International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 12, Issue 11 (November 2016), PP.48-55

Indigenize Manufacture - Chemistry Concepts - Equipment - Marketing

Vidya Sagar Thiruvalluri[1], Venkateswara Rao Kandavalli[2], AVSS Swamy[3]
[1, 2]*Andhra Pradesh Pollution Control Board, Amaravathi, Andhra Pradesh, India.*
[3]*Acharya Nagarjuna University, Nagarjunanagar, Andhra Pradesh, India .*

Abstract:- **This** is technology understanding and implementation of concepts to products to minimize impact of pollution. Theories and scope of measurement in designing many of the equipment and electronics background discussed for understanding to indigenized production. Here discusses scope of measuring theory, electric circuitry, electronics, standardization, limitations, wastage, hurdles and support from the policy makers in government to benefit public. Basic concepts covered in this paper for understanding all sections of people and smooth flow leaving scope to detailed concept for future study to implementation model.

Keywords:- chemistry concepts measurement scope, reversible electrode, adsorption, colloidal state, thermodynamics and spectroscopy applications, semiconductor applications, smart data-acquisition systems.

I. CHEMISTRY CONCEPTS - MEASUREMENT SCOPE

A. Electrochemistry

Electronic structure is guiding the conductance of elements and substances. For metals, outer most orbit is termed as valence orbit (Band) with little ionization potentials and not suitable to form covalent bonds for filling valence band completely. The electrons are stationary to that nucleolus and form bonds with unified theory of electrons in metals causing distribution of electrons covering more atoms causing further decrease of ionization potential, and little potential causing flow of electrons to a particular direction of applied potential and such materials called conductors with little resistance. The resistance of each substance is a function of temperature. The potential developed at the junction of specific metals referred to thermo-couple is used for measurement of temperature. The materials electrons structure, grouped to non-magnetic and magnetic. The magnetic materials further classified (i) ferromagnic, (ii) paramagnetic and (iii) diamagnetic.

Applications (Aptn): Low resistance Materials for Conductors, Non-linear resistors for protective devices, Resistors for heat /light generation, decrease current /potential and measurements. The magnetic property of materials uses extensively in power generation, energy conversions (electric to mechanical and vice versa), and power transformers to control voltage and current.

The electric current cause by decomposition to Cations and Anions of electrolytic solution, known as electrolysis, observations in this processes notified as Faraday' s laws of electrolysis and the system with boundaries is termed as electrolytic cell. It concluded that the weight ' **w**' in grams of material deposited or dissolved at an electrode is proportional to **I×t×e**, where **I** is current strength in amperes, t is time in sec., and e is the equivalent weight of the material. ' **F**' is a proportionality constant named with its founder ' Faraday' representing quantity of electricity {**w = (I×t×e)/F**}. If the ion has a valence of **z**, then 1 mole or 1 gram ion of these ions will contain **z** gram equivalent and will consequently carry **z** faradays, i.e., **zF** coulombs, where **F** is 96,500 resembling to Avogadro number [1,2]

A reversible electrode involves oxidized and reduced states refer loss and acceptance of electron. The electrodes constituting a reversible cell are reversible electrodes. They involve a metal or non metal in contact with a solution of its own ions are 1st type (Ex. $M|M^+$ and $M \leftrightarrow M^+ + e^-$). They involve a metal and a sparingly soluble salt of that metal in contact with solution of soluble salt of the same anion are 2nd type (Pt|A^-|A and $A^- \leftrightarrow e^-$). They involve an un-attackable metal such as gold or platinum immersed in a solution containing both oxidized and reduced states of an oxidation-reduction system in electrolytic solution is a 3rd type (Ex. $Sn^{+4} \leftrightarrow Sn^{+2} + 2e^-$). The electrodes not both states necessarily ionic and the purpose of un-attackable electrode is to act as conductor such as hydrogen gas electrode [3].

Aptn: current measurement, electroplating, purification of metals, electrolytic cells, capacitors, batteries, reference voltage cells, etc.

In electrolysis, external potential and current are a function of mobility of selective ions, application of Overvoltage concept [4] with ascending potential current measurement to differentiate ions is used qualitative and quantitative measurement of ions. ***F.W.Kohlrausch (1868),*** suggested a rapidly alternating current about 1000 times per second, to eliminate " polarization" at electrodes due to direct current in conductance of electrolyte measurement, standardized with E.M.F. of 1V, length between electrodes is 1cm and cross sectional area of electrodes is $1cm^2$ termed as specific conductance of electrolyte and represent $mhos/cm^2$ ($ohms^{-1}cm^{-2}$). Similarly, the concentrations of an ion in different pure electrolytic solutions with the same metal electrodes in contact with a **junction** (Glass or Fiber) produce electric potential and such arrangement is called concentration cells. ***J.N.Brǿnsted (1923)*** and ***T.M.Lowry (1923)*** introduced the proton transfer theory placing conjugate pairs of acid–base concentrations represent equilibrium state [5].

P.Debye and ***E.Hückel (1923)*** showed how the electrical free energy could be calculated by determining the electrostatic potential of an ion due to its oppositely charged ionic atmosphere and then evaluating the work done in charging the neutral to this potential [6] and is applicable to dilute solutions represented by

$\log f_{\pm} = -0.509 z_+ z_- (\mu)^{1/2}$; and $\mu = \frac{1}{2}(m_1 z_1^2 + m_2 z_2^2 + m_3 z_3^2 + ...)$, where m_1, m_2, m_3, *etc.*, in gram ions per 1000 grams of solvent and the subscripts 1, 2, 3, etc., their respective molalities.

Water consisting of its ions are in equilibrium represented by activity coefficients of ionic product K_w ($K_w = (^{\alpha}{}_{H3O+} \times {}^{\alpha}{}_{HO^-}) / {}^{\alpha}{}_{H2O}$). The specific conductance of pure water is $5.5x10^{-8}$ $ohm^{-1}cm^{-1}$ at 25°C. It is estimated pure water contains $1.1x10^{-7}$ gram equivalence of either hydrogen ions or hydroxyl ions per liter and K_w as $1.02x10^{-14}$ (considered $K_w = C_{H^+} \times C_{OH^-}$). ***S.P.L Sorensen (1909)*** [7] introduced a convenient scale in representing activity coefficient of hydrogen ion as pH by defining "negative logarithm of hydrogen ion concentration" ranging 0-14 (pH = -log $^{\alpha}{}_{H+}$). The measurement is carried out with a simple potentiometer in comparison with standard potential source using reference electrode such as calomel electrode ($Hg|Hg_2Cl_2|$0.1N KCl) or silver-silver chloride ($Ag|AgCl|Cl^-$ ($^{\alpha}$ = 1)) [8]. In this case the junction allows the transport of H^+ or OH^- ions only. The selectivity of ions in permeability of the junction raises potential has the application for estimation of that specific ion.

Aptn: Polarography, Speciation of ions identification / quantification, conductivity, qualitative and quantitative estimation of chemical species [9], concentration measurement and tracking chemical reactions, Concentration cells, specific ion meters, pH / pOH / other ions concentration measurement.

B. Adsorption and Colloidal State

The term adsorption is described the existence of a higher concentration of any particular substance at the surface of a liquid or solid than is present in the bulk of the medium where as absorption is uniform distribution of certain substance in the medium. According to the *Le Chatelier principle*, the absorption of a gas is accompanied by a decrease of enthalpy, i.e., an evolution of heat, known as heat of adsorption. The *van der Waals adsorption* or *physical adsorption* exhibit low heats of adsorption about 5 to 10 kcal per mole and the *activated adsorption* or *chemisorption* exhibit heats of adsorption about 10 to 100 kcal per mole. ***J.Willard Gibbs (1878)*** pointed out that the concentration of a solute at the surface of a liquid could be greater than in the bulk of the solution and referred thermodynamically as Gibbs adsorption equation [10].

A suspension contains particles large enough to see by the naked eye or, at least, in the microscope in a solvent with uneven distribution; and a true solution contains solute distributed in a solvent essentially of single molecules or ions. The important characteristics of the colloidal state are the presence of particles, which are larger than molecules but not large enough to be seen in the microscope (0.2μ–5mμ). It is assumed that the colloidal systems of liquid dispersion medium are called *sols*. Smoke, dusts, fog, mist, cloud and foam are different dispersion mediums. Most true solutions are optically clear, but colloidal dispersions scatter light called *Tyndall effect*, making the light path visible and solution turbid. An emulsion consists of small drops of one liquid 0.1-1.0 μm, dispersed in another liquid and attains stability with emulsifying (stabilizing) agent.

Aptn: TLC, HPLC, IC and GC, Nephelometer / Turbidimenter.

C. Gas Laws and Thermodynamics

At constant temperature, the volume of a definite mass of a gas is inversely proportional to the pressure termed as *Boyle' s law*. *Gay-Lussac' s law* or *Charles' s law* reveal the phenomenon of unit mass of gas at constant pressure, the volume raises in proportionality with raise in temperature and combining both theories it termed as ' *Equation of states'* representing PV=RT, whew R is termed gas constant. R represents 0.082054 Liter-atom $degree^{-1}$ $mole^{-1}$ or 8.314X107 ergs $degree^{-1}$ $mole^{-1}$ or 1.987 cal' s $degree^{-1}$ $mole^{-1}$. ***Dalton (1801)*** expressed a law on pressure of a mixed gas, is the sum partial pressures of its component gases in a fixed volume at constant temperature. It express $PV = (P_1+P_2+P_3)V = nRT$, where $n = n_1+n_2+n_3$ representing moles, $P_1 = n_1/n$, $P_2 = n_2/n$ and $P_3 = n_3/n$ are partial pressures or mole fractions of respective gases [11].

Zeroth Law of Thermodynamics states that if system A is in thermal equilibrium with system C, and system B is in thermal equilibrium with system C, then system A is in thermal equilibrium with system B. It is the basis of the thermometer. *First Law of Thermodynamics* states that, " The total energy of a system and its surroundings must remain constant, although it may be changed from one form to another" . Based on it

J.P.Joule derived a constant **'**J' known as the mechanical equivalent of heat representing 4.184 absolute joules i.e., $4.184X10^7$ ergs per calorie [12].
Aptn: Measurement of heat capacities, change of state (latent heat of melt and evaporation) [13], chemical reactions either endothermic or exothermic or generation of electromotive force, pressure gauges, thermometers, molecular weights, partial pressures of volatile compounds, boiling temperature, etc.

The second law of thermodynamics asserts that processes occur in a certain direction and that the energy has quality as well as quantity. *The Kelvin – Planck* and *Clausius* statements of the second law are negative statements, and not proved directly. So, the second law, like the first law, is based on experimental observations. The best-known reversible cycle is the Carnot cycle. *Kelvin – Planck statement* states, " It is impossible for any device that operates on a cycle to receive heat from a single reservoir and produce a net amount of work" . In other words, no heat engine can have a thermal efficiency of 100%. *Clausius Statement states*, " It is impossible to construct a device that operates in a cycle and produces no effect other than the transfer of heat from a lower temperature body to higher temperature body" . In other words, a refrigerator will not operate unless its compressor is driven by an external power source.
The chemist ***Walther Nernst (1906-1912)*** developed *third law of thermodynamics* often referred as Nernst's theorem or Nernst's postulate, states that the entropy of a system at absolute zero is a well-defined constant and is zero to a perfect crystal lattice. The direct use of the Third Law of Thermodynamics occurs in ultra-low temperature chemistry and physics.
Aptn: Energy conversion from thermal to mechanical / electrical, Air conditioning, power plants, heat – engine, Combustion engines, Chemical processes, reversible processes. The applications of this law have been used to predict the behavior of different materials to temperature changes.

D. EM Waves, Spectroscopy and Physics

The generation of oscillating current with dynamo / oscillator circuitry, at low frequencies 50/60 Hz is used for effective transmission of energy as AC current suitable for many applications with little noise and loss. As the frequency increases (30 KHz) it handles much power with miniature transformer and circuitry. If it crosses audible high frequencies level, if converted to mechanical energy and reached ultrasonic level, further increase around 40 KHz, it is used for cleaning purposes. The frequency increasing further, it is used for sonar sensing operation with transducer for radar functioning in water, air and atmosphere.

Fig.1

Fig.1 shows a sonar instrument for finding distance and depth of fishes in water body. Further increase in frequency, it generates electromagnetic waves (EM Waves) long frequency, as increase in frequency it crosses medium wave to short wave ranges, has applications in conventional low energy application of communication and termed as radio waves with AM (carrier audio signal amplitude modulation) to FM (carrier audio /video frequency modulation) to minimise distortion.

The interaction of EM waves with matter is in four types, emission, absorption, reflection and conductance. Any material is thermodynamically in equilibrium state with its surroundings. The *Stephen-Boltzmann law* ($Ie = s\ T^4$) stated that the total radiant flux emitted by a blackbody was proportional to the forth power of the absolute temperature. *Stephen-Boltzmann constant* s = 5.6686 x 10^{-6} (Watts/meters^{2}Kelvins^4). It is well known that, the structure of atom and molecules are in finite order with packets of energy and changes associated with absorption/emission of EM waves. Atomic spectra associated with X-ray to IR range via UV radiation. Molecular/ionic species spectral range is referring low energy transformations, rotational, vibration energy and ionization potentials covering HF, UHF, microwave, IR, Visible and UV radiations. The nuclear transformations and spectral ranges are covering X-rays, γ-rays and high energy sub atomic nucleons. **Fig.2** shows Electromagnetic Spectrum distribution, applications and representation.
Aptn: Advent of AAS; Flame Photometer; Spectro-photometer at UV, Vis and IR; ICP with wide spectrum scan for multi elements, FTIR (organic/ inorganic molecular species), XRF (crystalline structures and elements), General applications cover solar cells (photo-electric effect), radio, TV, LEDs, Monitors, Cell phone,

communication devises, ultra sonic scanners and echo recorders, Induction and Micro-wave ovens, IR – Vis – UV – X ray radiators and imaging equipments.

Some of the possible technologies for preparation of weather monitoring station are as follows. The wind direction finder, the theory of galvonometer applicable in signal generation, that is calibrated to digital signal to communicate. The theory of dynamo in generation of AC signal frequency used and it is calibrated to present wind speed (animometer). Either photoelectric effect (Crompton effect) or LDR (Light dependent resistor) used for calibration of solar radiation. Barometric pressure is calibrated with the change of frequency generated in variation of capacitance (due to change of distance between plates) of a LC circuit. The temperature measurement is based on processing and calibration of signal from thermister / thermocouple. The raingage and weight measurements are carried with spring balance attached to variable capacitor / inductor (moving ferrite/ coil) for singal generation.

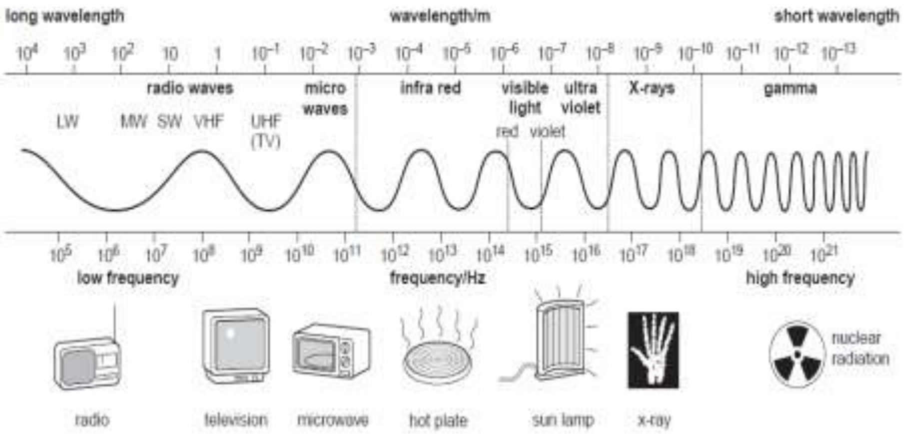


Fig.2: Electromagnetic Spectrum distribution and its applications

II. ELECTRONICS - COMMUNICATION

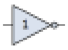
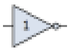
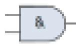
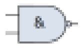
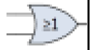
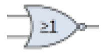
A. Semiconductors and Electronics

The "diamond structure" that is the arrangement of the Group IV (Gr. IV) atoms in diamond, silicon and germanium. Each atom has four equidistant, tetrahedrally arranged, the atom-atom bond direction is <111> and the inter bond angle is 109° 28'. In pure form, these elements exhibit high resistivity for conductance of electrons due to large band gap between forbidden (filled orbital) band and conduction (outer orbital) band. As atomic size increases with period, the energy gap between forbidden and conduction band decreases, causing conductance at higher temperature for Ge (Germanium). These elements exhibit intrinsic semi-conductance at higher temperature due to holes in excited electron lose in the crystal. With the neighbouring Gr. (III or V) elements doped in minute quantity as impurity causing deformation in crystal structure of Si / Ge, imbalance in bonds, facilitate transportation of electron in controlled manner subject to their arrangement called junctions. Subject to the valency of doped atom, Gr. III (such as Ga/In) or VI (such as As/Sb), the semiconductor material is termed as P-type or N-type, respectively. The band gaps between conduction and forbidden is narrow subject to the external electric field application at junction of this pair (PN). It is termed as diode (allowing conductance in one direction) and is the basic unit in electronics.

The combination of these junctions worked for control of current replacing passive electronic components such as vacuum tube components leads to inventing LSI technology in solid state components on consumer electronics including digital signal processing devices such as TTL logic gates, etc. and further development of CMOS [14] uses complementary and symmetrical pairs of p-type and n-type metal oxide semiconductor field effect transistors (MOSFETs) for logic functions (**Fig. 3.10**) support VLSI technology. Boolean algebra computations in digital electronics respect to logic gates and their truth table is at **Table 1**.

It is clear from the part of the Periodic Table Elements shown at table in **Fig.3(1)**, such as GaAs, GaP, InP, AlAs, GaN etc formed by combination of Gr. III and V elements [15]; Al(x)Ga(1-x)As, InAs(1-y)P(y), In(x)Ga(1-x)As(1-y)P(y) can also be formed and many of them have valuable properties suited for semiconductor technology. The Gr. II-VI semiconductors comprise the compounds containing Zn, Cd and Hg as the cations and O, S, Se and Te as the anions. The Gr. III-V and II-VI compounds comprising elements of lower atomic numbers are more ionic (less covalent) than Gr. III-V and II-VI compounds of elements of higher atomic numbers. The usual result is that the lower-atomic-number semiconducting compounds have larger valence-band to conduction-band energy gaps. The list of element having application in materials used for semiconductors at different concentrations from Gr. II, III, IV, V, VI of periodic table are Zn, Cd, Hg; B, Al, Ga, In; C, Si, Ge, Sn; N, P, As, Sb; O, S, Se, Te; respectively.

Table 1: Logic Gates, Boolean algebra and truth table.

Logic Gate	Inputs A	Inputs B	Logic Gate Output (Q) NOT A	NOT B	AND	NAND	OR	NOR	EX-OR	EX-NOR
										
Boolean algebra	**A**	**B**	$\bar{A}$	$\bar{B}$	**A .B**	$\overline{A.B}$ (= $\bar{A}+\bar{B}$)	**A+B**	$\overline{A+B}$ (= $\bar{A}.\bar{B}$)	$A.\bar{B}+\bar{A}.B$ (=A(+)B)	A.B+$\bar{A}.\bar{B}$ (= $\overline{A \oplus B}$)
Truth Table	0	0	1	1	0	1	0	1	0	1
	0	1	1	0	0	1	1	0	1	0
	1	0	0	1	0	1	1	0	1	0
	1	1	0	0	1	0	1	0	0	1

Aptn: Replaced high voltage power consuming vacuum tube electronic circuitry with solid-state sub-micron level high density multiple function circuits consisting op-amplifiers, power control switches, high frequency switches, micro-controllers, processors and precision oscillators. LCD, LEDs, EEPROM, HD/UHD display and record systems, solar cells, RAM, ROM, DAC /ADC (digital to analogue converter and vice versa), sensors, control equipment with artificial intelligence are prepared.

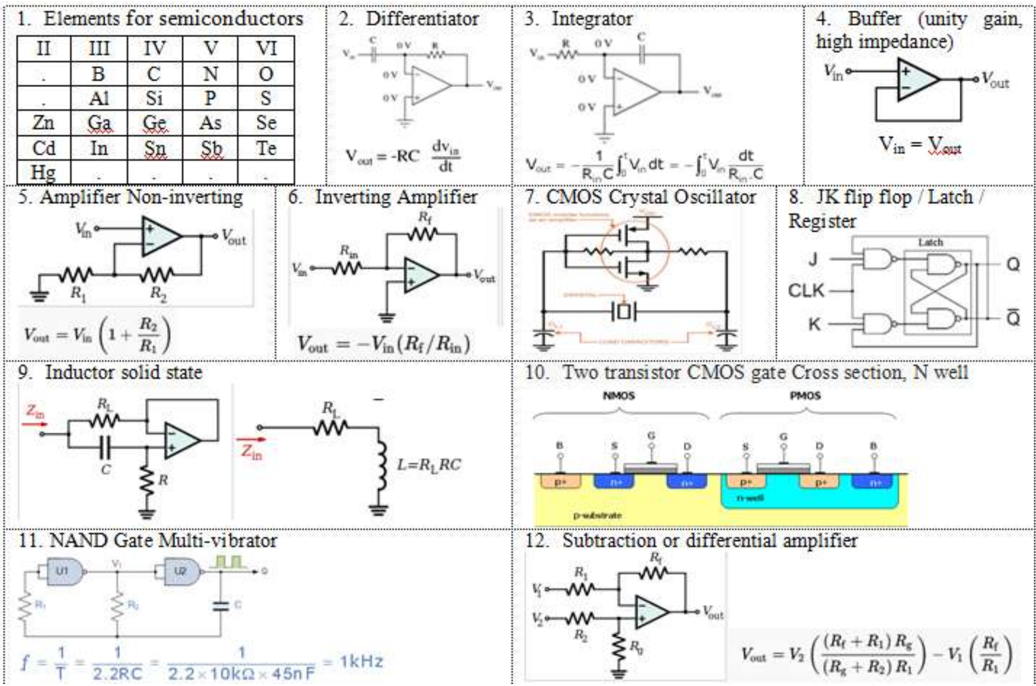
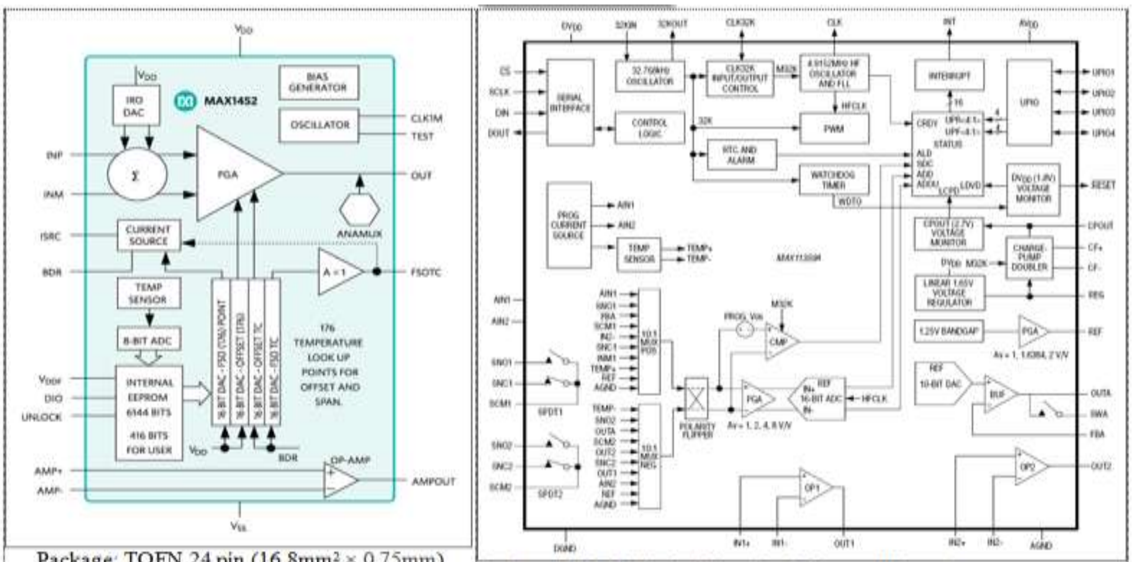


Fig.3: Electronics – Signal processing

B. Integrated Circuits (ICs in VLSI)

VLSI (Very large scale integration technology) integrated ICs with MOSFET provide high impedance amplifiers, comparators, counters, registers, oscillators, gates, power regulation and protected systems, RAM, ROM, ADC, DAC and communication at a single flat form in few square millimeters on thin film. Software controllable ICs for multiple function and single wire data transmission support to link with computers, PDAs (personal digital assistant) and Cellular phones [16] with sensors and signal. The present development of nanotechnology and interfacing biomoleculs in semiconductor technology scope diversified applications. **Fig.3** is a typical diagram of Signal processing circuits capable of differentiation, integration, amplification, inversion, unity gain, positive gain, high impedance to input signal, latch, flip-flop, solid state inductor, oscillator, prototype CMOS gate cross section, multi-vibrator and subtraction/ differential amplifier.

A typical Sample and hold signal processing self explanatory, block diagram circuits are shown at Fig.4(A) and 4(B). Both are smart data-acquisition systems (DAS) based on a 16-bit, sigma-delta analog-to-digital converter (ADC) and system-support functionality for a microprocessor (μP)-based system [17]. The device integrates ADC, DAC, operational amplifiers, internal selectable-voltage reference, temperature sensors, analog switches, oscillator, Precision op-amplifiers, Charge Pump, EPROM, and 1.8V and 2.7V voltage monitors in a single chip. An on-chip 1× to 8× programmable-gain amplifier (PGA) allows measuring low-level signals and reduces external circuitry. The MAX1452 (Fig.4A) is analogue-sensor signal processor optimized for industrial and process control applications utilizing resistive element sensors. It provides amplification, calibration and temperature compensation that enable an overall performance approaching the inherent repeatability of the sensor. The fully analogue signal path introduces no quantization noise in the output signal while enabling digitally controlled trimming with the integrated 16-bit DACs. The MAX11359A has a real-time clock (RTC) with alarm, a high-frequency phase locked loop (PLL) clock, four user-programmable I/Os, interrupt generator, dual SPDT analog switches and serial interface. It is compatible with either SPI/QSPI™ or MICROWIRE®, and is used to power up, configure, and check the status of all functional blocks. It is available in a space-saving, 40-pin TQFN package ($36mm^2$ × 0.75mm) and extended temperature ranges (-40°C to +85°C). With reference to multi core communication and processing ICs, these are primitive.



Package: TQFN 24 pin ($16.8mm^2$ × 0.75mm)

(A) MAX1452: Functional Diagram Analog-sensor signal processor

Package: TQFN 40 pin ($36mm^2$ × 0.75mm thickness)

(B) MAX11359A: Functional Diagram – 16-Bit data acquisition with ADC, DAC, UPIOs, RTC, Voltage Monitors and Temp Sensors.

Fig.4: (A) MAX1452; (B) MAX11359A

The bulky optical section of equipment for spectrum generation, grating, chopper for splitting light path, sensing and converting to signal and its measurement are would be replaced with digital camera and the facilities provided for autofocus techniques. The digital camera produced digital signals for intensity (strength), potential variations representing frequency (colour) and suitable wide spectral range covering IR to UV. The flash and IR/UV sourses provided, will act as source of light for the object to measure.

Aptn: battery-powered accelerometers, humidity sensors, pressure calibrators and controllers, pressure sensors, resistive elements/ sensors, strain gauges, transducers and transmitters. portable devices, medical testing / sensing equipment, data-acquisition systems, electrochemical and optical sensors, industrial control instruments, drone driver, biosensors, spectrophotometers, etc.

C. Interfacing Software and Peripherals

The key to operate and get the results from the instrument is software resembling to the language to communicate. It is three types; machine language (managing operations with hardware) followed with compiler (link to hardware and I/O devices) then operating software link to input and output instructions and to connect peripherals namely monitor, printer, keyboard, sensors, storage and soft switches in human language. Smart phones are mixed signal digital equipment having both features such as data processing and transceivers at vide spectra (low, high and ultrahigh frequencies) communicate to network provider, wifi and blue-tooth, audio synthesizers, video and photography with cameras, light sensors, spectrum analyzers etc. the sensors for light and focus correction are also may be interactive and quantified. The head phone and mike jacks, micro USB ports etc., are readily available for communication. Hence, the display, data management and transmission are simplified with the help of specially developed program. Some of the applications (apps) recently developed utilizing Smartphone I/O terminals (earphone jack, USB, camera, touch screen) are noise meter, oscilloscope, function generator, lux-meter, BP/ pulse monitor, voltage synthesizer, etc., and to be further developed.

Aptn: signal processor, communication, sample-and-hold units, sensors such as pH, conductivity/ TDS, nephelometer / visibility, noise, thermometer, calibrator, for multi-parameter monitoring equipment.

III. LABORATORY - EQUIPMENT - FINANCE

Some equipment required for Environmental laboratory are discussed here with theory and cost factors. Environmental laboratory is a comprehensive laboratory covering diversified fields as it is to fulfil the requirement of environmental acts covering Water act 1974 (Sec.17, 25, 26, 51-53), Air act 1981 (Sec.72, 21, 28 and 29), Environment (Protection) act 1986 (Sec. 12 and 13), rules and amendments issued there after. The Environmental laboratory require adequate work places for Analytical and Microbiology laboratory sections separately for instrumentation and infrastructure with dedicated place are (i) wet lab, (ii) Balances, (iii) Instruments with provision of Gas cylinders etc. (iii) Sample pre-treatment, (iv) wet lab for preparations, titrations, digestion & extraction (v) Sample receipt (vi) Sample storage, (vii) Conference, (viii) Library, (ix) Staff, (x) Computers, (xi) Store, (xii) Maintenance, (xiii) Laboratory Record, (xiv) Field monitoring equipment, (xv) Hazard Waste storage and (xvi) safe disposal system. The accreditation of ISO/IEC: 17025 mandatory for identification of Laboratory with MoEF&CC and OSHAS 18001 certification [18]. In following paragraphs, the numbers ending with K, in {} braces, indicate tentative cost in Thousand Rupees of instrument considering its life time >5 years with AMC service warranty.

AAS (Atomic Absorption Spectrophotometer) uses specific cathode tubes as light source for specific heavy metal. It requires acetylene - compressed purified air / nitrous oxide - argon for atomisation of sample at nebulizer. It measures the concentration of specific metal by its repetitive absorption frequency light that is emitted from cathode tube and deuterium lamp is used for reduction of noise and for operation of instrument in emission mode. Its detection sensitivity concentration is in the range up to ppm to ppb. ICP (Inductively coupled Plasma Analyser) works on emission mode and for effective atomisation argon plasma generated with ark, and the generated spectrum analysed for more number of heavy elements. TOC (Total Oxidisable Carbon Analyser) {2461K} is treated as substitute COD and specific for Carbon wether it is organic or inorganic species. It is utilising Zero-air or oxygen and generated CO_2 estimated with NDIR technology. IC (Ion Chromatography), GC (Gas Chromatography) {3785K}, HPLC (High Pressure Liquid Chromatography), are based on adsorption, solubility, mobility with stationary and mobile phases for isolation of compound, which inturn identified with detectors such as FID, ECD, TCD, NPD, MS-MS, etc. Gas chromatography with Mass Spectroscopy termed as GCMS and GCMS-MS {16541K}.

ISM (Ion Specific Meter); Polarography: FTIR (Fourier Transforming Infrared Radiation Spectroscopy); XRF/XRD (X-ray fluorescence / X-ray Diffraction Analyser); UV-Vis Spectroscope(340K); Amino acid / Protein analyser; Bomb-calorimeter; Melting and Flash point temperature monitor; COD Digester {174K}; Karl Fischer Titrator {408K}; BOD Incubator {144K}; Bacteriological Incubator {63K}; Microwave digester {1075K}; Ultrasonic cleaner, Microbalance {661K}; Semi-micro balance; Ovens, Fume cupboards; Water Purification Systems {444/-}; CO Analyzer {622K}; Ozone Analyzer {844K}; CN; water quality system for pH, Temperature, DO and TDS {307K}; pH cum Conductivity meter {111K}; etc., are part of laboratory. The static continuous monitors such as RTNMS (Real time Noise Monitoring Stations) {1553K}; CAAQMS {9680K}; Weather Monitoring Station; Stack flue gas Monitor are site specific. Some of the field equipment are Noise meter; Stack monitoring kit; FTIR; GC with PID/FD; VOC; Weather station; PM10 (Particulate matter less than 10 micron); PM2.5 (Particulate matter less than 2.5 micron); pH, Conductivity, DO, flow measurement multi-parameter kits etc.

IV. CONCLUTIONS

Presently, the manufacture of equipment is under multinational firms. The administrators and a part of scientific community are in wrong notation in synchronising general applications to instruments. For example, the Class-A noise meter [19] sensors are not different from good Smartphone, as the manufacturer aim is meeting the perception of ear, audible levels dBA & dBC and norms. The present development in digital camera improves performance of sensing, eliminates bulky precession optical grating arrangement, development in electronics miniaturises the hardware for processing the signal, its communication and storage. It is experiences for indigenised laboratory equipment, in process of submission of lowest quote, many of the manufacturers failed to produce quality product and service. For them, many factors governed for inferior service, (i) less turnover and lower budget profile, (ii) low cost not manageable to provide service, buy and through policy, (iii) No R&D, not meeting update improvement management, (iv) high interest rate on establishment and maintenance finance, (v) higher taxation, (vi) kick-backs on small and medium entrepreneurs for payment and (v) higher burden of politics and politicians prevent for indigenised internal market. Little Indian manufacturing competitors are facing delayed payments while importers had the advance payment (letter of credit). The public firms supporting imports in the name of higher specifications than required, exemption of taxation, etc., this is to be reviewed with the Government for the benefit of country as it strengthens its money circulation.

ACKNOWLEDGMENT

The Authors wish to acknowledge the Chairman, APPCB; the Member Secretary and officials of APPCB for their support.

REFERENCES

[1]. Elements of Physical Chemistry, The Conductance of Electrolytes. 12, 419, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[2]. Significance of conductance at infinite dilution. Van Rysselberghe, ibid., 20, 131 (1943)
[3]. Elements of Physical Chemistry, Electromotive force. 13, 455, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[4]. Polarographic analysis. Kolthoff and Lingane, Chem. Rev., 24, 1 (1939).
[5]. Elements of Physical Chemistry, Equilibria in Electrolytes. 14, 523, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[6]. Elements of Physical Chemistry, Equilibria in Electrolytes. 14, 510, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[7]. Definition of pH scales, Bates, ibid, 42, 1 (1948).
[8]. Silver-silver halide electrodes. Jans and Tamaguchi, ibid., 53, 397 (1953).
[9]. oncentration cell measurements. Hoyt, J. Chem. Ed., 14, 185 (1937.
[10]. Elements of Physical Chemistry, Surface Chemistry and Colloids. 15, 572, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[11]. Elements of Physical Chemistry, The Gas Laws. 2, 6-15, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[12]. Elements of Physical Chemistry, Thermodynamics and thermochemistry. 3, 61, 2nd Edn., Samuel Glasstone and David Lewis, Pub: Macmillan & Co. Ltd.
[13]. The Person-Kirchhoff law. Gucker, J. Chem. Ed., **8**, 2391 (1931).
[14]. Baker, R. Jacob (2010). CMOS: Circuit Design, Layout, and Simulation, Third Edition. Wiley-IEEE. p. 1174. ISBN 978-0-470-88132-3
[15]. Publications Concerning Semiconductors, © D.W.Palmer, 1999-2008; 2008.11c
[16]. https://www.maximintegrated.com/en/products/all-products.html is providing source of components suitable for designing as per requirement.
[17]. Courtesy of Maxim (IC) Mfd., https://www.maximintegrated.com/en/products/analog/data-converters/analog-to-digital-converters/MAX11359A.html, dated 13 September 2016.
[18]. Clause (b) of sub-section (l) of Section 12 and Section 13 of Environment (Protection) Act, 1986 (29 of 1986) read with rule l0 of the Environment (Protection) Rules, 1986, MoEF, GOI.
[19]. M.Phil. Dissertation " A Study on Noise Pollution Levels in Visakhapatnam City" Chapter 1.2 Sound descriptors, Author: T. VIDYASAGAR, 2003; Andhra University, Visakhapatnam.