Welcome students to the paper

electronic circuits ACB designer.

In today's module we'll be learning

about what is thermal runaway.

What is stability and what do

you mean by stability factor?

Myself Toyota virus accident

professor since college marks a goal.

So the outline of this noodle is as follows.

Will be learning about what do you mean

by thermal runaway in a transistor?

What do you mean stability

and stability factor?

So at the end of this module,

the student will be able to understand

the concept of thermal runaway and

will understand what is stability

and stability factor of a transistor.

So what is thermal runaway thermal

runaway is a self destruction process.

With that increase in temperature

creates such a condition,

which in turn increases the temperature.

Here, this uncontrolled rise in temperature

causes the component to get damaged.

The reverse saturation current

in semiconductor devices

changes with temperature.

In fact,

the reverse saturation current

approximately double s for every

10 degrees rise in temperature.

Now, as the leakage current of transistor

increases collector increases.

The Power Distribution at

the Collector Base junction.

This in turn increases the

temperature of collector wage.

I'm calling the collector

current to further increase.

This process becomes cumulative

and it is possible that the rating

of the transistor exceeded.

If this happens,

the transistor gets burnt out and this

process is known as thermal runaway.

Now thermal runaway can be avoided

by two methods using stabilization

circuitry and 2nd is using a heat sink.

So this is we'll see what doing

my thermal running with the help

of this formula.

That is,

you always have seen this.

It's nothing but formula of a

common emitter circuit where in

IC is nothing but a collective.

Even IB is the base current.

Beta is the amplification factor

for current gain and ICB is the

leakage correct so?

I see is equal to beta time IB plus

ICO or we can write it as IC is equal

to beta IB plus beta plus one ICB.

So what IC gets double for every

10 degree rise in temperature?

So if you take a look over here icbo is 10.

Let us say net 10 nano ampere at 20

degrees so at 30 it will look pretty at

40 degrees will come 40 nano amperes at 5080.

So each stack there's a 10 degrees

rise in temperature IC is Igbo.

That is the leakage current is going to get.

Double.

So if you take a look over here

what is going to happen?

I see bio if we have seen that

Ichigo gets double for every

10 degrees rising temperature.

So I see this increasing over here.

I see increases.

We can see that.

This issue,

which is their Wyer if this issue

which is there will also increase.

Where this is all going to also

increase because I C is equal

to beta IB plus beta plus IC,

so if ICP increases IC collected

the rate is also

going to increase.

If that increases the power dissipated

at the collector is also going to

increase the power dissipated at the

collector is given by VCC into ICC.

So ICC has increased.

That means a power disability at

the collector also is going to

increase and if power disability

occurs the collector has increased.

That means the temperature of

the collector base junction is

going to increase that and T

is going to increase in turn.

Now if T again increases that means I.

You go is again going to increase.

If I see increases this so this

is going to collect the current is

going to increase so this is going

to create a cumulative effect.

OK and finally the transistor

if we don't control it,

it is going to lead to what we

call as the thermal run away.

So there are two parameters which we use to.

Which we use that is a stability

and stability factor to see how

stable are particular transistor is,

whether it is going to,

whether there is going to get

heated up or not,

so that will come to know from this two

term that is stability and stability factor.

So as we have seen as temperature,

any transistor parameter changes.

Our Q point will also change,

so let's see there are three.

Again we'll take the same

formula and we'll see why.

So I see we have already seen that

ICV double s for every 10 degrees.

Present temperature so that is

clearly going to shift our this IC.

This is going to change so that

is going to shift accupoint next

VB base to emitter voltage.

That is from the input side of the

circuit base to emitter voltage

which you apply which gives us a

base current that also decreases

by 2.5 millivolts per degree

Celsius per degree Celsius.

It is going to decrease by 2.5.

So what is going to happen

if V is decreasing?

That means IB is also going to decrease.

So if IB decreases.

So this I see again there is going to

be effect on this particular collector.

Current and beta also now,

even if you take two similar transistors,

no value,

both of them are not going to give

us the same amplification factor.

And if this beta changes

over here in the formula,

that mean definitely ICC is going to change.

And whenever if IC is changing

what is going to happen?

So this is that the new point is

going to shift either towards the

saturation or towards the cutoff

and we have seen earlier that we

want our queue point to be at

the center of the load DC load.

OK no.

So stabilization or stability we

call it is a process of making the

transistor independent of this

temperature and transistor parameter

variations. Now stability OK.

So you continuing over here,

so the same part.

So let us see if this Q point this

Q3 is active view point right now

I've marked it with highlighted with red,

so if there is maybe an increase in this ICD,

what is going to happen from this view?

3 This from this operating point.

View 3 your operating point might shift

towards Q2 or maybe even towards Q1.

That is it is going closer and closer

towards the saturation region.

Or if our VB decreases what will happen is

it can maybe go towards Q4 or Q5. So if.

For these three reasons over here and here,

I've shown a small graph,

so we have seen that if the VB is

going to shift towards the left

because it is going to decrease by

2.5 millivolts per degree Celsius,

so you can see it is going to

have an effect on a,

which is nothing but a base current.

So let's see what is stability factor.

By definition,

the rate of change of collector current

with respect to collective leakage current

at constant application vector and

input voltage is called stability factor.

So if we take a look at,

it is nothing but the differentiation.

So South is the capital South we

used to denote severity factor.

So we write it as DIC by ICU.

That is,

is the collector current and this

is nothing but the leakage current

keeping delta and V constant.

Or we can also write it as South

Dash if you differentiate with

respect to collective.

With respect to V and we keep beta

in isolation or there's another

way you can put it double dash.

That is,

we write it as when you differentiate

with respect to beta and we keep

the leakage current and the

input voltage constant.

Now any change in collected early leakage

current changes the collector current.

If you just take a look at the the first

one is the widely used One South with me.

Differentiate with respect to leakage,

correct?

So the stability factor should be as

low as possible so that the collector

current doesn't get affected,

and in fact South equal to 1 is

the ideal value.

So that is what we should aim for.

Now the general expression in

fact for stability factor for C

configuration can be obtained as.

So again we'll take a look at the.

Explanation for common emitter

which you have seen earlier as well,

which is IC is equal to beta IV

plus beta plus one IC U wherein

we have seen IC is the collector

current IB is the base current.

ETA is amplification factor and I see

is nothing but the leakage current.

So what we do is we differentiate both the

villages and Rohs with respect to ICC.

So we see the LHHS when we differentiate

with respect to ICC itself it is

going to be one that is deep DX of X.

If you differentiate X with X itself,

it is going to give us always one.

So in this case D.

Life is going to be the one beta IBD.

This is differentiation.

Abby DIC plus beta versus one.

It's a constant.

You can check it out and we'll become

this differential of this leakage

current divided by I next what we?

OK. OK, this term over here we

have already seen earlier that

dicc by DIC is nothing but South,

South and here what we are doing

is nothing but the opposite of it.

That is, it is 1 by.

So we'll replace this by

1 by South over here.

Next what we do is we take this term beta.

Printed in view of DIT was the

LHS minus continuing over here it

comes minus over here and then.

What we do is we take this beta

plus one also to the LHS and

we remain with this next week.

OK, we take both the sides.

We just flip that is we take the

numerator denominator numerator

numerator and the denominator and so on.

South this South will go on top.

It will go in the numerator and

this term be top plus one also

will come in the numerator.

The top part.

This one minus beta del IB del IC is

going to come in the denominator so

we can always write L is equal to rho.

So we can write take this towards the NHS.

Nothing's happening so this is

the final formula which is of the

stability factor which is given by.

Beta Plus 1 / 1 minus Beta del IP

by Del IC so we can see that the

stability factor depends on the inside.

A beta Ibn isolated nothing but

a Ameriprise vector.

B is current and a collector.

So these are the so fact,

the reference book,

electronic devices and circuit

theory by Robert Goldstein.

Thank you.