COMPLEMENTARY COURSES	
CHEMISTRY: (COMPLEMENTARY TO BOTANY & PHYSICS PROGRAMMES)	
Course Outcome SEMESTER I Course Code: CHE1C01 Complementary Course I: GENERAL CHEMISTRY	
CO1	Basic knowledge about acidity or basicity enables one to be aware of the pros and cons of various habits he/she maintain in his/her daily life.
CO2	If you brush your teeth every morning when you wake up, you have already experienced your first base of the day. Toothpaste, which contains sodium fluoride, belongs to the group of weak bases. The high pH of toothpaste helps kill any bacteria that reside in your mouth at the time of brushing. Those bacteria prefer a neutral to slightly acidic environment, exactly the conditions of your unbrushed mouth
CO3	The everyday foods you eat also have characteristic properties of acids or bases. Let's say you drink a nice tall glass of orange juice for breakfast after brushing your teeth. Orange juice and oranges themselves are quite acidic on the pH scale. A high citric acid content gives the oranges a low pH. On the other hand, if you indulge in a steak and some potatoes for lunch, that food has mostly basic properties.
CO4	Your body produces gastric acid, an extremely acidic (pH 1-2) material that helps to break down the steak and potatoes you ate fro lunch. The acid turns on enzymes that break down the proteins in the food. This highly acidic environment also helps control potentially harmful microorganisms from entering your intestines, where they can cause serious illness. When your stomach produces too much gastric acid, you may experience a common condition called acid reflux or heartburn. This occurs when overproduction causes the acid to creep up your esophagus. Antacids, which are high pH and therefore basic, neutralize this acid to provide relief from the burning feeling.
CO5	Awareness about various analytical methods and their applications help one to be vigilant when he consumes products from market.
CO6	Self-life is the time period till which a compound will be fit for use. For medicines, it is the time required for 90% of drug ingredient to stay active after the date of manufacture. Hence we notice expiry date clearly marked on all the medicine packages. So in pharmacy we notice some medicines stored in refrigerator and some in dark places to maintain the self-life.
CO7	During manufacture of drug, there are many chemical intermediates and reagents used. So there are many chances that impurities like heavy metals, dirt etc. can also be present in final preparation. Analytical chemistry is used to see if the formulation is within limits of contamination. If the contamination is more, then it is unfit for consumption.
CO8	When a medical formulation is made in the form of a tablet, ointment, capsule etc. It is tested for its ability to release the medicine from within when put in a suitable medium. The dissolution studies are done to see if the medicine is released completely from the tablet. Also the time taken for release. Both these factors are essential because when a tablet is swallowed, it stays in the stomach only for an hour. So if it has to release the medicine, it has to do it within one hour. Also a medicine shows its effects at suitable dose and not sub-doses. So the tablet has to release the entire content within the said time. Hence dissolution studies are done by using analytical chemistry to test the release of drug from a formulation
CO9	Nuclear chemistry and its applications make one to assess, determine and understand about various matters like how to improve agricultural efficiency, whether the food we purchase is sterilised or not, how the good and efficient is the treatment for cancer etc.
CO10	Food irradiation is the process of using radioactive sources to sterilize foodstuffs. The radiation works by killing bacteria and viruses, or eliminating their ability to reproduce by severely damaging their DNA or RNA. Since neutron radiation is not used, the remaining food

	doesn't become radioactive itself, leaving it safe to eat. This method is also used to sterilize food packaging, medical devices, and manufacturing parts.
CO11	Essentially high-powered versions of the types of X-Ray machines used in medicine, industrial radiography cameras use X-rays or even gamma sources (such as Iridium-192, Cobalt-60, or Cesium-137) to examine hard to reach or hard to see places. This is frequently used to examine welds for defects or irregularities, or examining other materials to locate structural anomalies or internal components. Industrial radiography is also very useful for secure, non-invasive scanning at security checkpoints, such as airports, where x-ray baggage scanners are in routine use. Larger versions of the same machines are often used to examine shipping containers all over the world.
CO12	The use of isotopes and radiation techniques in agriculture comes under this category. Leading organizations have been working on the technology to increase agricultural production, improve food availability and quality, reduce production costs and minimize pollution of food crops. One major ongoing advancement is Sterile Insect Technique (SIT), that helps in large-scale food irrigation and biological control of pests.
CO13	Radioisotopes can be actively used for tracing the pollutants present in air. The dangerous residues of the radioisotope present even in small amounts in air can be very harmful to humans (can cause health effects such as kidney disease, etc.). Hence, the tracing quality helps to detect the residue easily, thereby ensuring a healthy and safe environment.
CO14	Knowledge about bioinorganic chemistry equips one to understand various biological processes and any anomaly about it is present at all. The biochemical processes by which all living organisms sustain life. Metabolism is the sum of all chemical processes occurring within living cells and organisms. Although most living organisms on earth share common pathways to sustain life they do so with the use of different sources of energy and carbon. Metabolism consists of two main types of reactions, catabolic and anabolic. Catabolic processes are ones in which biomolecules are being degraded or oxidized. Anabolic processes are ones in which biomolecules are built via biosynthesis and reduction.
SEMESTER II	
Course Code: CHE2C02 Complementary Course II: PHYSICAL CHEMISTRY	
CO1	Learning thermodynamics is of atmost importance in understanding various things we come across in daily life. Thermodynamics has several types of Applications in our daily life: Fossil-fueled steam power plants, Spark-ignition engines and Jet engines.All types of vehicles that we use, cars, motorcycles, trucks, ships, aeroplanes, and many other types work on the basis of second law of thermodynamics and Carnot Cycle. Even cooling machines, such as refrigerators and air conditioners, actually use heat, simply reversing the usual process by which particles are heated. The refrigerator pulls heat from its inner compartment-the area where food and other perishables are stored-and transfers it to the region outside. This is why the back of a refrigerator is warm.All the refrigerators, deep freezers, industrial refrigeration systems, all types of air-conditioning systems, heat pumps, etc work on the basis of the second law of thermodynamics.
CO2	Knowledge about crystals and liquid crystals too helps one to understand the chemistry behinds watches, LCD, communications lines, microprocessors etc
CO3	Watches: here is a reason why the "glass" covering on a watch face is referred to as a "crystal." Rather than being plain glass, it is actually a crystal lens that is precisely shaped and highly polished. Crystals have a long history of being used in watches because they have the ability to resonate subtle vibrations that help keep the mechanics running in smooth time.
CO4	Micro Processors: Most people instantly associate the word silicon with being modern and high-tech. This is partially because of Silicon Valley being an established technology center, but also because of silicon being a primary component in computer chip s and

	microprocessors. While all of this is certainly true, few people realize that all of this is possible because of crystals. Silicon is derived from melting crystals into a liquid form that can be molded and shaped. So as you read this, you are using the power of crystals to bring information to your fingertips.
CO5	LCD Display: Many of us encounter LCD displays on a regular basis. Be it from a monitor, a hand -held game, a cell phone screen or digital signage, we interact with LCD more often than we usually realize. Not everyone stops to think about what the name means or how it works. The short explanation is that LCD stands for Liquid Crystal Display. Because crystals in a liquid stat e can carry and direct light very precisely, they make an ideal solution for monitors and other displays. They must, howev er, be properly recycled when the equipment has exceeded its life.
CO6	Communications Lines: Whether you're making a telephone call from a land line or accessing high –speed Internet, you probably encounter fiber optic communications lines every day without eve n knowing it. These lines are actually made of glass. What you may be surprised to learn is that the glass is more than just heated sand. It also contains crystal, which strengthens the gl ass and gives it a more consistent, smooth flow
CO7	Knowledge on Collugative properties helps one to understand so many processes deeply.
CO8	Freezing point depression is used in winter to melt snow on the roads by putting salt on it. And also to make ice cream, since you can make much lower temperatures than zero by adding salt to an ice/water mixture.
CO9	Osmotic pressure has many applications, in particular in living systems: trees use it to get water to their leaves, to give just one example. You can also use it to desalinate water using pressure and semipermeable membranes.
CO10	Adding salt to water before or while heating it will increase its boiling point, so the water will actually be hotter than it would otherwise be when it comes to a boil. The amount of this increase, however, is quite negligible at low salt concentrations; adding a couple grams of salt to 10 cups of water, for example, would only yield a boiling point elevation of about 0.015 degrees Celsius, which will not affect your cooking significantly. Nonetheless, cooking is one use of boiling point elevation. It's also important to note that -- contrary to myth -- adding salt to water will not make it boil faster. Quite the contrary, in fact, it will take slightly longer to boil, since its boiling point has now been elevated.
CO11	Once a sugarcane crop has been harvested and the cane juice extracted, it must be refined to produce crystalline sugar for consumption. At some stages during the process, the cane juice or syrup is boiled, and the temperature at which it boils will depend on the sugar concentration. In fact, the boiling point elevation offers a way to monitor the level of saturation of the solution, which is an important consideration for crystallization.
CO12	There are widespread applications of electro chemistry one would have to come across in his/her daily life. Understanding of the theory of which helps him/her to get a grip on the chemistry behind those.
CO13	Electrochemistry has a number of different uses, particularly in industry. The principles of cells are used to make electrical batteries. In science and technology, a battery is a device that stores chemical energy and makes it available in an electrical form. Batteries are made of electrochemical devices such as one or more galvanic cells or fuel cells. Batteries have many uses including in: ➢torches ➢ electrical appliances such as cellphones (long-life alkaline batteries) ➢ digital cameras (lithium batteries) ➢ hearing aids (silver-oxide batteries) ➢ digital watches (mercury/silver-oxide batteries) ➢ military applications (thermal batteries)

CO14	The electrolytic cell can be used for electroplating. Electroplating occurs when an electrically conductive object is coated with a layer of metal using electrical current. Sometimes, electroplating is used to give a metal particular properties or for aesthetic reasons: ➢ corrosion protection ➢ abrasion and wear resistance ➢ the production of jewellery
SEMESTER III	
Course Code: CHE3C03 Complementary Course III: ORGANIC CHEMISTRY	
CO1	Learning organic chemistry probably has a lot to do with understanding about medicines and the actions behind it. Cleansing or sterilising agents works on the principles of organic chemistry as well.Polimers, plastics and petrochemical products doesn't have any different story too.
CO2	Medicine: Medicine is the prime store of organic compounds. Though not all but many drugs are made of organic substances. Like antibiotics, anticancer drugs, painkillers, anti-depressant, anesthetics, etc. Drugs to cure disease: As said before many drugs used for the treatment of diseases are made of organic compounds. Hence they are water-insoluble, bitter and also easily movable in the body tissues. To diagnose the disease chemistry uses some diagnosing aids to detect the organic part of the deficiency or disturbed substance. In diabetics, there is increased sugar levels and in severe cases even the ketone levels. Sugars have aldehyde groups (CHO) and ketones (C=O) groups. These groups are the targets in analysis. The more these groups during estimation, the more is the sugar levels and vice-verse. So organic chemistry in diagnosis aims to check for the organic functional group levels as a parameter of the disturbed substance in the body. In heart patients, the cholesterol levels from blood are estimated using study of ester and carboxylic acid groups.
CO3	Food: Food materials are solely made of carbon compounds viz. carbohydrates (CHO), proteins (NH2-CH-COOH), and fats (CH-COO-CH). Even vitamins are organic in nature. Study of the requirement of the body for various purposes like pregnancy, disease condition, body fitness, etc. experts advice use of vitamins (FOLIC acid in pregnancy), fat (minimize in heart diseases) and (protein rich diet for body building).
CO4	Cleansing agents: In industries and labs, organic solvents are widely used to clear of impurities. For example in drug extraction from plants, the fatty matter from the pulp is removed using petroleum ether. Thus organic chemistry through its knowledge of polarity, solubility, partition factors uses solvents to separate components for better use.
CO5	Sterilizing agents: Most of the sterilizing agents and disinfectants like phenol, formaldehyde etc are carbon compounds. Due to their properties like solubility, pH they can kill microbes and even human body cells. These kill the bacteria and other microbes due to either dissolving the microbe cell wall or damaging the protein layer etc. Their efficiency is enhanced by making small tweaks in the chemistry. Besides these solvents, there are gases like ethylene oxide which are used for sterilization of drugs and manufactured substances.
CO6	Analytic substances: Most substances we use like drugs, pesticides, etc., are analyzed qualitatively and quantitatively using different types of titrations, chromatography techniques, and spectrophotometry. Here the reagent use like acids or bases or reductive oxidative species is organic in nature. Further, the endpoint indicators in titration are developed by organic chemistry.
CO7	Synthetic fibers such as nylon—used in everything from toothbrushes to parachutes—would be out of the picture if it were not for the enormous progress made by organic chemistry. The same is true of plastics or polymers in general, which have literally hundreds upon hundreds of applications. Indeed, it is virtually impossible for a person in twenty-first century America to spend an entire day without coming into contact with at least one, and more

	likely dozens, of plastic products. Car parts, toys, computer housings, Velcro fasteners, PVC (polyvinyl chloride) plumbing pipes, and many more fixtures of modern life are all made possible by plastics and polymers
CO8	Then there is the vast array of petrochemicals that power modern civilization. Best-known among these is gasoline, but there is also coal, still one of the most significant fuels used in electrical power plants, as well as natural gas and various other forms of oil used either directly or indirectly in providing heat, light, and electric power to homes. But the influence of petrochemicals extends far beyond their applications for fuel. For instance, the roofing materials and tar that (quite literally) keep a roof over people's heads, protecting them from sun and rain, are the product of petrochemicals and ultimately, of organic chemistry.
SEMESTER IV	
Course Code: CHE4C04 Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY	
CO1	The application of physical chemistry in daily life is the phenomenon whereas the law of physic and chemistry applied in things that happening everyday in our life. Unlike other branches, it manages the standards of material science fundamental every single chemical interactions (e.g., gas laws), trying to quantify, connect, and clarify the quantitative parts of responses. The awareness about the principles of the subject helps one to understand the chemistry behind whatever processes he/she come across which works on the principles of physical chemistry. A few of human biological process which utilises physical chemistry principles are listed below.
CO2	Non-equilibrium thermodynamics; which is the thermodynamics of systems not at equilibrium. Living systems are examples of chemical reactions not at equilibrium and pH
CO3	Theory of electrolytes. Human body fluids are electrolytes.
CO4	Henry's law : relates to concentration of dissolved oxygen in the blood.
CO5	Gibb's free energy of a biochemical reaction.
CO6	Colligative properties & polymer molar mass determinations.
CO7	Reaction kinetics of biochemical reactions / enzyme kinetics
CO8	Behaviour of polymers in solution. Proteins and enzymes are polymers in solution
CO9	Colloidal properties of human body fluids.
CO10	Surface science of skin and other membranes
CO11	Photochemistry of vision
CO12	Colour chemistry and Solubility of tablets
CO13	Insolubility of titanium and tantalum alloy surgical implants in the human body. The insolubility of their corrosion products means they are harmless when these metals are placed within the human body.
CO14	The secondary, tertiary and quaternary structures of proteins. These are inter- and intramolecular dipole interactions between polymers.
CO15	The statistical mechanics of polymer solutions / the structure of polymer solutions such as there is Vitamin D production via interaction of sunlight with the skin
CO16	UV light and blindness and Raman spectroscopy for monitoring wound healing, and for tissue

	imaging
CO17	Neutron scattering. Small angle scattering is used to analyse the size and shape of biological molecules in solution. Both large and small biological molecules can be analysed in this way.