Criteria	Criteria 2- Teaching- Learning and Evaluation
Key Indicator	2.3 Teaching- Learning Process
Metric	2.3.1 Student centric methods, such as Interactive Classroom Activities methodologies used for participative learning

INTERACTIVE CLASSROOM ACTIVITIES

SMVITM faculty members engaging interactive classroom activities can significantly enhance student learning experiences and foster essential skills. The activities such as flipped classroom, Minute paper, Mind Map, quiz are used for interactive activities in the classroom. Also students are engaging themselves even outside the class room in case of flipped classroom.

Few of the documents related to these activates are documented as a sample evidences.

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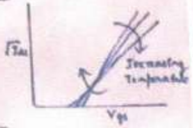
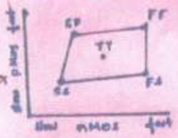
Non-ideal Transistor I-V effects

Temperature dependence
Transistor characteristics are influenced by temperature
- μ decreases with T
- V_t decreases linearly with T
- leakage increase with T
- V_t decreases linearly with T
- ON current decreases with T
- OFF current increases with T



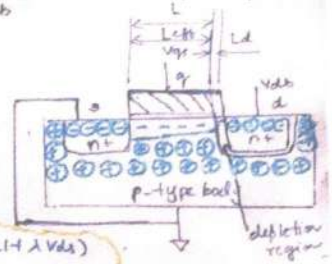
* Geometry Dependence
- $L_{eff} = L_{drawn} + X_L - 2L_D$
- $W_{eff} = W_{drawn} + X_W - 2W_D$
- Layout designers draw transistor with W_{drawn}, L_{drawn}
- Actual dimension may differ from some facts X_W & X_L

* Process Variation
- Transistors have uncertainty in process parameters
- process: L_{eff}, V_t, t_{ox} of nMOS & pMOS
- Variation is around typical (T) values
  - L_{eff}: short
  - V_t: low
  - t_{ox}: thin
- Slow (S): opposite
- Not all parameters are independent of nMOS & pMOS



* Environmental Variation
- V_{DD} and Temperature also vary in time and space
- Fast:
  - V_{DD}: High - T: Low

* Channel length Modulation
- Reverse-biased p-n junctions form a depletion region. Width of depletion L_d region grows with reverse bias V_{ds}
- $L_{eff} = L - L_d$
- Shorter L_{eff} gives more current
- I_{ds} increases with V_{ds}
- $V_{ds} \uparrow$ dep $\uparrow$ — shortening of channel ie $\Delta L = L_d$
- λ – empirical channel length modulation factor
- $I_{ds} = \frac{\mu C_{ox}}{2} \frac{W}{L} (V_{gs} - V_t)^2 (1 + \lambda V_{ds})$

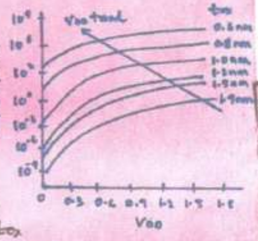


* Source of Leakage
1. Subthreshold Conduction
- In real transistors current doesn't abruptly cut off below threshold, but rather drop off exponentially with V_{gs}
- This leakage current when transistor is nominally OFF depends on: ε_{ox}, t_{ox}, N_{bulk}, W, L, T, V_t

$$I_{ds} = I_{ds0}\, e^{\frac{V_{gs} - V_{t0} + \eta V_{ds} - K_\gamma V_{sb}}{nV_T}} \left(1 - e^{\frac{-V_{ds}}{V_T}}\right)$$

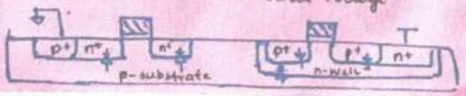
2. Gate Leakage
- There is a finite probability that carriers will tunnel through thin gate oxide
- This result in gate leakage current flowing into gate. I_{gate} is greater for electrons
- This probability drops off exponentially with t_{ox}

$$I_{gate} = WA\left(\frac{V_{DD}}{t_{ox}}\right)^2 e^{-B\frac{t_{ox}}{V_{DD}}}$$



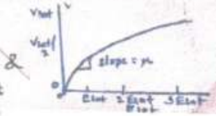
3. Junction Leakage
$$J_D = I_S\left(e^{\frac{V_D}{V_T}} - 1\right)$$

Substrate & well are tied to GND & V_{DD} to ensure these diodes remain reverse biased
- Reverse biased diode still conduct a small amount of current that depends on:
  - Doping levels
  - Area & perimeter of diffusion
  - The diode voltage



* Electric Fields Effects
1. Mobility Degradation
As we increase V_{gs}, there will be more number of Electrons attracted towards the channel. As the channel length is less & more Electrons are getting accumulated in channel, mobility of Electrons gets degraded because of collisions. This effect is termed as mobility degradation

2. Velocity Saturation
- $V = \mu E$
- At higher E, μ is no more constant & it varies and is due to velocity saturation effect
- Before the velocity reaches critical value
- $V = \frac{\mu E_{lat}}{1 + \frac{E_{lat}}{E_{lat}}}$
- When velocity reaches critical & greater its given by $V = V_{sat}$



* Threshold Voltage Effects
Ideal models assume V_t is constant but weakly depends on:

1. Body Effect
- V_t varies as potential b/w source & body varies is called body Effect.

$V_T = V_{T0} + \gamma\left(\sqrt{\phi_s + V_{sb}} - \sqrt{\phi_s}\right)$ — V_{T0} – threshold vtg when s & b are at same potential; ϕ_s – surface potential

$\phi_s = \frac{2KT}{q} \ln \frac{N_{bulk}}{n_i}$; $\gamma = \frac{\sqrt{2q\varepsilon_s N_{bulk}}}{\varepsilon_{ox}/t_{ox}}$

$N_{bulk} \uparrow \Rightarrow V_T \uparrow$

$C_{ox} \uparrow \Rightarrow V_T \downarrow$

- V_{bs} applied, the application of negative V_{bs} $\uparrow$ width of depletion region, voltage required to invert the channel increases

2. Drain Induced Barrier Lowering (DIBL)
- Drain voltage (V_{ds}) $\uparrow$ creates an electric field → affects the threshold voltage.
- As channel length $\downarrow$, DIBL effect shows up & variation caused in threshold voltage $V_t' = V_t - \eta V_{ds}$
- η = DIBL coefficient
- High drain voltage causes current to increase

3. Short channel Effect
- In small transistors the s/d depletion regions extend into a significant portion of the channel.
- Impacts amount of charge required to invert channel
- $V_t \uparrow$ with L

(4MW20EC051) SANJANA RAO

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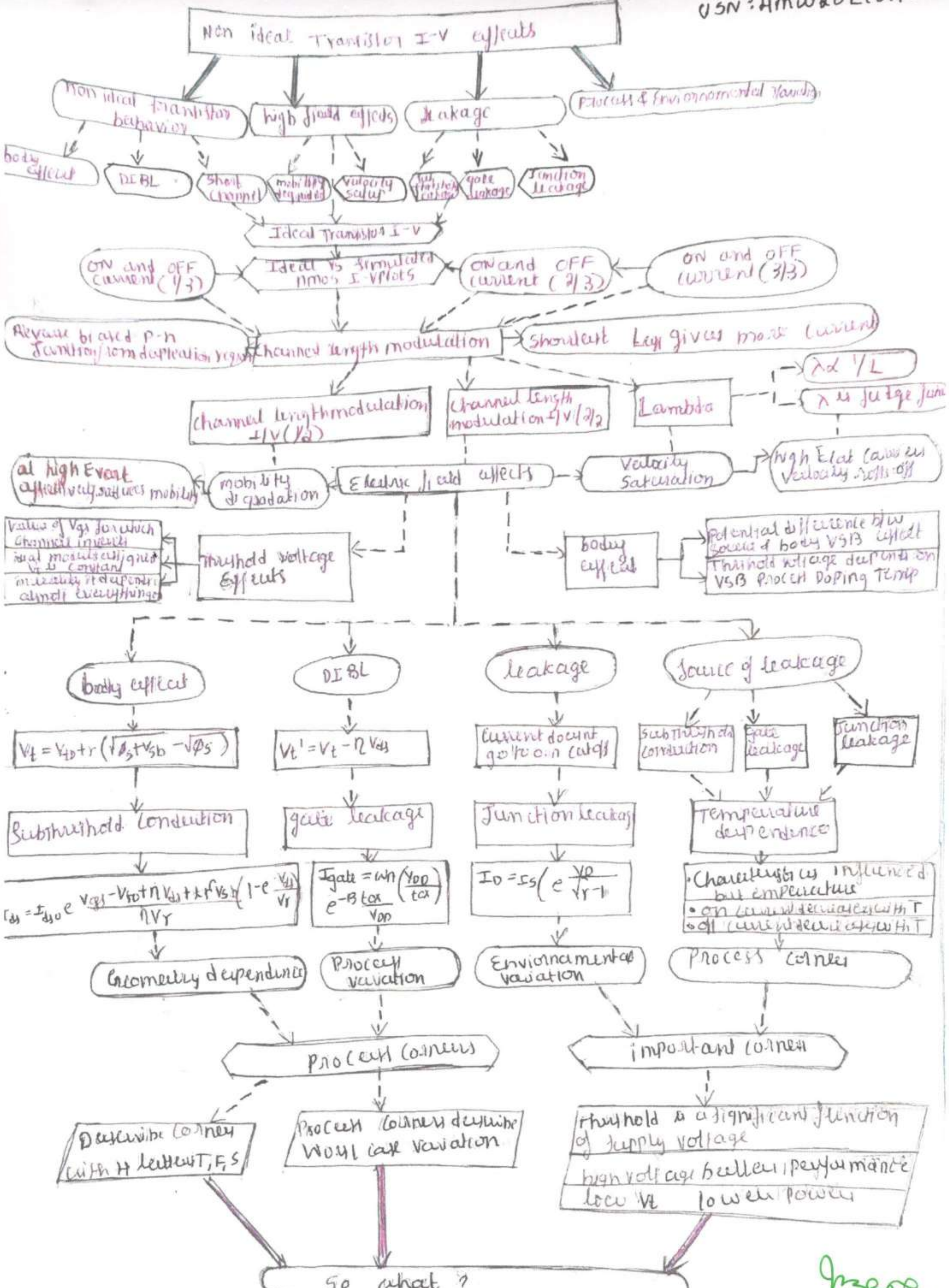
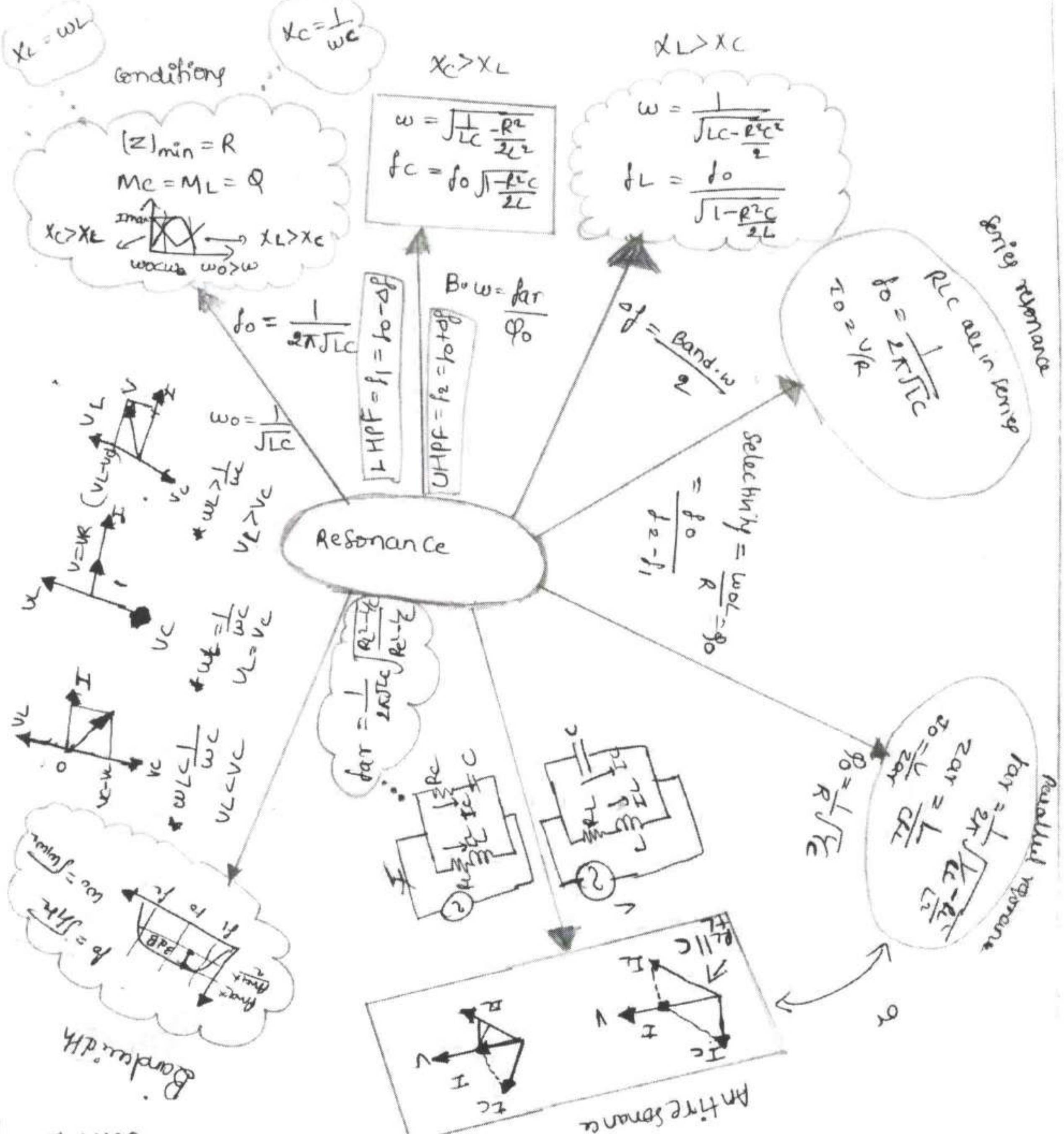
Name: RAKSHA
USN: 4MW20EC046



RESONANCE :-

ANUSHA (4MW20EC012)
MANASA (4MW20EC029)
MEDINI (4MW20EC031)
SOWJANYA (4MW20EC033)



* LHPF ⇒ Lower half frequency

* UHPF ⇒ Upper half frequency

Network Theory

Team members

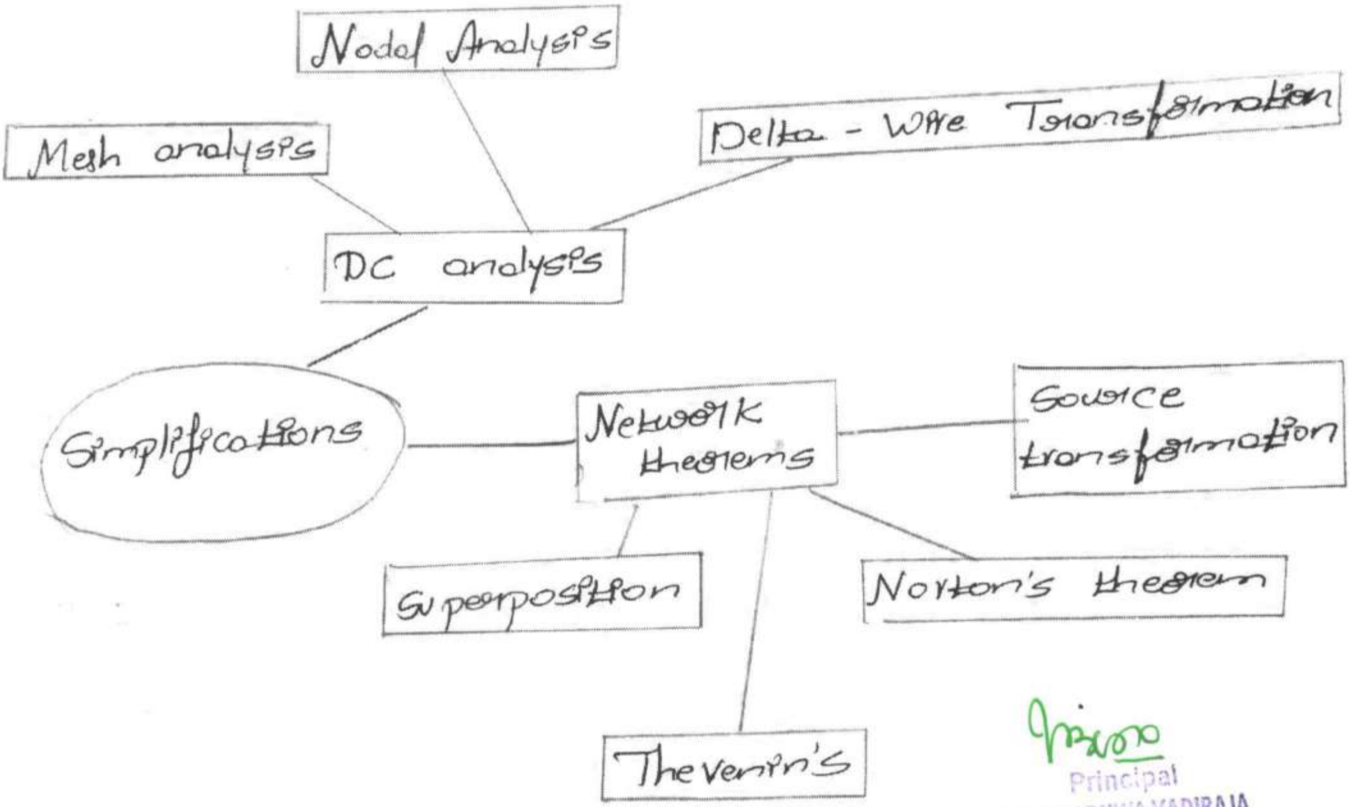
1] Nikhitha shetty

2] Manasa

3] Harshatha

4] Ankitha Shet

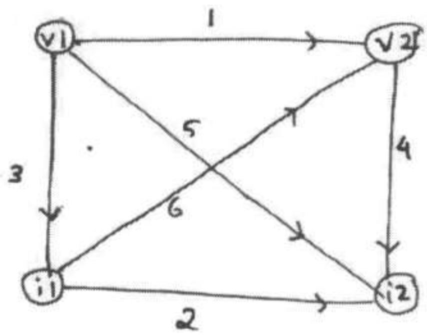
Mind Map



Mind map for

Network parameters

team
Nagaraj
Auston
Adarsh
Abhishek



where

1 → Z - Parameter
2 → Y - Parameter
3 → ABCD Parameter
5 → h - parameter
4 → A'B'C'D' Parameter
6 → g - Parameter

Z - Parameter

V1 = Z11*I1 + Z12*I2
V2 = Z21*I1 + Z22*I2

Y - Parameter

I1 = Y11*V1 + Y12*V2
I2 = Y21*V1 + Y22*V2

ABCD Parameter

V1 = A*V2 + B*I2
I1 = C*V2 + D*I2

A'B'C'D' Parameter

V2 = A'*V1 − B'I1
I2 = C'*V1 − B'*I2

h - Parameter

V1 = h11*I1 + h12*V2
I2 = h21*I1 + h22*V2

g - Parameter

I1 = g11*V1 + g12*I2
V2 = g21*V1 + g22*I2

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SHRAVYA S M
4MW20EC055.

MINUTE PAPER

Please answer these questions using sentences

What are you hoping to learn today?

I hope to learn more about memory cell.

What did you learn today?

I learnt about Betn. rowseled and types of memory cell. Dynamic cell and its structure.

What do you need to learn more about?

I need to learn more about its structure and where it is used.

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Soumya . C. Shett
4MW20EC050

MINUTE PAPER

Please answer these questions using sentences

What are you hoping to learn today?

We learnt about Two types of memory cell i.e Static RAM (SRAM) and Dynamic RAM (DRAM) with 1, 4, 6 Transistors.

What did you learn today?

· Learnt about CMOS Pseudo Static RAM cell, using Transmission Gate, NMOS Pseudo static RAM cell and their Stick diagram.

What do you need to learn more about?

We would like to learn more about the ~~(4T)~~ memory cell and its real time usage.

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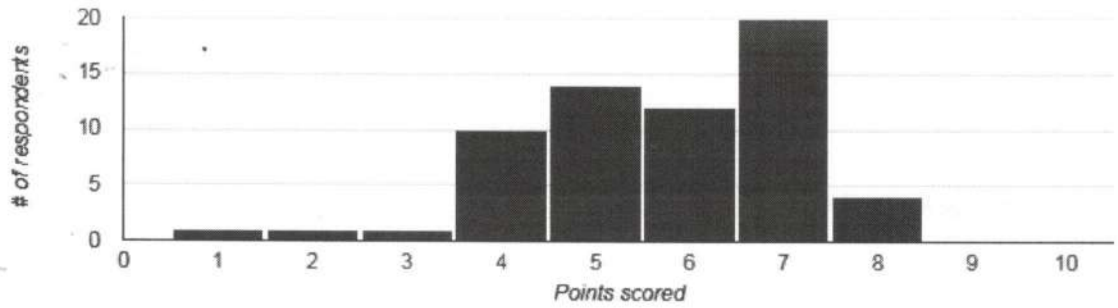
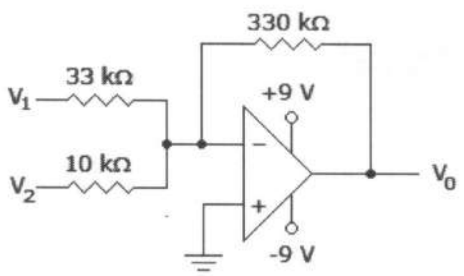
AC Quiz-1 Analysis
21-07-2022

Average	Median	Range
5.71 / 10 points	6 / 10 points	1 - 8 points

Total points distribution

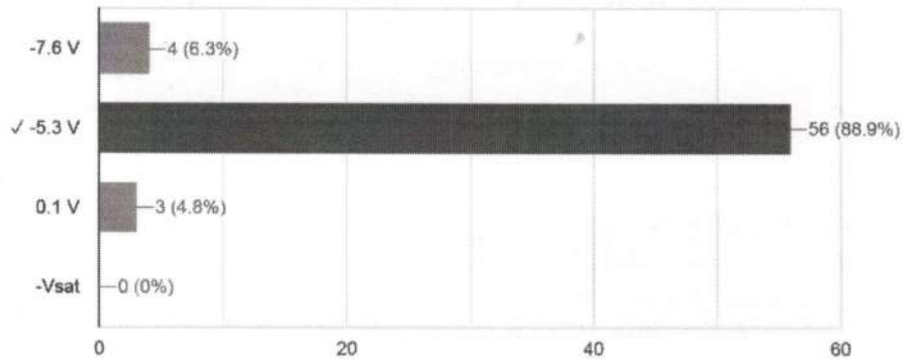


Q1



Calculate the output voltage if V1 = 0.2 V and V2 = 0.1 V

56 / 63 correct responses



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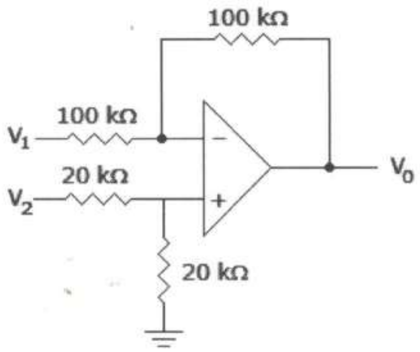
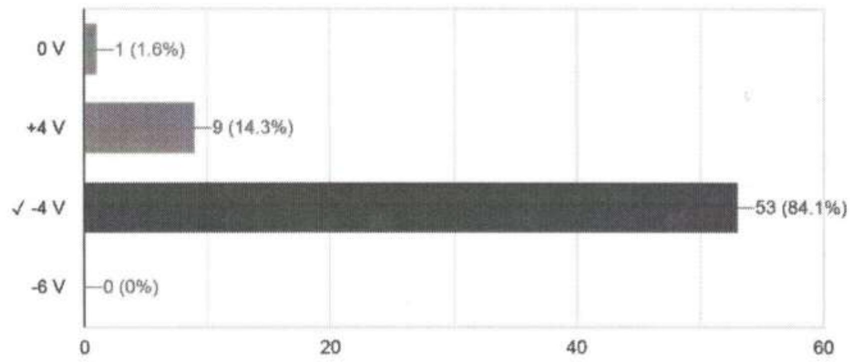
Q2



Calculate the output voltage if V1 = 2 V and V2 = -2 V

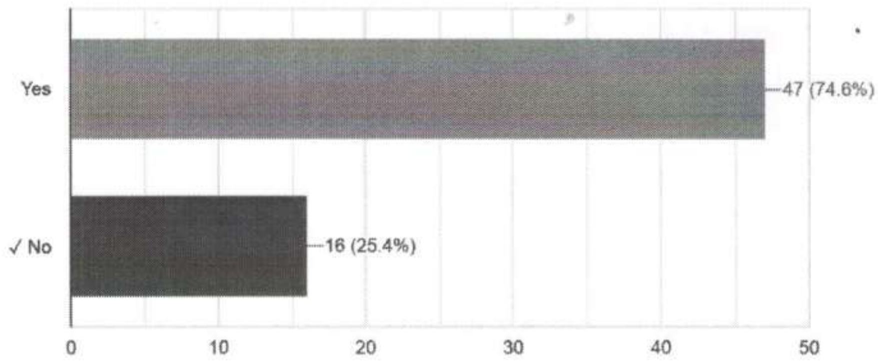
53 / 63 correct responses



Q3

Using a single op-amp in inverting configuration, can we get a voltage gain of +0.5 ?

16 / 63 correct responses



Note: In an inverting amplifier, gain is negative

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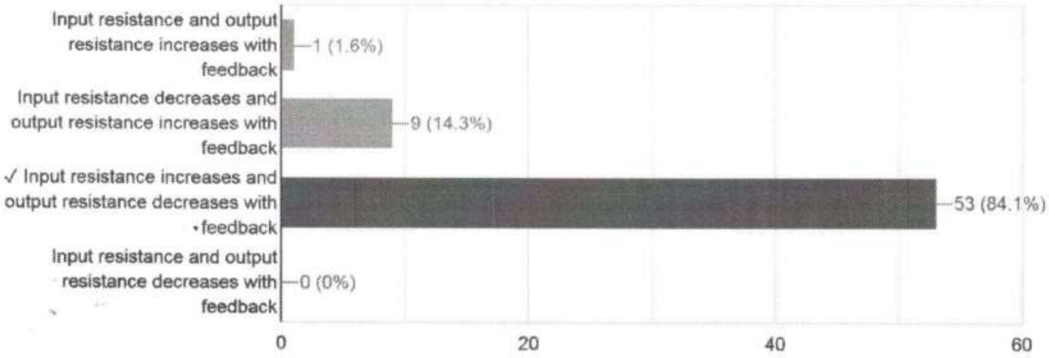
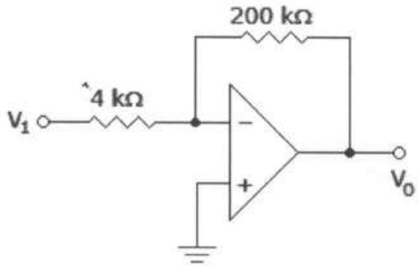
Q4

Which of the following statements is true with reference to op-amp non-inv amplifier?

53 / 63 correct responses

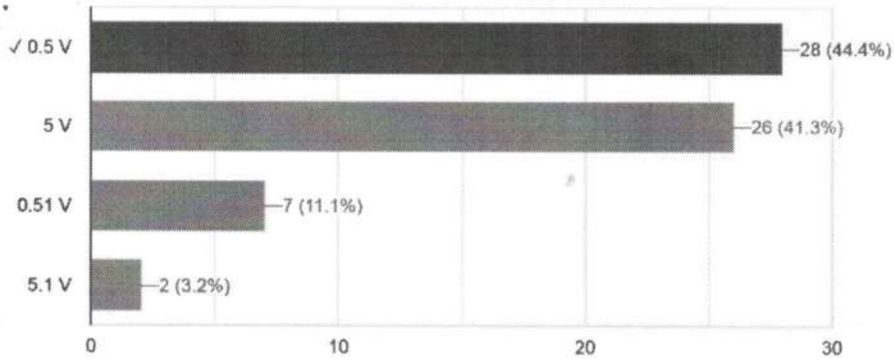


Q5



What is the amplitude of the output voltage if the input is a sinusoidal with 10 mV amplitude?

28 / 63 correct responses



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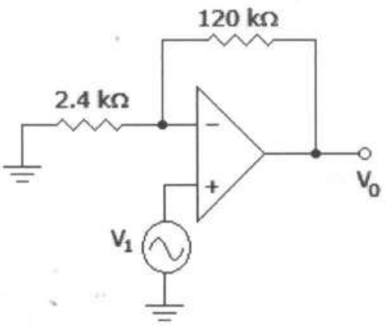
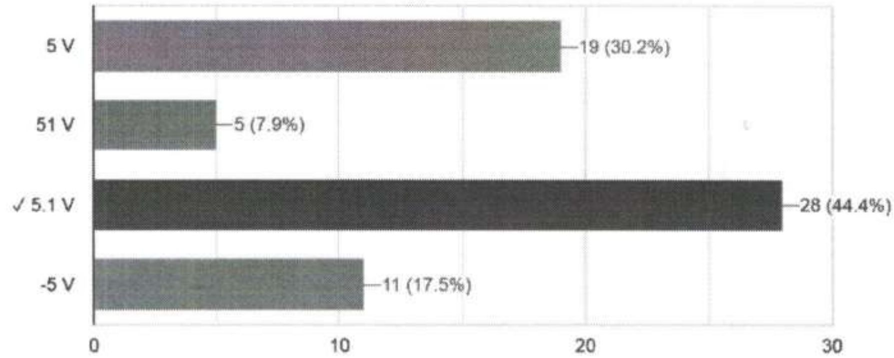
Q6.

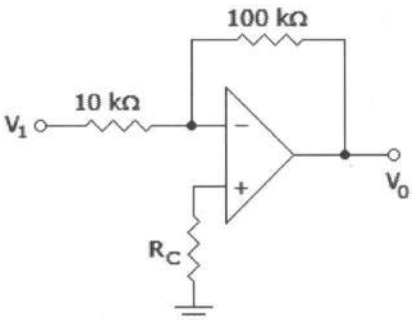


What is the amplitude of the output if the input is a sinusoidal with 100 mV amplitude?

28 / 63 correct responses

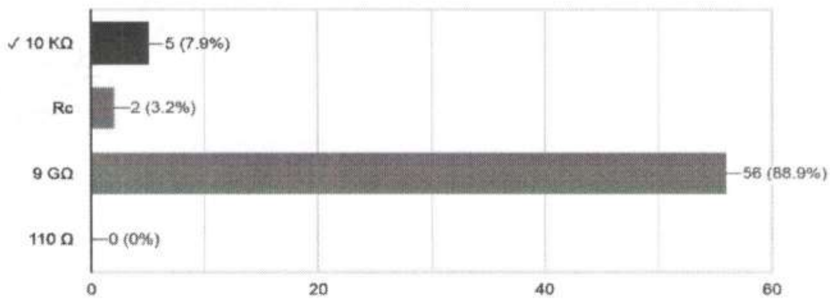


Q7.



What is the input resistance of the amplifier if Ri = 1 MΩ and A = 100,000.

5 / 63 correct responses



Note: For inverting amplifier, Rif = R1

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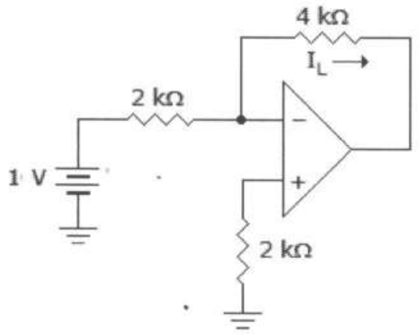
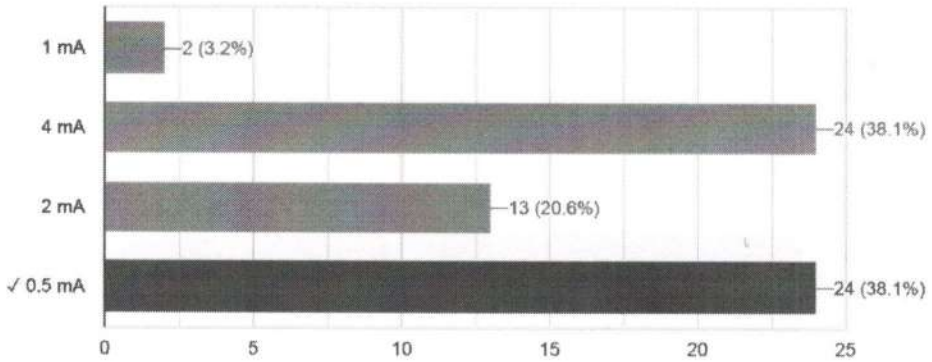
Q8.

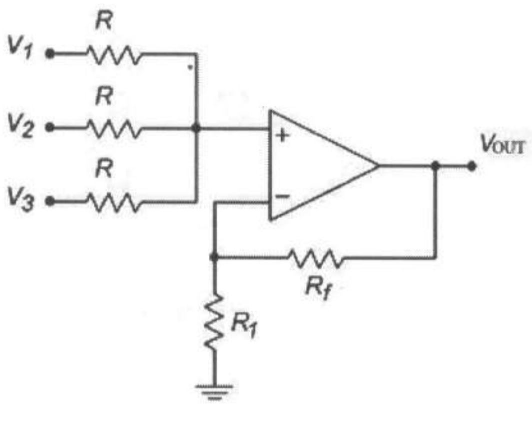


What is the value of the current IL ?

24 / 63 correct responses

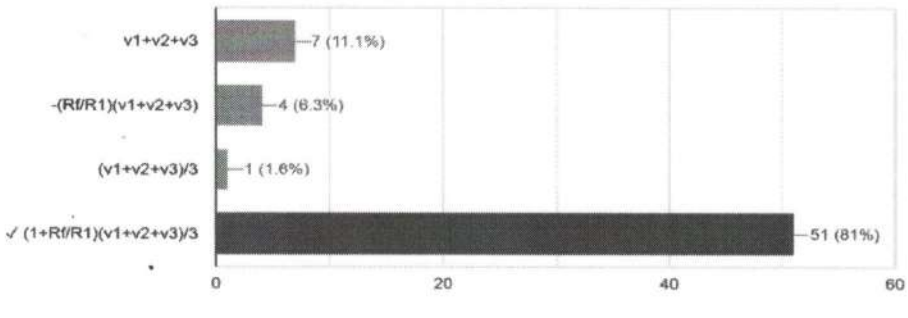


Q9.



Output voltage is

51 / 63 correct responses



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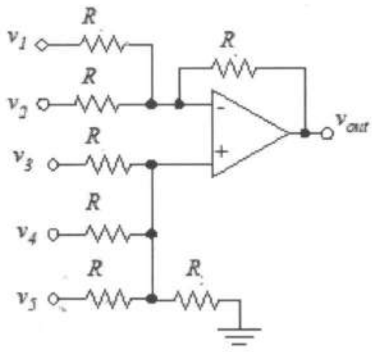
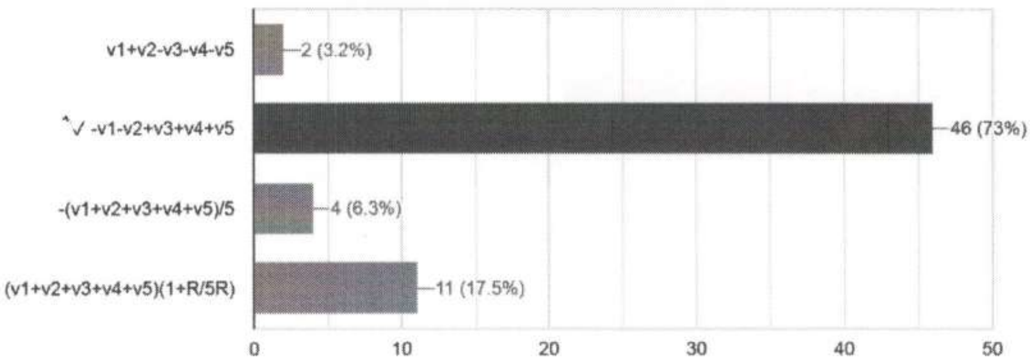
Q10.



Output voltage is

46 / 63 correct responses



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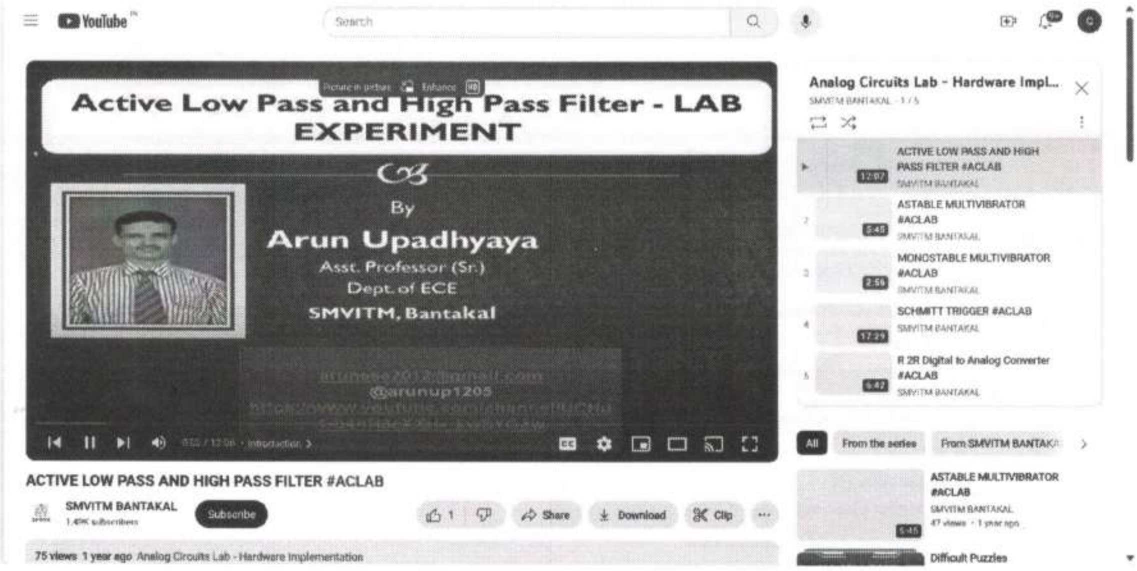

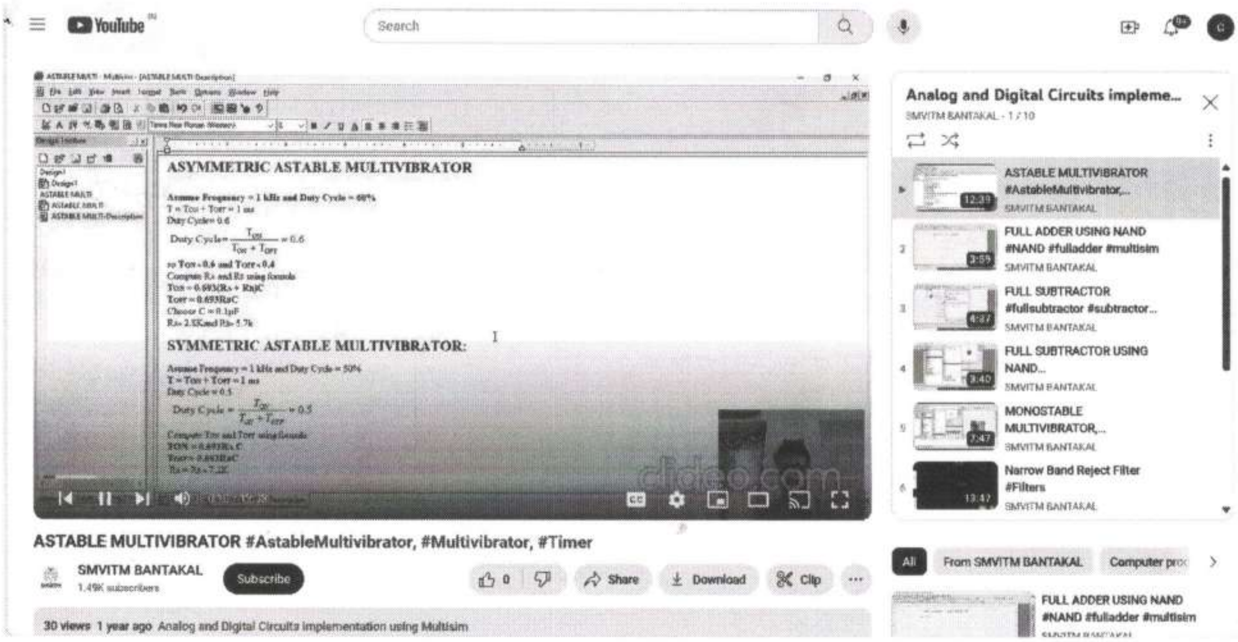

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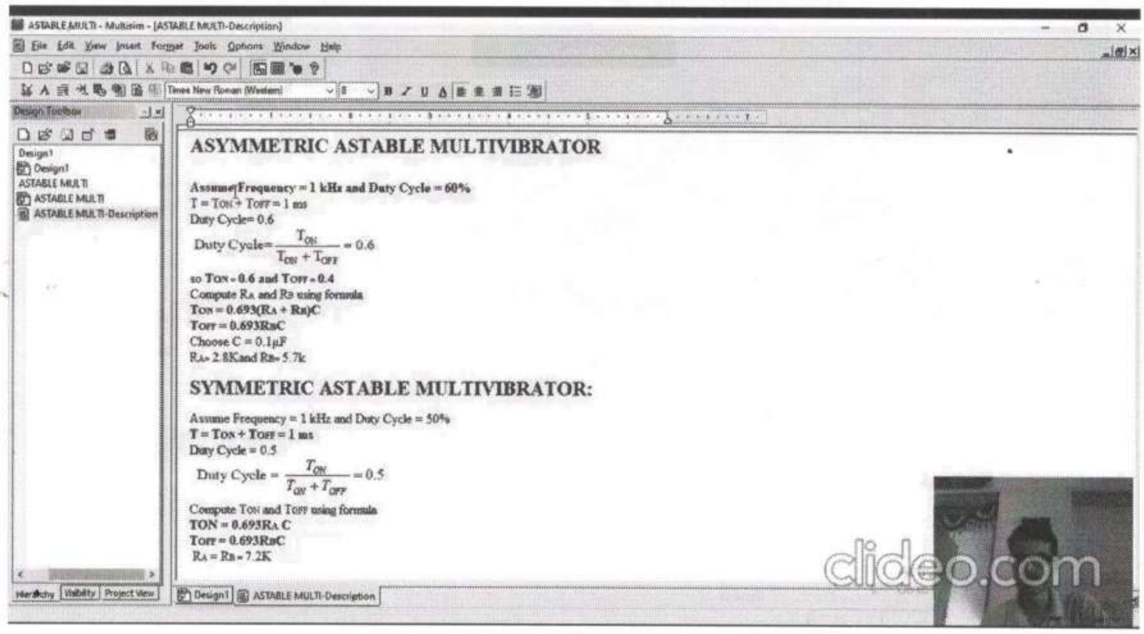

ASYMMETRIC ASTABLE MULTIVIBRATOR

Assume Frequency = 1 kHz and Duty Cycle = 60%
$T = T_{ON} + T_{OFF} = 1$ ms
Duty Cycle= 0.6

$$\text{Duty Cycle} = \frac{T_{ON}}{T_{ON} + T_{OFF}} = 0.6$$

so $T_{ON} = 0.6$ and $T_{OFF} = 0.4$
Compute R_A and R_B using formula
$T_{ON} = 0.693(R_A + R_B)C$
$T_{OFF} = 0.693R_BC$
Choose $C = 0.1\mu F$
$R_A = 2.8K$ and $R_B = 5.7k$

SYMMETRIC ASTABLE MULTIVIBRATOR:

Assume Frequency = 1 kHz and Duty Cycle = 50%
$T = T_{ON} + T_{OFF} = 1$ ms
Duty Cycle = 0.5

$$\text{Duty Cycle} = \frac{T_{ON}}{T_{ON} + T_{OFF}} = 0.5$$

Compute T_{ON} and T_{OFF} using formula
$TON = 0.693R_A C$
$T_{OFF} = 0.693R_BC$
$R_A = R_B = 7.2K$

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Announce something to your class

Arun Upadhyaya ECE
Jul 4

Watch the video on the topic of Minimum Shift Keying for the next class
https://youtu.be/2HVVPiKFOk8
https://youtu.be/EZPqLdt--Uk
https://youtu.be/ODo5wOB1slM

Add class comment...

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Shrinidhi Devadiga
4MW20EC058

VLSI ASSIGNMENT

SUMMARY ON NON IDEAL TRANSISTOR.

The Shokely Transistor model derived a current-voltage expression for an ideal transistor. Some of the non ideal characterstics are 1) Velocity Saturation: Electron velocity is related to electric field through mobility by the equation $v = \mu E$, where $\bar{E}$ is the lateral electric field between drain & Source. At higher E. μ is no more constant and it varies and is due to velocity saturation effect. As channel length becomes Shorter, lateral electric field increases drain current and transistor becomes more velocity Saturated and this increase and this decreases drain current. Ids
2) Mobility digradation:- Velocity of charge carriers depend on electric field and when the carriers travel along the length of the channel, they get attracted to the Surface by the vertical electric field. Therefore they bounce against the Surface during their travel. This reduces Surface mobility decreases in comparision with the mobility along the channel As mobility decreases current also decreases.
3) Channel length modulation:- Ideally drain current Ids is dependent on Vds in the Saturation region making Transistor a perfect current Source. when Vds is increased further near the drain barriers is built due to depletion region & reduces the length of the channel. This result in reducing the length of the channel by ld. Thus in Saturation saturation the effective channel length is
$Ids = \beta/2 (Vgs - Vt)^2 (1 + Vds)$.
4) Body effect:- MOSFET have 4th implicit terminal called body/ Substrate along with gate, Source & drain - the

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Threshold voltage V_t which is assumed to remain constant is no more a constant value & varies as potential b/w source and body is varied. Body effect parameter γ depends on doping level concentration. thus by varying γ threshold voltage can be varied.

v) Sub Threshold conduction:- The ideal IV model ensures current flow from source to drain only when $V_{gs} > V_t$. But in practical transistor. current does not abruptly cut off below threshold but rather drops exponentially $V_{gs} < V_t$ is called weak inversion/ Subthreshold Subthreshold conduction is useful for designing low power analog circuits & dynamic circuits

vi) Drain Induced Barrier Lowering (DIBL)

As the drain voltage V_{ds} is increased it creates an electric field that effects the threshold voltage is especially pronounced as in short channel transisto

vii) Junction Leakage:- The mos structure is considered there exists pn junction b/w diffusion and the substrate. With cmos structures pn junction b/w diffusion and the substrate or well forming diodes. Leakage current usually lie in the range 0.1-0.01 $fA/\mu m^2$. which is negligibly when compared to other leakage currents

viii) Temperature Dependence:- With increase in temperature drain current decreases with temperature when Transistor is ON. & when Transistor is off, the junction leakage & subthreshold conduction contributes to leakage current and this increase.

ix) Geometry dependence:- The Layout designer would draws transistor with width & length W_{drawn} & L_{drawn} while mask preparation the actual length gate dimensions may differs by x_ω and x_L. If the variations in the length & width of the transistor there will be variations in the performance.

Shravya S M
4MW20EC055

Summary on Non - ideal Transistor I-V effects

The shockely transistor model derived a current - voltage expression for an ideal transistor some of the non ideal characteristics are 1) mobility degradation: V = μ E where v is the carrier drift velocity and μ is mobility. The mobility term is independent of the vertical electric field E. The causes of mobility degradation is, when stronger vertical electric fields can attact charge carriers travellings along the inversion layer & cause it to collide with the oxide interface. 2) Velocity saturation: under strong lateral electric fields. the charge carriers are accelerated & the collisions between the charge carriers and silicon lattice increases. Beyond certain level of electric field, the carrier drift velocity saturates at Vsat This is called velocity saturation 3) Body effect: If the body is not connected to the source and it is connected to a different potential, then this causes the threshold voltage to vary. 4) Drain Indused barrier cowering (DIBL): The drain and the body from a PN junction, if the voltage on the drain is positive & the voltage on the body is negativen, then this PN junction is reverse biased with increase in Vds, reverse bias keeps increasing there by depletion region increases in size & start infringing on the chanel. 5) Junction leakage: It refers to the undesired flow of current through the junctions of a semiconductor device, such as a diode or a transistor. 6) short channel effects: It ocurs in electronic devices due to the reduced channel length in transistors. 7) Sub-threshold Conduction: Also Know as sub threshold leakage It refers to the flow of current in a transistor, when it is operating below the threshold voltage, the transistor is not fully turned on, but there is still a small amount of leakage current passing through channel. 8) channel ~~length~~ length modulation: As Vds increases, the depletion region increases and the channel length becomes shorter. The current is inversely proportional to the ~~length~~ length of the channel. 9) Gate leakage: The gate and the channel from a capacitor. Ideally no current should pass through the capacitor. It can be reduced by substituting the silicon dioxide with higher dielectric constant material

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SUMMARY

laplace transform is a particular integral transform. This can be used for solving linear differential equations. laplace transform can convert many common functions such as sinusoidal functions, damped sinusoidal functions, and exponential fuctions into algebraic functions of complex variable s.

Operations such as differenciation and integration can be replaced by algebric operations in the complex plane. Thus, a linear differential equation can be transformed into an algebric equation in complex variable s.

Applications of laplace transform is to solve differential equations (both ordinary and partial), applications to RLC circuit analysis. Laplace transform converts differencial equations in the time domain to algebric equations in the frequency domain. 1) transformation of the time to frequency domain, 2) manipulate the algebric equations of the form a solution, 3) inverse transformation from frequency to time domain.

laplace transform formula is given by,

$$F(s) = \int_0^{\infty} f(t)e^{-st}\,dt$$

$F(s)$ ⟶ laplace transform

s ⟶ complex number

t ⟶ real number >= 0

dt ⟶ first derivative of the function $f(t)$

Summary

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Laplace transform is the integral transform of the given derivative function with real Variable to convert into a complex function with variable s. It is useful in reducing the solution of a ordinary linear differential equation with constant coefficients to the solution of a polynomial equation. In laplace transform, we calculate or analyse the circuit based open their frequency and time properties.

We have many number of properties in laplace transform they are linear property, Shifting property and so on. We are having inverse laplace transform also the laplace transform of sin at is $\frac{a}{s^2+a^2}$. The laplace transform of cosat is $\frac{s}{s^2+a^2}$.

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Summary of Laplace Transform :-

The Laplace transform allows equations in the "time domain" to be transformed into an equivalent equation in the Complex S Domain.

$\mathcal{L}\{f(t)\} = F(s)$. , where the letter 's' has no special significance, and is used with the Laplace Transform as a matter of common convention.

Laplace transform is the integral transform of the given derivative variable function with real variable t to convert into a complex function with variable s.

$$\mathcal{L}\{f(t)\} = \int_0^\infty f(t)e^{-st}dt.$$

The properties of Laplace transform are :-

* Linearity : The transform of a finite sum of time functions is the sum of Laplace transforms of the individual functions

$$\mathcal{L}\{f_1(t) + f_2(t) + f_3(t) + \cdots + f_n(t)\} = F_1(s) + F_2(s) + F_3(s) + \cdots + F_n(s)$$

* Scaling theorem: (Multiplication by K).

If K is a constant, then

$$\mathcal{L}\{K f(t)\} = K * \mathcal{L}\{f(t)\} = K * F(s).$$

* Real differentiation :

$$\mathcal{L}\left\{\frac{df(t)}{dt}\right\} = sF(s) - f(0^-)$$ where $f(0^-)$ is the value of $f(t)$ when $t=0^-$.

* **Real Integration property:**

$$\mathcal{L}\left\{\int_0^t f(t)\,dt\right\} = \frac{F(s)}{s}.$$

* **Differentiation by 's' (Multiplication by 't') property.**

$$\mathcal{L}\{t f(t)\} = -\frac{dF(s)}{ds}.$$

* **Complex Translation property.**

$\mathcal{L}\{e^{at} f(t)\} = F(s-a)$ where 'a' is a complex number &

$\mathcal{L}\{e^{-at} f(t)\} = F(s+a)$.

* **Real Translation (Shifting) theorem:**

$$\mathcal{L}\{f(t-T)\} = e^{-Ts} F(s).$$

* **Initial Value theorem:**

$$f(0^+) = \lim_{t \to 0^+} f(t) = \lim_{s \to \infty} sF(s)$$

* **Final Value theorem:**

$$\lim_{t \to \infty} f(t) = \lim_{s \to 0} sF(s).$$

* **Convolution theorem:**

$$f_1(t) * f_2(t) = \int_0^t f_1(\tau) f_2(t-\tau)\,d\tau = \int_0^t f_2(\tau) f_1(t-\tau)\,d\tau$$

↑ convolution — where τ is the dummy variable.

$$\therefore \mathcal{L}\{f_1(t) * f_2(t)\} = F_1(s) \cdot F_2(s).$$

There are four basic Standard Time functions :-

* Step ⇒ $\mathcal{L}\{u(t)\} = 1/s$
* Ramp ⇒ $\mathcal{L}\{r(t)\} = 1/s^2$
* Parabolic
* Impulse ⇒ $\mathcal{L}\{\delta(t)\} = 1$

* Step function is a function which has a value of A for $t \geq 0$ and 0 for $t<0$.
* Ramp function is one which has slope 'A' where 'A' is called Magnitude or amplitude of ramp function.
* Impulse function is one which exists only at $t=0$ and is zero elsewhere. ⇒ It is also called Delta function { $\delta(t)$ }.

Then,

$$r(t) \xrightarrow{\text{Differentiate}} u(t) \xrightarrow{\text{Differentiate}} \delta(t)$$

ramp function → unit step function → Impulse function

$$\delta(t) \xrightarrow{\text{Integrate}} u(t) \xrightarrow{\text{Integrate}} r(t)$$

Laplace transform of periodic function,

$$F(s) = \frac{1}{1-e^{-sT}} F_1(s).$$

Inverse Laplace Transform:-

If $L\{f(t)\} = F(s)$, then,

$$L^{-1}\{F(s)\} = f(t).$$

Two cases:

i) If Degree of $N(s)$ < degree of $D(s)$, then apply partial fraction method directly.

$$F(s) = \frac{N(s)}{D(s)}$$

ii) If degree of $N(s) \geq$ degree of $D(s)$, then, divide $N(s)$ by $D(s)$, then apply partial fraction method to second term.

$$F(s) = Q + F_1(s) = Q + \frac{N'(s)}{D'(s)}.$$

Application of Laplace transform:

Laplace transform can be used to transform the time domain circuits into s domain circuits to simplify the solution of integral differential equations to the manipulation of a set of algebraic equations.

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