THE MODERN ART OF ELECTRONICS

INNOVATIVE INTEGRATED CIRCUITS

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COLLEGE OF ENGINEERING
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Accredited by NAAC with 'A' Grade | NBA (ECE, EEE, CSE, MECH & IT)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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About Karpagam College of Engineering

The Karpagam College of Engineering, established in the Year 2000, is an Autonomous institution, Approved by AICTE, NewDelhi and Affiliated to Anna University, Chennai. The college offers various Under Graduate and Post Graduate Engineering programmes. The College is accredited by NAAC with 'A' Grade, TCS and Wipro with 4500 students and 426 teaching and non-teaching staff members, Karpagam College of Engineering strives to impart quality education and an excellent career start to all its students.

The Placement and Training facilities add a feather to its cap ensuring the students get placed on campus. The 10 Centers of Excellence strive to impart practical and experimental exposure to the students and serve as a window to the corporate world.

The College is situated at Myleripalayam, 15kms from Coimbatore Central Railway station. The serene location surrounded by green fields and rich clusters of coconut groves creates a calm atmosphere conducive to learning and growth. Infrastructure with well-equipped laboratories and libraries, well maintained Play grounds, Hostels, Food Court, Gymnasium and an Indoor Stadium.

Vision

To become one of the best institutions at the National and International level by incorporating innovative teaching -learning methods to enable the students to secure a high-value career, motivate to pursue higher education and research to serve the society.

Mission

To bring out knowledgeable engineers and professionals in their field of specialization by having qualified and trained faculty members and staff besides necessary infrastructure and to create highly conducive teaching and learning environment .

To work in close association with stakeholders by way of enhanced industry – institute interaction, to take up need based research and industry specific programmes.

To organize co-curricular and extracurricular activities for character and personality development to produce highly competent and motivated engineers and professionals to serve and lead the society.

About the Department of Electronics and Communication Engineering

The embryonic formation of the Department of Electronics and Communication Engineering was in the year 2000 with the introduction of an undergraduate course. The Department has been accredited by the National Board of Accreditation (NBA) and affiliated to Anna University, Chennai. The Department over the time has grown in several dimensions and provides a magnetic ambience in teaching and learning. Apart from four years B.E course, the Department also offers two full time M.E courses (VLSI Design and Communication Systems) and Anna University approved Ph.D Research Centre to expand the scope of research focus of the department

Students pursuing B.E in ECE have a full and flexible undergraduate curriculum. Numerous streams can be tailored to fit every individual's interests, skills and career goals. ECE has gained a reputation for producing top-notch engineers for industry and academia.

Postgraduate study in ECE prepares students for leadership roles in research, development and design positions that require skill and imaginative engineering solutions.

The major areas of faculty expertise of the department include Biomedical Signal Processing, Communication Systems, Computer networks, Control Systems, Digital Signal Processing, Image Processing, Instrumentation, RF and Microwaves, Microstrip Antennas, Optoelectronic and Optical Communication, VLSI Design, Wireless Communication, Embedded Systems and MEMS.

The Department has Centers of Excellence in the field of VLSI Design, Embedded Systems, Communication and Networks and Signal Processing. The Department has signed MoUs with leading industries and organizations for establishing collaborative research, conducting Workshops, Seminars and for organizing International Conferences. Professional associations such as ECE association and IEEE student chapter are developed for professional interaction.

<u>Vision</u>

To provide innovative teaching and learning methodologies for excelling in a high-value career, higher education and research to the students in the field of Electronics and Communication Engineering to meet the needs of the industry and to be a part of the advancing technological revolution.

<u>Mission</u>

To create engineers of high quality on par with international standards by providing excellent infrastructure and well qualified faculty.

To enhance the collaborative and multidisciplinary activities to develop human and intellectual qualities.

To provide technical expertise to carry out research and development.

Adiabatic logic for Memristor based Non-volatile memory

Introduction:

Chua (1971), a professor at the School of California, Berkley, proposed the existence of a novel, fourth fundamental circuit element named memristor and he established that this new gadget might now not be described as a mixture of the other basic electrical components. The term ADIABATIC comes from the Greek expression that is used to define a thermodynamic process that consumes no energy from the atmosphere and hence, there is no energy loss in the form of dissipated heat (Takahashi et al. 2014). In principle, a computing device need not dissipate any energy; the transfer of energy over a dissipative medium dispersed randomly small amounts of energy if that transfer is made sufficiently slowly.

Normal switching and Adiabatic switching:

The normal switching method can be understood by using a simple CMOS inverter (Takahashi et al. 2014). The CMOS inverter circuit consists of pull-up and pull-down configurations(MOS transistor) connected with a load capacitance C. Each transistor can also be modeled through an ideal switch in series with a resistor which is equivalent to the channel resistance of the transistor in the saturation mode.. When the logic level of the structure is "1", there is a sudden current flow through R, where R is the corresponding resistance of PMOS pull-up network. A charge $Q = CV_{dd}$ is distributed to the load and the energy which the supply is $E_s = QV_{dd} = CV_{dd}^2$ where V_{dd} is DC power supply voltage. The energy kept in the load C is half of the supplied energy: $E_{stored} = \frac{1}{2}CV_{dd}^2$.

The same amount of energy is dissipated for the period of discharge in the NMOS pull-down configuration since no energy can enter the ground rail $Q \times V_{gnd} = Q \times 0 = 0$. From the energy conservation law, a normal CMOS logic radiates heat and in this way, it trashes energy in every charge-discharge cycle. The total energy is given by the equation (1.1).

$$\begin{aligned} E_{total} &= E_{charge} + E_{discharge} \\ &= \frac{1}{2}CV_{dd}^2 + \frac{1}{2}CV_{dd}^2 \\ &= CV_{dd}^2 \qquad (1.1) \end{aligned}$$

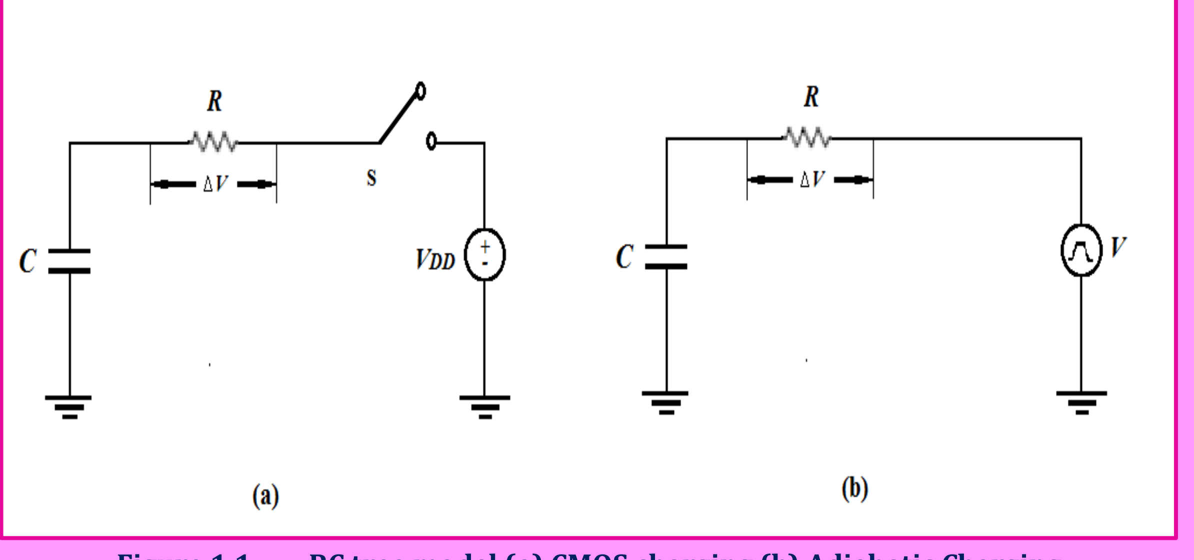


Figure 1.1 RC tree model (a) CMOS charging (b) Adiabatic Charging

If the logic is driven by a frequency f $(=\frac{1}{T})$, where T is the period of the signal, then the power of the CMOS gate is determined by the equation (1.2).

$$P_{total} = \frac{E_{total}}{T} CV_{dd}{}^{2} f \qquad (1.2)$$

Adiabatic switching is normally used to reduce energy loss during charging/discharging. During adiabatic switching, all the nodes are charged or discharged at a constant current to reduce power dissipation. The adiabatic switching can be best explained by contrasting it with the conventional dissipative switching technique. The main idea of the adiabatic switc transitions are considered to be sufficiently slow, therefore the heat is not radiated significantly.

If a constant current source transports the $Q = CV_{dd}$ charge during the period ΔT, the energy dissipation in the channel resistance R is given by the equation (1.3).

$$E_{diss} = \xi P \Delta T$$

$$E_{diss} = \xi \bar{I}^{2} R \Delta T$$

$$E_{diss} = \xi \left(\frac{CV_{dd}}{\Delta T}\right)^{2} R \Delta T \qquad (1.3)$$

where E_{diss} is the energy dissipation, the current $\bar{I}$ is measured as the average of the current flowing to C and ξ is a shape factor which depends on the shape of the clock edges. It takes on the least value $\xi_{min} = 1$ if the charge of the load capacitor is DC modulated. The above equation indicates that when the charging period ΔT is forever long, in theory, the energy dissipation is condensed to zero. This is called adiabatic switching.

Dr. V. SAMINATHAN
Associate Professor, ECE

An Adjustable Window Function for modelling Future Generation Memristor Device

In circuit theory there are three basic two-terminal devices such as resistor, capacitor, and inductor. The fourth fundamental missing circuit device called as memristor which is categorized by L. Chua in 1971. The memristor has a memristance M and the functional relation between flux φ and charge q is given by dφ = Mdq. The memristance M depends on charge q which is the time integral of the current through the memristor. Hewlett Packard lab stated that the memristor was invented physically using two terminal titanium-di-oxide (TiO2) in 2008. HP lab clarified the first physical demonstration of a memristor, ensuing Chua's theory and flashing in the electronic industry.

Sigmoidal Function:

Sigmoidal functions is used to model growth processes in which a particular quantity of the system progressively increases from an initial value to final value and also useful in circumstances where the results are partially or completely unknown. Modeling the memristor is very important to design memristor based circuits and explores their performance.

The total memresistance is an addition doped and undoped resistance and it is given by the equation (1),

$$\mathrm{R_{mem}(z) = R_{ON}(z) + R_{OFF}(1 - z)}, \qquad (1)$$

The doped region width is given by z =W/D and D is a total length. The resistance $\mathrm{R_{OFF}}$ and $\mathrm{R_{ON}}$ is the logic one and logic zero of the memory resistor.

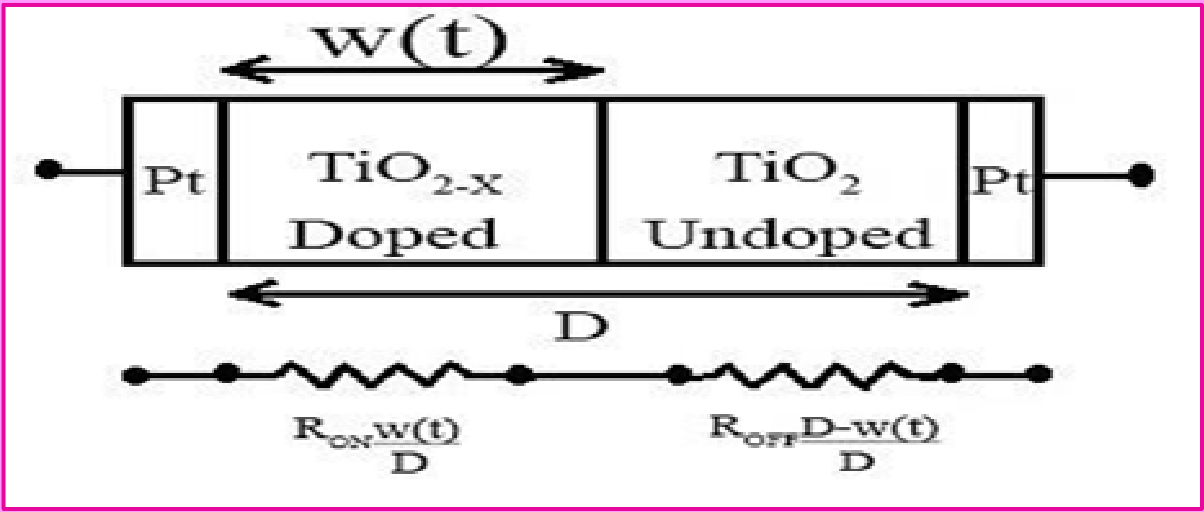


Figure.1.Memristor model

Modeling Nonlinearity Of HP Memristor Model By controllable Window Function:

The logistic equation of sigmoidal function varies from lower asymptote, traces a maximum point of inflexion and then downwards zero at an upper asymptote. The Richards equation has an extra parameter that permits the curve between any value of smallest and heist asymptote. Consider the modified sigmoidal equation which is having the above feature is given by in equation (2),

$$S(y) = 1 + \exp(-k_1 k_2 y)^{-\frac{1}{k_2}} \qquad (2)$$

Where $k_1, k_2 > 0$ determine the growth rate and the horizontal shift respectively. According to [6] to the first step is to determine the inverse $y = S^{-1}(z)$,

$$S^{-1}(z) = \frac{1}{k_1 k_2}\left[\ln\left(z^{k_2}\right) - \ln\left(1 - z^{k_2}\right)\right] \qquad (3)$$

Next to obtain $\bar{f}(z) = 1/f(z)$,

$$\bar{f}(z) = \frac{d}{dz}\left[S^{-1}(z)\right] \qquad (4)$$

Then, calculating the reciprocal of $\bar{f}(z)$ to obtain the window $f(z)$.

$$f(z) = k_1[z\,(1 - z^{k_2})]$$

(5)

The distinct curves are obtained by adding a control parameter p

$$f(z) = k_1[z\,(1 - z^{k_2})]^p \qquad (6)$$

Where $p \in \mathbb{R}^+$. The parameter k2 controls the skewness of the window. The flatness of the region is determined around z_{max} for the proposed window function by the value of p.

Dr. S. DEEPA
Associate Professor, ECE

RF Back Scatter for Battery free IOT

RF Backscatter is a technology for transmitting IOT data due to its energy efficiency and without power hungry. Energy can be mainly harvested from Radio waves, Light sources and Kinetic energy. Battery free IOT receives data through light is called as visible light communication or light fidelity; it sends data through RF backscatter.

RF Backscatter uses existing signals (Radio, Television and Mobile) to transmit data without using battery power. Backscattered devices uses antenna to receive the existing signal

and convert it into hundreds of microwatts power. Backscatter communication works by emitting a radio signal, and then monitoring the reflections of that signal from sensors.

By using chirp spread spectrum modulation with their backscatter system, the data was able to transmit up to 2.8 kilometers. The sensors themselves could run on mere microwatts, so they only require very small batteries and could potentially even run from harvested ambient energy.

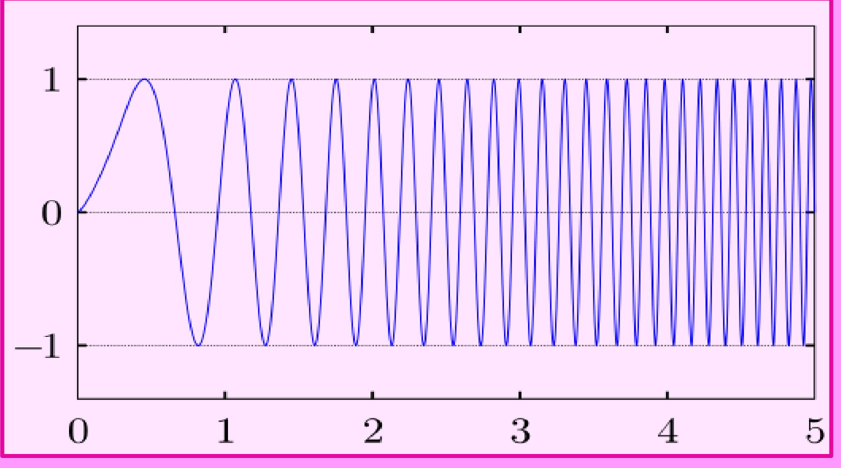
Chirp:

Chirp stands for 'Compressed High Intensity Radar Pulse'. It is a signal which frequency either increase or decrease with time. It is very common is sonar and radar. It is also used in spread spectrum.

Chirp Spread Spectrum:

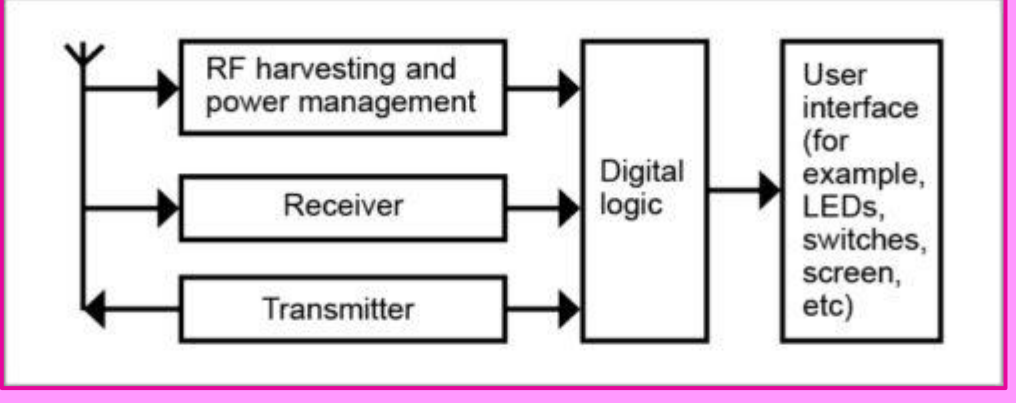
Chirp Spread Spectrum was developed for radar applications. Chirp signals have constant amplitude and pass the whole bandwidth in a linear or non-linear way from one end to another end in a certain time. Chirp spread spectrum uses complete bandwidth to transmit signals. If the frequency changes from lowest to highest, it is call up-chirp and if the frequency changes from highest to lowest, we call it down-chirp. Following is the example of linear up-chirp:

- CSS (chirp spread spectrum) techniques helps to transmit signals for very large distances.
- Bandwidth, time product is always greater than one (B*T>1).
- Chirp spread spectrum is resistive to Doppler shift.
- It is used for low power and low data rates.



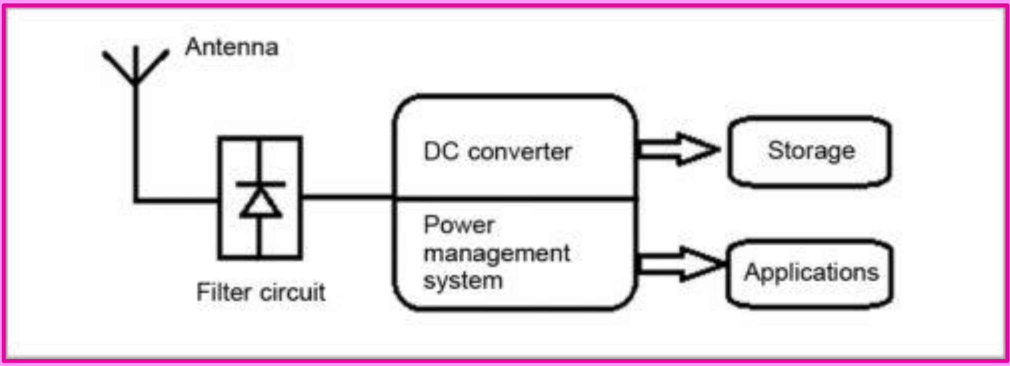
Chirp spread spectrum

General architecture of RF backscatter



Block diagram of ambient backscattering device

The harvester, transmitter, and receiver are the three main components of the ambient backscatter design. The Harvester circuitry is in charge of extracting energy from ambient RF signals in order to power the battery-free device. The message is conveyed by the transmitter backscattering RF signals incident on its antenna by modulating the antenna to reflect or absorb signals. An antenna on the receiver intercepts some of the power of RF signals backscattered by the transmitter. Finally, a decoding technique is used to decode the message.



RF energy harvesting circuit

<u>RF energy harvester:</u>

An RF energy harvester module is made up of an antenna that receives RF signals from the environment. The received signals are amplified by a voltage doubler/multiplier, which operates without the use of a power source. The voltage amplifier is formed by cascading a number of voltage doublers in series for greater amplification.

A DC converter, also known as an RF rectifier, converts the received low voltage of RF signals and stores the harvested energy in a capacitor. The harvester also has a power management system that manages the use of stored power, which can then be used for various applications.

A DC converter, also known as an RF rectifier, converts the received low voltage of RF signals and stores the harvested energy in a capacitor. The harvester also has a power management system that manages the use of stored power, which can then be used for various applications.

<u>RF backscatter transmitter:</u>

Backscattering of RF signals is based on the fundamental principle of electromagnetic wave reflection and absorption. An electromagnetic wave is reflected or absorbed when it encounters a boundary between two transmission media with different impedances/densities. Thus, backscattering of RF signals is accomplished by modulating an antenna's impedance in the presence of an incident signal.

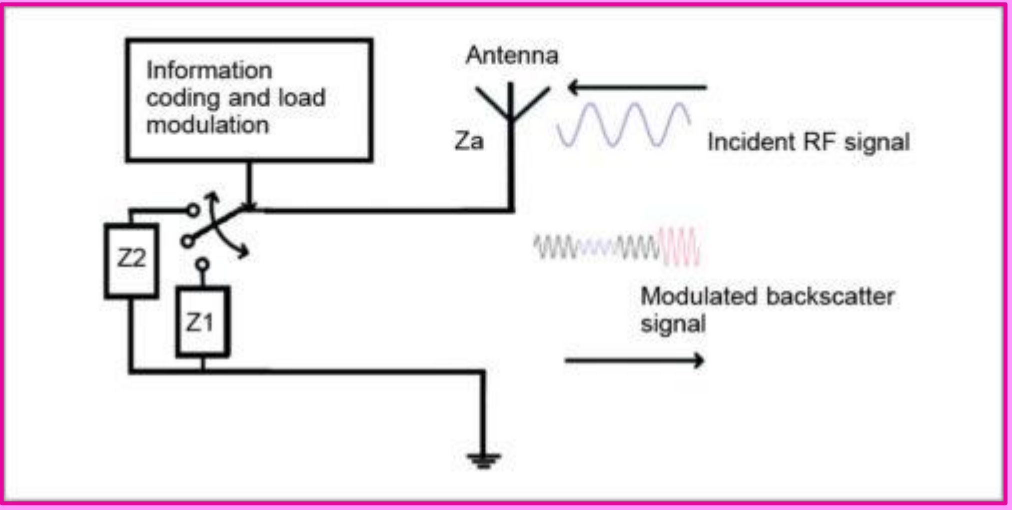
A switch (load modulator) in the backscatter transmitter modulates the impedance of the antenna, causing a change in the amount of energy reflected by the antenna. The switch's input signals are a series of bits 1 and 0, which are used to toggle the antenna between backscatter (reflective) and non-backscatter (absorptive) states in order to send bits to the receiver. Bit 1 represents the reflective state, while bit 0 represents the absorptive state.

<u>RF backscatter receiver:</u>

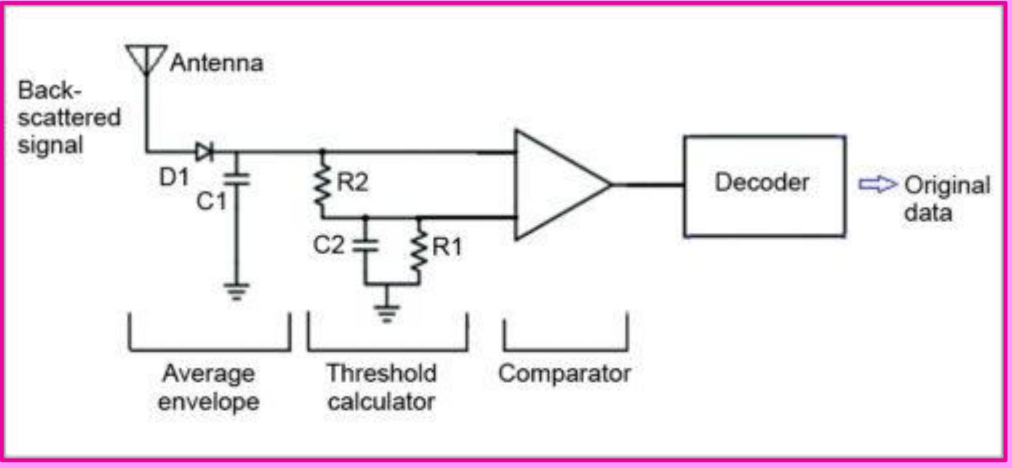
The receiver uses a simple circuit composed of three main components to demodulate backscatter signals: an envelope average circuit, a threshold calculator, and a comparator. The received signal is first smoothed to average out modulation variations.

To smooth out natural variations in RF signals, the RF backscatter receiver employs an envelope detector and a resistive/capacitive (RC) circuit (TV signals). The averaging circuit's output produces two signal levels (say, V1 and V0; V1>V0), which correspond to bits 1 and 0.

The receiver first computes a threshold value using threshold computation circuitry to distinguish between the two. The produced signal level, along with the threshold value, is fed into the comparator, which generates bits 1 and 0, which correspond to V1 and V0. The comparator's output is then sent to the microcontroller for decoding and further processing. The received signal is decoded using an averaging mechanism.



Circuit diagram for RF backscatter Transmitter



Circuit diagram for RF backscatter Receiver

Advantages:

There are several advantages of RF backscatter.

- It is battery-free. While it can only collect microwatts of electricity, it is enough to power itself and small onboard sensors such as LEDs, touch sensors, low power displays and the like.
- It does not need any special purpose chips and other analogue components. It can be manufactured using commonly available components.
- Its size is relatively small—about the size of a carrom coin.
- Cost of manufacturing is quite low—about ₹ 50 each.
- It does not need a dedicated power source (unlike in RFID communication), since it leverages radio signals that are already around.

Limitations:

RF backscatter technology has certain limitations.

- As backscatter transmitters use ambient RF signals for circuit operation and data transmission, it is usually not possible to control RF sources for transmitting power and operating on certain frequencies.

- RF backscatter communicates ranging from several metres to tens of metres with low data rates. While it depends on scenarios where the technology is applied, if it needs to cover a large area, multiple devices are required.
- The amount of electricity it collects is small. It can only collect enough electricity to power small sensors like LEDs, pressure sensors, accelerometers and so on. It can be faded due to noise.
- RF backscatter may potentially face several security issues since backscatter transmitters are simple devices and RF sources are not controllable.

Applications:

- The advancement of RF backscatter technology enables device-to-device communication. It has the potential to connect the Internet of Things (IoT), which is the future of connected living. A table, for example, could use this technology to alert someone who was nearby and left a key on the table.
- Smart sensors could be built, installed permanently inside any structure, and programmed to communicate with one another in order to alert the structure's condition.
- RF backscatter can be used in a variety of applications, including smart devices (wearables such as health trackers that perform continuous analysis of a person's health condition), logistics for tracking, and medical equipment that monitors patient health even when there is no power, among others. This technology enables devices, such as backscatter transmitters, to operate autonomously with little human intervention.

Mr. C. Mukuntharaj,
Assistant Professor, ECE

Role of Voltage level shifter in a multiple supply voltage systems

Power optimization of a system is achieved by scaling down the supply voltage. Alternatively, the system can be partitioned into different subsystems based on the performance requirements and supplied with appropriate supply voltages. In the multi-V_{DD} design technique, different (or multiple) supply voltage level are incorporated to operate the different circuit blocks (or subsystems) of the SoC. As shown in Figure 1, the subsystems which require optimized-energy consumption are supplied with low supply voltage (V_{DDL}), i.e., sub-threshold voltage level, by compromising the speed performance. Instead, the subsystems which need high-speed performance are supplied with high supply voltage (V_{DDH}), above threshold voltage level, with degradation in the energy performance. For example, a processor core which needs high frequency clock and higher supply voltage for high speed operation is interfaced with Universal Serial Bus (USB) core which needs low frequency and lower supply voltage based on the protocol standards. So, the total power consumption of the system is drastically reduced by supplying low voltage to the USB core for its normal operation.

The voltage scaling technique scales down the supply voltage towards near/sub-threshold of a MOS transistor that optimizes the energy consumption of the system. But, it worsens the system speed performance with undesired time constraints. Hence Multiple Supply Voltage Design (MSVD) or multi-V_{DD} design has been developed to achieve a balanced energy-efficient and high-speed operation with the support of voltage level shifters. They are buffer circuits that interface different voltage domains together by translating low voltage swing to high voltage swing or vice-versa. Hence, the development of low-power systems on a chip with multiple V_{DD} using VLS is encouraged.

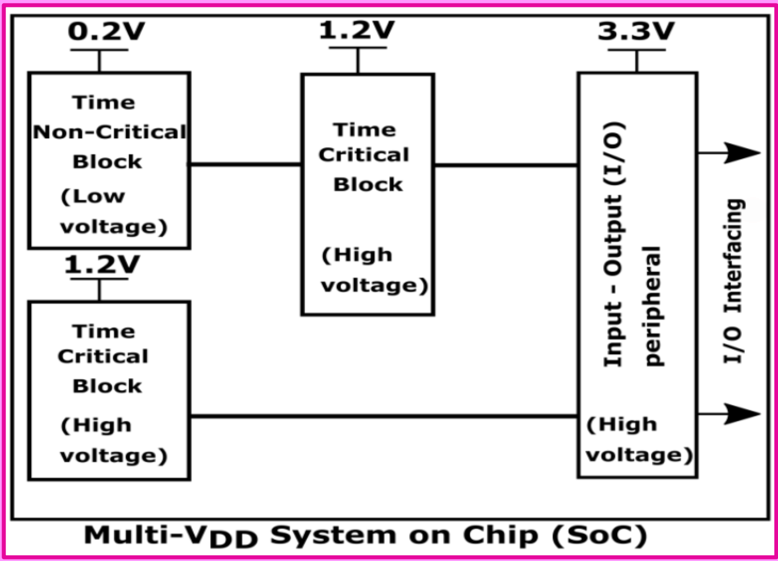


Figure 1: An example of multi-VDD System-on-Chip

The voltage scaling strategies are categorized as follows:

i. Static voltage scaling: Different subsystems in the SoC are supplied with various fixed voltage levels
ii. Multi-level voltage scaling: A subsystem can be applied with two or more voltage levels which can be fixed based on the mode of operation.
iii. Dynamic voltage and frequency scaling: For a subsystem, various supply voltage levels are applied dynamically based on the work load assigned to that system.
iv. Adaptive voltage scaling: A subsystem is supplied with different voltages which are adjusted by the control circuit employed.

Though the voltage scaling/multi-V_{DD} scheme contributes for power optimization, the limitations associated with the architectural design are,

- Timing analysis is more complex due to different blocks supplied with multiple V_{DD}.
- Multi-V_{DD} design requires additional resources (i.e., voltage regulators) to supply multiple voltage levels across the system.
- Impact on silicon area requirement due to power grid complexity.

The possible solution for the above issues is grouping the low voltage modules and high voltage modules separately. This method enables to reduce the number of voltage rails required; hence the power grid complexity is minimized.

VOLTAGE LEVEL SHIFTER (VLS):

The voltage level shifter (or level shifter, LS or Level Converter, LC) is a digital integrated circuit employed for level shifting the low voltage signal into high voltage signal and vice-versa. The LS confirms the compatibility between Integrated Circuits (ICs) which are functioning with different supply voltages by interfacing them together. So the VLS is also referred as Voltage Interfacing Circuit (VIC). In the modern SoC, the LSs are vastly incorporated to interconnect multiple logic blocks/processors, memories and other input/output (I/O) peripheral circuits. Figure 2 shows the conceptual diagrams of voltage level shifters. The low voltage input signal which is to be level shifted is applied to the input terminal and level-shifted high voltage output signal is obtained from the output terminal as shown in Figure 2a. In addition, the voltage level-up shifter circuit is supplied with two voltages (i.e., V_{DDL} and V_{DDH}). Similarly, Figure 2b shows the voltage level-down shifter in which the high voltage input signal is level-down shifted to low voltage output signal with supply voltages V_{DDL} and V_{DDH}. Among these two circuits high-to-low voltage conversion is achieved by utilizing simple inverter chain (i.e., Buffers). But, the conversion of low-to-high voltage requires an optimized design approach to realize voltage level-up shifters.

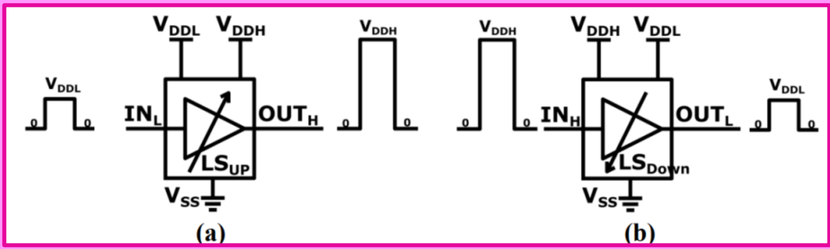


Figure 2: Concept of level shifter: (a) Voltage level-up shifter (b) Voltage level-down shifter

Importance of Level Shifters in VLSI Systems:

In the multi-V_{DD} technique, the time non-critical modules are supplied with low supply voltages while time critical modules are supplied with high supply voltages to minimize the power/energy consumption of the system. Even though the signal with low voltage swing is produced by the low voltage module, it is not recognized by the high voltage module while they are interfaced together. In other words, low voltage swing is not able to drive the high voltage module which causes larger static current flow in the high voltage domain. To address this issue, the LSs are inserted between the low voltage and high voltage domains to perform normal operation.

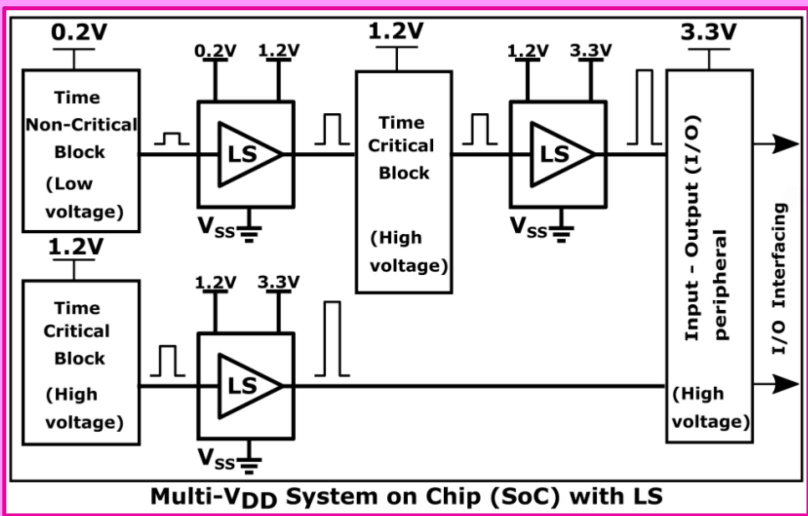


Figure 3: An example of multi-V_{DD} System-on-Chip employing level shifter (LS)

Moreover, during signal transitions, LSs appropriately drive the subsequent circuit blocks by ensuring the perfect timing of the signal. So, the LSs are mandatory to translate the signals from low voltage to high voltage since the most of the subsystems in the multi-V_{DD} SoC prefers low supply voltage (i.e., sub-threshold voltage) for energy optimization. The low-to-high voltage level conversion is an important task; hence the voltage level-up shifters are employed to achieve proper operation by interfacing the various voltage domains as shown in Figure 3. On the other hand, design of LS for multi-V_{DD} system is a challenging task due to their power dissipation, propagation delay and area requirements. Therefore, realization of the contemporary LSs aim to attain the enhanced energy-delay performance by employing buffer, Differential Cascaded Voltage Switch (DCVS) and Current Mirror (CM) structures.

Mr. R. Selvakumar,
Assistant Professor, ECE

Integrated Circuit (IC)

Integrated circuit (IC), too called a microelectronic circuit, microchip, or chip, is a gathering of electronic components, manufactured as a single unit, in which miniaturized dynamic gadgets (e.g., transistors and diodes) and inactive gadgets (e.g., capacitors and resistors) and their interconnects are built upon a lean substrate of semiconductor fabric (regularly silicon). The coming about the circuit is in this way a little solid "chip," which may be as little as several square centimeters or as it were several square millimeters. The individual circuit components are for the most part infinitesimal.

Origin:

Integrated circuits have their root within the innovation of the transistor in 1947 by William B. Shockley and his group at the American Phone and Transmit Company's Chime Research facilities. Shockley's group (counting John Bardeen and Walter H. Brattain) found that, beneath the proper circumstances, electrons would frame an obstruction at the surface of certain gems, and they learned to control the stream of power through the gem by controlling this obstruction. Controlling electron stream through a precious stone permitted the group to make a gadget that may perform certain electrical operations, such as flag intensification, that were already done by vacuum tubes. They named this gadget a transistor, from a combination of the words exchange and resistor. The consider of strategies for making electronic gadgets utilizing strong materials got to be known as solid-state gadgets. Solid-state gadgets are demonstrated to be much sturdier, less demanding to work with, more solid, much littler, and less costly than vacuum tubes. Using the same principles and materials, engineers soon learned to create other electrical components, such as resistors and capacitors. Now that electrical devices could be made so small, the largest part of a circuit was the awkward wiring between the devices

In 1958 Jack Kilby of Texas Disobedient, Inc. and Robert Noyce of Fairchild Semiconductor Organization autonomously thought of a way to decrease circuit estimate encourage. They laid exceptionally lean ways of metal (ordinarily aluminum or copper) specifically on the same piece of fabric as their gadgets. These little ways acted as wires. With this procedure, a complete circuit may well be "integrated" on a single piece of strong fabric and a coordinates circuit (IC) in this way is made. ICs can contain hundreds of thousands of person transistors on a single piece of fabric the estimate of a pea. Working with that numerous vacuum tubes would have been unreasonably ungainly and costly. The innovation of the coordinates circuit made innovations of the Data Age doable. ICs are presently utilized broadly in all strolls of life, from cars to toasters to entertainment stop rides. computers and associated devices to perform the desired functions.

Analog versus digital circuits:

Fundamental IC types Analog versus computerized circuits Analog, or straight, circuits regularly utilized were a couple of components and are hence a few of the best sorts of ICs. For the most part, analog circuits are associated with gadgets that collect signals from the environment or send signals back to the environment. For illustration, an amplifier changes over fluctuating vocal sounds into an electrical flag of shifting voltage. An analog circuit at that point alters the flag in a few valuable ways—such as increasing it or sifting it of undesirable commotion. Such a flag might at that point be nourished back to an amplifier, which would replicate the tones initially picked up by the amplifier. Another commonplaceutilize for an analog circuit is to control a few gadgets in reaction to nonstop changes within the environment. For case, a temperature sensor sends a changing flag to an indoor regulator, which can be modified to turn a discussed conditioner, radiator, or broiler on and off once the flag has come to a certain value.

An advanced circuit, on the other hand, is planned to acknowledge it was voltages of, particularly given values. A circuit that employment, as it were two states, is known as a parallel circuit. The circuit plan with two-fold amounts, “on” and “off” speaking to 1 and (i.e., genuine and untrue), employments the rationale of Boolean variable-based math. (Mathis additionally performed within the double number framework employing Boolean variable-based math.) These fundamental components are combined within the design of ICs for advanced computers and related gadgets to perform the specified capacities.

Application-specific ICs An application-specific IC (ASIC) can be either a computerized or an analog circuit. As their title infers, ASICs are not reconfigurable; they perform as they were one particular work. For case, a speed controller IC for an inaccessible control car is hard-wired to do one work and might never end up a chip. An ASIC does not contain any capacity to take after interchange instructions.

Radio-frequency ICs Radio-frequency ICs (RFICs) are broadly utilized in versatile phones and remote gadgets. RFICs are analog circuits that ordinarily run within the recurrence run of 3 kHz to 2.4 GHz (3,000 hertz to 2.4 billion hertz), circuits that would work at around 1 THz (1 trillion hertz) being in advancement. They are as a rule thought of as ASICs indeed in spite of the fact that a few may be configurable for a few comparable applications.

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I ECE

The hottest trends in science and technology

Trilateral support researchers in early detection of promising ideas accelerating the kick-off of their development thus increasing the probabilities of becoming successful in the creation of long-term impact, both for science and society.

Trilateral has also aimed to facilitate the incorporation and implementation of responsible research and innovation into the Future and Emerging Technologies context to better align processes and outcomes, with societal values, needs and expectations. This focus will also help stakeholders to make better- informed decisions related to their future investments and development activities.

Based on intensive research, consultation, validation and prioritization the final result is a list of top 20 trends with major potential for growth and impact from 2020 towards 2025.

I. INFORMATION AND COMMUNICATIONS TECHNOLOGY:

1. 3D Printing Molecules
2. Adaptive Assurance of Autonomous Systems
3. Neuromorphic Computing (new types of hardware) and Bio-mimetic AI
4. Limits of Quantum Computing: Decoherence and use of Machine Learning
5. Ethically Trustworthy AI & Anonymous Analytics
6. Beyond 5G Hardware
7. New Approaches to Data Interoperability in IOT

II. BIO, HEALTH & LIFE SCIENCES.

1. Cognitive Augmentation & Intelligence Amplification
2. Regenerative Medicine
3. Drug Discovery & Manufacture Using AI
4. Bio-informatics & AI in Omics'
5. Cellular Senescence & Life Extension
6. Bio Robotics/Bionics

III. ENVIRONMENT, ENERGY & CLIMATE CHANGE
1. Energy Efficient Water Treatments
2. Algae Against Climate Change
3. High-Temperature Superconductivity & Twist Electronics
4. Self-Healing Batteries
5. Net Zero Concepts(building) & Beyond Smart Grids
6. Arctic Climate Change
7. Zero Power Sensors & Ocean Wiring and Sensors

How we identified the top 20 trends:

PREFET took a unique approach to identification and analysis of early signals for promising future and emerging technologies. The project used four layers of analysis:
Massive data analysis through a semi-automated scanning (Intelligence Augmentation, IA) Manual scanning through desktop research (Human Intelligence) which provided an essential creative dimension. Crowd (expert) feedback (Social Intelligence) provided through PREFET's Open Trend Consultation (OTC) with over 3000 responses which helped us to broaden the expertise available for trend validation, prioritization and augmentation. Unconventional expert feedback (Expert Intelligence) during the Trendington Event (Madrid, 13-14 November 2020) with experts in ICT, Health & Life Sciences, Environment, Energy & Climate Change, RRI, ethics of technology, but also architects, artists, CSOs, designers, and futurologists that helped us to provide further insights, a better understanding of embedded opportunities and challenges (technological as well as legal, ethical and societal), and mapping the synergies and multidisciplinary of trends. Trendington was complemented with in-depth interviews with other non-usual stakeholders (designers, artists and architects).

What's next?:

We have developed tools and methodologies to pre-validate new and emerging trending technologies with high impact potential and helped researchers improve their project building processes for advancing Future and Emerging Technologies (FET) trends, such as better identification of ideas at early stages, good planning and effective decision making in their development.

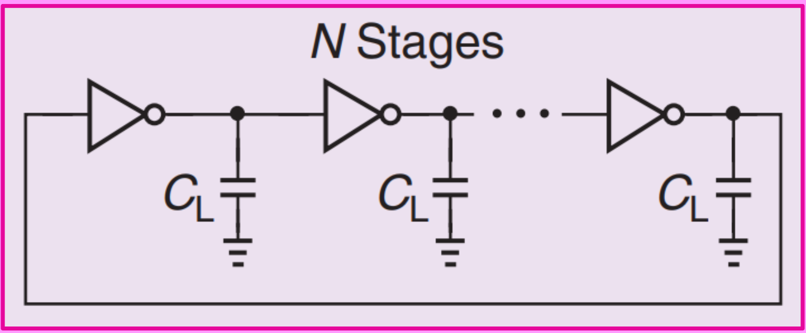
18L127 PARIPOORANAM S
III ECE A

Ring Oscillators

Due to large tuning range, compact architecture, and ability to create numerous phases, ring oscillators are extensively utilised in various systems. These benefits come at the cost of phase noise compared to inductance–capacitance (LC) oscillators. The idea is ring-shaped oscillator.

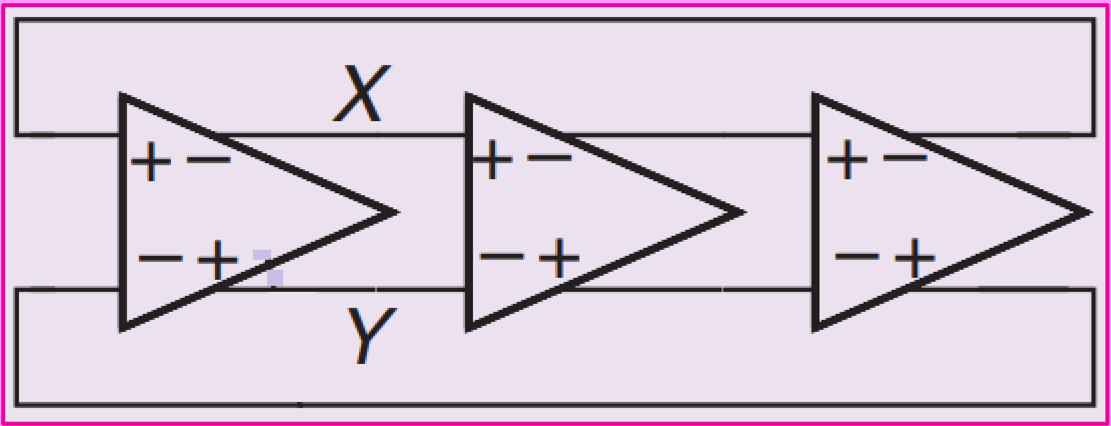
A ring oscillator, in its most basic form, consists of N gain stages in a loop, with negative feedback at low frequencies to prevent latch-up. If each level inverts, N must be an odd number. One half of the oscillation period T_0 is formed when a rising edge at a node within the loop travels through N inverters and returns as a falling edge. As a result, T_0 equals $2NT_D$, where T_D stands for the long signal gate delay. Three points should be made about the inverter-based ring depicted in figure. First, the oscillation frequency f_0 is inversely proportional to V_{DD} since the delay of an inverter decreases as the supply voltage V_{DD} increases. This supply sensitivity, K_{VDD}, is problematic because noise on V_{DD} influences the output frequency directly.

Second, the average power drawn from V_{DD} is nearly equal to $N f_0 C_L V_{DD}^2$ for a total load capacitance of C_L at each node. Third, an N-stage ring generates N output phases with a minimum gap of T_D seconds, or $[T_D/2NT_D](2\pi) = \pi/N$ rad, but the actual phase difference is due to inversion at each step.



A ring oscillator consisting of N inverters

The use of differential rings can significantly reduce the problem of supply noise. We prefer that the differential pairs experience virtually full switching in an implementation like the one illustrated in figure and so create a single-ended voltage swing equal to $I_{SS} R_D$. To do this, we choose these transistors with a broad enough input voltage difference so one transistor switches off when the input voltage difference is $I_{SS} R_D$. A ring with only three stages, on the other hand, does not offer full switching because the loop's delay is too short for V_X and V_Y to reach V_{DD}. In this situation, it can be seen that the maximum swing is around 0.5 $I_{SS}R_D$. The tail current source must operate in the saturation range for reasonable supply rejection.



A three-stage differential ring oscillator

Differential rings also have the advantage of being able to generate several phases with a minimum spacing of π divided by an even number. This is feasible because, even at low frequencies, a differential ring with an even N can exhibit negative feedback.

18L109 – Dinesh J
III ECE C

Short story

TRAVEL

A family was traveling on a bike where no one was there except some more wheels. A man who drove was talking to his consort who was just behind him and being tortured by his little daughter who was right afore him. Bit by bit they started an agonizing speech about the perfidy of their relatives. Being involved in talk and pain, he lost control for a second.

A lorry coming right opposite, hit them off and he was losing control and the bike tilted towards left. There his consort lost grip and she directly fell down and her head and hair turned red. Slowly she was losing her life.

In the meantime, he clasped his little daughter tightly and tried to take off his leg which was completely squashed by the bike. At that instant, another lorry was coming opposite. He threw her and lorry hit him off. On the green land, that little child looked for parents. But she was unaware that they were dead.

Time passed... she cried for food and no one was there.

Time passed... she cried for a drop of water and no one was there.

Time ticked away, she was still crying.

After three days this world missed an ideal soul.

A single second is enough to flip your life upside down.

But in those three days, she was longing for what we are blessed with.

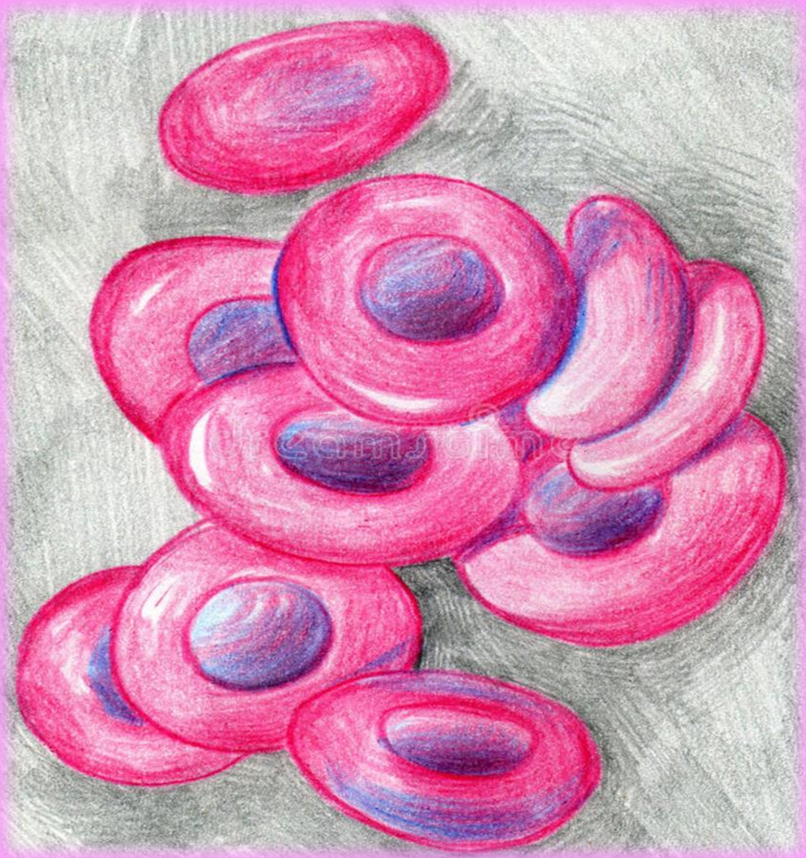
We are god's child.

19L244Sobika M
II ECE B

Drawings & Arts

20L111
BHAVASHRI

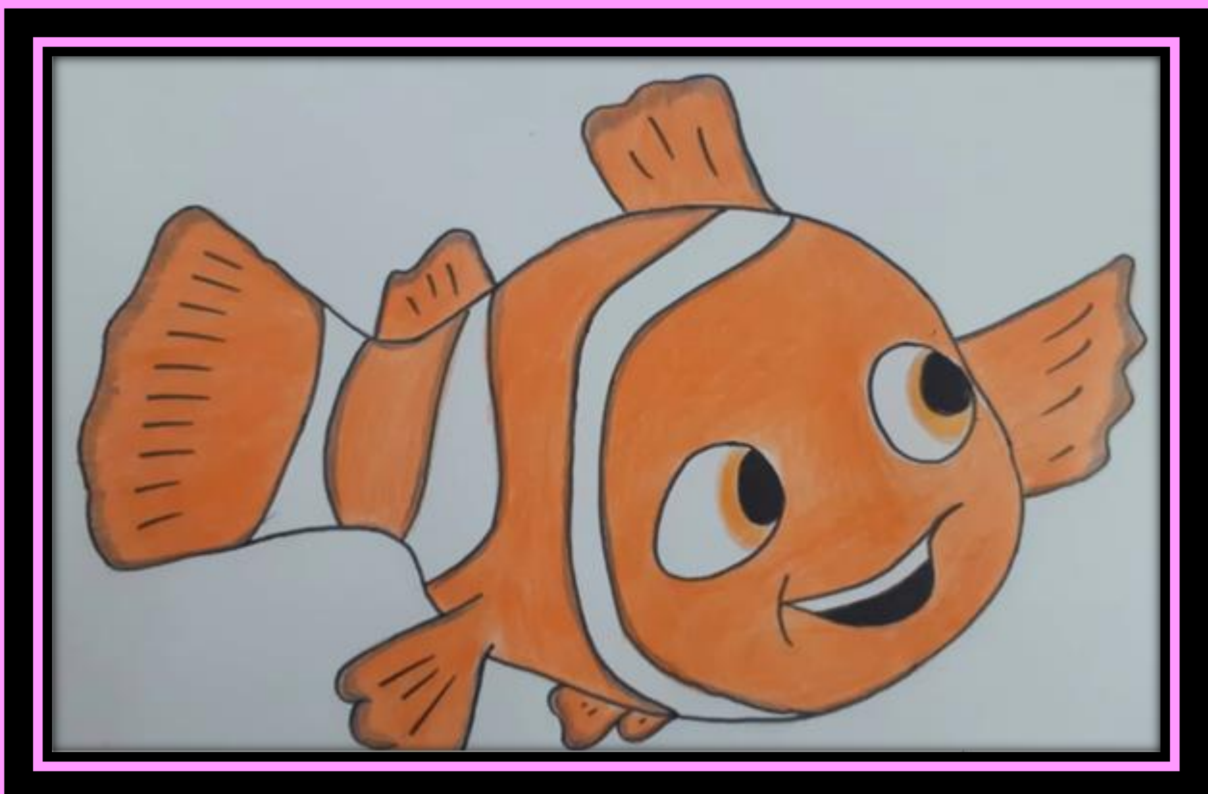
19L208
BRINDHA B



19L229
NAVEEN K

19L318
JANAKALAKSHMI. R

18L210
DINESH M



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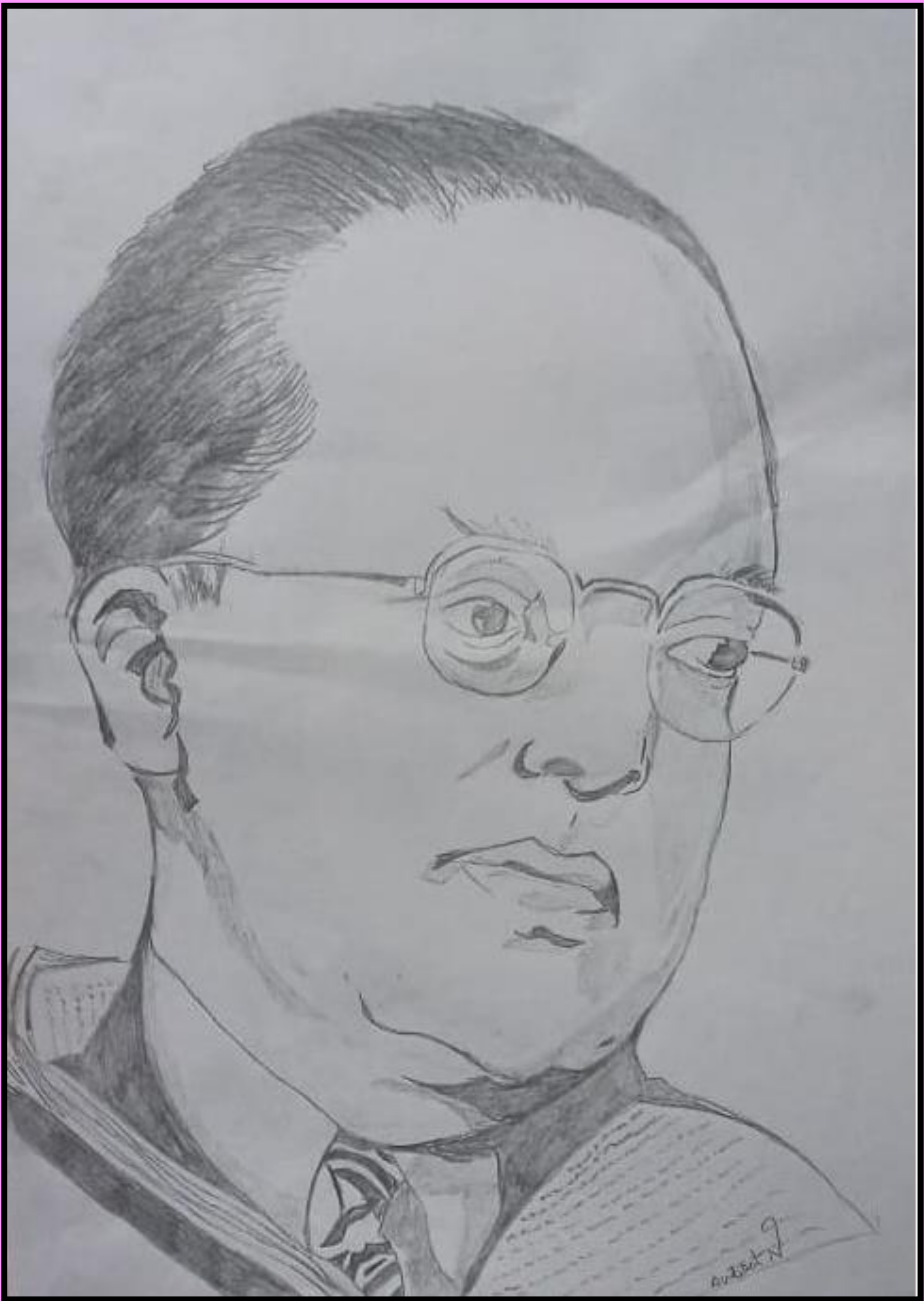
AISHWARIYA A



19L146
SUDARSAN N

19L331
MYTHILI S

17L319
JOHNPAUL A P

18L144
VEERAKUMAR N

Programme Educational Objectives (PEOs)

•**PEO1:** Graduates will be able to comprehend Mathematics, Science, Engineering fundamentals, laboratory and work based experience to formulate and solve problems related to the domain and shall develop proficiency in computer based engineering and the use of computational tools.

•**PEO2:** Graduates will be prepared to communicate and work team based on the multidisciplinary projects practicing the ethics of their profession with a great sense of social responsibility.

•**PEO3:** Graduates will recognize the importance of lifelong learning to shine as experts either as entrepreneurs or as employees and thereby broadening their professional knowledge.

Programme Outcomes (POs)

GRADUATES WILL HAVE

•**PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

•**PO2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

•**PO3: Design/ Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

•**PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

•**PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

•**PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

•**PO7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

•**PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

•**PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

•**PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

•**PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

•**PO12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

GRADUATES WILL HAVE

•**PSO1:** Good knowledge and hands-on competence to solve emerging real-world problems related to Electronic Devices and Circuits, Communication Systems, Digital Systems, and Electro-magnetics.

•**PSO2:** Demonstrate proficiency in specialized software packages and computer programming useful for the analysis/design of electronic engineering systems and profession.

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