EC 8353 - Electron Devices and Circuits

Part A - Nov./Dec. 2019

1. Why the depletion layer is very thin in zener diode?

At junction, carriers diffuse from their higher concentration to lower concentration and left behind ions, since the ions are formed are more per unit length (high concentration), depletion layer is very thin.

2. What is a rectifier? Mention its types?

Rectifier is a device which converts alternating current to pulsating dc.

Types: Half wave rectifier, centre tapped FWR and Bridge rectifier.

3. How FET is used as volt. variable resistor (VVR)?

FET is usually operated in constant current portion of its o/p characteristics. But if it is operated in the region prior to pinch off, it behaves as VVR.

4. Mention 'thermal runaway' in transistor and how it is avoided?

Thermal runaway is a process of positive feedback. The system get hot is dissipated heat causes destructive results.

It can be prevented by creating small change in temperature to big change in power dissipation.

5. Mention significance of coupling and bypass capacitor on BJT of amplifiers

Bypass capacitor reduces noise & spike on power lines

Coupling capacitor blocks dc signal.

6. State Miller's theorem.

Miller theorem refers to the process of creating equivalent circuits. It asserts that floating impedance element, supplied by volt. sources connected in series, maybe split into two grounded elements with corresponding impedances.

7. A tuned circuit has resonant frequency 1600 KHz and bandwidth 10 KHz. Calculate Q factor.

$$Q = \frac{f_r}{BW} = \frac{1600}{10} = 160$$

8. What is the impact of crossover distortion in an amplifier?

It is the period between crossing of half cycles, none of the transistors is active, o/p is zero, signal is distorted.

Due to crossover distortion, each transistor conducts for less than half cycle than full cycle.

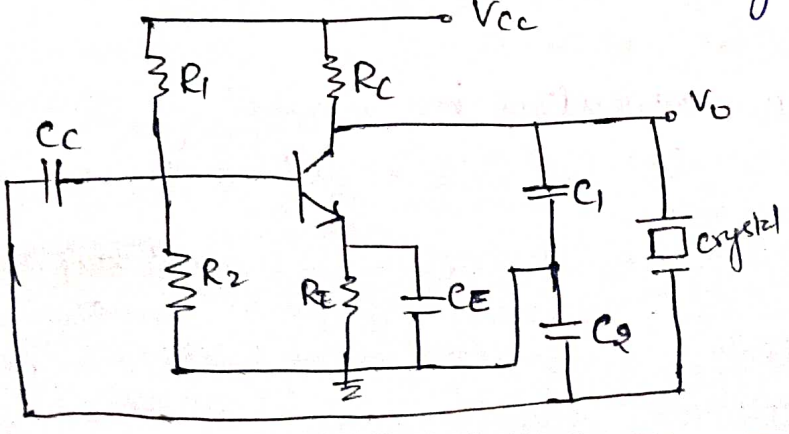
9. Which type of feedback increases gain of amplifier?

Positive feedback increases gain of amplifier.

Negative feedback increases gain of amplifier.

$A_{vf} = A_v / 1 \mp \beta A_v$.

10. Draw equivalent circuit of crystal Oscillator.



Part-A. Nov./Dec 2020

1) What is diffusion capacitance?

The capacitance that exists in forward biased junction is called as diffusion capacitance. It is also defined as rate of change of injected charge with applied voltage. $C_D = dQ/dV$.

2) Give the applications of LASER diode.

* Laser Printer
* CD Player
* Used as pointer
* Reading bar codes.

3) Mention the advantages of MOSFET.

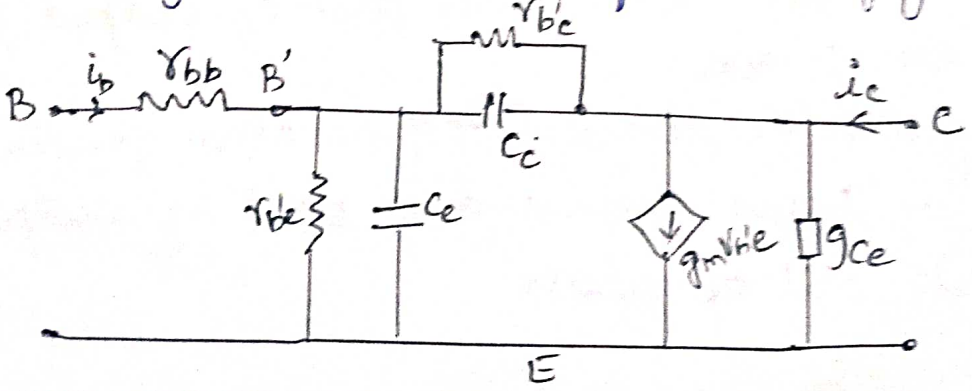
* Higher input impedance
* High drain resistance due to low resistance of Channel
* Easy to manufacture.
* High Speed of operation.

4) A unijunction transistor has $r_{B_1} = 4\,k\Omega$, $r_{B_2} = 2.5\,k\Omega$. Find intrinsic standoff ratio and peak point volt, if $V_{BB} = 15\,V$ and barrier potential is 0.7 V.

Intrinsic Standoff ratio $\eta = \dfrac{R_{B1}}{R_{B_1} + R_{B_2}} = \dfrac{4}{4+2.5} = 0.615$

Peak volt. $V_P = \eta V_{BB} + V_d = 0.615 \times 15 + 0.7 = 9.925\,V$

5) Draw hybrid π model of CE configuration.



6) Mention the condition for proper amplification of a signal.

* Proper zero signal collector current
* Minimum proper base emitter voltage at any instant
* Minimum proper collector emitter voltage.

7) Enumerate the need for neutralization.

In tuned amplifiers, base and collector capacitance becomes dominant. Since, reactance is low, frequency is high which promotes oscillation. It will stop the amplifier operation. In order to prevent oscillation, neutralisation is needed.

8) What is common mode rejection ratio?

It is defined as the ratio of differential mode gain to common mode gain. $CMRR = \frac{Ad}{Ac}$.

9) Give the condition for sustained oscillation.

* Magnitude of loop gain must be greater than one. $|A\beta| > 1$
* Total phase shift of circuit must be 360°; [$\phi = 36$

(ie) $A\beta = 1 \angle 0°$

10) Mention the types of feedback.

* Positive feedback (regenerative feedback)
  - Input signal and part of output signal are in phase
* Negative feedback (degenerative feedback)
  - Input signal and part of output signal are in out of phase.

Unit 1 (2 marks)

1) Determine the peak output voltage of a half wave rectifier, if the diode has $V_F = 0.7V$ and the ac input is 22V. April/May 2019

$$V_{dc} = \frac{V_m}{\pi}$$

$$V_{dc} = \frac{22}{\pi}$$

2) List few applications of Laser diode? April/May 2019, April/May 2017

1) Medical equipment used in surgery.

2) Consumer products like optimal disk equipment, laser printers, hologram scanners, compact disc, players

3) Measure distance

3) An a.c voltage of peak value 20V is connected in series with a silicon diode and load resistance of 500Ω. If the forward resistance of diode is 10Ω find the peak current through the diode Nov/dec 2018

$$V = IR$$

$$I = V/R$$

$$= \frac{20}{510}$$

$$I = 0.039A$$

4) State two disadvantages of half wave rectifier. Nov/dec 2018

1) ~~It requires four d~~

1) Low rectification efficiency

2) High Ripple factor

3) Low TUF

5) What is diffusion capacitance of PN Junction? April/May 2017 April/May 2018

A movement of charge carriers due to the Concentration gradient in a semiconductor is called process of diffusion.

$$C_D = \frac{dQ}{dV}$$

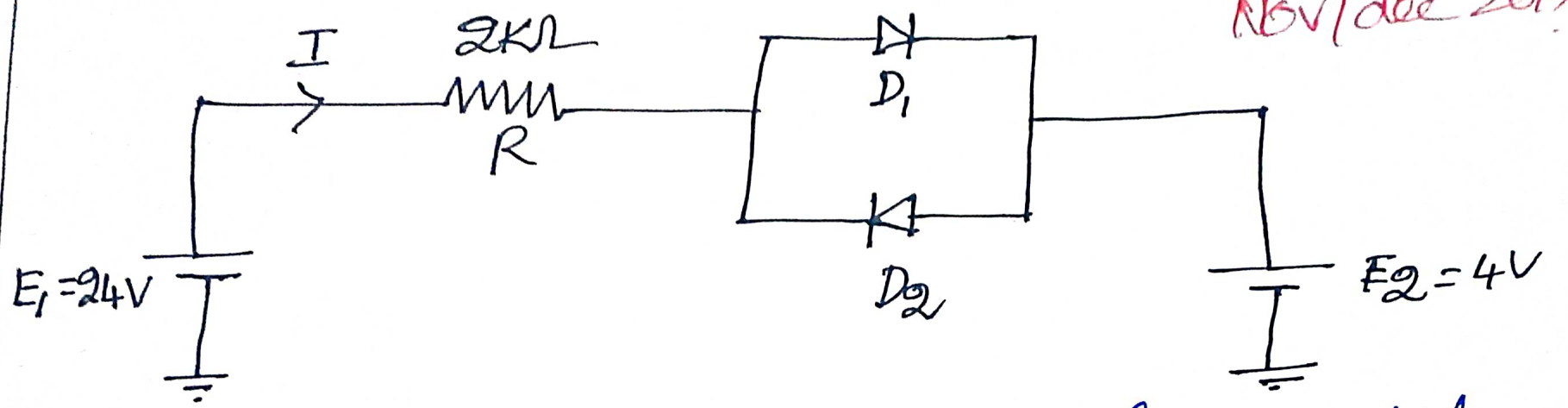
Where dQ is change in charge due to minority carriers, and dV is change in voltage across diode.

6) What is hole current in PN diode? April/May 2018

In semiconductors current is caused by both electrons in Conduction band and holes in Valance band. The current that is caused by the hole motion is called hole current.

D) Find the current I in the following circuit.

NOV/dec 2017



Assume the diodes to be of Silicon and forward resistance of diodes to be zero.

$$I = \frac{E_1 - \text{drop across diode} - E_2}{R}$$

$$= \frac{24 - 0.7 - 4}{2 \times 10^3}$$

$$I = 9.65 \text{ mA}$$

Unit - I
PN Junction Devices

1, what is meant by Diffusion current in a Semi-conductor?

NOV/Dec 2014
April/May 2015

In Semiconductor material, the charge carriers have the tendency to move from the region of higher concentration to that of lower concentration of the same type of charge carriers. This movement of charges carriers takes place resulting in a current called diffusion current. It depends on material type & concentration gradient.

2, what is transition capacitance & Diffusion capacitance?

April may 2011
Nov/Dec 2014

The capacitance due to depletion layer is known as depletion capacitance or transistion capacitance, it can be expressed as,

$$C_T = \frac{dQ}{dV} = \frac{\varepsilon A}{d}$$

A - Cross sectional area of depletion region
W - width (or) thickness of depletion region.

3 Define Rectifiers. List the types of Rectifiers.

Nov/Dec 2014
April/May 2015

A rectifier is an electrical device that converts altering current (AC) which periodically reverse direction to direct current (DC) which flows in only one direction. This process is known as rectification.

Rectifiers are classified into two types based

on the conduction of AC input.
They are,

* Half wave rectifier (HWR)
* Full wave rectifier (FWR)

4. A silicon diode has a saturation current of 7.5μA at room temperature to 300°K. calculate the saturation current at 400°K.

April/May 2011
Nov/Dec 2015

Given:

$I_{O1} = 7.5\mu A$ at $T_1 = 300°K$

$I_{O2} = ?$ at $T_2 = 400°K$.

$$I_{O2} = I_{O1} 2^{(T_2 - T_1)/10}$$

$$= 7.5 \times 10^{-6} \times 2^{(400-300)/10}$$

$$= 7.5 \times 10^{-6} \times 2^{10}$$

$$I_{O2} = 7.68 mA.$$

5, what is meant by diffusion capacitance?

NOV/Dec 2017
NOV/Dec 2014

If the diode is biased in the forward direction, the potential barrier at the junction is lowered & diffusion of charge carriers take place. Hence the electrons which enter the P-side from n-side & holes which enter the n-side from P-Side constitute majority carriers &

this process is called minority carrier injection. An incremental capacitance which is defined as the rate of change of injected charge with applied voltage is called diffusion or storage capacitance C_D.

$$C_D = \frac{\tau I}{\eta V_T}$$

6. Relate voltage & current of forward biased PN Junction diode. May/Jun 2014

The V-I characteristic equation (or) diode current equation is used to relate voltage & current of forward biased PN Junction diode,

$$I = I_0 \left[e^{V/\eta V_T} - 1 \right]$$

where I_0 = Reverse saturation current
V = Applied voltage
V_T = Voltage equivalent of temperature
η - Emission coefficient (or) ideality factor.

7. What is meant by dynamic Resistance of PN diode. NOV/DEC 2011

The dynamic resistance is the resistance offered by PN Junction diode when AC voltage

is applied. when the AC circuit is connected to the diode and forward biased voltage is applied to the diode AC flows through diode. In AC circuit, charge carriers does not flows in single direction, It flows in both forward & Reverse direction.

It is denoted in r_f,

$$r_f = \frac{\text{change in voltage}}{\text{change in current}}$$

8, A Silicon diode has a saturation current of 10μA at room temperature to 300°K. calculate the saturation current at 400°K. April/may 2008

Given

$I_{O1} = 10\mu A$ at $T_1 = 300°K$

$I_{O2} = ?$ at $T_2 = 400°K$

$$I_{O2} = I_{O1}\, 2^{(T_2 - T_1)/10}$$

$$I_{O2} = 10 \times 10^{-6} \times 2^{(400-300)/10}$$

$$= 10 \times 10^{-6} \times 2^{10}$$

$$I_{O2} = 0.01024 = 10.24\ mA$$

9, Define Knee Voltage of a Diode. NOV/Dec 2010

The forward voltage, at which the current through the PN Junction starts to increase is called as knee voltage.

10, What is Peak Inverse Voltage? Nov/Dec 2010

The Peak Inverse voltage (PIV) is the maximum inverse voltage that can be applied to the PN Junction without damage to the Junction.

11, Define Depletion Region in PN Junction Diode.
Nov/Dec 2007

The depletion region refers to a region where flow of charge carriers are decreased over a given time & finally result in empty mobile charge carriers or full of immobile charge carriers.

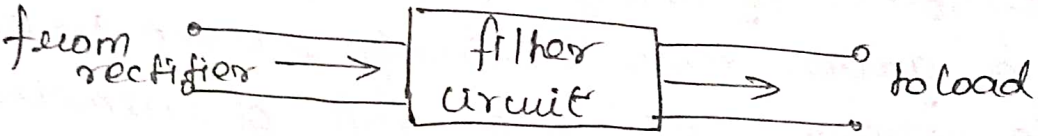
Depletion refers to reduction or decrease in quantity of something.

12, Differentiate Zener Breakdown & Avalanche Breakdown. April/May 2011 Nov/Dec 2011 April/May 2015

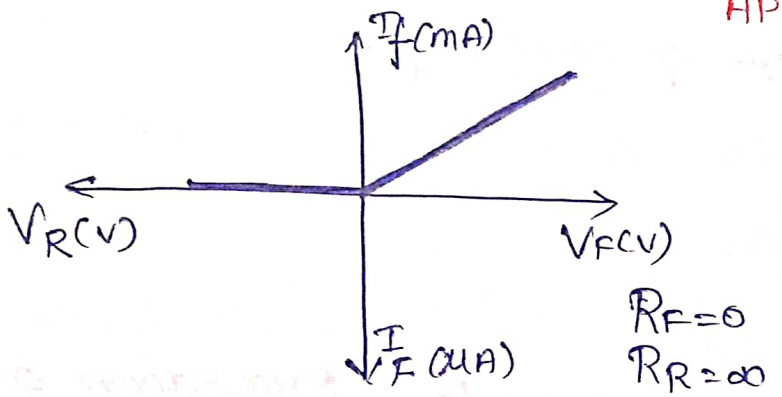
Zener Breakdown	Avalanche Breakdown
Breakdown occurs due to heavily doped Junction & applied strong electric field	Breakdown occurs due to avalanche multiplication between thermally generated ions.
Doping level is high	Doping level is low
Breakdown occurs at lower voltage compared to avalanche breakdown	Breakdown occurs at higher voltage.

13, what is the need for a filter in rectifier?
Nov/Dec 2016

The output of a rectifier is pulsating & contains a steady DC component with undesirable ripples. If such pulsating DC is given to the electronic circuits, it produces disturbances & other interferences, Hence ripples have to be kept far from the load. This is achieved by using filter circuit between rectifier & load.



14 Draw the V-I characteristics of an ideal Diode.
April/May 2008



15, what is meant by Breakdown voltage?
Nov/Dec 2007

The reverse voltage, at which PN Junction breakdown takes place with sudden rise in current is called as breakdown voltage

Unit 2 (2 marks)

1) FET has lower thermal noise than BJT - Justify. April/May 2019

A BJT is having two PN junctions whereas an FET is having only one PN junction. Hence charge carriers will have to cross more depletion regions in BJT and hence the possibility of additional of thermal noise and minority charge carrier is higher. But in FET, there is no significant depletion region between drain & source.

2) What is meant by latching in SCR? April/May 2019

Ability of SCR to remain in ON state even when the gate current is removed is called latching.

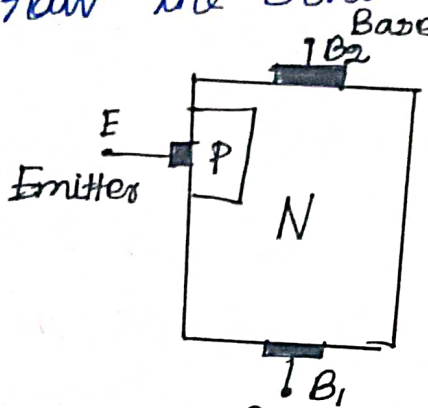
3) State any two differences between JFET & BJT April/May 2018 Nov/Dec 2018

JFET	BJT
1. Unipolar device	1. Bipolar device
2. Voltage Controlled device	2. Current Controlled device
3. Input resistance is high	3. Input resistance is low
4. Less Noise	4. More Noise.

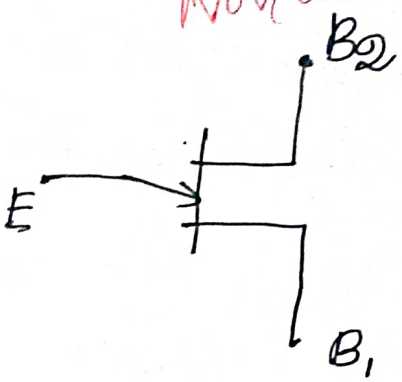
4) What is break over voltage of SCR? April/May

It is the voltage at which the SCR is switched from the OFF position to ON position. Its value is maximum for zero gate current. SCR's have a forward break over voltage ranging from 50 to 1200V.

5) Draw the structure of UJT. Nov/dec 2017



Structure



Symbol

6) Define Early effect. Nov/dec 2016

When the collector base voltage is increased the depletion region across collector base increases. Hence the effective width of base decreases. The variation of effective base width by collector base voltage is called base width Modulation or early effect.

7) Determine the Base current for the CE transistor circuit if $I_c = 80$ mA and $\beta = 170$.

Nov/dec 2016

$$I_c = \beta I_B$$

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

$$= \frac{80 \times 10^{-3}}{170}$$

$$I_B = 470.59\ \mu A$$

Unit 3

1) State the Need for Coupling capacitor in a transistor amplifier?

April / May 2019

Coupling capacitors are essential components in amplifier circuits. They are used to prevent interference of a transistor's bias voltage by AC signals. In most amplifier circuits, this is achieved by driving the signal to the base terminal of a transistor through a coupling capacitor.

2) What is Source follower?

April/may 2018

A common drain amplifier ina MOSFET circuit is called as Source follower. It provides Voltage and current gain

Unit II
Transistors

1. What is meant by biasing? Dec/Nov 2014

Applying external voltage to a transistor is called biasing. In order to operate transistor properly as an amplifier, it is necessary to correctly bias the two Pn junction with external voltage. Depending upon external bias voltage polarities used, the transistor works in one of the three regions.

2. What is a Thyristor? Mention any two of them. April/May 2014

Thyristor is a semiconductor device whose switching action depends on internal regenerative feedback. It can be operated only as a switch. It can have two, three, or four terminal. It is unidirectional or bidirectional device. Two of them are 1) Silicon controlled Rectifier (SCR)
2) Insulated Gate Bipolar Transistor (IGBT).

3. Difference between BJT & FET. Nov/Dec 2014 April/May 2014

BJT	FET
It is a current controlled device	FET is a Voltage controlled device.
configurations are CE, CB & CC.	configurations are CS, CG and CD
Bipolar device.	unipolar device
High noise level	low noise level

4, Define the pinch off voltage. NOV/DEC 2007
NOV/DEC 2012

The value of V_{DS} at which the channel is pinch off. ie., all the free charges from the channel get moved, is called the pinch off voltage in a JFET.

Electron charge, donor/acceptor concentration density, permittivity of channel material & half width of channel bar are the parameters that control the pinch off-voltage of JFET.

5, Name the operating modes of BJT Transistor. NOV/DEC 2010

There are four modes of operation in a Transistor. They are,

* Active or Normal active
* cut off
* Saturation
* Inverted Active

6, what is meant by amplification factor of JFET. April/May 2011

Amplification factor is given by the drain resistance & transconductance.

Amplification factor = Drain resistance × Transconductance

$$\text{Amplification factor } \mu = \left.\frac{\Delta V_{DS}}{\Delta V_{GS}}\right|_{I_D \text{ constant}}$$

$$\mu = r_d \times g_m.$$

1, Difference between E MOSFET & D MOSFET.

Nov/Dec 2011

Parameters	E - MOSFET	D - MOSFET
Channel	Exists permanently	channel is physically absent
Operation	can be operated in depletion mode as well as enhance mode	can only be operated in enhance mode.

8, Operation modes of BJT with reference to Junction biasing.

May / June 2014

Mode	EBJ Bias	CBJ Bias
Active (or Normal Active)	Forward	Reverse
cut off	Reverse	Reverse
Saturation	Forward	Forward
Inverted Active	Reverse	Forward

10 compare BJT, FET & MOSFET. May/Jun 2011

BJT	FET	MOSFET
High voltage gain	Low voltage gain	Low voltage gain
Low current gain	High current gain	High current gain
~~fast~~ Medium Switching time	fast Switching time	fast Switching time
Requires zero input to turn it 'off'	Some require an input to turn it 'off'	Some required positive Some required negative to turn it off
current controlled device.	Voltage controlled device	Voltage controlled device
easy to bias	difficult to bias.	difficult to bias.

11 What are the configurations types of transistor? Dec/Jan 2012

common - Base (CB)

common - Emitter (CE)

common - collector (CC)

12 what is the thermal resistance of power BJT? Nov/Dec 08

Thermal resistance is the resistance to the flow of heat. Heat flows from the Junction to the surrounding air. larger the transistor case, smaller the thermal resistance & Vice-Versa. Thermal resistance is reduced by providing heat sink with transistors.

13, what is the value of cut in voltage for a BJT. Nov/Dec 2008

For Silicon BJT it is 0.7V
For Germanium BJT it is 0.3V.

14, List some advantages of MOSFETs. April/May 2010

MOSFETs combine the inherent advantages of Solid-State devices such as,

* Small Size
* Low Power consumption
* Simplicity of construction
* Mechanical ruggedness.
* Very high input impedance
* Switching time is less

15, Applications of SCR, TRIAC, DIAC, UJT.

Nov/Dec 2017

SCR Application:

* Controlled rectified
* DC to AC converters called invesiters
* AC to DC convertors called choppers
* AC voltage Stabilizers.

TRIAC Application:

* light dimmer circuits
* AC Power flasher
* Static DC switching of application
* Temperature controller

DIAC Application:

* motor Speed control
* Light diming circuits
* temperature controller
* A C & other domestic application

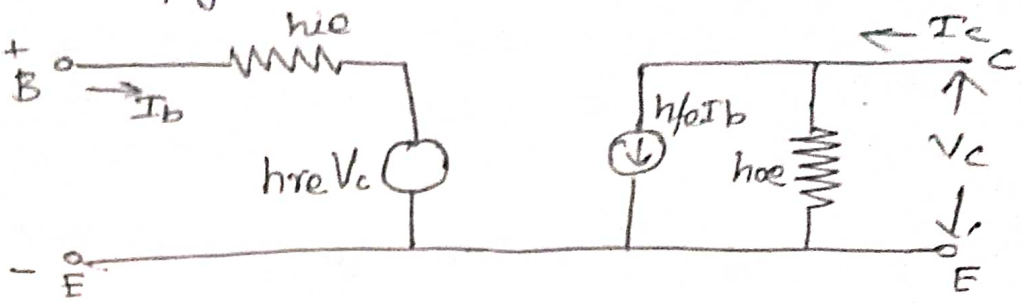
UJT Application

* Sawtooth waveform generator
* timing circuit
* relaxation oscillator
* automobile ignition circuit.

Unit - III
Amplifiers

1. Draw the hybrid model of BJT in Common Emitter Configuration. April/May 2015 April/May 2018

The hybrid model of BJT in Common Emitter Configuration is shown below.



For two Port network,

$$V_b = h_{ie} I_b + h_{re} V_c$$

$$I_c = h_{fe} I_b + h_{oe} V_c$$

2. what are amplifiers? write its uses. NOV/DEC 2014

An amplifier is used to increase the signal level; i.e the amplifier is used to get a large signal output from a small signal input. If the input of the amplifier is sinusoidal signal then the output of the amplifier must be sinusoidal waveform with frequency same as that of the input.

To make the transistor work as an amplifier, it is to be biased to operate in the

active region. i.e) base emitter junction is to be forward biased, while base-collector junction to be reversed biased.

Uses of amplifiers, They are used in Video amplifiers, microwave amplifier, musical instrument amplifiers etc.

3, Define the four h parameters. NOV/Dec 2014 NOV/Dec 2010

$h_{11} = \left.\frac{V_i}{I_i}\right|_{V_o=0}$ = input resistance with output short-circuited, in ohms

$h_{12} = \left.\frac{V_i}{V_o}\right|_{I_i=0}$ = Ratio of output voltage at input with input open circuited.

This parameter is ratio of similar quantities, hence unitless.

$h_{21} = \left.\frac{I_o}{I_i}\right|_{V_o=0}$ = Forward current transfer ratio or current gain with output short-circuited.

This parameter is ratio of similar quantities, hence unitless.

$h_{22} = \left.\frac{I_o}{V_o}\right|_{I_i=0}$ = output admittance with input open circuited, in mhos.

They have different units. In other words they are mixture of different units & hence referred to as hybrid parameters.

5, what are hybrid parameters. Nov/Dec 2010

$h_{11} = \frac{V_i}{I_i}\Big|_{V_o=0}$, $h_{12} = \frac{V_i}{V_o}\Big|_{I_i=0}$, $h_{21} = \frac{I_o}{I_i}\Big|_{V_o=0}$

and $h_{22} = \frac{I_o}{V_o}\Big|_{I_i=0}$ are hybrid parameters.

a) with output short circuit.

$h_{11} = h_i$ = input resistance

$h_{21} = h_f$ = Short circuit current gain.

b) with input open circuit.

$h_{12} = h_r$ = Reverse voltage transfer ratio

$h_{22} = h_o$ = output admittance.

6, How are amplifiers classified according to input?

The amplifiers are classified into two types according to the input signals. They are,

* Small Signal amplifiers
* Large Signal amplifiers

7, How are amplifiers classified according to the transistor configuration?

The amplifiers are classified into three types according to the transistor configuration. They are,

* common Emitter (CE) amplifier
* common Base (CB) amplifier
* common collector (CC) amplifier

8, what are the different analysis available to analyze a transistor?

The different analysis ~~or~~ which are used to analyze a transistors are,

1, Large Signal Dc analysis

2, Small Signal equivalent analysis
3, Amplifier Analysis.

9, Why CE configuration is preferred over CB configuration?

The common emitter configuration (CE) provides maximum voltage and current gain. The other configurations like common base provide either high current gain or voltage gain but not both for a BJT.

An amplifier that does amplification of both voltage as well current are always preferred & hence does the choice of CE becomes obvious.

10, Define base width modulation (early effect).

As the voltages applied to the base-emitter and base collector junctions are changed, the depletion layer widths and the quasi-neutral vary as well. This causes the collector current to vary with the collector emitter voltage.

A variation of the base-collector voltage results in a variation of the quasi-neutral with in the base. The gradient of the minority-carrier density in the base therefore changes, yielding ↑ collector current as collector base current ↑. This is called early effect.

11, Define current gain and voltage gain.

The voltage gain of the amplifier is defined as the ratio of output voltage to the input voltage.

$$Av = \frac{V_{out}}{V_{in}}.$$

Similarly, the current gain of the amplifier is defined as the ratio of output current to the input current.

$$A_i = \frac{I_{out}}{I_{in}}$$

18. Define input impedance and output impedance of a transistor

The input impedance of an electrical network is measured of the opposition to current flow, both static (resistance) & dynamic (reactance), into the load network being connected that is external to the electrical source.

The output impedance of an electrical network is measure of the opposition to current flow, both static (resistance) & dynamic (reactance), into the load network being connected that is internal to the electrical source. output impedance is sometimes referred as source impedance or internal impedance.

19. Define base spreading resistance.

Large area bipolar transistors can have a non-uniform current distribution due to the resistance of the base layer. Since the base current is applied through the thin base layer, there can be a significant series resistance in large devices. This resistance causes a voltage variation across the base region. This voltage variation in turn causes a variation

of the emitter current drawing, especially since the emitter current drawing depends exponentially on the local base-emitter current.

14. Define Thermal run away & heat sink.

Thermal run away occurs in situations where an increase in temperature changes the conditions in a way that causes a further increase in temperature, often leading to destructive result. It is a kind of uncontrolled positive feedback.

A heat sink is a passive heat exchanger that transfers the heat generated by the electronic or a mechanical device to a fluid medium where it is dissipated away from the devices.

15. How can a DC equivalent circuit of an amplifier be obtained?

To draw the DC equivalent circuit of an amplifier. The following steps should be followed. They are.

* Remove all ac-Source (or) ground ac Source to 0
* Remove all coupling capacitor as they blocks the dc
* Replace Base-emitter junction by forward bias PN Junction diode.
* Replace Base-Collector junction by current Source of base current (I_B)

16. In a common base connection, current amplification factor is 0.9. If the emitter current is 1 mA, Find the value of base current. NOV/Dec 2017

Given

Current amplification factor, $\alpha = 0.9$

Emitter current = 1 mA.

$$\alpha = \frac{I_C}{I_E} \Rightarrow I_C = \alpha I_E$$

$$= 0.9 \times 1\,mA$$

$$= 0.9\,mA$$

$$I_E = I_B + I_C$$

$$\Rightarrow I_B = I_E - I_C = (1 - 0.9)\,mA$$

$$\Rightarrow I_B = 0.1\,mA$$

17. Define transconductance of MOSFET. NOV/Dec 2017

It is defined as the ratio of a small change in the drain current to the corresponding small change in the gate voltage at a constant drain voltage.

$$g_m = \left(\frac{\partial I_D}{\partial V_{GS}}\right)_{V_{DS}} = \left.\frac{\Delta I_D}{\Delta V_{GS}}\right|_{\text{constant } V_{DS}}$$

Unit IV

1) What is cross over distortion? April/May 2018

Cross over distortion is a type of distortion which is caused by switching between devices driving a load.

2) Write the advantages of push pull amplifier April/May 2018

1) Low distortion

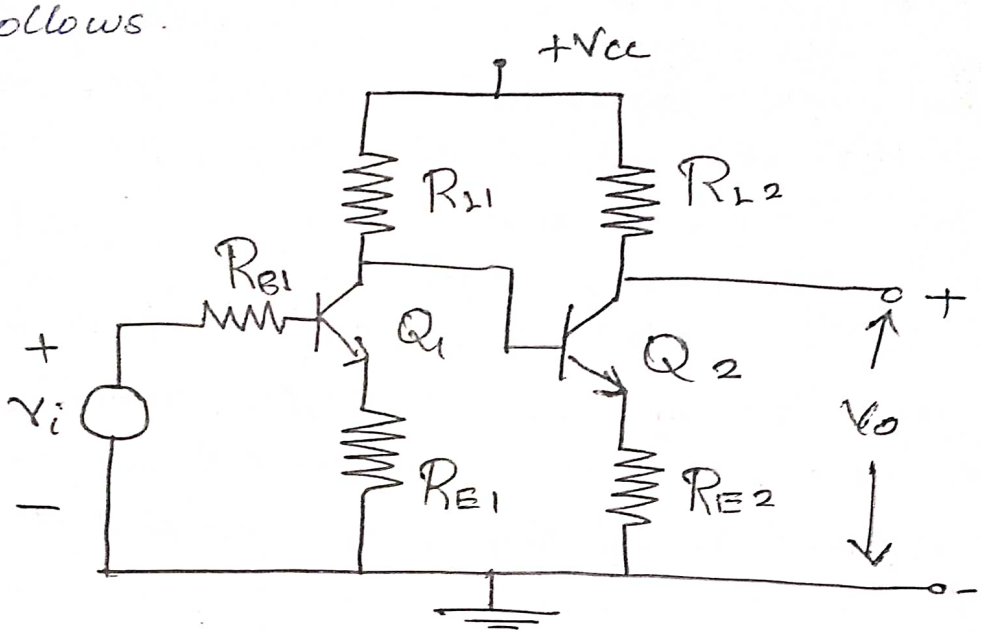
2) Absence of Magnetic saturation in the coupling transformer core.

Unit - IV

Multistage Amplifiers & Differential Amplifier

1, Draw cascaded amplifiers? April/may 2015

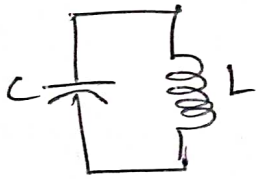
The cascade amplifiers circuit is as follows.



2. Draw the ideal tuned circuit & write the expression for its resonant frequency.

April/may 2015

The ideal tuned circuit is shown below



In radio, when an arrangement of L, C and R responds to particular frequencies, it is called a 'tuned' circuit.

The resonant frequency of the above circuit

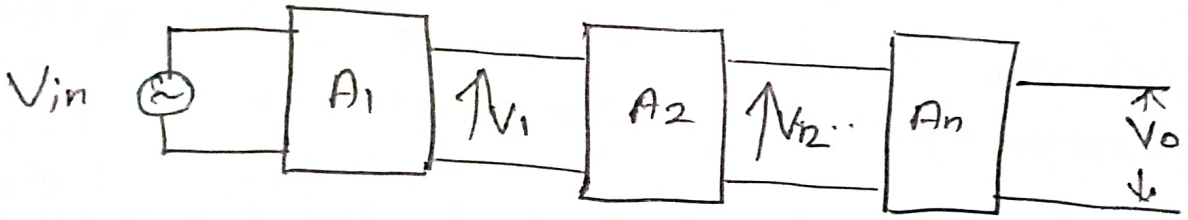
is given by f_0

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

3. Write down the need of cascading the amplifier.

Nov/Dec 2014

For most systems a single transistor amplifier does not provide sufficient gain or bandwidth or will not have the correct input or output impedance matching. The solution is to combine multiple stages of amplifier. To increase the voltage gain of the amplifier, multistage amplifiers are connected in cascade. The output of one stage of the one amplifier is the input to another stage.



4. What is CMRR? List the various methods of improving CMRR.

Nov/Dec 2014
April/May 2017

The common-mode rejection ratio (CMRR) of a differential amplifier is defined as the ratio of the differential amplifier-mode gain to common mode gain.

$$CMRR = |A_d|/|A_{cl}$$

methods to improve CMRR in differential amplifier are,

1) Use of constant current bias
2) Use of current mirror circuit.

5, what are the advantages of differential amplifier. Nov/Dec 2011

Advantages of differential amplifier are as follows.

→ High differential Voltage gain
→ Low common mode gain
→ Large bandwidth
→ Low offset Voltage & currents
→ Low output impedance
→ High input impedance.
→ Two input terminals

6, Define CMRR and write its Significance in differential amplifier. May/Jun 2014, April/may 2011 April/may 2010

The common-mode rejection ratio (CMRR) of differential amplifier is defined as the ratio of the differential amplifier-mode gain to common mode gain.

$$CMRR = \frac{A_d}{A_c}.$$

when $V_1 = V_2$, many disturbance signals noise signals appear as a common input signal to the bothe input terminals which should be rejected.

Output voltage interms of CMRR,

$$V_o = A_d V_d \left[1 + \frac{1}{CMRR} \frac{V_c}{V_d}\right]$$

CMRR is very large, so if V_c & V_d bothe are Present, the output is proportional to the difference signal only, the common mode component is greatly rejected.

7, What is a differential Amplifier?

Nov/Dec 2018

An amplifier which is designed to amplify the difference between two input signals is called the differential amplifier.

$$V_o = A_D(V_1 - V_2)$$

where A_D - differential Gain

V_o - output voltage

V_1 & V_2 - input voltages.

8. when two signals V_1 & V_2 are connected to the two input of a differential amplifier. define a difference signal Vd & common signal V_c

The difference signal Vd is defined as the difference of the two signal input.

$$V_d = V_1 - V_2$$

The common mode signal V_c is defined as the average of the two signal.

$$V_c = V_1 + V_2$$

9, what are the ideal values of Ad & Av with reference to the differential amplifier.

Ideally A_c should be zero and Ad should be large, ideally infinite.

10, Applications of differential Amplifier.

The applications of differential amplifiers are,

* Used in IC applications
* AGC circuits &
* phase inverters.

11, mention the advantages of Push Pull amplifier.

1, The efficiency is much higher than class A operation.
2, when there is no input signal, the power dissipation is zero.
3, The even harmonics get cancelled. This reduces the harmonic distortion.
4, Ripple present in supply voltage also get eliminated
5, Due to the transformer, impedance matching is possible

b) As the dc current components flow in direction through the primary winding there is no possible of dc saturation of the core.

12) Difference between common mode and difference mode?

Nov/dec 2018

The gain of the differential amplifier in common mode is given by.

$$A_c = \frac{V_o}{V_c} \quad \text{where } V_c = \frac{V_1 + V_2}{2}$$

The gain of the amplifier in differential mode is given by,

$$A_d = \frac{V_o}{V_d} \quad \text{where } V_d = V_1 - V_2.$$

In differential mode it amplifies the difference between the input voltage.

In common mode it amplifies the average of the input signals.

13) Mention the neutralisation techniques.

In tuned RF amplifiers, transistors are used at the frequencies nearer to their unity gain bandwidth. To amplify a narrow band of high frequencies centred around a radio frequency.

The neutralization techniques used are

* Hazaltine Neutralization.
* Neutralization using coil.

14. List out the efficiencies of power amplifiers Nov/dec 2016.

The power amplifier has the higher efficiencies.

The class A power amplifier have efficiency of 25 to 50%.

The class B power amplifier have efficiency of upto 78.5%.

The class AB power amplifier have efficiency of 50%-to 60%.

The class C power amplifier have efficiency of 80%.

15, what is Bicmos cacade amplifier:

Bipolar junction transistors offer high speed, high gain & low output resistance which are excellent properties of high frequency analog amplifier, whereas cmos technology offers high input resistance & is excellent for consuming gate.

Combining BJT technology & cmos technology. Bicmos technology has been formed.

Bicmos technology use the characteristics of each type of transistor most appropriately and form cascade amplifiers.

16. A multistage amplifier employs five stages each of which has a power gain of 30. What is the total gain of the amplifier in db. NOV/Dec 2017

$A_V = A_{V1} A_{V2} A_{V3} A_{V4} A_{V5}$

$= 30 \times 30 \times 30 \times 30 \times 30$

$= (30)^5 = 24\,300,000$

Gain in dB $= 10 \log (24\,300,000)$

$A_{V(dB)} = 73.86$ dB

17. What is thermal runaway? NOV/Dec 2017

Heat in the power transistor decreases the base-emitter voltage and tends to increase current. If the diodes are in cooler environment. I_{CQ} increases more. More heat is produced in an unrestrained cycle known as thermal runaway.

Unit 5

1) An oscillator operating at 1MHz has a stability of 1 in 10⁴. What will be the minimum value of frequency generated? April/May 2019

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

2) The overall gain of a multistage amplifier is 140. When Negative Voltage feedback is applied the gain is reduced to 17.5. Find the fraction of the output that is feedback to the input. Nov/dec 2018

$$A_V = 140 \qquad A_{Vf} = 17.5$$

$$A_{Vf} = \frac{A_V}{1 + A_V m_V}$$

$$17.5 = \frac{140}{1 + 140 m_V}$$

$$m_V = \frac{1}{20}$$

3) In a phase shift oscillator $R_1 = R_2 = R_3 = 1M\Omega$ and $C_1 = C_2 = C_3 = 68\,PF$. At what frequency does the circuit oscillate? Nov/dec 2018

$R_1 = R_2 = R_3 = R = 1M\Omega = 10^6\Omega$

$C_1 = C_2 = C_3 = 68PF = 68 \times 10^{-12} F$

$$f_0 = \frac{1}{2\pi RC\sqrt{6}}$$

$$= \frac{1}{2\pi \times 10^6 \times 68 \times 10^{-12}\sqrt{6}}$$

$f_0 = 954 Hz$

4) A tuned circuit has a resonant frequency of 1600 KHz and a Bandwidth of 10KHz. What is value of a factor.

April/May 2017

$$Q_r = \frac{F_r}{BW} = \frac{1600K}{10K} = 160.$$

5) An Amplifier has a current gain of 240 and Input Impedance of 15KΩ without feedback. If Negative current feedback ($m_i = 0.015$) is applied, what will be the Input impedance of amplifier?

Nov/dec 2017

$$Z_{in}' = \frac{Z_m}{1 + m_i A_i}$$

$$= \frac{15K}{1 + (0.015)(240)} = 3.26K\Omega$$

Unit - V

Feedback Amplifiers & oscillators

1, write the disadvantages of negative feedback in amplifiers & how it can be overcome? April/May 2015 April/May 2019

* The overall gain of the system will be decreased by connecting the negative feedback
* If the system is not properly designed. It may lead to produce oscillations

→ The disadvantages of reducing the gain can be overcome by adding few more stages of amplifiers.

2, what is the expression for the frequency of oscillations of a wein-bridge oscillator? April/May 2015

The expression for the frequency of oscillations of a wein bridge oscillator is given by.

$$f_r = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

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

if $R_1 = R_2 = R$ & $C_1 = C_2 = C$.

$R_3/R_3 > 2$ will provide a sufficient gain for the circuit to oscillate at the desired frequency.

3, Which is the most commonly used feedback arrangement in cascaded amplifier & why?

Nov/Dec 2014

Voltage Series feedback is the most commonly used feedback arrangement in cascaded amplifiers. Voltage Series feedback increases input resistance & decreases output resistance.

Increases in input resistance reduces the loading effect of previous stage & the decrease in output resistance reduces the loading effect of amplifier itself for driving the next stage.

4, State the Barkhausen Criterion for an Oscillator.

Nov/dec 2016 Nov/Dec 2014, April/May 2017

1, The oscillator circuit should consist of an amplifier & a portion of the output should be feedback to the input. for sustained oscillations, the feedback voltage must be in phase with the input ie Total phase shift around the loop must be 360°.

2. The amount of energy or power feedback to the input must be sufficient to the input circuit. $|AB|=1$ ie the magnitude of loop gain must be unity.

5, List the advantages of negative feedback amplifier. April/may 2011, April/may/2010

* Negative feedback stabilizes almost any type of disturbance or noise occurrence.
* It is used to overcome the non-linearity of the system.
* It helps us to flatten the frequency response of the system. (decreases frequency distortion)
* negative feedback makes the system to less dependent on the temperature & other external properties of the system
* Decrease output resistance & Sensitivity of s/m.
* Increase input resistance & Bandwidth of the output signal.

6, State the condition to obtain sustained oscillations in oscillator circuit? may/Jun 2014

1, The oscillator circuit should consist of an amplifier & a portion of the output should be feedback to the input. For sustained oscillations, the feedback voltage must be in phase with the input ie Total phase shift around the loop must be 360°.

2, the amount of energy or power feedback to the input must be sufficient to the input circuit. $|AB=1|$ ie) the magnitude of loop gain must be unity.

7. Mention any two high frequency LC oscillator.
Nov/Dec 2010

* Quartz Crystal Oscillator
* Colpitts oscillator
* Hartley oscillator.

are Some of the high frequency LC oscillators.

8. Advantages of Crystal Oscillator. Nov/Dec 2012 Nov/Dec 2014

* The crystal oscillator have very high frequency Stability.
* It has high frequency of operation.
* It has very low frequency drift due to change in temperature & other parameters.
* The Q is very high.
* The crystal oscillator is possible to obtain very high precise & stable frequency of oscillators.
* It has automatic amplitude control.

9. mention the types of feedback amplifier connections. Nov/Dec 2014, April/May 2018

There are four types of feedback amplifier connections. They are,

* Voltage - series feedback amplifiers
* Voltage - Shut feedback amplifiers

* Current Series feedback amplifiers
* Current Shunt feedback amplifiers

10, What is meant by positive feedback? May 04, April/May 2018

If the feedback signal is inphase with the input signal the net effect of the feedback will increase the input signal given to the amplifier. Hence the input voltage applied to the amplifier is increased thereby increasing the output. This type of feedback is called positive or regenerative feedback.

11, What is meant by negative feedback? May 06

If the feedback signal is out of phase with the input signal the net effect of the feedback will decrease the input signal given to the amplifier. Hence the input voltage applied to the amplifier is increased thereby decreasing the output. This type of feedback is called as negative or degenerative feedback.

12, Define Sensitivity.

The fractional change in amplification with feedback divided by the fractional change without feedback is called the Sensitivity of the transfer gain.

$$\text{Sensitivity} = \frac{dA_f / A_f}{dA / A} = \frac{1}{1+AB}$$

13, Define 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) = $1 + A\beta$

where A = Amplification factor (or) gain

β = feedback factor.

14, State the frequency for RC phase shift oscillator.

April/May 2018

The frequency of oscillation for the RC Phase shift oscillator is

$$f_r = \frac{1}{2\pi RC\sqrt{6}}$$

For oscillator operation $A\beta = 1$.

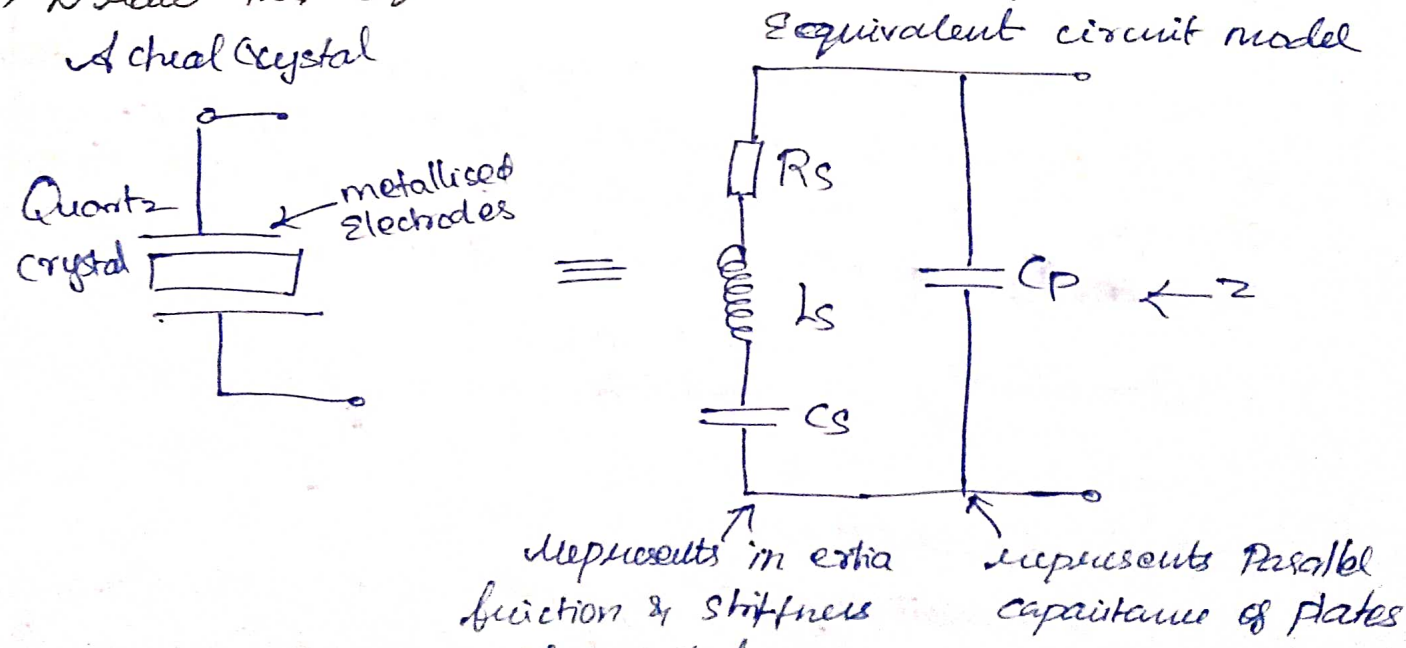
|A| must be more than 29.

C – capacitance.

R – Resistance.

f_r – frequency of oscillation.

15, Draw the equivalent circuit of crystal oscillator.



The equivalent electrical circuit for the quartz crystal as a series RLC circuit, Parallel with capacitance Cp.

6. An amplifier has a current gain of 240 and input impedance of 15 kΩ without feedback. If negative current feedback (current attenuation = 0.015) is applied, what will be the input impedance of the amplifier? NOV/DEC 2017

Given data:

$A_I = 240$

$R_i = 15\,K\Omega$

$\beta = 0.015$

$$R_{if} = \frac{R_i}{1 + A_I \beta} = \frac{15\,K}{1 + (240 \times 0.015)}$$

$$\boxed{R_{if} = 3.26\,K\Omega}$$

7. What are the essential blocks of a transistor oscillator? NOV/DEC 2017

The essential blocks of an oscillator are

i) Amplifier
ii) Feedback circuit
iii) Tank circuit.