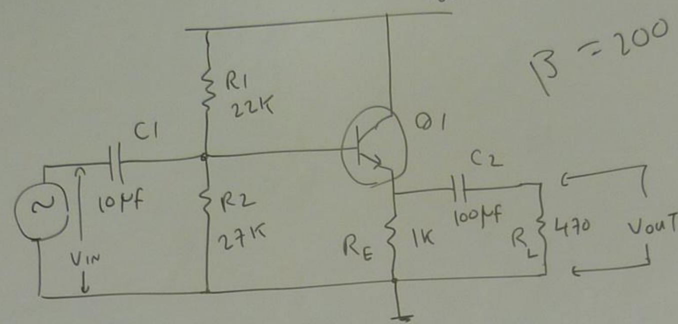
IN

1

$||R_2||\{\beta(r_e + R_E||R_L)\}$

re

Pb FOR THE GIVEN CIRCUIT, CALCULATE
(a) re (b) THE GAIN OF THE CIRCUIT (c) INPUT RESISTANCE
(d) OUTPUT RESISTANCE



$\beta = 200$

(a) $r_e = \dfrac{30\,mV}{I_c}$

$I_c = I_E = \dfrac{V_E}{R_E}$

$V_E = V_B - V_{BE}$

$V_B = \dfrac{V_{cc} R_2}{R_1 + R_2}$

$V_B = \dfrac{15 \times 27}{22 + 27} = 8.3V$

$V_E = V_B - V_{BE}$
$= 8.3 - 0.6 = 7.7V$

$I_E = I_C = \dfrac{V_E}{R_E} = \dfrac{7.7}{1k} = 7.7mA$

$r_e = \dfrac{30\,mV}{I_c} = \dfrac{30\,mV}{7.7\,mA} = 3.9\Omega$

(b) GAIN = $A_v = 1$

(c) $r_{in} = R_1 || R_2$

$r_{in} = \dfrac{1}{\dfrac{1}{R_1} + \dfrac{1}{r}}$

$= \dfrac{1}{\dfrac{1}{22 \times 10^3}}$

$= 10.$

(d) $r_o =$

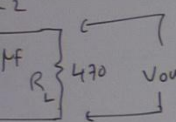
...ULATE

...IRCUIT (c) INPUT RESISTANCE

$= 15V$

$\beta = 200$

...2



$= \frac{15 \times 27}{22+27} = 8.3V$

$= V_B - V_{BE}$

$= 8.3 - 0.6 = 7.7V$

$= I_C = \frac{V_E}{R_E} = \frac{7.7}{1k} = 7.7mA$

$r_e = \frac{30mV}{I_c} = \frac{30mV}{7.7mA} = 3.9\Omega$

(b) GAIN = $A_v = 1$

(c) $r_{in} = R_1 \,||\, R_2 \,||\, \beta(r_e + R_E || R_L)$

$$r_{in} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\beta\left(r_e + \frac{R_e R_L}{R_e + R_L}\right)}}$$

$$= \frac{1}{\frac{1}{22\times10^3} + \frac{1}{27\times10^3} + \frac{1}{200\left(3.9 + \frac{1\times10^3 \times 470}{1\times10^3 + 470}\right)}}$$

$= 10.2\,k\Omega$

(d) $r_o = r_e = 3.9\Omega$

APPLICATION OF CE & CC AMPLIFIER

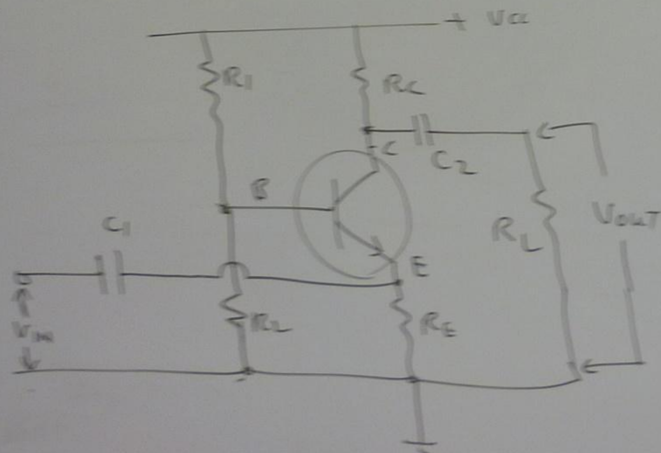
CE AMPLIFIER ⟶ AMPLIFICATION

CC AMPLIFIER ⟶ BUFFER

BECAUSE $A_V = 1$

THE COMMON BASE (C.B) AMPLIFIER

- NO CURRENT GAIN
- ONLY VOLTAGE GAIN



THE INPUT SIGNAL IS APPLIED TO EMITTER AND OUTPUT IS TAKEN OUT FROM COLLECTOR

COMPARISON

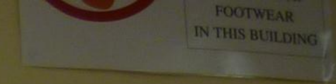
CB AMPLIF

CONFIGURAT

CE

CC

CB



Comparison of CE, CC and CB amplifiers

Configuration	Input Resistance	Output Resistance	Phase Shift	Voltage Gain (A_V)	Current Gain (A_I)	Power Gain A_P	Special Features
CE	Medium	Medium ($-R_C$)	180	High	Medium	High	R_E stabilizer, amplification
CC	High	Low ($-r_e$)	0	Unity	High	High	Buffer, $A_V = 1$
CB	Low	Medium ($-R_C$)	0	Medium	Unity	Medium	No A_I only A_V

EXERCISE

FOR THE GIVEN CIRCUIT, CALCULATE THE FOLLOWINGS

(a) V_B AND V_E

(b) I_C

(c) r_e

(d) VOLTAGE GAIN A_V

(e) INPUT RESISTANCE r_{in}

(f) OUTPUT RESISTANCE r_o

(g) OUTPUT VOLTAGE V_o