Bachelor of Science (BSc)

Program Educational Objectives (PEOs) Biotechnology/Microbiology:

PEO-1: Prospective Employment and Career Prospects-Developing the potential for vertical career growth in Biotech-oriented industries, service sectors and related avenues.

PEO-2: Proficiency- Inculcating technical and managerial skills crucial for real time scenarios through the enhancement of problem-solving skills and advanced technical documentation ability.

PEO-3: Affectionate Objective- Grooming the students with technical proficiency to equip them for the emergence of sustainable technology and solutions for prevailing environmental, societal and cultural concerns.

PEO-4: Research Methods-Nurturing the research aptitude to provide solutions for global challenges and abilities to explore hidden potential of the matter

PEO-5: Continuous Learning-Instilling knowledge and awareness on professional ethics, bioethical and health issues, intellectual property rights and life-long learning through career oriented courses

Program Outcomes (POs) Biotechnology/Microbiology:

By the end of the program the students will be able to:

PO 1. Understand concepts of Biotechnology/Microbiology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, and molecular biology.

PO 2. Demonstrate the Laboratory skills in cell biology, basic and applied microbiology with emphasis on technological aspects

PO 3. Be competent to apply the knowledge and skills gained in the fields of plant biotechnology, animal biotechnology and microbial technology in pharma, food, agriculture, beverages, herbal and nutraceutical industries.

PO 4. Critically analyze environmental issues and apply the biotechnology knowledge gained for conserving the

environment and resolving environmental problems.

PO 5. Demonstrate comprehensive innovations and skills in the fields of biomolecules, cell and organelles, molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare.

PO 6. Apply the knowledge and skills of immunology, bioinformatics, computational modelling of proteins, drug design and simulations to test models and aid in drug discovery.

PO 7. Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of biotechnology.

PO 8. Learn and practice professional skills in handling microbes, animals and plants and demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animals handling, intellectual property rights, biosafety, and biohazards.

PO 9. Demonstrate thorough knowledge and application of good laboratory and good manufacturing practices in biotech industries

PO 10. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up of small-scale enterprises or CROs

Bachelor of Science (BSc)

CURRICULUM COMPONENTS

Components		Credits
University Core (Table 1)	Ability Enhancement Courses (06 Courses)	**12**
	Skill Enhancement Courses (06 Courses)	**12**
Discipline Core Courses (8 Courses) (Table 2)		**32**
Discipline Specific Major Electives (8+4 Courses) (Table 3)		**32R/48H***
Discipline Specific Minor Electives (6 Courses) (Table 3)		**24**
Interdisciplinary Minor Electives (04 Courses) (Table 4)		**16**
Project/Field Internship/Skill Based Project		**28H/44R***
Total		**172**

*** Opt either 04 Specialized Courses (for Honors Degree) or Research Based Industrial Project (for Research Degree)**

** Note: Any student opting out after I year / II year will obtain undergraduate Certificate/Diploma respectively in the specific discipline subject to mandatory 450hrs (8-10 week) ,10 credit Internship in SUB/Industry/Research organization.

COURSE CODE	BACTERIOLOGY AND SYSTEMATICS	Total Lec:45 Hours
SC23MB001		**3-0-2**
Learning Objectives	At the completion of this course, the will know ● Characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili. ● Common bacteria by their salient characteristics; classify bacteria into groups. ● Nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments. ● Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.	
Pre-requisites:	Elementary knowledge about microbes & microbial metabolism.	

UNIT	CONTENT	HOURS
I	Cell organization : Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative cell wall, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS). Effect of antibiotics and enzymes on the cell wall. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation	10
II	Bacteriological techniques : Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing nonculturable bacteria.	7
III	Microscopy : Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope	8
IV	Growth and nutrition : Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action.	10
V	Bacterial Systematics : Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences.	10

Course Outcome as per Bloom's Taxonomy	
CO1	The students will be able to **characterize**[2] bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.
CO2	The students will be able to d**ifferentiate**[2] a large number of common bacteria by their salient characteristics
CO3	The students will be able to **classify**[4] bacteria into groups.
CO4	The students will be able to **define**[4] the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments

CO5	The students will be able to **demostrate[2]** basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria
Text Books	●JPelczar, E C S Chan and N R Krieg, Microbiology. 5th edition,1993, McGraw Hill M Book Company. ●GJ Tortora, BR Funke and CL Case,Microbiology: An Introduction. 9th edition, 2008, Pearson Education. ● C P Baveja,Textbook of Microbiology. 6th edition, 2019, Arya Publication. ● D K Maheshwari, S Chand, Text Book of Microbiology .6th edition, 2013.
Reference Books	● J Cappucino and N Sherman, Microbiology: A Laboratory Manual. 9th edition, 2010, Pearson Education Limited. ● J M Wiley, L M Sherwood and Woolverton, C J Prescott's, Microbiology. 9th edition 2013, McGraw Hill International. ● R M Atlas, Principles of Microbiology. 2nd edition, 1997, W M T Brown Publishers. ● R Y Stanier, J L Ingraham, M L Wheelis, and P R Painter, General Microbiology. 5th edition, 2005, McMillan ● H F Lodish ,Molecular Cell Biology 8th edition, 2016, New York: W.H. Freeman. ● J EKrebs, B Lewin, S T Kilpatrick, Goldstein, Lewin's Genes XI, 2014, Sudbury: Jones and Bartlett.

COURSE CODE	**BACTERIOLOGY AND SYSTEMATICS**	**Practical:30 hours**
SC23MB001P		
	1. Preparation of different media: synthetic media CzapekDox media and /or BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar. 2. Simple staining 3. Negative staining 4. Gram's staining 5. Acid fast staining-permanent slide only. 6. Capsule staining 7. Endospore staining. 8. Isolation of pure cultures of bacteria by streaking method. 9. Preservation of bacterial cultures by various techniques. 10. Estimation of CFU count by spread plate method/pour plate method.	

COURSE CODE	MICROBIAL PHYSIOLOGY AND METABOLISM	Total Lec: 45
SC23MB002		3 – 0 – 2
Learning Objectives:	● The course will provide students fundamental knowledge and methodologies for microbial studies and be able to relate knowledge to various microbial applications. ● Develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways and to enable students to better understand microbial world.	
Pre-requisites:	Elementary Biology	
UNIT	CONTENT	HOURS
I	Microbial nutrition and transport: Classification of microorganisms based on nutrient and energy source. Nutrient uptake and transport: passive and facilitated diffusion, primary and secondary active transport, iron uptake, concept of uniport, symport, antiport, group translocation.	6
II	Microbial growth and influence of environmental factors: Bacterial growth curve (generation time and specific growth rate), diauxic growth, synchronous growth, batch and continuous cultures. Effect of temperature, pH, oxygen concentration, solute and water activity on growth.	10
III	Carbon metabolism and energy generation: Concept of aerobic respiration, anaerobic respiration and fermentation. Glucose degradation/catabolism by microbes via: Embden-MeyerhofParnas (EMP) pathway /glycolysis, Entner-Doudoroff (ED) pathway, Pentose phosphate pathway (PPP), Krebs Cycle /Tricarboxylic Acid Cycle, Glyoxylate cycle. Electron transport during aerobic respiration: components of mitochondrial electron transport chain (ETC), chemiosmotic hypothesis, oxidative phosphorylation and ATP generation, uncouplers and inhibitors of respiratory chain, comparison of mitochondrial and bacterial electron transport, branched respiratory chain in bacteria (E. coli) under high and low levels of O2. Anaerobic respiration with nitrate as final electron acceptor: dissimilatory nitrate reduction (denitrification, nitrate /nitrite and nitrate/ammonia respiration).	12
IV	Bacterial fermentations: Alcohol fermentation and Pasteur effect, lactate fermentation (homofermentative and heterofermentative pathways). Concept of linear and branched fermentation pathways	7
V	Chemolithotrophic and phototrophic metabolism: Definition, physiological groups of chemolithotrophs, aerobic chemolithotrophy with details of H2 oxidizers and anaerobic chemolithotrophy with details of methanogens. Families of phototrophic bacteria. Anoxygenic photosynthesis with reference to purple and green bacteria and oxygenic photosynthesis with reference to cyanobacteria: photosynthetic pigments and photophosphorylation (cyclic and noncyclic). C1 metabolism: CO2 fixation by Calvin cycle, reductive TCA and methanogenesis	10
Course Outcomes as per Bloom's Taxonomy		
CO1	They will **understand**[2] the nutritional requirement of Microorganisms	
CO2	The student will be capable of **describing**[4] the growth characteristics of the microorganisms	
CO3	They will be able to critically **evaluate**[5] the growth under unusual environmental condition of temperature, oxygen, and solute and water activity.	
CO4	The students will be able to **analyse**[4] concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.	

CO5	They will be able to **illustrate**[4] the associated mechanisms of microbes to energy generation for their survival
Text Books:	● MT Madigan, and JM Martinko, Biology of Microorganisms. 14th edition, 2014, Prentice Hall International Inc. ● S. R. Reddy and S. M.Reddy., Microbial Physiology, 2005, Scientific Publishers India ● J.M Willey, L.M Sherwood, and C.J Woolverton, Prescott's Microbiology. 9th edition, 2013, McGraw Hill Higher Education.
Reference Books:	● Stanier, Ingraham, et.al, The Microbial world, 2010, Mc Millan Educational Ltd., London ● Franklin and Snow, Biochemistry of Antimicrobial Action, 1989, Chapman and Hall, New York. ● Sturart. Harris and Harris. The control of Antibiotic Resistance in Bacteria, 2002.

COURSE CODE	**MICROBIAL PHYSIOLOGY AND METABOLISM**	**Practical:30 hours**
SC23MB002P		**1**
	1. Study and plot the growth curve of E. coli by turbidometric method. 2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data. 3. Effect of temperature and pH on growth of E. coli or Aspergillus 4. Demonstration of alcoholic fermentation. 5. Effect of carbon and nitrogen on microbial growth.	

COURSE CODE	Agriculture and Food Microbiology	Total Lec:45	
SC23MB003		3 – 0 – 2	
Learning Objectives:	● The topics covered will provide in-depth knowledge of Microbiology. ● Understand the role of microbes in industrially applied fields. ● Understand the mechanism & methods of microbial process for industrial applications.		●
Pre-requisites:	Elementary knowledge about microbes & microbial metabolism.		
UNIT	CONTENT		
I	Plant Growth Promoting Microorganisms: Mycorrhizae, Rhizobia, Azospirillum, Azotobacter, Frankia, phosphate-solubilizers flouroscent Pseudomonads. Outlines of biological nitrogen fixation (symbiotic, non-symbiotic). Biofertilizers - Rhizobium, Cyanobacteria.		5
II	Importance of studying food and dairy microbiology: Natural flora and Sources of contamination of foods in general. Classification of food in relation to shelf life, Microbial spoilage: principles, intrinsic and extrinsic factors that affect growth and survival of microbes in foods, Spoilage of vegetables, fruits, meat, eggs, canned foods.		10
III	Principles, physical methods of food preservation: temperature, Pasteurization, types (canning, drying); High pressure and Irradiation; chemical methods of food preservation: salt, sugar, organic acids, SO2 and antibiotics.		10
IV	Microbiology of fermented milk : Starter lactic cultures, fermented milk products: yogurt, butter and cheese, other fermented foods: idly, bread. Nutritional value of fermented foods. Microorganisms as food: single cell protein, edible mushrooms. Probiotics: definition and uses.		10
V	Definition of food poisoning, food infections and toxications: Causative agents, foods involved, symptoms and preventive measures. Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Escherichia coli, Shigella, Listeria monocytogenes.		10
Course Outcomes as per Bloom's Taxonomy			
CO1	They will u**nderstand**[2] the basic concepts of industrial microbiology.		
CO2	The **relevance**[2] of industrially applied microbes in human welfare.		
CO3	Students will be able to critically **evaluate**[5] different methods & applications of microbes.		
CO4	They will **know**[1] the scope of industrial microbiology.		
CO5	Students will be able to **illustrate**[4] microbial interaction & production.		
Text Books:	● Ray, B. (1996). Fundamentals of Food Microbiology, CRC Press, USA. ● Rangaswami, G. and Bhagyaraj, D.J. (2001). Agricultural Microbiology, 2nd Edition, Prentice Hall of India, New Delhi. ● Patel, A.H. (1984). Industrial Microbiology, Mac Milan India Ltd., Hyderabad. ● Singh, R.P. (2007). Applied Microbiology. Kalyani Publishers, New Delhi.		
Reference Books:	● Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge. 2. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.		

	● Andrews AT, Varley J. (1994) Biochemistry of milk products. Royal Society of Chemistry. ● Banwart GJ. (1989), Basic food microbiology, Chapman & Hall, New York. ● EcEldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical. ● Frazier WC and Westhoff DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.	

COURSE CODE	**Agriculture and Food Microbiology Lab**	**Practical:30 hours**
SC23MB003P		**1**
	1. MBRT of milk samples and their standard plate count. 2. Isolation of food borne bacteria from food products. 3. Isolation of food borne fungi from food products. 4. Isolation of spoilage microorganisms from bread. 5. Microbiological examination of canned foods. 6. Microbiological examination of mushrooms. 7. Isolation of spoilage bacteria from fruits and vegetables. 8. Effect of temperature on the spoilage of food products.	

COURSE CODE	Industrial Biotechnology	Total Lec: 45
SC23MB004		3 – 0 – 2
Learning Objectives:	• To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs. • The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures.	
Pre-requisites:	Elementary Biology	
UNIT	CONTENT	HOURS
I	Fermentation: Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.	10
II	Primary Metabolites: Production of commercially important primary metabolites like organic acids, amino acids and alcohols.	5
III	Secondary Metabolites: Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.	10
IV	Production of Industrial Enzymes: Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.	10
V	Production of recombinant proteins: Therapeutic and diagnostic applications of vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	To explain the steps involved in the production of bio products and methods to improve modern biotechnology	
CO2	To apply basic biotechnological principles, methods and models to solve biotechnological tasks	
CO3	To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.	
CO4	To design and deliver useful modern biotechnology products to the Society.	
CO5	Recognize the concepts of industrial biotechnology.	
Text Books:	1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005. 2. Kumar, H.D. "A Textbook on Biotechnology" IInd Edition. Affiliated East West Press Pvt.Ltd., 1998. 3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004. 4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" IInd Edition Cambridge University Press, 2001. 5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand& Co. Ltd., 2006.	
Reference Books:	1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968. 2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005. 3. Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology",IInd Edition, Panima Publishing, 2000.	

	4. Moo-Young, Murrey, “Comprehensive Biotechnology”, 4 Vols. Pergamon Press, (An Imprintof Elsevier) 2004. 5. Stanbury, P.F., A. Whitaker and S.J. Hall “Principles of Fermentation Technology”, IInd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995. 6. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999. 7. K.G.Ramawat&Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications

COURSE CODE	**Industrial Biotechnology Lab**	**Practical:30 hours**
SC23MB004P		**1**
	1. Microbial production, detection and estimation of enzymes: Amylase /Protease/ Lipase 2. Microbial production, detection and estimation of amino acid: Glutamic acid 3. Microbial production, detection and estimation of organic acid: Citric acid 4. Microbial production, detection and estimation of alcohol: Ethanol 5. A visit to any educational institute/industry to see different parts of an industrial fermenter and downstream processing techniques.	

COURSE CODE	Medical Microbiology:	Total Lec.:45
SC23MB005		3-0-2
Learning Objectives	**Course Objective**: The candidate will gain knowledge about pathogenesis, diagnosis, control and treatment of medically important – viral diseases; bacterial diseases; fungal diseases; and parasitic infections.	
Pre-requisites:	Basic knowledge of microbes: bacteria, virus	

UNIT	CONTENT	HOURS
I	General properties of viruses Structure: cultivation, pathogenesis and various diagnosis techniques. Antiviral agents, chemotherapy and vaccines. Viroids, prions, virusoids and satellite RNA. General properties, antigenic structure, pathogenesis, clinical findings, lab diagnosis, prevention, control and treatment of - HIV, HAV, HBV, Rabies, Influenza, Dengue, Yellow Fever, Measles, Mumps, Rubella, Polio, Oncogenic Viruses.	10
II	Normal flora of human body: General attributes and virulence factors of bacteria causing infections – invasiveness and toxigenicity. Pathogens, pathogenesis, clinical manifestations, lab diagnosis, epidemiology, chemotherapy and prevention of diseases caused by– Staphylococcus, Streptococcus, C. diphtheriae, Cl. tetani, Cl. botulinam, B.pertussis, M. tuberculosis, N. gonorrheae, S. typhi, V. cholera , S. dysentriae, T. pallidum. Y. pestis, Leptospira interrogans.	10
III	Epidemiology and control of community infections: Nosocomial infections – factors that influence hospital infection, hospital pathogens, routes of transmission, investigation, prevention and control. Hospital waste management.	5
IV	Detection and recovery of fungi from clinical specimens: Molecular and advanced diagnostic methods for mycological infections. Antifungal agents- testing methods and quality control. Yeasts of medical importance – Candida, Cryptococcus sp. Fungi of medical importance – Dermatophytes and Superficial mycoses, systemic mycoses, opportunistic mycoses, Dimatiaceous fungi, Eumycotic mycetoma.	10
V	Introduction to parasitology: Host–parasite relationship, mechanism of pathogenesis, transmission and life cycle of the Protozoan – Entamoeba, Toxoplasma, Cryptosporidium, Leishmania, Giardia, Trypanosoma, Trichomonas, Balantidium and Plasmodium. Helminthes – Cestodes – Taenia solium and T.saginata, Echinococcus. Trematodes – Fasciola hepatica, Fasciolopsisbuski, Paragonium, Schistosomes. Nematodes – Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Wucheriria	10

Course Outcomes as per Bloom's Taxonomy	
CO1	Study about the properties, pathogenecity, lab diagnosis of pathogenic viruses.

CO2	Know about the normal microbial flora of human
CO3	Learn about the characters, pathogenecity, lab diagnosis of bacterila pathogens.
CO4	Get knowledge on nosocomial infections.
CO5	Gain knowledge hospital waste management
CO6	Get in-depth knowledge on fungal pathogens.
CO7	Learn about pathogenic protozoans and helminthes.
Text Books:	● Jawetz. E, Melnick J.L, Adelberg E.A , Review of Medical Microbiology, Lange Medical Publications, ELBS, London. Ed. 28; 2013. ● H.C. Dube , Introduction to Fungi, Vikas Publishing House. Ed.3; 2005. ● D.R. Arora & B.R. Arora Medical Parasitology, CBS Publishers & Distributors, New Delhi. 1st Edn., 2002.
Reference Books:	● Ananthnarayanan. R & C. K. JeyaramPanicker, Textbook of Microbiology,;Orient Longman.Ed.8; 2006. ● David Greenwood, Richard B. Slack John F. Peutherer Medical Microbiology, Churchill Livingstone, London. 16th Edn., 2002. ● Baron EJ, Fine Gold S.M; Diagnostic Microbiology. Blackwell Scientific Systems. 1995. ● J.G. Colle, A.Simmons, A.G. Fraser, B.P. Marmion, Mackie & McCartney Practical Medical Microbiology, Elsevier.Ed.14; 2006. ● Topley & Wilson, Topley & Wilson's Principles of Bacteriology, Virology & Immunity, Vol III; Bacterial Diseases, Edward Arolla, London. Ed.8; 1990.

COURSE CODE	**MEDICAL MICROBIOLOGY Lab**	**Practical:30 hours**
SC23MB005P		**1**
	1. Identify pathogenic bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests 2. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS 3. Study of bacterial flora of skin by swab method 4. Perform antibacterial sensitivity by Kirby-Bauer method 5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms) 6. Study of various stages of Malarial parasite in RBCs using permanent mounts.	

Syllabus

SEMESTER I

COURSE CODE	Analytical and Organic Chemistry - I	Total Lec 45
SC23CH001		3-0-2
Learning Objectives:	After studying this course the students will know – ● Prepare graduates with the skills of sampling with accuracy and who will be able to evaluate the data analytically. ● To produce graduates whose basic concepts are clear in different methods of analytical chemistry. ● Prepare graduates with the skills to critically assess and solve problems requiring the application of chemical principles. ● To produce graduates whose basic concepts are clear in both organic chemistry.	
Pre- requisite:	Elementary chemistry (10+2)	
UNIT	CONTENT	HOURS
I	Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	8
II	Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer- Lambert's law. UV-Visible spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument. Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers,determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques,structural illustration through interpretation of data, effect and importance of isotope substitution. Flame atomic absorption and emission spectrometry:Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs,techniques of atomization and sample introduction; method of background correction, sources of chemical interferences and their method of removal,techniques for the quantitative estimation of trace level of metal ions from water samples.	12
III	Fundamentals of organic chemistry: Physical effects, electronic displacements: inductive effect, electromeric effect, resonance and hyperconjugation, cleavage of bonds: homolysis and heterolysis, structure, shape and reactivity of organic molecules: nucleophiles and electrophiles, reactive intermediates: carbocations, carbanions and free radicals, strength of organic acids and bases: comparative study with emphasis on factors affecting pk values.	9
IV	Stereochemistry: Conformations with respect to ethane, butane and cyclohexane, interconversion of wedge formula, Newmann, sawhorse and Fischer repretentations, concept of chirality (up to two carbon atoms) and configuration: geometrical and optical isomerism (enantiomerism, diastereomerism and meso compounds), threo and erythro; D and L; *cis – trans* nomenclature; CIP rules: R/S (for upto 2 chiral carbon atoms) and E/Z nomenclature (for up to two C=C systems).	8

V	Aliphatic hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure, alkanes: (up to 5 Carbons) preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent, reactions: free radical substitution: halogenations, alkenes: (up to 5 Carbons), preparation: elimination reactions: dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule), *cis* alkenes (partial catalytic hydrogenation) and *trans* alkenes (Birch reduction), reactions: *cis* addition (alk. $KMnO_4$) and *trans* addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, ozonolysis, oxymecuration-demercuration, hydroboration-oxidation, alkynes: (up to 5 Carbons), preparation: acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetra halides and dehydrohalogenation of vicinal- dihalides, reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	8
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will gain a firm knowledge in and **understanding** in analytical data with errors, accuracy and precision.	
CO2	They will be able to **evaluate**[5] several optical methods of analysis.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	
Text Books:	● SM Khopkar, Basic Concepts of Analytical Chemistry, 2009, New Age, International Publisher. ● D Gary, Analytical Chemistry, 6th Ed., Christian, 2004, John Wiley & Sons, New York. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models in InorganicChemistry, John Wiley and Sons Publications. ● E L Eliel, Stereochemistry of Carbon Compounds, 2017, Cyber Tech Publications. ● I L Finar,OrganicChemistry(Vol. I & II), E L B S.	
Reference Books:	● S. Hook, P. Kurtz, M. Todorovich, The Ethics of Teaching and Scientific Research, Prometheus Books, 1977. ● B. Stanley, J.E. Sieber, G. B. Nelton, Research Ethics: A Psychological Approach, University of Nebraska Press, 1996.	

COURSE CODE	Analytical and Organic Chemistry – I (Practical)
SC23CH001P	**2**
	Section A: Analytical Chemistry 1. Calibration of glassware, pipette, burette and volumetric flask. 2. Determination of sodium carbonate and sodium bicarbonate in a mixture by titrimetry. 3. Estimation of total hardness of a given sample of water by complexometric titration. 4. Determination of alkali present in soaps/detergents. 5. Determination of Fe^{2+} in Fe_2O_3. **Section B**: Organic Chemistry 1. Preparation of Benzamide 2. Preparation of Benzophenone Oxime 3. Purification of organic compounds by crystallization (from water and alcohol) distillation. 4. Hydrolysis of methyl salicylate. 5. Preparation of dibenzyledineacetone.

Syllabus

SEMESTER II

COURSE CODE	Inorganic and Physical Chemistry - I	Total Lec.: 45
SC23CH002		3-0-2
Learning Objectives:	After studying this course the students will know – ● Prepare graduates with the skills to critically assess and solve problems requiring theapplication of chemical principles. ● To produce graduates whose basic concepts are clear in fundamental inorganic chemistry. ● To produce graduates who will have clear understanding about concepts of physical chemistry like states of matter and chemical kinetics	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	CONTENT	HOURS
I	Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg uncertainty principle. hydrogen atom spectra, need of a new approach to atomic structure, quantum mechanics, time independent Schrodinger equation and meaning of various terms in it, significance of ψ and ψ^2, Schrödinger equation for hydrogen atom, radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (only graphical representation), radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals, significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s, shapes of s, p and d atomic orbitals, nodal planes, discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s), rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.	10
II	Chemical Bonding and Molecular Structure: Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculationof lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, concept of resonance and resonating structures in various inorganic and organic compounds. MO approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+, comparison of VBT and MOT.	10
III	Kinetic Theory of Gases: Postulates of kinetic theory of gases and derivation of the kinetic gas equation, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases, Boyle temperature (derivation not required), critical phenomena, critical constants and their calculation from van der Waals equation.	8

IV	Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effectof temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). Solids: Forms of solids, symmetry elements, unit cells, crystal systems, Bravais latticetypes and identification of lattice planes, laws of crystallography - law of constancy of interfacial angles, law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law, structures of NaCl, KCl and CsCl (qualitative treatment only),defects in crystals glasses and liquid crystals.	9
V	Chemical Kinetics: The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates, order and molecularity of a reaction, derivation of integratedrate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants),half–life of a reaction, general methods for determination of order of a reaction	8
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **define**[1] about the structure of atoms.	
CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of bonding for both ionic and covalent compounds.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	
Text Books:	● R L Madan, Chemistry for Degree Students (Semester I), 2016 S Chand PublishingHouse; First edition. ● R Sarkar, General and Inorganic Chemistry (Vol I), 2011, New Central Book Agency, 3rd Ed. ● P. Atkins and J. De Paul, 8th Edition, 2006, International Student Edition, Oxford UniversityPress. ● B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition,1998, Shoban Lal Nagin Chand & Co., Jalandhar.	
Referenc e Books:	● J E Huheey, E A Keiter, R L Keiter and O K Medhi, Inorganic Chemistry: Principlesof Structure and Reactivity, 2006 Pearson Education India. ● J D Lee, A new Concise Inorganic Chemistry, 5th Ed, 2016 Wiley Publication. ● F A Cotton, G Wilkinson, and P L Gaus, Basic Inorganic Chemistry, 3rd ed. WileyPublication. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models inInorganic Chemistry, John Wiley and Sons Publications. ● K. J. Laidler and J. M. Meiser, Physical Chemistry, 1999, 3rd Edition, Houghton Mifflin Comp.,New York, International Edition.	

COURSE CODE	Inorganic and Physical Chemistry – I (Practical)
SC23CH002P	2
	Section A: Inorganic Chemistry 1. Determination of carbonate and hydroxide present in amixture. 2. Determination of oxalic acid and sodium oxalate in a mixture by titrating it with standard $KMnO_4$/NaOH solution. 3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$. 4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 5. Soil Analysis-Determination of pH of soil. **Section B**: Physical Chemistry 1. Determination of density using specific gravity bottle 2. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non- hazardous liquids) 3. Study of the variation of viscosity of sucrose solution with the concentration of a solute. 4. Determination of the surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids) 5. Study of variation of surface tension of detergent solution with concentration.

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SEMESTER III

COURSE CODE	Analytical and Organic Chemistry - II	Total Lec.: 45
SC23CH003		3-0-2
Learning Objectives:	After studying this course the students will know – ● Prepare graduates with the skills of sampling with accuracy and who will be able to evaluate the data analytically. ● Prepare graduates with the skills to critically assess and solve problems requiring the application of chemical principles. ● To produce graduates whose basic concepts are clear in organic chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation, Techniques for quantitative estimation of Ca and Mg from their mixture.	12
II	Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations, techniques used for the determination of equivalence points, techniques used for the determination of pKa values.	12
III	Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of enantiomeric excess (ee)/diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents, chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.	12
IV	Aromaticity: Aromaticity and Huckel rule - A general concept, molecular orbital picture of benzene, aromatic electrophilic substitution, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts (alkylation and acylation).	12
V	Chemistry of Carbonyl compounds: Preparations and reactions: addition and condensation reactions; Cannizzaro, Perkin, aldol, benzoin, haloform,Phenols: General methods of preparation and reactions, Reimer-Tiemannand Kolbe reactions, relative acidity of phenol, alcohol and carboxylic acid. Nitrogen Containing compounds: Nitrobenzene and reduction products, Comparative basicity of aliphatic and aromatic amines, Diazonium Salts: Preparation and synthetic applications.	12

Course Outcomes as per Bloom's Taxonomy	
CO1	They will acquire an **understanding[2]** about thermal methods of analysis.
CO2	They will be able to **evaluate[5]** several separation techniques of analysis.
CO3	They will acquire an **understanding[2]** about electroanalytical method
CO4	Students will be able to **understand[2]** basic concept of aromaticity.
CO5	They will be able to **explain[2]** the chemistry of carbonyl compounds.
Text Books:	● SM Khopkar, Basic Concepts of Analytical Chemistry, 2009, New Age, International Publisher. ● D Gary, Analytical Chemistry, 6th Ed., Christian, 2004, John Wiley & Sons, New York. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models in InorganicChemistry, John Wiley and Sons Publications. ● E L Eliel, Stereochemistry of Carbon Compounds, 2017,Cyber Tech Publications. ● I L Finar,OrganicChemistry(Vol. I & II), E L B S.
Reference Books:	● H H Willard, et al., Instrumental Methods of Analysis, 7th Ed. 1988, Wardsworth Publishing Company, Belmont, California, USA. ● A I Vogel, A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery andothers), 5th Ed. 1989, The English Language Book Society of Longman ● R T Morrison and R N Boyd,Organic Chemistry, Prentice Hall. ● T W Graham Solomon,Organic Chemistry, John Wiley and Sons. ● P Sykes,A Guide Book to Mechanism in Organic Chemistry, Orient Longman. A Bahl and B S Bahl, Advanced Organic Chemistry,2012, S Chand Publishing House.

COURSE CODE	Analytical and Organic Chemistry – II (Practical)
SC23LM003P	1
	Section A: Analytical Chemistry 1. Identification and separation of the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography. Measure the Rf value in each case. 2. Identify and separate the sugars present in the given mixture by paper chromatography. 3. Paper chromatographic separation of Fe^{3+}, Co^{2+} and Cu^{2+}. 4. Determination of the Exchange Capacity of a Cation Ion Exchange Resin. **Section B**: Organic Chemistry 1. Aldol condensation reaction between benzaldehyde and acetone. 2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method). 3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture. 4. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method). 5. Synthesis of diazoaminobenzene from aniline (conventional method). 6. Preparation of dibenzalacetone (Green method).

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SEMESTER IV

COURSE CODE	Inorganic and Physical Chemistry - II	Total Lec.: 45
SC23CH004		3-0-2
Learning Objectives:	After studying this course the students will know – ● To produce graduates whose basic concepts are clear in fundamental inorganic chemistry. ● To produce graduates who will have clear understanding about concepts of physical chemistry like states of matter and chemical kinetics and also about the coordination chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Transition Elements (3d series):General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.	9
II	Coordination Chemistry: Valence Bond Theory (VBT): inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6),structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT, IUPAC system of nomenclature. Crystal Field Theory: crystal field effect, octahedral symmetry, crystal field stabilization energy (CFSE), crystal field effects for weak and strong fields. tetrahedral symmetry, f Factors affecting the magnitude of D,spectrochemical series, comparison of CFSE for Oh and Td complexes,	9
III	Phase Equilibria: Thermodynamics of phase transition-Clapeyron-Clausius equation and its applications, phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one- component system (water), two component systems (phenol-water, lead-silver), equilibrium constant from distribution coefficient ($KI + I_2 = KI_3$).	9
IV	Chemical Equilibrium: Free energy change in a chemical reaction, thermodynamic derivation of the law of chemical equilibrium, distinction between ΔG and ΔG^o, Le Chatelier's principle, relationship between *Kp, Kc & Kx* for reactions involving ideal gases.	9
V	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, buffer solutions, solubility and solubility product of sparingly soluble salts – applications.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **define**[1] about the structure of atoms.	
CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of bonding for both ionic and covalent compounds.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	

Text Books:	● R L Madan, Chemistry for Degree Students (Semester I), 2016 S Chand PublishingHouse; First edition. ● R Sarkar, General and Inorganic Chemistry (Vol I), 2011, New Central Book Agency,3rd Ed. ● P. Atkins and J. De Paul, 8th Edition, 2006, International Student Edition, Oxford UniversityPress. 2. ● B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition,1998, Shoban Lal Nagin Chand & Co., Jalandhar.
Referenc e Books:	● J E Huheey, E A Keiter, R L Keiter and O K Medhi, Inorganic Chemistry: Principlesof Structure and Reactivity, 2006 Pearson Education India. ● J D Lee, A new Concise Inorganic Chemistry, 5th Ed, 2016 Wiley Publication. ● F A Cotton, G Wilkinson, and P L Gaus, Basic Inorganic Chemistry, 3rd ed. WileyPublication. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models inInorganic Chemistry, John Wiley and Sons Publications. ● K. J. Laidler and J. M. Meiser, Physical Chemistry, 1999, 3rd Edition, Houghton Mifflin Comp.,New York, International Edition.

COURSE CODE	Inorganic and Physical Chemistry – II (Practical)
SC23CH004P	2
	Section A: Inorganic Chemistry 1. Determination of Acid-neutralizing power of a Commercial Antacid. 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA. 3. Determination of concentration of Potassium Permanganate solution using Ferrous Ammonium sulphate. 4. Determination of chlorine in bleaching powder using iodometric method. 5. Preparation of potash alum. **Section B**: Physical Chemistry 1. Saponification of ethyl acetate. 2. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate. 3. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (using dilute solutions of soaps and shampoos to preventdamage to the glass electrode) using pH-meter. 4. Preparation of buffer solution of sodium acetate-acetic acid and ammonium chloride-ammonium hydroxide. 5. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

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SEMESTER V

COURSE CODE	BIOLOGICAL CHEMISTRY	Total Lec: 60
SC23CH005		4-0-0
Learning Objectives	● Prepare students with the knowledge of enzymes, coenzymes and their mechanism. ● To produce students whose concepts are clear in nuclic acids and bio-synthesis	
Pre-requisite	None.	
UNIT	CONTENT	HOURS
I	Enzymes, co-enzymes and their mechanism of action: enzymes, classification, inhibition, mechanism of action of chymotrypsin, aldolase, alcohol, lysozyme, cofactors as derived from vitamins, co-enzymes, prosthetic, prosthetic group and apoenzymes.	12
II	Structure and biological functions of coenzyme-A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FAD, lipoic acid, mechanisms of reactions catalyzed by the above cofactors.	12
III	Nucleic Acids: Retro-synthetic analysis of Nucleic Acids - nucleotides, nucleosides, nucleobases (A, T, G, C and U), sugars (Ribose and deoxyribose), assembly of oligonucleotide chain: synthesis of polymer support, nucleosides and nucleotides, solid phase synthesis of oligo-nucleotides (DNA/RNA) through phosphoramidite and phosphorothionate approach.	12
IV	Application of protecting groups (-NH_2 and –OH functions, Base and Acid labile) and their deprotection and purification, concept of depurination.	12
V	Bio-synthesis: Terpenoids - C5, C10, C15, C20 units; alkaloids - quinine and morpholine.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand**[2] themechanism and action of enzymes and co-enzymes.	
CO2	They will be able to **illustrate**[2]structure and biological function of some enzymes.	
CO3	Students will **understand**[2] the details of nucleic acid.	
CO4	They will **learn**[2] the application of protecting groups.	
CO5	They will **develop**[3] the knowledge ofbio-synthesis.	
Text Books:	● A L Lehninger, **Principles of Biochemistry**, 1992CBS Publishers, Delhi. ● DVoet, J G Voet & CW Pratt, **Fundamentals of Biochemistry**, 1999 John Wiley & Sons, New York. ● H R Mahler and E H Cordes, **Biological Chemistry**, 1971, 2nd Edition, Harper and Row Pub., New York	
Reference Books:	● C Walsh, **Enzymatic Reaction Mechanisms**(1979), W.H. Freeman & Co., New York. ● I L Finar, **Organic Synthesis**, 1975, 5th edition. Vol.2, Longman Press, USA.	

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SEMESTER V

COURSE CODE	APPLIED CHEMISTRY	Total Lec.: 60
SC23CH006		4-0-0
Learning Objectives :	● Prepare students with the in-depth understanding of industrial chemistry ● To gain the knowledge in applied chemistry.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Soaps and Detergents: Theory of surface action, soap manufacture: raw materials, characteristics of cold process, semi boiled process and boiled process, additives of soap, detergent action of soap, influence of fatty acid composition of the oil on properties of soap, manufacture of soap for different purposes-laundry soaps, toilet soaps, liquid soaps, transparent soaps, baby soaps, shaving soaps, medicated soaps, textile soaps, naphtha soaps, marine soaps. T.F.M value of soaps, shampoos	12
II	Paints and Varnishes: Paints as protective coatings, paints and enamels, materials for paint manufacture, oils used-unmodified oils and their pre-treatment, modified drying oils, resins and copolymers, natural resins, phenolic resins, alkyd resins, urethane resins, epoxy resins - Driers, thinners, pigments and miscellaneous ingredients, mechanism of polymerization and drying of oils; varnishes and lacquers: composition and uses, oleo resinous varnishes, defects in varnish films.	12
III	Flavour and Perfume Chemistry: Concept of flavor, difference between perfumes and flavour, flavour characterisation, sensory analysis-descriptive and discriminant sensory analysis, flavour of coffee, tea, cocoa, onion and garlic, synthetic ingredients of food flavourings, odour, odorants, olfaction, classification of odour, general physiology of olfaction, perfume raw materials - terpeneless and sesquiterpeneless oils, concrete oils, absolute oils, isolates from essential oils, tincture, balsams and resins, source and c hemical nature of commercially important gums (gum Arabic, gum tragacanth, karaya gum, British gum, gum myrrh), balsams (balsam of Peru, balsam of Tolu, styrax) and resins.	12
IV	Dairy Chemistry: Milk definition, general composition of milk, constituents of milk - lipids, proteins, carbohydrates, vitamins and minerals, physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity. Factors affecting the composition of milk: Adulterants, preservatives and neutraliser, examples and their detection, estimation of fat, acidity and total solids in milk. Processing of Milk: Destruction of microorganisms in milk, physicochemical changes taking place in milk due to processing - boiling, pasteurisation, types of pasteurisations - bottle, batch and HTST (High Temperature Short Time) - vacuum pasteurisation - Ultra High Temperature Pasteurisation. Milk products: Cream, definition, composition, chemistry of creaming process, gravitational and centrifugal methods of separation of cream, estimation of fat in cream, butter: definition, composition, theory of churning, estimation of acidity and moisture content in butter, ghee: major constituents, common adulterants added to ghee and their detection.	12
V	Basic principles of Nanochemistry: Brownian motion, surface forces, self-assembly, general methods of synthesis of nanomaterials: Top-down production, bottom-up production, types of nanomaterials, carbon nanotubes, fullerenes, quantum dots, nanowires, nanocones, haeckelites, graphenes and metal nanoparticles.	12

	Applications of nanomaterials in medicine: Immunogold labelling, applications in medical diagnosis, nano based drug delivery, biomimetic nanotechnology, DNA nanotechnology	
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will **understand**[2] the preparation and properties of soaps and detergents.	
CO2	They will be able to **demonstrate**[2] kinetics and mechanism of polymerisation.	
CO3	They will be able to **explain**[3] the applications of polymers.	
CO4	They will be able to **develop**[3] the procedure of characterization of polymers.	
CO5	They will be able to **analyse**[4] the morphology and applications of polymers	
Text Books:	● B. Somdavi: Applied Chemistry, MJP Publications, 2006. ● N. Groom, The Perfume Handbook, Chapman and Hall, 1992. ● D. J. Rowe, The chemistry of flavours and fragrances, Blackwell publishing ltd., 2005. ● B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut, 2011.	
Reference Books:	● C.N.R. Rao, Muller and A. K. Cheetham, Chemistry of Nanomaterials, Vol. I & II, Wiley VCH Verlag GmbH KGaA, 2002.	

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SEMESTER

VI

COURSE CODE	MATERIALS CHEMISTRY	Total Lec.: 60
SC23CH007		**4-0-0**
Learning Objectives	● Prepare students with the concept of materials chemistry ● To produce students with knowledge of various inorganic and organic materials.	
Pre-requisite	None.	
UNIT	**CONTENT**	**HOURS**
I	Introduction: Materials and their classification, inorganic and organic materials.	8
II	Inorganic materials: Design and synthesis of inorganic materials, requirements and constraints, combination properties of composites, functional materials, active materials; solid state reactions for synthesis of inorganic materials: ceramic methods, precursor method and sol-gel synthesis, physical and chemical vapour depositions;	14
III	Properties of inorganic materials: carbides, nitrides, structural and functional ceramics, intermetallics; intrinsic and extrinsic properties: electrical, optical and magnetic properties; ceramic superconductors, magnetic ceramics.	12
IV	Molecular electronics: molecular materials for electronics and molecular scale electronics: Molecular properties, molecular arrangement and molecular interactions, piezoelectric and pyroelectric organic materials; molecular magnets based on transition metal complexes and organic ferromagnets.	14
V	Organic non-linear optical materials: photochromic organic materials and their classes; conducting polymers: polyacetylene, polypyrrole, polyaniline and polythiophene; conductive change transfer materials: TTFTCNQ, metal–dithiolate systems, fullerenes.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand**[2] the concept of material chemistry	
CO2	They will be able to **illustrate**[2] techniques for synthesis of inorganic materials.	
CO3	Students will **understand**[2] the properties of inorganic materials.	
CO4	They will learn to **apply**[3] the knowledge of molecular material wherever required.	
CO5	They will **develop**[3] the knowledge of properties of organic materials.	
Text Books:	● E. Sambandan, Short Notes on Applied and Advanced Inorganic Materials Chemistry, 2006, iUniverse. ● C. N. R. Rao, K Biswas, Essentials of Inorganic Materials Synthesis, 2015, Wiley Pulication. ● D. Sangeeta, J R. LaGraff, Inorganic Materials Chemistry Desk Reference, 2nd Edition, 2005, CRC Press. ● P. J. Vander Put, Inorganic Chemistry of Materials, 1998, Plenum Press, New York.	
Reference Books:	● M.C. Petty, M.R. Bryce and D. Bloor, An Introduction to Molecular Electronics, 1995, Edward Arnold, London. ● U. S. Schubert, N. Hüsing, Synthesis of Inorganic Materials, 4th Edition, 2019, Wiley Publication.	

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SEMESTER

VI

COURSE CODE	TOXICOLOGY	Total Lec.: 60
SC23CH008		4-0-0
Learning Objectives :	● Prepare students with the in-depth understanding of polymer chemistry ● To gain the knowledge in the preparation, properties, characterization and applications of polymers.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Food Toxicology: Introduction, Food Toxicology, Toxicology of food additives, legal and regulatory aspects	12
II	Cosmetic Toxicology: Introduction, potential exposures, toxicity of shampoos and conditioners, permanent wave treatment, colorants, bleachers and sprays, cutaneous diseases, respiratory diseases, regulatory aspects	12
III	Medical Toxicology: Introduction, Mission of medical toxicology, Nomenclature, Toxicological fact sheets and databases, Human risk assessment, ecotoxicology, conclusion	12
IV	Wildlife Toxicology: Introduction, environmental and ecological toxicology, Wildlife susceptibity to poisons, Comparative toxicology, Integrated problem saving	12
V	Pestiside Toxicology: Introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will **understand**[2] the preparation and properties of polymers.	
CO2	They will be able to **demonstrate**[2] kinetics and mechanism of polymerisation.	
CO3	They will be able to **explain**[3] the applications of polymers.	
CO4	They will be able to **develop**[3] the procedure of characterization of polymers.	
CO5	They will be able to **analyse**[4] the morphology and applications of polymers	
Text Books:	● F. W. Bill Meyer, Text book of polymer science, III Edition, John Wiley and sons, New York. ● Curtis Klaassen, Toxicology: The Basic Science of Poisons, 9th Edition, Mc Grow Hill Education ● A. Wallace Hayes, Claire L. Kruger, Hayes' Principles and Methods of Toxicology, 6th Edition, CRC Press ● Ali S. Faqi, A Comprehensive Guide to Toxicology in Nonclinical Drug Development, 2nd Edition ● Raktim Pal, Effect of Pesticide on Soil Microbial Properties Paperback, 2008	
Reference Books:	● Esther Haugabrooks and A. Hayes, History of Food and Nutrition Toxicology, 1st Edition 2023. ● Personal Care Products and Human Health, 1st Edition, Philippa Darbre, 2023 ● Ronald J. Kendall, Thomas E. Lacher, George C. Cobb, Stephen Boyd Cox Wildlife Toxicology: Emerging Contaminant and Biodiversity Issues, 2016, CRC Press.	

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SEMESTER VIII

COURSE CODE	Analytical Chemistry-III	Total Lec.: 45
SC23CH009		3-0-2
Learning Objectives :	● Prepare students with the in-depth understanding of analytical chemistry ● To gain the knowledge in the preparation, properties, characterization and applications of polymers.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Introduction: Scope & objectives, analytical chemistry and chemical analysis, classification of analytical methods, sample selection, sample processing, steps in a quantitative analysis, quantitative range (bispartite classification), data organisation, analytical validations, errors, type of errors, gross errors and their sources, the tools of analytical chemistry and good lab practices.	9
II	Calculations used in Chemistry: Chemical stoichiometry, molarity, molality, etc. Preparing samples for analysis: primary, secondary standard etc., classical methods of analysis: gravimetric, volumetric, titrimetric, potentiometric methods.	9
III	Analytical Chemometrics: Propagation of measurement uncertainties (accuracy and precision), mean, mode, median, range, standard deviation, useful statistical test: the F test, the student 'T' test, the 'Chi' test, 'Q' test the correlation coefficient, significant figures, regression analysis (least square method for linear and non-linear plots),	9
IV	Automation in the Laboratory: Principles of automation, process control through automated instruments, autoanalyzers (single channel and multi-channel),basic sequences of multi-fold operational analyzers in segmented and non-segmented flows.	9
V	Polarography: Origin of polargraphy, Current-voltage relationship, Theory of polarographic waves (DC and sampled DC (tast) polarograms), Instrumentation, Ilkovic equation, qualitative and quantitative applications.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will **understand**[2]nuclear chemistry and radioactive equilibrium.	
CO2	They will be able to **define**[1]learn the separation techniques.	
CO3	They will **build**[3] knowledge of thermal methods.	
CO4	They will **understand**[2]theprinciple of polarography.	
CO5	They will be able to **demonstrate**[2] polarographic methods.	
Text Books:	● S M Khopkar, Basic Concepts of Analytical Chemistry, 3rd Ed, 2008 New Age International Publishers. ● J. A. Dean, Analytical Chemistry Notebook, 2nd Edition 2004, McGraw Hill. ● R. M. Berma, Analytical Chemistry Theory and Practice, 3rd Edition, 2019, CBS Pulication. ● G. D. Christian, Analytical Chemistry, 6th Edition, 2007, Wiley pulication. ● P. Malhotra, Analytical Chemistry - Basic Concepts, 2016, Anne Book Publishers.	
Reference Books:	● D A Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 2000, 7th Edition, Saunders College Publishing, Philadelphia, London. ● J H Kennedy, Analytical Chemistry: Principles, 1990, 2nd Edition, Saunders Holt, London.	

COURSE CODE	Analytical Chemistry – III (Practical)
SC23CH009P	**2**
	1. Separation of Co^{2+} & Ni^{2+} by Ion Exchange chromatography. 2. Separation of Ni^{2+} & Fe^{3+} by Ion Exchange chromatography. 3. Separation of Zn^{2+} & Mg^{2+} by Ion Exchange chromatography. 4. To determine the amount of Iron/Calcium in milk powder. 5. Detection of Caffeine in commercial products (Tablet) by TLC. 6. Separation of blue or black Ink/ chlorinated insecticides by paper chromatography. 7. To determine Iodine value of an oil. (Coconut oil, Castor oil, Soybean Oil, Cotton seed oil, etc) 8. To determined % purity of the given sample of Aspirin. 9. Separation of mixture of drugs by TLC & column chromatography 10. To determine the acidity of lubricating oil sample.

Syllabus

SEMESTER VIII

COURSE CODE	ORGANIC CHEMISTRY III	Total Lec.: 45
SC23CH0010		3-0-2
Learning Objectives	● Prepare students with the in-depth knowledge of organometallic chemistry. ● To produce students with increased familiarity with modern research topics in organometallic chemistry	
Pre-requisite	Organic chemistry reaction mechanism.	
UNIT	CONTENT	HOURS
I	Conformation and reactivity of acyclic and cyclic systems: Acyclic compounds, the Felkin-Anh model, the Hawk model and Sharpless asymmetric epoxidation; cyclic compounds: monocyclic (3- to 8-membered rings) and bicyclic compounds (bridged, fused and spiro).	9
II	Basic of Photochemistry: Photochemical laws, quantum yield, electronically excited states- life times-measurements of the times, flash photolysis, stopped flow techniques, energy dissipation by radiative and non-radiative processes, absorption spectra, photochemical stages - primary and secondary processes, photochemistry of aromatic compounds, isomerisation, additions and substitutions,	9
III	Nucleophilic Substitution at Saturated Carbon: Mechanism and stereochemistry of S_N1, S_N2, S_Ni reactions, reactivity: the effect of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambient nucleophiles: regioselectivity, competition between S_N1 and S_N2 mechanisms. Neighbouring Group Participation: evidences of N.G.P.; the phenonium ion, participation by pi and σ bonds, anchimeric assistance, classical versus non-classical carbonium ions – the present status.	12
IV	E1 mechanism, E2 mechanism, E1 vs E2 mechanism, aromatic electrophilic substitution reaction mechanism, aromatic nucleophilic substitution reaction mechanism, nucleophilic addition mechanism, electrophilic addition mechanism, free radical addition mechanism, rearrangements	6
V	Pericyclic Reactions: Conservation of orbital symmetry, Woodward-Hoffmann rules, frontier molecular orbital (FMO) theory, orbital overlap effects in cycloadditions, electrocyclizations, sigmatropic rearrangements and chelotropic reactions, Paterno-Buchi, Norrish type I and II reactions.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will have an advanced **understanding**[2] of conformation and reactivity of cyclic and acyclic systems.	
CO2	They will be able to **apply**[3] their knowledge of reaction intermediates.	
CO3	They will **understand**[2]thestructure-reactivity relationship.	
CO4	They will **build**[3] the in-depth knowledge of polymerization.	
CO5	They will be able to **analyze**[4]enantioselective reaction and their applications.	

Text Books:	● A Bahl, B S Bahl, Advanced Organic Chemistry: Reactions and Mechanism, 2012, 2nd Edition, S. Chand Publishing. ● M B Smith & J March, March's Advanced Organic Chemistry, 2001, 5th Edition, John Wiley & Sons, New York. ● Clayden, Greeves, Warren and Wothers, Organic Chemistry, 2001, Oxford University Press.

	● P Sykes, A Guide book to Mechanism in Organic Chemistry, 1997, 6th Edition, Orient Longman Ltd., New Delhi. ● M S Singh, Advanced Organic Chemistry: Reactions and Mechanism: Pearson Education (Singapore) Pte. Ltd. (2005)
Reference Books:	● S M Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, 1990, 1st Edition, Macmillan India Ltd., New Delhi. ● T H Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition (1998), Addison – Wesley Longman Inc (IS Edition). ● G SZweifel and M. H. Nantz, Modern Organic Synthesis, 2007, Freeman and Company, New York. ● M S Singh, Advanced Organic Chemistry: Reactions and Mechanism: 2005, Pearson Education (Singapore) Pte. Ltd.

COURSE CODE	Organic Chemistry – III (Practical)
SC23CH0010P	2
	1. Preparation and characterization of two steps organic compounds I Step- Dil HNO_3 + Phenol 4-Aminophenol II Step- 4-Aminophenol+ Acetic Anhydride Paracetamol 2. Benzilic acid from benzoin Synthesis (Benzilic acid rearrangement). 3. Stilbene from benzyl chloride - Wittig reaction. 4. Quinoline from aniline - Skraup synthesis. 5. Lycopene from tomatoes. 6. Eucalyptus oil from leaves (Steam distillation). 7. Isolation and crystallization of terpene from tomato puree. 8. Extraction of caffeine from tea leaves. 9. Synthesis of aspirin/paracetamol. 10. Synthesis of oil of wintergreen.

Syllabus

SEMESTER VIII

COURSE CODE	INORGANIC CHEMISTRY-III	Total Lec.: 45
SC23CH0011		3-0-2
Learning Objectives:	● Prepare students with the fundamentals of main group chemistry and transition metal chemistry. ● To produce students whose basic concepts are clear in symmetry based concepts.	
Pre-requisite:	Knowledge about main group elements and transition metals.	
UNIT	CONTENT	HOURS
I	Main Group Chemistry: Periodic trends in properties of elements, atomic size, ionization potential, electron affinity, electro negativity, diagonal relationship, inert-pair effect, shielding effect, octet rule, hydrides and their classification: ionic, covalent and interstitial, basic beryllium acetate and nitrate, study of the following compounds with emphasis on structure, bonding, preparation, properties and uses, boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine, peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and properties of halogens	12
II	Metal-Ligand Bonding in Transition Metal Complexes: Crystal field splitting diagrams in complexes of low symmetry; spectrochemical and nephelauxetic series; thermodynamic and structural effects; site selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory, molecular orbital theory as applied to metal complexes. Electronic spectra of Transition Metal Complexes: Spectroscopic ground states; Term symbols, Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes; charge transfer spectra; electronic spectra of d^1 to d^{10} O_h and T_d systems, O_h and T_d Co(II) and Ni(II) complexes	10
III	Organometallic Chemistry: Organometallic Chemistry: Structure and bonding, brief overview of transition metal orbitals, types of ligands and their properties, metal-carbonyl complexes - synthesis - structure and reactions of metal carbonyls - the nature of M- CO bonding - binding mode of CO and IR spectra of metal carbonyls, soft vs hard ligands, electron counting, formal oxidation state, 18-e rule and its exceptions. Reactions of organometallic complexes: Ligand substitution/ exchange/dissociation processes and thermochemical considerations, catalyzed and assisted ligand substitution reactions, oxidative addition (definition, mechanism, thermodynamic consideration), oxidative addition of non-polar and polar electrophilic reagents, reductive elimination (bite angle effects, π-acid effects), transmetallation (definition, mechanism, utility)	10
IV	Chemistry of Lanthanides and Actinides: Introduction, chemistry of 'f' block elements, position in periodic table, oxidation states and their stability, lanthanide and actinide contraction, magnetic properties, spectral properties, separation technologies in lanthanides: (a) ion exchange, (b) solvent extraction	6

V	Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX2, ABX3 type compounds, spinels, band theory, metals and semiconductors.	8

Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **define**[1]main group elements, their properties and bonding.
CO2	Students will be able to **apply**[3] the knowledge about different compounds of main group elements.
CO3	They will acquire an **understanding**[2] of metal ligand bonding in transition metal complexes.
CO4	They will be able to **analyze**[4] the electronic spectra of transition metal complexes.
CO5	They will **understand**[2] the symmetry based concepts for inorganic molecules.
Text Books:	● R Sarkar, General and Inorganic Chemistry (vol I), 2011, 3rd Edition, New Central Book Agency. ● F A Cotton and G. Wilkinson,Advanced Inorganic Chemistry, 1999, 6th Edition, John Wiley & Sons, New York. ● J E Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, 2006, 4th Edition,Addison-Wesley Pub. Co., New York. ● A Kar, Advanced Inorganic Chemistry, 2017, Vol I & II, CBS. ● J D Lee, Concise Inorganic Chemistry, 5th edition, 2008, Oxford University Press.
Reference Books:	● R S Drago, Physical Methods in Inorganic Chemistry, 197, International Edition, Affiliated East-West Press, New Delhi, ● K F Purcell and John C. Kotz, Inorganic Chemistry, 1987, W. B. Sauders Com., Hong Kong. ● K. Veera Reddy, Symmetry and Spectroscopy of Molecules, 1999, New Age International Pvt. Ltd.

COURSE CODE	Inorganic Chemistry – III (Practical)
SC23CH0011P	2
	1. Preparation of Cuprous Chloride, Cu_2Cl_2 2. Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$ 3. Preparation of Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ 4. Synthesis of Cis and trans Potassium dioxalatodiaquachromate (III) $K[Cr(C_2O_4)_2.(H_2O)_2]$ 5. Synthesis of Tetraamminecarbonatocobalt (III) ion 6. Synthesis of Potassium tris(oxalate)ferrate(III). 7. Synthesis and catalytic application of a solid acid, 12-tungstosilicic acid. 8. Synthesis, purification and metalation of a bio-inorganically important porphyrine ligand. 9. Determination of zinc oxide in pharmaceutical preparations by EDTA titration. 10. The preparation of hexamminecobalt(III) chloride and pentammineaquocobalt(III) chloride: Synthesis, isolation and characterization of the complex.

Syllabus

SEMESTER VIII

COURSE CODE	PHYSICAL CHEMISTRY-III	Total Lec.: 45
SC23CH0012		3-0-2
Learning Objectives:	● Prepare students with the basic knowledge of symmetry and group theory and molecular spectroscopy. ● To produce students whose basic concepts are clear in quantum mechanics and nanotechnology.	
Pre-requisite:	Basic knowledge of thermodynamics.	
UNIT	CONTENT	HOURS
I	Symmetry and group theory: Symmetry based concepts: Energy level diagrams of metal complexes, symmetry elements and operations, determination of point group of a molecule, group representations, features of specific character tables Point symmetry operations, groups and group multiplication tables, similarity transformation and conjugate classes, identification of point groups, representation of symmetry operators and groups, rules (without derivation) for construction of character tables with illustrations, symmetry elements and symmetry operations of the platonic solids, symmetry of the fullerene structure. The Great Orthogonality Theorem: statement and interpretation, construction of character tables of simple molecules projection operators (without derivations)	12
II	Quantum mechanics: Overview of experimental findings; identification of classical and quantum systems, Bohr's correspondence principle, postulates of quantum mechanics, properties of wave functions, operators and related theorems; degeneracy, spread of observation and uncertainty principle, Ehrenfest's theorem, exactly solvable problems: step potential and tunnelling, harmonic oscillator, rigid rotator; elementary discussion of the H-atom solution.	8
III	Principles of molecular spectroscopy: Fundamentals; rotational spectra: classification of molecules into spherical, symmetric and asymmetric tops; diatomic molecules as rigid rotors - energy levels, selection rules and spectral features, isotope effect, intensity distribution, effect of non-rigidity on spectral features. Vibrational spectra of diatomics: potential energy of an oscillator, Harmonic Oscillator approximation, energy levels and selection rules, anharmonicity and its effect on energy levels and spectral features: overtones and hot bands, vibration-rotation spectra of diatomics: origin; selection rules; P, Q and R branches. Raman spectra: origin, selection rules, classical and quantum treatment of rotational and vibrational Raman spectra of diatomics, resonance Raman spectroscopy. NMR spectra: theory, relaxation process, spin interactions - its origin, equivalent protons, a few representative examples.	10

IV	Thermodynamics and statistical mechanics: Maxwell-Boltzmann distribution with degeneracy (for both distinguishable and indistinguishable particles), partition function and its properties, interpretation of thermodynamic laws, thermodynamic function in terms of partition functions, molecular partition functions (translational, rotational, vibrational and electronic) for ideal gas, calculation of thermodynamic functions for monoatomic and diatomic gases, equipartition principle, equilibrium constant in terms of partition function.	8

V	Elementary nanotechnology: Principles and practices, density of states – zero dimensional solid, one-dimensional quantum wire, thin film and three-dimensional box; some special nanomaterials – fullerenes, carbon nanotubes and nanodiamonds; optical properties of metallic nanoparticles; nanolithography.	7

Course Outcomes as per Bloom's Taxonomy	
CO1	The students will be able to **demonstrate**[2] the symmetries of physical systems.
CO2	They will **understand**[2] of the Quantum Mechanics postulate on the physical systems.
CO3	Students will learn to **classify**[2] the combination of spectroscopic methods and techniques are optimal for solving the specific scientific problem.
CO4	They will **understand**[2] the concepts of statistical thermodynamics.
CO5	They will **develop**[3]theknowledge of common applications for nanotectnology.
Text Books:	● A K Mukherjee, Group Theory in Chemistry: Bonding and Molecular Spectroscopy, 2018, 1st Edition, The Orient Blackswan. ● C N R Rao, A Müller, A K Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, 2004Wiley-VCH, Weinheim. ● C N Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 1994, 4th Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi. ● R. C. Mukherjee, Modern Approach to Physical Chemistry I, 2016, Bharati Bhawan Publishers & Distributors. ● T. Varghese, K. M. Balakrishna, Nanotechnology: an Introduction to Synthesis Properties and Applications of Nanomaterials, 2012, Atlantic Publishers & Distributors Pvt Ltd.
Reference Books:	● F A Cotton, Chemical Applications of Group Theory, 3rd Edition, John Wiley & Sons, New York, 1999. ● S C Rakshit, Molecular Symmetry Group and Chemistry, The New Book Stall, Kolkata, 1988. ● R Taylor, The Chemistry of Fullerenes, Advanced Series in Fullerenes, Vol 4, 1995, World Scientific, Singapore ● C. Poole, Introduction to Nanotechnology, Wiley Student Edition, 2016, Wiley.

COURSE CODE	Physical Chemistry – III (Practical)
SC23CH0012P	**2**
	1. Determination of dissociation constants of weak acid and weak base. 2. Conductometric titration of an acid and a base. 3. Potentiometric titration of acid and base. 4. Kinetics of catalytic decomposition of H_2O_2. 5. Kinetics of acid catalysed hydrolysis of sugar. 6. Study the kinetics of the following reactions. a. Initial rate method: Iodide-persulphate reaction b. Integrated rate method: 7. Acid hydrolysis of methyl acetate with hydrochloric acid. 8. Determination of molar mass of non-electrolyte by Walker-Lumsden method 9. Determination of partition/distribution coefficient of Benzoic acid in water and toluene 10. Determination of composition of liquid mixtures by refractometry. (toluene and alcohol, water and sucrose)

SANJEEV AGRAWAL GLOBAL EDUCATIONAL UNIVERSITY, BHOPAL

Proposed Scheme & Syllabus
For

Bachelor of Science (BSc)

Certificate/Diploma/Degree/Honors Degree/ Research Degree

in

Physics

w.e.f. 2023-24 (According to NEP 2020)

School of Sciences

PHYSICS

Program Educational Objectives (PEOs) Physics:

PEO-1: Prospective Employment and Career Prospects-Developing the potential for vertical career growth in investigation laboratories, service sectors and related avenues.

PEO-2: Proficiency- Inculcating technical and managerial skills crucial for real time scenarios through the enhancement of problem-solving skills and advanced technical documentation ability.

PEO-3: Affectionate Objective- Grooming the students with technical proficiency to equip them for the emergence of sustainable technology and solutions for prevailing environmental, societal and cultural concerns.

PEO-4: Research Methods-Nurturing the research aptitude to provide solutions for global challenges and abilities to explore hidden potential of the matter.

PEO-5: Continuous Learning-Instilling knowledge and awareness on professional ethics related to crime prevention and evidence analysis and life-long learning through career-oriented courses.

Program Outcomes (POs) Physics:

By the end of the program the students will be able to:

PO 1. Understand the fundamentals of various branches of Physics.

PO 2. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups.

PO 3. Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO 4. Apply the key concepts and standard methodologies to solve problems related to Physics.

PO 5. Apply their skill in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO 6. Apply the knowledge and skills to explain why physics is an integral activity for addressing social, economic, and environmental problems.

PO 7. Possess the level of proficiency in subject required for post-graduation as well as for pursuing research in Physics and related interdisciplinary subjects.

PO 8. Apply methodologies to the solution of unfamiliar types of problems.

PO 9. Design solutions stemming from the application of Physics the local issues.

PO 10. Explore new areas of research in pure Physics and applied Physics.

Bachelor of Science (BSc)

CURRICULUM COMPONENTS

Components		Credits
University Core (Table 1)	Ability Enhancement Courses (06 Courses)	**12**
	Skill Enhancement Courses (06 Courses)	**12**
Discipline Core Courses (8 Courses) (Table 2)		**32**
Discipline Specific Major Electives (8+4 Courses) (Table 3)		**32R/48H***
Discipline Specific Minor Electives (6 Courses) (Table 3)		**24**
Interdisciplinary Minor Electives (04 Courses) (Table 4)		**16**
Project/Field Internship/Skill Based Project		**28H/44R***
Total		**172**

*** Opt either 04 Specialized Courses (for Honors Degree) or Research Based Industrial Project (for Research Degree)**

** Note: Any student opting out after I year / II year will obtain undergraduate Certificate/Diploma respectively in the specific discipline subject to mandatory 450hrs (8-10 week) ,10 credit Internship in SUB/Industry/Research organization.

Distribution of credits across all components

SEM.	University Core Courses. (one course = 02 credit) (Table 1)		Discipline Courses (DC) [one course = 4 credit] (Table 2)	Main Faculty (as per prerequisite)		Interdisciplinary Minor Elective Tracks (Employment Oriented) (Table 4)	Project/ Field Internship/ Skill Based Projects/Research Projects/industrial Projects	Total
	AEC	SEC		Discipline Specific Elective (one course = 4 credit) (Table 3)				
				(Major)	(Minor)			
I	2	2	4	4	4	4	3(PBL)	23
II	2	2	4	4	4	4	3(PBL)	23
III	2	2	4	4	4	4	3(PBL)	23
IV	2	2	4	4	4	4	3(PBL)	23
V	2	2	-	4+4	4		4(SIP)	20
VI	2	2	-	4+4	4		4(Minor Project)	20
VII			12				8(Major)	20
VIII*			4	16*			16*(Research/Internship Project)	20(4+16*)
Total	**12**	**12**	**32**	**32R/32+16*H**	**24**	**16**	**28H/28+16*R**	**172**

*** Opt either 04 Specialized Courses (For Honor Degree) or Research Based Industrial Project (For Research Degree)**
Note: PBL- Project Based Learning, SIP- Summer internship Project, SEC- Skill Enhancement Courses, AEC- Ability Enhancement Courses.

Syllabus SEMESTER I

COURSE CODE	MATHEMATICAL PHYSICS	Total Lec. :45
SC23PH001		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To introduce the students to vector calculus, partial differential equation, curvilinear coordinates, and Fourier series. ● To be able to understand and apply the vector differentiation and integration to physical problems. ● To be able to understand and analyze the solution of partial differential equations. ● To be able to understand the green's theorem, Stokes the oremandits application to physical problems. ● To be able to understand and apply the beta function and gamma function in physical problems.	
Pre-re quisite:	Physics &Mathematics(10+2)	
UNIT	CONTENT	HOURS
I	Properties of vectors, scalar product and vector product, scalar triple product and their interpretation in term so far area and volume respectively, scalar and vector fields, vector differentiation: directional derivatives and normal derivative, gradient of a scala field and its geometrical interpretation, divergence and curl of a vector field ,Del and Laplaci an operators, vector identities.	10
II	Ordinary integrals of vectors, double and triple integrals, change of order of integration, Jacobian, notion of infinite simalline, surface and volume elements, line, surface and volume integrals of vector fields, flux of a vector field, Gauss ' divergence theorem, Green's and Stokes theorems and the verification (no rigorous proofs).	12
III	Solutions to partial differential equations using separation of variables :Laplace's equation in problems of rectangular geometry, solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes, solution of 1D heat flow equation, plotting of functions,approximation:Taylorandbinomialseries(statementsonly),firstorder differential equations(variables reparable, homogeneous, non-homogeneous), exact and in exact differential equations and integrating factor.	6
IV	Some special integrals : eta and Gamma functions and relation between them, expression of Integrals in terms of Gamma functions, orthogonal curvilinear coordinates, derivation of gradient, divergence, Curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems	7
V	Periodic functions, orthogonality of sine and cosine functions, dirichlet conditions (statement only), expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, evenandoddfunctionsandtheirfourierexpansions,application,summingof infinite series, parseval's identity and its application to summation of infinite series.	10
Course Out comes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1]the partial differential equation, Beta function, and Gamma	

	function.
CO2	They will be able to **analyze**[4]thesolutionofordinary,and partial differential equation.
CO3	They will be able to identify the Beta function, Gamma function and **apply**[3] it in physical Problems.
CO4	They will be able to **calculate**[4] the gradient, curl, divergence, and,1dimensional,2 Dimensional and 3dimensional vector integration.
CO5	They will be able to **understand**[2] the Green's theorem, Stokes the oremandits **application**[3] to physical problems.
Text Books:	● S. Paland S .C. Bhunia, Engineering Mathematics,2015,OxfordUniversityPress. ● M.R.S piegel, Fourier Analysis,2004,TataMcGraw-Hill. ● Arfken, Weber, Mathematical Methods for Physicists, 2005, Harris, Elsevier.
Reference Books:	● Susan M. Lea, Mathematics for Physicists, 2004, Thoms on Brooks/Cole. ● George F .Simmons, Differential Equations, 2006, Tata McGraw-Hill. ● Erwin Kreyszig, Advanced Engineering Mathematics, 2015, Wiley.

Practical

COURSECODE	**PHYSICSLAB-I**	**Practicals:**
SC23PH001P		**1**
	1. Measurements of length (or diameter)using vernier caliper, screw gauge and travelling microscope. 2. To study the random error in observations. 3. To determine the height of a building using a sextant. 4. To determine the moment of inertia of a Fly wheel. 5. To determine g and velocity for are ely falling body using digital timing technique. 6. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method). 7. To determine the Young's modulus of a wire by optical lever method. 8. To determine the modulus of rigidity of a wire by Maxwell's needle. 9. To determine the elastic on stants of a wire by Searle's method. 10. To determine the value of g using bar pendulum. 11. To determine the value of g using Kater's pendulum.	

Syllabus SEMESTER II

COURSECODE	MECHANICS	Total Lec.:45
SC23PH002		3-0-2
Learning Objectives:	The course provides deep knowledge about the following: ● The students will be introduced about the frame of reference (inertial and non-inertial), transformation, Invariance, and its use in analysis of a moving system. ● The course will give knowledge about the important on concept like center of mass, moment of inertia, fictions (pseudo)forces and its use in describing rotational motion. ● The course provides the students about the knowledge of understanding the properties of fluid and fluid motion through concepts like surface tension and viscosity. ● The understanding of physics of vibration and oscillation.	
Pre-requisites:	Elementary Idea of Calculus, Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, introduction to special relativity And relative is trick in mathematics.	

UNIT	CONTENT	HOURS
I	Reference frames, inertial frames; Galilean transformations; Galilean invariance, many system of particles dynamics, center of mass, principle of conservation of momentum,variable-mass system:motion of rocket,work-energy theorem, conservative and non-conservative forces, elastic and inelastic collisions between particles, center of mass and laboratory frames, two body problem and its reduction to the one-body problem and its solution, law of gravitation, gravitational potential energy, potential and field due to spherical shell and solid sphere, Kepler's laws.	10
II	Angular momentum of a particle and system of particles, torque, principle of conservation of angular momentum, rotation about a fixed axis, moment of inertia ,moment of inertia for rectangular, cylindrical and spherical bodies, kinetic energy of rotation, motion involving both translation and rotation, non-inertial frames and fictitious forces,uniformly rotating frame,laws of physics in rotating coordinate systems, centrifugal force, coriolis force and its applications.	10
III	Molecular model of matter, surface tension, surface energy, the angle of contact between surfaces, capillary phenomena ,excess pressure on a curved liquid membrane, dependence of surface tension on external factors ,elastic moduli and their relations, twisting torque on a cylinder or wire, kinematics of moving fluids , Poiseuille's equation for flow of a liquid through a capillary tube.	7
IV	Simple harmonic oscillations, differential equation of SHM and its solution, kinetic energy ,potential energy ,total energy and their time-average values ,damped oscillation, forced oscillations: transient and steady states; resonance, sharpness of resonance ;power dissipation and quality factor, a pair of linearly coupled oscillators – Eigen frequencies and normal modes (matrix m ode of analysis not required here),super position of perpendicular oscillations, Lissajous figures	8
V	Michelson-Morley experiment and its outcome ,postulates of special theory of relativity, Lorentz transformations, simultaneity and order of events, Lorentz contraction, time dilation, relativistic transformation of velocity, frequency and wave number. relativistic addition of velocities, variation of mass with velocity ,mass less particles, mass-energy equivalence, relativistic Doppler effect, relative stick in ematics , transformation of energy and momentum.	10
Course Outcomes as per Bloom's Taxonomy		

CO1	Students will be able to **define**[1]referenceframeanditssignificanceinconnectionwith mechanics.
CO2	They will beabletoTheywillbeableto**nterpret**[2]thelawofgravitation and Kepler's law and Their **application**[3] in problem related with physics.
CO3	They will be able to **understand** [2]the concept of elasticity ,surface tension ,viscosity and Fluid flow.
CO4	They will be able to **distinguish** various types of simple harmonic motion.
CO5	They will be able to **understand**[1] the concept of time dilation ,length contraction and the concept Of simultaneity.
Text Books:	● DSMathur,2000, S. Chandand Company Limited, ● C. Kittel, W.Knight, et.al,Mechanics, Berkeley Physics, vol.1, 2007,TataMcGraw-Hill. ● GR Fowles and G.L. Cassiday Analytical Mechanics,2005,CengageLearning,
Reference Books:	● RP Feynman , R.B. Leighton, M. Sands, Feynman Lectures, Vol. I,2008, PearsonEducation. ● RR esnick, Introduction to Special Relativity, 2005, John Wiley and Sons. ● RL Reese, University Physics,2003,ThomsonBrooks/Cole,

Practical

COURSE CODE	PHYSICSLAB-II	Practicals:
SC23PH002P		1
	● Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope. ● To study the random error in observations. ● To determine the height of a building using a Sextant. ● To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. ● To determine the Moment of Inertia of a Flywheel. ● To determine g and velocity for a freely falling body using Digital Timing Technique ● To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).	

Syllabus SEMESTER III

COURSE CODE	THERMAL AND STATISTICAL PHYSICS	Total Lec.:45
SC23PH003		3-0-2
Learning Objectives:	The course provides deep knowledge about the following: ● This paper deals with the study of Thermodynamics and Statistical Physics. ● Course provides the concepts of heat, work, and energy. ● Student learns the different laws of thermodynamics. ● Students learns the concept of thermo-dynamical functions and there relations, and also about the Statistical Physics and its implementations. ● Students learn about the contributions of Physicists.	
Pre-requisites:	Fundamentals of thermodynamics.	

UNIT	CONTENT	HOURS
I	Thermodynamics-I: Reversible and irreversible process. Heat engines. Definition of efficiency, Carnot's ideal heat engine, Carnot's cycle. Effective way to increase efficiency, Carnot's engines and refrigerator, Coefficient of performance, Second law of thermodynamics, Various statements of Second law of thermodynamics, Carnot's theorem, Clapeyron's latent heat equation, Carnot's cycle and its applications. Steam engine, Otto engine. Petrol engine. Diesel engine.	10
II	Thermodynamics-II: Concept of entropy. Change in entropy in adiabatic process. Change in entropy in reversible cycle. Principle of increase of entropy. Change in entropy in irreversible process. T-S diagram. Physical significance of Entropy, Entropy of a perfect gas. Kelvin's thermodynamic scale of temperature, The size of a degree. Zero of absolute scale, Identity of a perfect gas scale and absolute scale. Third law of thermodynamics. Zero point energy, Negative temperatures (not possible), Heat death of the universe. Relation between thermodynamic variables (Maxwell's relations).	10
III	Statistical Physics-IDescription of a system : Significance of statistical approach, Particle-states, System-states, Micro-states and Macro-states of a system, Equilibrium states, Fluctuations, Classical and statistical probability, The equi-probability postulate, Statistical ensemble, Number of states accessible to a system, Phase space. Micro canonical ensemble, Canonical ensemble, Helmholtz free energy, Enthalpy, First law of thermodynamics, Gibbs free energy, Grand canonical ensemble.	7
IV	Statistical Physics-II: Statistical Mechanics: Phase space. The probability of a distribution. The most probable distribution and its narrowing with increase in number of particles. Maxwell-Boltzmann statistics. Molecular speeds. Distribution and mean, r.m.s. and most probable velocity. Constraints of accessible and inaccessible states. Quantum Statistics: Partition Function. Relation between Partition Function and Entropy, Bose-Einstein statistics. Black-body radiation, The Rayleigh-Jeans formula, ThePlanck radiation formula, Fenni-Dirac statistics. Comparison of results. Concept of Phase transitions.	8
V	Contributions of Physicists: S.N. Bose, M.N. Saha, Maxwell. Clausius, Boltzmann, Joule. Wien, Einstein, Planck, Bohr. Heisenberg,Fermi, Dirac, Max Born. Bardeen.	10

Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **define**[1] thermodynamics laws.
CO2	They will be able to **interpret** [2]the law thermodynamics and their **application**[3] in problem related with physics.
CO3	They will be able to **understand** [2]the concept of thermodynamics and statistical physics
CO4	The will be able to **distinguish**[4]between thermal and statistical physics
CO5	They will be able to **understand**[1]theconceptofradiations and different thermal statistics

Text Books:	● Unified Physics, R. P. Goyal, Shiva lal Agarwala & Company ● Heat, Thermodynamics and Statistical Physics, Brijlal, Dr. N. Subrahmanyam, P. S. Hemne, S. Chand Publications.
Reference Books:	● Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill. ● A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. ● Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications. ● Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill 14 ● Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa ● University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. ● Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

Practical

COURSE CODE	**PHYSICS LAB-III**	**Practicals:**
SC23PH003p		**1**
	● To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. ● To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus. ● To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method. ● To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. ● To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). ● To study the variation of Thermo- Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	

Syllabus SEMESTER IV

COURSE CODE	**WAVES AND OPTICS**	**TotalLec.:45**
SC23PH004		**3-0-2**

Learning Objectives:	● The Course provides knowledge of SHM ,superposition of two SHMs, Lissajous figure and various types of oscillation. ● In this course, students will be introduced to fundamental concepts of waves and optics ● It develops understanding about Fermat's and Huygens's principles and their applications and related phenomena like Interference and diffraction of light. ● It give knowledge about the construction and working of LASER and its applications	
Pre-requisites:	Elementary idea of mechanics, mathematics, and optics.	
UNIT	**CONTENT**	**HOURS**
I	**Simple Harmonic Motion (SHM): S**uperposition of SHMs (superposition of twocollinearandtwoperpendicularSHMshavingequalfrequenciesanddifferentfrequencies, Beats and Lissajous Figures). **Free Damped Oscillations**: Introduction, damping forces, brief quantitative and qualitative description of damped oscillation of a system having one DoF (equation of motion, solution, large, critical &small damping, energy of a weakly damped oscillator , logarithmic decrement ,relaxation time and Q-factor). **Forced Oscillations and Resonance** :Introduction, brief quantitative and qualitative description of forced oscillation of a system having one degree of freedom(DoF) (equation of motion, solution ,resonance).	10
II	**Mechanical Waves:** Types of mechanical waves, mathematical description of wave (i,e,, classical wave equation), speed of transverse wave, energy in wave motion, wave interference, boundary conditions, and superposition, standing waves In a string, normal modes of a string. **Sound and Hearing:** Sound waves, speed of sound waves, sound intensity and decibal, standing sound waves & normal modes, resonance and sound ,interference Of waves and Beats ,Doppler Effect ,shockwaves.	10
III	**Fermat's and Huygens's principles:**Light is an electromagnetic spectrum, Fermat's principle and its application, Huygens's principle its application. **Interference:**Young'sexperiment-coherence,intensitydistributionandvisibility offringes, Fresnel's Biprism, Interference in thin films, Interference at anair wedge, Newton' srings, Michelson's interferometer.	9
IV	**Diffraction:** Fraunh offer and Fresnel Diffraction: Diffraction at a single slit, double slit, Diffraction by multiple slits, Diffraction grating, Resolving power- Rayleigh' scriterion, Resolving power of a grating and telescope, Fresnel diffraction-halfperiodzone,Zoneplate,Diffractionatacircularapertureandatastraightedge (qualitative treatment only).	9
V	**Lasers:** Spontaneous emission, absorption, and stimulated emission, Einstein's AandBcoefficientsandrelationbetweenthem,conditionforamplification,population inversion, methods of optical pumping, energy level schemes of Ruby laser and He-Ne laser, properties and uses of lasers.	7
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define** [1]Lissajousfigure,damped and forced oscillator, Doppler effect, Fermat' s principle ,interference & diffraction ,Einstein A and B coefficients.	
CO2	They will be able to **interpret**[2] various types of oscillation s, interference &diffractions Through various apertures.	
CO3	They will be able to **understand**[2] various optical phenomena, principles ,working ,and Applications of optical instruments ,spontaneous and stimulated emission of radiation ,optical	
	Pumping and population in version ,basic lasing ,various types of lasers in details and their applications.	
CO4	The y will be able to **distinguish** [4]various types of oscillations, lasers ,diffractions(Fresnel & Fraunh offer)	
CO5	They will be able to **understand**[1] the concept of interference ,diffraction, working principle of Various types of lasers.	

Text Books:	● P. Tipler, Physics for Scientists & Engineers,6th Edition, 2007, W.H. Freeman. ● A. Ghatak, Optics,7th Edition, 2020, Mc Graw Hill Education India Private Limited. ● K. Thyagrajan &A.K. Ghatak, Lasers: Fundamentals & Applications, 2nd Edition, 2016 , Laxmi Publications Private Limited.
Reference Books:	● A. Lipson, S.G. Lipson, &H. Lipson, Optical Physics,4th Edition, 2010,Cambridge University Press. ● B.B. Laud, Lasers &Non-line r Optics,2011, New Age International Private Limited. ● H. Parthasarathy, 1stEdition, 2021, Harish Parthasarathy, CRC Press.

Practical

COURSE CODE	**PHYSICS LAB-IV**	**Practicals:**
SC23PH004P		**1**
	● To determine the wavelength of sodium source using Michelson's interferometer. ● To determine wavelength of sodium light using Fresnel Biprism. ● To determine wavelength of sodium light using Newton's Rings. ● To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. ● To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating. ● To determine dispersive power and resolving power of a plane diffraction grating.	

Syllabus SEMESTER V

COURSE CODE	**CLASSICAL ELECTRODYNAMICS**	**Total Lec.:45**
SC23PH005		**3-0-0**

Learning Objectives:	● Interpret the deeper meaning of the Max wellian field equations and account for their symmetry and transformation properties, domain of validity, and limitations ● Formulate of electromagnetic problems with the help of electrodynamics potentials and super potentials, and make a detailed account for gauge transformations and their use ● Master the technique of deriving and evaluating formulae for the electromagnetic fields from very general charge and current distributions ● Calculate the electromagnetic radiation from radiating systems (aerials, localized charge and current distributions) at rest ● Calculate the electromagnetic radiation from localised charges which move arbitrarily in time and space, taking into account retardation effects. Account for the underlying approximations and assumptions	
Pre-requisites:	Physics + Mathematics (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Electrostatics: Electric potential, Poisson and Laplace's equations. Boundary value problems, Uniqueness theorems, Green's theorem. Method of images, Method of separation of variables (Cartesian Coordinates, Spherical and Cylindrical Coordinates), Multiple expansion.	10
II	Electromagnetic Waves: Maxwell's equations, Boundary conditions, Wave equation and its complex notation, Electromagnetic waves in vacuum, Electromagnetic waves in non conducting and linear media, Electromagnetic waves in linear conducting media. Poynting theorem, Reflection, refraction and polarization of electromagnetic waves.	10
III	Waveguides and Cavities: Metallic boundary conditions, Electromagnetic waves confined to hallow metallic pipe, TE, TM and TEM modes, TE and TM modes in rectangular waveguides, Bessel's function, TE and TM modes in cylindrical waveguides, Dielectric waveguides, TE and TM modes in rectangular and cylindrical Resonant cavities.	9
IV	Potential, Fields and Radiations: Scalar and vector potentials, Gauge transformation, Coulomb and Lorentz gauge, Retarded potential, Lienard-Wiechert potentials, Fields due to moving charge, Power radiated by an accelerated charge and angular distribution, Bremstrahlung Cerenkov and Synchrotron radiations.	9
V	Relativistic Electrodynamics: Four vectors, Lorentz transformation in terms of Four vectors, Lorentz transformation matrix, Transformation of electromagnetic fields, Field Tensor, Dual field strength tensor, Maxwell's equations in terms of strength tensors,	7
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1] terms related to electrostatics..	
CO2	They will be able to **interpret**[2] electromagnetic waves .	
CO3	They will be able to **understand**[2] various wave guides and cavities.	
CO4	They will be able to **distinguish**[4] potential, fields and radiations.	
CO5	They will be able to **understand**[1] theconceptof relativistic electrodynamics.	
Text Books:	● David J. Griffith; Introduction to Electrodynamics, PHI Private Limited, 1999 2. ● John D. Jackson; Classical Electrodynamics, Wiley Eastern Limited, 1998 3. ● F.F. Chen; Plasma Physics and Controlled Fusion,Springer,2006	
Reference Books:	● Edward C. Jordan and Heith G. Balmain; Electromagnetic Waves and Radiating Systems, PHI, 1991 2. ● W.K.H. Panofsky and M. Phillips; Classical Electricity and Magnetism, Dover Publications; 2nd Ed., 2005 3. ● J A Bittencourt; Fundamentals of Plasma Physics, 3rd Ed, Springer, 2004	

Syllabus SEMESTER V

COURSE CODE	ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM	Total Lec . :45
SC23PH006		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To describe, in words, the ways in which various concepts in electromagnetism come into play in particular situations; ● To represent these electromagnetic phenomena and fields mathematically in those situations; ● And to predict outcomes in other similar situations. ● The overall goal is to use the scientific method to come to understand the enormous variety of	

	electromagnetic phenomena in terms of a few relatively simple laws.	
Pre-re quisite:	Physics & Mathematics(10+2)	
UNIT	**CONTENT**	**HOURS**
I	Electrostatics Coulomb's inverse square law – Gauss theorem and its applications (Intensity at a point due to a charged sphere & cylinder) – Principle of a capacitor – Capacity of a spherical and cylindrical capacitors –Energy stored in a capacitor – Loss of energy due to sharing of charges.	10
II	Current Electricity Ampere's circuital law and its applications - Field along the axis of a circular coil and Solenoid – Force on a conductor in a magnetic field – Theory of Ballistic Galvanometer – Figure of merit – Damping Correction – Wheatstone network – Carey Foster's Bridge – Potentiometer - Measurement of current, resistance and low voltage.	12
III	Magnetism Intensity of magnetization - Susceptibility – Types of magnetic materials – Properties para, dia and ferromagnetic materials – Cycle of magnetization – Hysteresis – B-H curve – application of BH curve–Magnetic energy per unit volume.	6
IV	Electromagnetic Induction Laws of electromagnetic induction – Self and mutual induction – Self-inductance of a solenoid – Mutual inductance of a pair of solenoids – Coefficient of coupling – Experimental determination of self and mutual inductance (Rayleigh's method) Growth decay of current in circuit containing Land R – Growth and decay of charge in circuit containing C and R – High resistance by leakage – Charging and discharging of capacitor through Land R.	7
V	AC Circuits Alternating EMF – Alternating EMF applied to circuits containing L and R – C and R – Alternating EMF applied to circuits containing L, C and R – Series and Parallel resonance circuits – Sharpness of resonance– Q factor – Power in AC circuits – Power factor – Watt less current	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1]the electrostatics and its theorem.	
CO2	They will be able to **analyze**[4]theampere's circuital law.	
CO3	They will be able to identify the magnetism and **apply**[3]it in physical problems.	
CO4	They will be able to calculate 4 the electromagnetic inductions and practical applications.	
CO5	They will be able to **understand**[2] the AC Circuitsits **application**[3] to physical problems.	
Text Books:	● Brijlal and Subramaniyam – Electricity and Magnetism – S. Chand & Co. ● R. Murugesan, Electricity and Magnetism, S.Chand & Co.	
Reference Books:	● Narayana moorthy and Nagaratnam, Electricity and Magnetism NPC, Chennai ● Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education. ● Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.	

Practical

COURSE CODE	**PHYSICS LAB-V**	**Practicals:**
SC23PH006P		**1**

	● To study the characteristics of a series RC Circuit. ● To determine an unknown Low Resistance using Potentiometer. ● To determine an unknown Low Resistance using Carey Foster's Bridge. ● To compare capacitances using De'Sauty's bridge. ● Measurement of field strength B and its variation in a solenoid (determine dB/dx ● Determine output characteristics of a LVDT & measure displacement using LVDT ● Measurement of Strain using Strain Gauge. ● Measurement of level using capacitive transducer. ● To study the characteristics of a Thermostat and determine its parameters. ● Study of distance measurement using ultrasonic transducer. ● Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75) ● To measure the change in temperature of ambient using Resistance Temperature Device (RTD).

Syllabus SEMESTER VI

COURSE CODE	QUANTUM MECHANICS	TotalLec. :45
SC23PH007		3-0-0
Learning Objectives:	After studying this paper the students will know– ● Foundation of quantum mechanics–failure of classical mechanics. ● Concept of operator formalism - position, momentum and energy operators, operator algebra. ● Schrodinger equation and its applications (e.g., particle in one- & three-dimensional potential box, quantum mechanical tunneling ,potential barrier, delta potential, potential step, transmission coefficient, Hydrogen atom. ● Concept of identical particles.	
Pre-re quisite:	Foundations of Physics & Mathematics	
UNIT	CONTENT	HOURS
I	**Dirac Delta Function and Kronecker Delta Function:** Dirac delta function and Kronecker delta function, phase and group velocity, wave packet, Gaussian wave packet. **Blackbody Radiation:** Blackbody radiation, Planck's quantum hypothesis, explanation of black body radiation.	10
II	**Fundamental Concepts:** Photoelectric effect, Compton effect, specific heat of solids,deBrogliewavelength/ wave-particle duality,Davison-Germer experiment, wave packets/Gaussian wave packet, phase and group velocity ,concept of wave function,differences between classical & quantum mechanics,Heisenberg's uncertainty principle,Fourier transform and momentum - spacewave function(i.e. expansion of a wave function in terms of position and momentum wave functions).	12
III	**Operator Formalism:** Operator formalism, position, momentum and energy operators ,operator algebra,commutator,expectationvalue,Ehrenfesttheorem,Hermitianoperators,Hermitianadjoint,variouspr opertiesof Hermitianoperator,operatorscommutingwithH,simultaneouseigenfunctionsof commuting operators, postulates of quantum mechanics,	6
IV	**Schrödinger Equation:** Schrodinger equation ,free particle solution ,super position of wave functions ,stationary states, orthogonality of eigen funtions, degenerate & non degenerate eigen values ,probability current density, time dependent and time independent Schrödinger equation.	7
V	**Applications of Schrodinger equation in simple cases:** One dimension-infinite square well potential, both one and three dimensional cases of a particle in a box ,finite square well, attractive delta function potential, harmoni coscillator, potential step, and potential barrier, simple harmonic oscillator.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Dirac delta function and Kronecker delta function, black body radiation, photo electric effect, various quantum mechanical operator and Schrodinger equation.	
CO2	They will be able to **interpret**[2] various operators, wave function.	
CO3	They will be able to **understand**[2] the theory of quantum measurements, wave packets and Uncertainty principle.	
CO4	They will be able to **distinguish**[4] various types of oscillations, lasers, diffractions(Fresnel & Fraunh offer)	
CO5	They will be able to **understand**[1] the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, timed ependent and Time independent cases, probability density and the normalization techniques.	
Text Books:	● Donald B Grey, Quantum Physics for Beginners,2020,Han Global Trading Pt Ltd. ● P.W.Mathewsand K.Venkatesan, A Textbook of Quantum Mechanics, 2nd Edition, 2017,Tata Mc Graw Hill. ● Ghatak and Loknathan,QuantumMechanics-Theory and Applications, 5th Edition, 2015, Laxmi Publications.	
Reference Books:	● L.I. Schiff, Quantum Mechanics,4thEdition,2017, Mc Graw Hill Education. ● D.J.Griffiths,Introduction to Quantum Mechanics, 2019, Cambridge University Press. ● P.A.M. Dirac, The Principles of Quantum Mechanics, 4thEdition, 1981, Oxford Science Publications.	

SEMESTER VI

COURSE CODE	PLASMA PHYSICS	TotalLec. :45
SC23PH008		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To introspect the plasma parameters and various phenomena associated with its applications. ● Interpret the basics of the plasma parameters and related fluid equations ● Analyze the behavior of electromagnetic waves and electron beam with plasma ● Introspect the particle motions under the influence of external electric and magnetic field	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Introduction Basic concepts of plasma, concept of temperature, Debye length, plasma frequency, criteria for plasmas	10
II	Fluid equations Response of plasma to the fields, DC conductivity, AC conductivity, RF conductivity, collisions	12
III	Waves in Plasma: Plasma in relation with electromagnetic waves, electromagnetic wave propagation, propagation in inhomogeneous plasma, electrostatic waves in plasma, energy flow	6
IV	Interaction of plasmas with electron beam Two-stream instability, relativistic electron beam-plasma interaction, growth rate, Cerenkov free electron laser, free electron laser and energy gain	7
V	Particle motion in uniform electric fields, particle motion in uniform magnetic fields, non-uniform electric and magnetic fields, time-varying electric and magnetic fields, curvature drifts, adiabatic invariance, magnetic mirror, Tokomak	10
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will beableto**define**[1]Plasma and its criteria	
CO2	They will be able to **interpret**[2] various fluid equation..	
CO3	They will be able to **understand**[2] the waves in plasma.	
CO4	They will be able to **distinguish**[4] various types of plasma with electron beam	
CO5	They will be able to **understand**[1 the] Particle motion in electric fields.	
Text Books:		
Reference Books:	● Introduction to Plasma Physics and Controlled Fusion by F. F. Chen, 3rd edition (2016), Springer International Publishing. ● Interaction of electromagnetic waves with electron beams and plasmas by C.S. Liu and V.K. Tripathi, (1994) World Scientific. ● Principles of Plasma Discharges and Materials Processing by Michael A. Lieberman and Alan J. Lichtenberg, 2nd edition (2005) Wiley	

Practical

COURSECODE	PHYSICSLAB-VI	Practicals:
SC23PH008P		1
	● Measurement of Planck's constant using black body radiation and photo-detector ● Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light ● To determine work function of material of filament of directly heated vacuum diode. ● To determine the Planck's constant using LEDs of at least 4 different colours. ● To determine the wavelength of H-alpha emission line of Hydrogen atom. ● To determine the ionization potential of mercury. ● To determine the absorption lines in the rotational spectrum of Iodine vapour. ● To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet. ● To setup the Millikan oil drop apparatus and determine the charge of an electron. ● To show the tunneling effect in tunnel diode using I-V characteristics. ● To determine the wavelength of laser source using diffraction of single slit	

Syllabus SEMESTER VIII

COURSE CODE	SOLID STATE PHYSICS	TotalLec. :45
SC23PH009		3-0-0
Learning Objectives:	After studying this paper the students will know– ● Knowledge and understanding of crystal structure, electronic and vibrational properties of solid-state systems. ● Basic properties of metals, insulators and semiconductors. ● Semiconducting elements for the use in electronic devices. Low-dimensional semiconductors.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Crystal Structure: Introduction, Crystal lattice and translation vectors, unit cell, Basis, Symmetry operations ,point groups and space groups, types of lattices (Plane lattice and Space lattice with bcc and fcc), Lattice directions and planes, Miller indices, simple Crystal structure.	10
II	Bonding and Band Theory of Solids: Introduction, Concept of inter-atomic forces, Cohesive energy and types of bonding, Primary bonds (ionic bonds, Covalent bond and metallic bond), secondary bonds(Vander walls bond andhydrogen bonds)The Bloch theorem (only statement and properties), The Kroning Perry model, Energy versus Wave Vector relationship - different representations (Brillouin Zones).	12
III	Introduction, construction, working and characteristics of semiconductor diode, Zenerdiode, transistor (n-p-n and p-n-p transistor), Transistor Characteristics (CB, CE, CC), JFET (Construction and its characteristics).	6
IV	Schottky diode, MIS structures, basic equations in flat band conditions, MIS capacitances, current flow mechanisms in MS junction and MIS junction, depletion and enhancement type MOS FETS, capacitances in MOS FETs, quantitative analysis of I - V characteristics, thresholds in MOSFETS, charge trapping and flat band voltage, study of CMOS devices	7
V	Power diodes, ratings, reverses recovery characteristics, fast recovery diodes, Power transistors, Switching characteristics, construction of SCR, two transistors analogy, I- V characteristics, gate trigger characteristics, turn on and turn - off times, losses, reverse recovery characteristics, SCR ratings, dv/dt and di/dt characteristics, thyristor types, construction and characteristics of DIACs and TRIACs, static induction, thyristors, , light activated thyristors, Gate turn off thyristors (GTO), MOS controlledthyristors, programmable Unijunction transistors, Silicon Unidirectional switch (SUS), IGBT	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Crystal structure	
CO2	They will be able to **interpret**[2]bonding and band theory	
CO3	They will be able to **understand**[2]thesemiconductor diode.	
CO4	They will be able to **distinguish**[4]varioustypesofsemiconductor devices.	
CO5	They will be able to **understand**[1] the power electronic devices.	
Text Books:	● M. H. Rashid: Power Electronics. ● P. C. Sen: Power electronics ● B. G. Streetman and S. Banergee : Solid state Electronic Devices D.A. Roustan : Bipolar Semiconductor Devices.	
Reference Books:	● Karl Hess: Advanced theory of semiconductors devices. ● S. M. Sze: Physics of Semiconductor Devices 2nd edition. ● A Dir - Bar - Lev: Semiconductor and Electronic Devices.	

Syllabus SEMESTER VIII

COURSE CODE	NUCLEAR, ATOMIC AND MOLECULAR PHYSICS	Total Lec.: 45
SC23PH010		3-0-0
Learning Objectives:	• Objective of this course is to learn atomic, molecular and spin resonance spectroscopy	
Pre-requisite	General and Basic atomic structure	
UNIT	CONTENT	HOURS
I	One Electron Atom: Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, and Hyperfine structure. Two valance Electron Atom: Vector model for two valance electrons atom, LS coupling, Pauli Exclusion Principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling.	10
II	Atom in Magnetic Field: Zeeman Effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field.	7
III	Molecular Spectroscopy: Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions. Electron spin and nuclear magnetic resonance spectroscopy	7
IV	Nuclear forces and Models: Introduction of nuclear forces, nuclear binding energy, theoretical and practical estimate of dependence of binding energy, saturation, short range type, Nuclear fission and fusion, magic number, shell models, Liquid drop model	12
V	Particle Accelerators: Particle accelerator, linear resonance accelerator, cyclotron, synchro cyclotron, Vande-graff generator	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Describe the atomic spectra of one and two valance electron atoms.	
CO2	Explain the change in behavior of atoms in external applied electric and magnetic field.	
CO3	Explain rotational, vibrational, electronic and Raman spectra of molecules	
CO4	Describe electron spin and nuclear magnetic resonance spectroscopy and their Applications	
CO5	Able to understand the concept of particle accelerators	
Text Books:	• Introduction of Atomic spectra- White • Atomic and Nuclear Physics – N.Subramanayam and Brijlal • Elements of nuclear physics – M.L Pandya, R.P. Yadhave	
Reference Books:	• White, H.E., Introduction to Atomic Spectra, McGraw Hill, (1934). • Banwell, C.N. and McCash, E.M., Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007)	

Syllabus SEMESTER VIII

COURSE CODE	ANALOG AND DIGITAL CIRCUITS	TotalLec. :45
SC23PH011		3-0-0
Learning Objectives:	After studying this paper the students will know– ● To know the characteristics of various components. ● To understand the utilization of components. ● To design and analyze small signal amplifier circuits. ● To learn Postulates of Boolean algebra and to minimize combinational functions ● To design and analyze combinational and sequential circuits ● To know about the logic families and realization of logic gates.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Differential amplifier Circuit Configurations, Dual Input Balanced Output Differential amplifier, DC analysis, AC analysis, Inverting and Non Inverting Inputs, Constant Current Bias Circuit. Block diagram of a typical Op-Amp, Open loop configuration, Inverting and Non-inverting amplifiers, Op-amp with negative feedback, Voltage Series Feedback, Effect of feedback on closed loop gain, Input resistance, Output resistance, Bandwidth and Output offset voltage, Voltage follower. Practical Op-amp, Input Offset Voltage, Input bias current- input offset current, total output offset voltage, CMRR frequency response.	10
II	Applications of Op amps (15) DC and AC amplifier, Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Integrator and Differentiator. Oscillator: Principles , Oscillator types, Frequency stability, Response , Phase Shift oscillator ,Wein Bridge Oscillator, LC Tunable Oscillator , Multivibrators, Monostable and Astable, Comparators, Square Wave and Triangle wave generators. Voltage regulations: Fixed regulators, Adjustable voltage regulators, Switching regulators.	12
III	FETs and Digital Circuits: FETs: JFET, V-I characteristics, MOSFET, low frequency CS and CD amplifiers. Digital Circuits: Digital (binary) operations of a system, OR gate, AND gate, NOT, EXCLUSIVE OR gate, De Morgan Laws, NAND and NOR DTL gates, modified DTL gates, HTL and TTL gates, output stages, RTL and DCTL, CMOS, Comparison of logic families	6
IV	Combinational Logic Circuits: Basic Theorems and Properties of Boolean Algebra, Canonical and Standard Forms, Digital Logic Gates, The Map Method, Product-of-Sums Simplification, Don't-Care Conditions, NAND and NOR Implementation, Exclusive-OR Function, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers.	7
V	Sequential Logic Circuits: Sequential Circuits, Storage Elements: Latches and flip flops, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Shift Registers, Ripple Counters, Synchronous Counters, Random-Access Memory, Read-Only Memory.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Differential amplifier and its applications	
CO2	They will be able to **interpret**[2] applications of OPAMP	
CO3	They will be able to **understand**[2] the FETs and Digital Circuits.	
CO4	They will be able to **distinguish**[4] various types of combinational logic circuits.	
CO5	They will be able to **understand**[1] the sequential logic circuits..	
TextBooks:	● Integrated Electronics: Analog and Digital Circuits and Systems, 2/e, Jaccob Millman, Christos Halkias and Chethan D. Parikh, Tata McGraw-Hill Education, India, 2010. ● Digital Design, 5/e, Morris Mano and Michael D. Cilette, Pearson, 2011.	
ReferenceBooks:	● Electronic Devices and Circuits, Jimmy J Cathey, Schaum's outline series, 1988. ● Digital Principles, 3/e, Roger L. Tokheim, Schaum's outline series, 1994.	

Syllabus SEMESTER VIII

COURSE CODE	ELEMENTS OF CONDENSED MATTER PHYSICS	TotalLec. :45
SC23PH012		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To study some of the basic properties of the condensed phase of matter especially solids. Condensed matter physics (CMP) is the fundamental science of solids and liquids. ● As the largest branch of physics, it has the greatest impact on our daily lives by providing foundations for technology developments.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Basic Structures; symmetry properties, packing fractions, directions and position orientation of planes in crystal, concept of reciprocal lattice, concept of brillouin zones, closed packed structure, and structures of some binary/ternary compounds. Elementary concepts of polycrystalline, Nano crystalline and amorphous materials. Elementary concepts of defects in solids. X-ray scattering from solids including Laue conditions and line intensities.	10
II	Energy bands: Electron in periodic potential, Bloch function, solution of wave equation of electron in periodic potential, reduced, periodic and extended zone schemes. Construction of Fermi surfaces in brillouin zones for two - dimensional lattices, Introduction to methods for calculations of energy bands and their features. Semiconductors: Direct and indirect band gap semiconductors effective mass, intrinsic carrier concentration, impurity conductivity thermal ionization Revision on p-n junction and rectification, metal- semiconductor contacts, schotky barrier.	12
III	Dielectric properties of Solids, electronic, ionic, orientational, polarzabilities, static dielectric constant for gases, internal field in solids, dielectric constant of solids, dielectric relaxation in alternating fields, dielectric losses, complex dielectric constant.	6
IV	Concept of Energy Band: Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, Bloch theorem and crystal momentum, Classification of metal, insulator and semiconductors.	7
V	Super conductivity: Basic concepts, Meissner effect, heat capacity, energy gap, London equation, coherence length Josephson effect (flux quantization), type I and II superconductors, BCS theory, Introduction to high Tc Superconductors.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] basic structure of crystals.	
CO2	They will be able to **interpret**[2] energy bands.	
CO3	They will be able to **understand**[2] the dielectric properties of solids..	
CO4	They will be able to **distinguish**[4] various types of energy band.	
CO5	They will be able to **understand**[1] the super conductivity.	
Text Books:	● Srivastava, J.P., Elements of Solid State Physics, Prentice Hall of India, (2008).	
Reference Books:	● Introduction to Solid State Physics 4 th Ed. C. Kittel, ● Solid State Physics by A .J. Dekker ● Solid State Physics by N. W. Ashoroff &N. D. Mermin ● Solid State Physics S.O. Pillai ● Solid state Physics by R. L. Singhal	

Practical

COURSE CODE	PHYSICSLAB-VIII	Practicals:
SC23PH012P		1
	● To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO. ● To test a Diode and Transistor using a Multimeter. ● To design a switch (NOT gate) using a transistor. ● To verify and design AND, OR, NOT and XOR gates using NAND gates. ● To design a combinational logic system for a specified Truth Table. ● To convert a Boolean expression into logic circuit and design it using logic gate ICs. ● To minimize a given logic circuit. 8. Half Adder, Full Adder and 4-bit binary Adder. ● Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C. ● To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates. ● To build JK Master-slave flip-flop using Flip-Flop ICs. ● To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram	

SEMESTER I

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA001	ALGEBRA AND CALCULUS -I	L-T-P 3-1-0
Learning Objectives	The main objectives of the course ● To give foundation knowledge for the students to understand basics of mathematics including applied aspect. ● To equip the student with necessary analytic and technical skills by applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.	
Prerequisite	Elementary idea about calculus	
UNIT	CONTENT	HOURS
I	Determinants and Matrices, Matrix- Definition. Types, Basic Operation on Matrices, Transpose of Matrix. Elementary operations on matrices, Determinants, Minors and Co factor, Ad joint and Inverse of Matrix. Singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix.	12
II	Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices. Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations. Cramer's Rule.	12
III	Functions of one variable, Limit of a function (ε-δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of singe variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. Successive Differentiation, nth Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.	12
IV	Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normal of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula).	12
V	Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection.	12
	Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **understand**[2] basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.	
CO2	Students will be able to **understand**[2] wide ranging application of the subject and have the knowledge of matrices and basics of differentiation	
CO3	The student is **equipped**[3] with necessary analytic and technical skills by applying the principles of differentiation; he/she learns to solve a variety of practical problems in science and engineering.	
CO4	The student is **equipped**[3] with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.	
CO5	The students will also be able to **compute**[1]nth derivative of various functions .	
Text Books:	● Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008 2. Fuzhen Zhang, ● Matrix Theory- Basic Results and Techniques, Springer, 1999 3. ● Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010	
Reference Books:	● John Wiley & Sons, 1999 2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.,1974 . ● S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication. 1992 ● H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007 ● Suggested digital platform: NPTEL/SWAYAM/MOOCs	

Semester II

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA002	ALGEBRA AND CALCULUS -II	L-T-P 3-1-0
Learning Objectives	The main objectives of the course ● To give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics. ● To equip the student with necessary analytic and technical skills by applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.	
Prerequisites:	Elementary idea about calculus.	
UNIT	**CONTENT**	**HOURS**
I	Introduction to Sets. Forms and Types of set, Venn diagram, Basic Operations on Set, Union and Intersection of Set, Demorgan's Law for two sets. Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence Modulo n, Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups. An Alternative set of postulates of groups, Subgroups, Permutations, Cyclic Permutations, Even and odd permutations, group of Permutations alternating group, Integral power of an element of a group, Order of an element of a group.	12
II	Group homomorphism, Isomorphism on groups, the relation of isomorphism in the set of all groups Complexes and subgroup of a group, theorems on subgroups, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem, Cyclic group, generating system of group.	12
III	Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.	12
IV	Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Drichlet's theorem. Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	14
V	Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions	10
	Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to understand[2] basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.	
CO2	Students will be able to understand[2] wide ranging application of the subject and have the knowledge of Algebra.	
CO3	The student is equipped[3] with necessary analytic and technical skills by applying the principles of differentiation; he/she learns to solve a variety of practical problems in science and engineering.	
CO4	The student is equipped[3] with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.	
CO5	The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics	
Text Books:	● Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008 2. Fuzhen Zhang, ● Matrix Theory- Basic Results and Techniques, Springer, 1999 3. ● Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010	
Reference Books:	● John Wiley & Sons, 1999 2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.,1974 . ● S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication. 1992 ● H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007 ● Suggested digital platform: NPTEL/SWAYAM/MOOCs	

Semester III

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA003	DIFFERENTIAL EQUATIONS	L-T-P 3-1-0
Learning Objectives	The objective is to provide main concepts of differential equations: Ordinary differential equations and Partial differential equations. Specific course objectives are the following: ● Learn to evaluate first order linear and non-linear differential equations. ● Learn to solve second order and higher order linear differential equations using appropriate methods. ● Learn to solve linear systems of ordinary differential equations. ● Learn to solve linear and non-linear partial differential equations using appropriate methods. ● Learn to classify and solve second order partial differential equations using appropriate methods.	
Prerequisites	Elementary idea about Differential and Integral Calculus.	
UNIT	CONTENT	HOURS
I	Ordinary Differential equations: Degree and order of a differential equation, Formation of differential equation, Differential equations of first order and first degree: Variable separable, Homogeneous, Reducible to homogeneous, Linear, Reducible to linear, first order exact differential equations, Differential equations of first order and higher degree: Solvable for x, y, p, Clairaut's form.	12
II	Differential Equation of First Order and Higher Degree, Linear Differential Equation with Constant Coefficient of Higher Order, Cauchy's Differential Equation, Method of Variation of Parameter, Simultaneous Differential Equation, Introduction to series solution method.	12
III	Order and degree of partial differential equations, concept of linear and non-linear partial differential equations, formation of partial differential equations, linear partial differential equation of first order: Lagrange's method, non-linear partial differential equation: the four standard forms, Charpit's general method of solution.	12
IV	Formation of first and second order partial differential equations: Linear & Non-Linear Partial differential equation of First Order, Homogeneous & Non-Homogeneous Linear P. D.E with constant coefficient of Higher Order, Separation of Variables	12
V	Partial differential equations of second and higher orders, classification of linear second order partial differential equations: elliptic, parabolic and hyperbolic through illustrations only, homogeneous linear equations with constant coefficients: complimentary functions and particular integrals, non-homogeneous equations with constant coefficients, partial differential equations reducible to equations with constant coefficients.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **understand**^{2} first order ordinary differential equations utilizing the standard Techniques for separable, homogeneous, linear or exact cases.	
CO2	Student will be able to **understand**^{2} Differential Equation of First Order and Higher Degree	
CO3	They will be able to **analyze**^{4} the solution of higher order ordinary differential equation using either of applicable methods.	
CO4	They will be able to **understand**^{2} and will be able to solve linear and non-linear partial differential equations of first order.	
CO5	They will be able to **classify**^{4} partial differential equations of second order and solve them using applicable technique.	
Text Books:	● M D Raisinghania, Ordinary and partial Differential Equations, 2017, S Chand, I9th Edition. ● N P Bali, Differential Equations, 2006, Lakshmi Publications 10th Edition. ● V Sundarapandian, Ordinary and partial Differential Equations, 2012,Tata McGraw Hill Education private Ltd.	
Reference Books:	● S L Ross, Differential Equations, 1984, John Wiley and Sons, 3rd Edition, ● I Sneddon, Elements of Partial Differential Equations, 1967, McGraw-Hill, International Edition. ● S Guruprasad, A Textbook of Partial Differential Equations, 2017, New Age Publication.	

Semester IV

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA004	DISCRETE MATHEMATICS	L-T-P 3-1-0
Learning Objectives	• To Develop a solid understanding of fundamental concepts: Gain a deep understanding of foundational concepts in discrete mathematics • To Analyze and solve problems using graph theory: Understand the fundamental concepts of graph theory. • To Explore the theory of computation: Understand the basic concepts of computational complexity, algorithm analysis, and the classification of computational problems.	
Prerequisites	12th with Mathematics Stream	
Unit	**CONTENTS**	**HOURS**
I	**Logic**: Propositional equivalence, predicates and quantifiers, Methods of proofs, proof strategy, sequences and summation, mathematical induction, recursive definitions and structural induction, program correctness. **Counting**: The basics of counting, the pigeonhole principle, permutations and combinations, recurrence relations, solving recurrence relations, generating functions, inclusion-exclusion principle, and application of inclusion-exclusion. Mathematical Induction **Set Theory:** Definitions and the Element Method of Proof, Properties of Sets, Algebraic Proofs, Boolean Algebra.	**14**
II	**Sequence:** Describing a sequence, Arithmetic and geometric sequence, sum of Arithmetic and geometric sequence. Solving Recurrence relation, the characteristic root technique	**8**
III	**Relations:** Relations and their properties, n-array relations and their applications, representing relations, closure of relations, equivalence of relations, partial orderings. **Graph theory:** Introduction to graphs, graph terminology, representing graphs and graph isomorphism, connectivity, Euler and Hamilton paths, planar graphs, graph coloring, introduction to trees, application of trees.	**12**
IV	**Group theory:** Groups, subgroups, generators and evaluation of powers, cosets and Lagrange's theorem, permutation groups and Burnside's theorem, isomorphism, automorphisms, homomorphism and normal subgroups, rings, integral domains and fields.	**12**
V	**Lattice theory**: Lattices and algebras systems, principles of duality, basic properties of algebraic systems defined by lattices, distributive and complimented lattices, Boolean lattices and Boolean algebras, uniqueness of finite Boolean expressions, prepositional calculus. Coding theory: Coding of binary information and error detection, decoding and error correction	**14**
Course Outcomes as per Bloom's Taxonomy		
CO 1	At the end of the course the students should be able to**:** **Understand**[1] the key concepts and structures in discrete mathematics, such as sets, relations, functions, logic, proof techniques, and mathematical induction.	
CO 2	**Learn**[2] the fundamental concepts and techniques in graph theory, including graph representation, connectivity, paths, cycles, trees, and basic graph algorithms.	
CO 3	**Understand**[1] various discrete structures, such as sets, relations, and sequences, and understand their properties and applications.	
CO 4	**Explore**[4]propositional and predicate logic, and develop skills in constructing and evaluating logical arguments. Also, learn about Boolean algebra and its applications in digital circuits.	
CO 5	**Enhance**[3] analytical thinking skills by solving complex problems using discrete mathematics techniques, including identifying patterns, formulating solutions, and evaluating their correctness.	
Text Books	1. K.H. Rosen: Discrete Mathematics and its application, 5th edition, Tata McGraw Hill. 2. C. L. Liu: Elements of Discrete Mathematics, 2nd edition, TMH 2000 3. B.Kalman: Discrete Mathematical Structure, 3rd edition, Chapter	
Reference Books	1. Discrete Mathematics: Elementary and Beyond" by László Lovász, József Pelikán, and Katalin L. Vesztergombi, Springer. 2. "Mathematical Structures for Computer Science" by Judith L. Gersting, W.H. Freeman and	

	Company.	

Semester V

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA005	**REAL ANALYSIS**	**L-T-P 3-1-0**
Learning Objectives:	● To understand infinite sets and completeness property of R ● To learn Concept of cluster points and statement of Bolzano-Weierstrass theorem ● To evaluate Cauchy convergence criterion for sequences. ● To Learn Comparison test, convergence of p-series, Root test, Ratio test, alternating series and Leibnitz's test.	
Pre-requisites:	12th Passed with Mathematics Stream	
UNIT	**CONTENT**	**HOURS**
I	Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, supremum and infimum, completeness property of R, Archimedean property of R, intervals. Continuity and Differentiability of functions: Continuity of functions, Uniform continuity, Differentiability, Taylor's theorem with various forms of remainders.	**12**
II	**Sequence and Series:** Sequences, theorems on limit of sequences Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences and series. Cauchy's theorem on limits. Concept of cluster points and statement of Bolzano-Weierstrass theorem. **Integration:** Riemann integral-definition and properties, integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.	**12**
III	Absolute convergenceMonotone sequences and their convergence (monotone convergence theorem without proof). Infinite series. Cauchy convergence criterion for series, positive term series, geometric series.	**12**
IV	Tests for convergence, comparison test, convergence of p-series Cauchy's root Test, ratio Test, Rabbe's, Logarithmic test, Alternating series, Leibnitz's theorem. (Tests of Convergence without proof) Definition and examples of absolute and conditional convergence.	**12**
V	Uniform Convergence: Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Dritchlet's test, Convergence and uniform convergence of sequences and series of functions. Differentiability of functions, Power series and radius of convergence.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	Students will be able to **describe**[1] the fundamental properties of the real numbers that underpin the formal development of real analysis;	
CO2	They will be able to**demonstrate**[3] an understanding of the theory of sequences and series, continuity, differentiation and integration;	
CO3	They will be able to**demonstrate**[3] skills in constructing rigorous mathematical arguments.	
CO4	They will be able to**apply**[3] the theory in the course to solve a variety of problems at an appropriate level of difficulty;	
CO5	They will be able to**demonstrate**[3] skills in communicating mathematics.	
Text Books:	● H.K. Pathak, Real Analysis, 2019, Shree ShikshaSahityaPrakashan. ● B.R. Thakur & R.S. Chandel, 2020, Real Analysis, Ram Prasad and Sons. ● R.G. Bartle and D.R. Sherbert,2000, Introduction to Real Analysis, John Wiley and Sons (Asia) P. Ltd.	
Reference Books:	● E. Fischer, Intermediate Real Analysis, 1983, Springer Verlag. ● K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, 2003, Springer Verlag. ● R. Kumar and B. Sharma, Principle of Real Analysis, 2020, Mahaveer Publications.	

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA006	INTEGRAL CALCULUS AND VECTOR ANALYSIS	L-T-P 3-1-0
Learning Objectives:	● The objectives of the course typically aim to provide students with a strong foundation in calculus and its application to vector analysis. ● To develop a deep understanding of the concepts of integration and applications of integration ● To develop a solid understanding of vector concepts and their applications, including vector operations ● To study partial derivatives, gradients, directional derivatives, optimization of multivariable functions, and multiple integrals.	
Pre-requisites:	A solid foundation in pre-calculus topics such as sequences and series, complex numbers, and conic sections can be helpful for a smoother transition into integral calculus and vector analysis.	
UNIT	**CONTENT**	**HOURS**
I	Multiple Integrals- definition of the double integrals- evaluation of the double integrals double integrals in polar coordinates – triple integrals – applications of multiple integrals volumes of solids of revolution – areas of curved surfaces – change of variables – Jacobians.	**12**
II	Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	**12**
III	Operations with vectors. Scalar and vector product of three vectors. Product of four vectors. Reciprocal vectors. Scalar-valued functions over the plane and the space. Vector function of a scalar variable: Curves and Paths. Vector fields	**12**
IV	The vector deferential operator del. The gradient of a scalar point function. The derivative of function. Properties of gradient of vector function. Directional derivative, Divergence and curl of a vector point function. Properties of divergence and curl. Solenoidal and irrotational vectors.	**12**
V	Line, surface and volume integrals - Integral Theorems - Gauss, Greens and Stokes (Without proof) – Problems.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	The completion of the course will enable the students to: **Develop**[1] a solid understanding of fundamental concepts in integral calculus	
CO2	**Apply**[2] integral calculus to solve problems in various fields, such as finding areas between curves	
CO3	**Learn**[3] the basic concepts of vector calculus, including vector fields, vector functions, limits, continuity, and differentiability of vector functions.	
CO4	**Study**4 the concepts of gradient, divergence, and curl of vector fields and their applications in physics, engineering, and other disciplines.	
CO5	**Develop**[3] problem-solving skills by applying integral calculus and vector analysis techniques to solve real-world problems in physics, engineering, and related fields.	
Text Books:	1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007 2. Murray R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill. 3. Suggested digital platform: NPTEL/SWAYAM/MOOCs	
Reference Books:	1. "Vector Calculus" by Jerrold E. Marsden and Anthony J. Tromba, W.H. Freeman and Company). 2. "Advanced Calculus" by Patrick M. Fitzpatrick, American Mathematical Society	

Semester VI

COURSE CODE	COURSE NAME	Total Lecture: 60
SC23MA007	LINEAR ALGEBRA	L-T-P 3-1-0
Learning Objectives:	• The objective of this course is to introduce the fundamental theory of two objects, namely - rings and vector spaces, and their corresponding homomorphisms. • The course introduces the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers, used in finite fields with applications • This course emphasizes the application of techniques using the ad-joint of a linear operator and their properties to least squares approximation and minimal solutions to systems of linear equations.	
Prerequisites:	Basics of Algebra	
UNIT	**CONTENT**	**HOURS**
I	**Introduction of Rings and Ring Homomorphism**: Definition and examples of rings, Properties of rings, Sub-ring, Integral domains and fields, Characteristic of a ring, Ideals, Ideal generated by a subset of a ring, Factor rings, Operations on ideals, Prime and maximal ideals. Ring homomorphism, Properties of ring homomorphism, First, Second and Third Isomorphism theorems for rings, The Field of quotients.	**12**
II	**Introduction of Vector Spaces**: Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence and dependence of vectors, Basis and dimension, Dimension of subspaces.	**12**
III	**Linear Transformations**: Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Isomorphism, Isomorphism theorems, Invertibility and the change of coordinate matrix.	**12**
IV	**Inner Product Spaces:** Inner product spaces and norms, Ortho-normal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality	**12**
V	**Dual Spaces and Diagonalizable Operators:** Dual spaces, Double dual, Dual basis, Transpose of a linear transformation and its matrix in the dual basis, Eigenvalues, Eigenvectors, and characteristic polynomial of a linear operator; Diagonalizability, Invariant subspaces and Cayley-Hamilton theorem; The minimal polynomial for a linear operator.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	Students will be able to **describe**[1] the significance of unique factorization in rings and integral domains.	
CO2	They will be able to **acquire**[1] knowledge of important concepts such Ring homomorphism & isomorphism from discrete mathematics to advanced abstract mathematics	
CO3	They will be able to **demonstrate**[3] with the characteristic polynomial, eigen-values, eigenvectors, as well as the geometric and the algebraic multiplicities of an eigen-value and **apply**[2] the basic diagonalization result.	
CO4	They will be able to **demonstrate**[3] inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain ortho-normal basis.	
CO5	They will be able to **apply**[3] the theory in the course to solve a variety of problems at an appropriate level of difficulty	
Text Books:	H.K. Pathak, Linear Algebra, 2019, Shree Shiksha Sahitya Prakashan B.R. Thakur & R.S. Chandel, Linear Algebra, 2019, RAM PRASHAD & SONS	
Reference Books:	Kenneth Hoffman and Ray Kunze, Second Edition, Linear Algebra PEARSON Education India Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Forth Edition, Linear Algebra PEARSON Education India	

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA008	PROBABILTY AND STATISTICS	L-T-P 3-1-0
Learning Objectives:	The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.	
Prerequisites:	Basic Concepts of Mathematics	
UNIT	CONTENT	HOURS
I	Introduction to Probability: Sample space, Types of Events related to probability,Basic notions of probability.Additive and multiplicative law of probability, Conditional Probability and Independence: Conditional probability, Bayes' theorem, Dependent and Independent events.	12
II	Probability Distribution: Random Variables, Continuous and discrete random variables. Binomial, Poisson, Normal, and Exponential distributions.	12
III	Measure of central tendency, Measures of dispersion, Moments, Expectation skewness, kurtosis, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression.	16
IV	Curve fitting by the numerical method: Curve fitting by of method of least squares, fitting of straight lines, second degree parabola and more general curves.	8
V	Formation of Hypothesis, Test of significance: Large sample test for single proportion, Difference of proportions, Single mean, Difference of means, and Difference of standard deviations. Test of significance for Small samples:t- Test for single mean, difference of means, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attributes	12
Course Outcomes as per Blooms Taxonomy		
CO1	Students will be able to **understand**[2] the basic knowledge on fundamental probability concepts, including random variable, probability of an event, additive rules and conditional probability	
CO2	They will be able to **understand**[2]several well-known distributions, including Binomial, Geometrical, Negative Binomial, Pascal, Normal and Exponential Distribution	
CO3	They will be able to **understand**[2] the basic statistical concepts and measures.	
CO4	They will be able to understand the fitting of various curves by method of least square.	
CO5	They will be able to apply[4] the statistics for testing the significance of the given large and small sample data by using t- test, F- test and Chi-square test They will be able to understand the fitting of various curves by method of least square.	
Text Books:	● R.E. Walpole, R.H. Myers, S.L. Myers and K. Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, 2007, Pearson International Edition. ● M. Spiegel, J. Schiller and R. Srinivasan, Schaum's Outline of Probability and Statistics, 2000, McGraw Hill. ● W. Mendenhall and R. Beaver, Introduction to Probability and Statistics, 1994, Wadsworth Publishing.	
Reference Books:	● S. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 1988, John Wiley. ● M. Berger, An Introduction to Probability and Stochastic Processes, 1992, SpringerVerlag.	

Semester VII

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA009	COMPLEX ANALYSIS	L-T-P 3-1-0
Learning Objectives:	• To present students the elements and importance of the Complex analysis. • Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations. • Learn some elementary functions and valuate the contour integrals. • To enable the students to the differentiability of complex functions and its related.	
Prerequisites:	12th with Mathematics	
UNIT	**CONTENT**	**HOURS**
I	**Analytic Functions and Cauchy−Riemann Equations** Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy−Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.	**12**
II	Elementary Functions and Integrals Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals, Complex integration: Line integrals Rectifiable Arcs - Line Integrals as Functions of Arcs Cauchy's theorem for a rectangle Cauchy's integral formula.	**12**
III	The Calculus of Residues: The Residue theorem - The Argument principle - Evaluation of definite integrals - Harmonic functions: The Definitions and basic Properties - Mean value property - Poisson's Formula. Singularities and classifications- Isolated singularities: Removable singularity Pole and essential singularity-Residues-Cauchy's Residue theorem-problems	**12**
IV	Series and Residues Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.	**12**
V	The Riemann Mapping Theorem - Statement and Proof- Boundary Behavior - Use of the reflection principle - Analytic arcs - Conformal mapping of Polygons: The Behavior at an angle - the Schwartz - Christoffel Formula - Mapping on a rectangle.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	**The completion of the course will enable the students to:** **Learn and Describe**[1] the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations.	
CO2	**Evaluate**[2] line integrals, curve integrals, singularities and determine the values of integrals using residues.	
CO3	**Apply** and **understand**[3] about limits and to know how they are used in series and problems	
CO4	**Analyze**[4] functions of complex variable in terms of continuity, differentiability and analyticity. Apply Cauchy-Riemann equations and harmonic functions to solve problems	
CO5	**Expand**[4] some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.	
Text Books:	• S. Ponnusamy Foundations of Complex Analysis Narosa Publisher 2003 • A.R.Vasistha and Etal Complex Analysis Krishna prakashan media pvt ltd 2008. • A.F.Beardon Complex Analysis John Wiley and Sons 1979	
Reference Books:	L.V.Ahlfors Complex Analysis Mc Graw Hill, NewYork 2013	

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA010	NUMERICAL METHODS	L-T-P 3-1-0
Learning Objectives:	• This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering. • The objective is to provide a basic understanding of the derivation, analysis, and use of these numerical methods, along with an elementary understanding of finite precision arithmetic and the conditioning and stability of the various problems and methods. • This will help you choose, develop and apply the appropriate numerical techniques for your problem, interpret the results, and assess accuracy.	
Prerequisites:	A strong understanding of mathematical concepts	
UNIT	**CONTENT**	**HOURS**
I	**Errors in Numerical computations**: Errors and their Accuracy'. Mathematical Preliminaries, Errors and their Analysis. Absolute. Relative and Percentage Errors. A General error formula. **Solution of Algebraic and Transcendental Equations**: The bisection method. The iteration method, The Method of False position. Newton Raphson method, Generalized Newton Raphson method	**12**
II	**System of linear equations**: Iteration methods, rate of convergence. Matrix factorization methods. Least square method for inconsistent system. Gaussian elimination. Gaussian elimination with scaled partial pivoting. Gauss Jordan Method. LU decomposition.	**12**
III	**Operators** –finite differences, average, differential, etc., their inter-relations. Difference of polynomials. Difference equation. Interpolation. Lagrange's methods, error terms. Newton's fundamental interpolation. Forward, backward and central difference interpolations. Interpolation by iteration.	**12**
IV	**Interpolation:** Difference schemes, interpolation formulas using differences. Lagrange and Newton interpolation. Hermite interpolation. Divided differences. **Numerical differentiation:** Based on interpolation, the method of undetermined coefficients, Error estimates.	**12**
V	**Numerical integration:** Trapezoidal, Simpson's, and Weddle's rules. Gauss Quadrature Formulas. **Ordinary differential equations**: Euler's method, Single-step methods, Runge-Kutta's method	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	**The completion of the course will enable the students to:** Student will be able to apply[1] appropriate theories, principles and concepts relevant to the numerical analysis.	
CO2	Student will be able to analyze[2] and interpret information from a variety of sources relevant to Numerical Analysis.	
CO3	They would be able to demonstrate[3] numerical methods for solving various problems.	
CO4	Student will be able to establish[2] the limitations, advantages, and disadvantages of different numerical methods.	
CO5	Student will be able demonstrate[3] competence with understanding the theoretical and practical aspects of the use of numerical methods.	
Text Books:	(i) S. Rangnatham, M.V.S.S.N. Prasad, V.Ramesh Babu Numerical Analysis Fourth Edition, S. Chand. (ii) S.S. Sastry Fifth Edition PHI Learning	
Reference Books:	(i) Numerical Mathematics and Computing by W. Cheney and D. Kincaid, 3 rd edition, Brooks/Cole Pub. Co. 1994. (ii) Elementary Numerical Analysis by K. Atkinson, 2nd edition, John Wiley & Sons, Inc., 1993.	

Semester VIII

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA011	**LINEAR PROGRAMMING AND OPTIMIZATION TECHNIQUES**	**L-T-P 3-1-0**
Learning Objectives:	The main objective is to introduce the most widely used optimization method, linear programming to the students. Specific course objectives are the following: ● Explain basic concepts of optimization, modeling and linear modeling (LP). ● Define the LP's assumptions and explain the different methods, such as graphical approach and Simplex method of solving Linear Programming Problem. ● Explain the various mathematical models of LPP and different methods of solving.	
Pre-requisites:	Basic Concepts of Matematics	
UNIT	**CONTENT**	**HOURS**
I	Basics of OR and LPP: Development of OR, Definition, characteristics, scope, objectives and limitations of OR, convex sets, Basic feasible solutions, Formulation of LPP, Graphical Method to solve LPP, General LPP, Canonical and Standard forms, Properties of solutions and theory of Simplex method.	12
II	Introduction to artificial variables, two-phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal- dual relationships, Dual Simplex method, economic interpretation of the dual.	12
III	Transportation Problem: Formulation of Transportation problem, degeneracy in transportation problem, Balanced and Unbalanced transportation Problems. Various methods of solving Transportation problem: Starting Solution and Optimization of initial solution.	12
IV	Assignment Problems: Formulation of Assignment Problem, Hungarian method of Solving Assignment problem: finding initial solution, condition of optimality check, balanced and unbalanced Assignment problems.	12
V	Sequencing Problems: Introduction – Basic Assumptions – Sequencing n Jobs on 2 Machines – Sequencing n Jobs on 3 machines – Sequencing 2 Jobs on n Machines. Queuing Theory : General Concepts and Definitions – Classification of queues – Poisson Process, Properties of Poisson Process – Queuing Models: 1. (M/M/1):(∞/FCFS), 2. (M/M/1):(N/FCFS), 3. (M/M/c):(∞/FCFS)	12
Course Outcomes as per Bloom's Taxonomy		
CO1	**The completion of the course will enable the students to:** Students will be able to **formulate**[3] the LPP.	
CO2	They will be able to **conceptualize**[4] the feasible region.	
CO3	They will be able to **solve**[3] the LPP with two variables using graphical Simplex and Big-M Methods	
CO4	They will be able to **solve**[3] the Transportation problem with different Methods.	
CO5	They will be able to **Understand**[2] the Concept of Assignment Problem and Queuing -Theory.	
Text Books:	● S D Sharma and Himanshu Sharma, Operation research: Theory, Methods and Applications, 2010, KedarNath Ram Nath publishers, ● R K Gupta, 2014, Linear Programming, Krishna Prakashan Media. ● G S Sandhu, , 2019, Linear Programming, First World Publications.	
Reference Books:	● F S Hillier and G.J. Lieberman, Introduction to Operations Research, 2004, 8th Ed., Tata McGraw Hill, Singapore. ● HA Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.	

COURSE CODE	COURSE NAME	Total Lecture: 60
SC23MA012	MATHEMATICAL TRANSFORMS AND TECHNIQUES	L-T-P 3-1-0
Learning Objectives:	• Express non periodic function to periodic function using Fourier series and Fourier transforms. • Course intends to deliver the concept of Laplace transforms, Fourier series, separation method techniques for ordinary and partial differential equation and apply it to various levels.	
Prerequisites:	12th with Mathematics Stream	
UNIT	**CONTENT**	**HOURS**
I	**Laplace Transforms I:** Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications.	**12**
II	**Laplace Transforms II**: Definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) and problems. Solution of linear differential equations using Laplace transforms. Transform of standard function, finds Inverse LT by different methods, Partial fraction method, convolution theorem, solving ODEs by Laplace Transform method.	**12**
III	**Fourier Series:** Fourier integral representation, Fourier sine and cosine integral, Fourier Transform and Inverse Fourier transform of constant and exponential function. Properties and its application	**8**
IV	**Fourier Transforms:** Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms**.** **Z –Transforms:** Elementary properties, inverse Z-transform, convolution theorem, formation and solution of difference equations.	**16**
V	**Partial Differential Equations and Applications:** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method; Charpit's method; method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	**The completion of the course will enable the students to:** Solve Laplace transforms using integrals and Evaluate inverse of Laplace transforms by the method of convolution.	
CO2	Solve the linear differential equations using Laplace transform	
CO3	Summarize the concept of Laplace transforms to the real-world problems of engineering.	
CO4	Understand the nature of the Fourier series that represent even and odd functions and Determine Half- range Fourier sine and cosine expansions	
CO5	Possess the knowledge and skills for employability and to succeed in competitive examinations	
Text Books:	1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.	
Reference Books:	1.G. Shanker Rao, "Mathematical Methods", I. K. International Publications, 1st Edition, 2009. 2. G. Shanker Rao, "Engineering Mathematics-1", I. K. International Publications, 1st Edition, 2009.	

SANJEEV AGRAWAL GLOBAL EDUCATIONAL UNIVERSITY, BHOPAL

Proposed Scheme & Syllabus
For

Bachelor of Science (BSc)

Certificate/Diploma/Degree/Honors Degree/ Research Degree

in

Forensic Science

w.e.f. 2023-24 (According to NEP 2020)

School of Sciences

Bachelor of Science (BSc)

Program Educational Objectives (PEOs) Forensic Science:

PEO-1: Prospective Employment and Career Prospects-Developing the potential for vertical career growth in investigationlaboratories, service sectors and related avenues.

PEO-2: Proficiency- Inculcating technical and managerial skills crucial for real time scenarios through the enhancement of problem-solving skills and advanced technical documentation ability.

PEO-3: Affectionate Objective- Grooming the students with technical proficiency to equip them for the emergence of sustainable technology and solutions for prevailing environmental, societal and cultural concerns.

PEO-4: Research Methods-Nurturing the research aptitude to provide solutions for global challenges and abilities to explore hidden potential of the matter.

PEO-5: Continuous Learning-Instilling knowledge and awareness on professional ethics related to crime prevention and evidence analysis and life-long learning through career-oriented courses.

Program Outcomes (POs) Forensic Science:

By the end of the program the students will be able to:

PO 1. Understand concepts of Forensic Science and demonstrate interdisciplinary skills acquired in Forensic biology, Forensic chemistry, Forensic physics, questioned documents and cyber forensics.

PO 2. Demonstrate the Laboratory skills in Forensic biology, Forensic chemistry, Forensic physics, questioned documents and cyber forensicswith emphasis on technological aspects

PO 3. Apply the knowledge and skills gained in the fields of Forensic biology, Forensic chemistry, Forensic physics, questioned documents and cyber forensics.

PO 4. Critically analyze shortcomings in scientific analysis of evidences and apply the knowledge gained for protecting the Integrity and confidentiality of evidences to serve justice.

PO 5. Demonstrate comprehensive innovations and skills in the fields of Forensic biology, DNA Fingerprinting, Forensic chemistry, Toxicology, Forensic physics, ballistics, questioned documents and cyber forensics with respect to applications for human welfare.

PO 6. Apply the knowledge and skills of scientific concepts of forensic science to aid in investigation.

PO 7. Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of forensic science.

PO 8. Learn and practice professional skills in handling and analyzing evidences of different fields of forensic science.

PO 9. Demonstrate thorough knowledge and application of good laboratorypractices in forensic investigative agencies

PO 10. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up of and working in different investigative agencies.

COURSE CODE	POLICE SCIENCE AND CRIMINAL JUSTICE SYSTEM	Total Hrs: 60 Lecture: 45 Practical: 15
SC23FS001		(3-0-2)
Learning Objectives:	After studying this paper, the students will know – ● To promote independent thinking, learning in criminal Administration of justice. ● To understand the basic concepts of penology& offences against person & property. ● To study different police organization and its set up at various levels. ● To understand the basic concepts and insights in police science. ● To conduct empirical research on different topic regarding the administration of criminal justice.	
Pre-requisite:	Basic understanding of forensic science and its principles.	

UNIT	CONTENT	HOURS
I	**Crime and Administration of Justice:** Meaning, Difference between civil and Criminal Justice, Object of Punishment, Kinds of Punishment, Primary and Sanctioning Rights, Primary and Secondary functions of Court of Law**.** Elements, nature, causes and consequences of crime. Deviant behaviour. Hate crimes, organized crimes and public disorder, domestic violence and workplace violence. White collar crimes	9
II	**Punishment Under the code and Victimology:** Death (s – 53), Commutation of Sentence (ss – 54, 55), Imprisonment (ss – 55, 60, 73-74), Fine (ss – 63, 65 - 70). Rules for Assessment of Punishment: (ss – 71, 72, 75). Basics of Victimology. Juvenile delinquency. Social change and crime. Psychological Disorders and Criminality. Situational crime prevention.	9
III	**Offences against Human body and Property:** Culpable homicide (ss – 299, 301, 304), Murder (ss – 300-303), Negligence (s –304A), Abetment to suicide (ss-305-306), Attempt to commit above offences (ss- 307-309) Simple Hurt (ss- 319, 321, 323), Grievous Hurt (ss- 320,322, 325), Rape (ss- 375-376), Unnatural offence (s-377)**.** Theft (ss-378, 380-382), Extortion (ss- 383 – 389), Robbery (ss-390, 3902 – 394, 401), Dacoity (ss-391, 395 – 400 & 402), Cheating (ss-415 - 420)	9
IV	**Police organization under central government:** General information about their structure and function**s** of BSF, Assam rifle, CRPF, CISF, ITBP, NSG Police organization under central government: general information about their structure and function BPR&D, CBI, IB, RAW, INTERPOLE.	9
V	**State Police organization**: General organization of police at state and range level. Police organization at district level. The police and policing Commissioner and system of policing Other police department (state): criminal investigating department (CID) State armed police, home guards and women police Forensic science labs and other forensic institutions.	9

Course Outcomes as per Bloom's Taxonomy	
CO1	**Analyse**[3] inequalities within the criminal justice system; including those based on discrimination and disparities by race, gender, class, ability, and sexuality
CO2	**Summarize**[4] the process of judicial review and identify criteria used by courts to evaluate the constitutional policy Identify and synthesize social theory about crime, justice, and social deviance
CO3	**Apply**[3] critical thinking skills in the reading and interpretation of legal materials (statues, court decisions)

CO4	Have a basic **knowledge[2]** of procedural rules and evidentiary rules and understand the relationship between procedural rules and substantive law
CO5	**Understand[2]** the organization & setup of par- military forces
Text Books:	● B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty FirstCentury, Select Publishers, New Delhi. ● M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi. ● R. Gupta, Sexual Harassment at Workplace, LexisNexis, Gurgaon. ● R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey.
Reference Books:	● B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty FirstCentury, Select Publishers, New Delhi ● M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi. ● S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific andInvestigative Techniques, 2nd Edition, CRC Press, Boca Raton. ● W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton. ● R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey. ● W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime SceneInvestigation, CRC Press, Boca Raton. ● S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific andInvestigative Techniques, 2nd Edition, CRC Press, Boca Raton. ● D.E. Zulawski and D.E. Wicklander, Practical Aspects of Interview and Interrogation, CRC Press, Boca Raton

List of Practical

1. To review past criminal cases and elucidate which theory best explains the criminal behaviour of the accused.
2. To review crime cases where criminal profiling assisted the police to apprehend the accused.
3. To cite examples of crime cases in which the media acted as a pressure group.
4. To examine a case of juvenile delinquency and suggest remedial measures.
5. To evaluate how rising standards of living affect crime rate.
6. To visit a 'Model Police Station' and examine the amenities conventional police stations.
7. To review the organisational structure of Para-military force in India.
8. To study the organisation of police in India.
9. To Study the cases of phycological cases in India.
10. To study the White-collar crime.

COURSE CODE	COMPUTER FUNDAMENTALS AND ORGANIZATION	
SC23FS013		**(4-0-0)**
Learning Objectives:	After studying this paper, the students will know – ● To develop a foundational understanding of computer components, architecture, and operation principles. ● To learn about the organization and structure of computer systems, including memory management, input/output devices, and data representation. ● To gain knowledge about computer hardware components such as the CPU, motherboard, storage devices, and peripheral devices. ● To study software concepts, including operating systems, programming languages, and software development processes. ● To learn about the basics of computer networks, including network protocols, communication models, and network security.	
Pre-requisite:	Basic of computer and mathematics	
UNIT	**CONTENT**	
I	**Number Systems and Logic Gates and Combining Logic Gates:** **Number Systems:** decimal system; Binary; Octal and Hexadecimal number systems, Place Value, number conversion, Binary Coded Decimal. **Logic Gates:** The AND Gate; The OR Gate; The Inverter and Buffer; The NAND Gate; The NOR Gate; The Exclusive OR Gate; The Exclusive NOR Gates; The NAND and NOR Gate as an Universal Gate; Gates with more than Two Inputs. **Combining Logic Gates:** Constructing Circuits from: Boolean Expression, Drawing a Circuit from a Maxterm and Minterm Boolean Expression; Truth Tables and Boolean Expressions;, Boolean postulates, Demorgan's theorem .	
II	**Simplification of Boolean Expression:** Simplifying Boolean Expression using boolean postulates; Karnaugh Maps with Two, Three, Four, Five Variables, Don't care condition; Tabulation method. **Data Processing Circuits:** Multiplexers, Demultiplexers, Decoders of 16 Decoder, BCD to Decimal Decoders, Seven Segment Decoders, Encoders, Parity Generators and Checkers, Magnitude Comparator.	
III	**Arithmetic Circuits and Arithmetic Unit:** Binary Addition; Half Adders; Full Adders; Three Bit Adders; Binary Subtraction; Parallel Subtractors; 2's Complement Notation; Addition & Subtraction of Signed Numbers; 2's Complement Adders/ Subtractor.; Design of Fast Adders. Binary Multiplication; Multiplication of Positive Numbers; Binary Multipliers; Signed-Operand Multiplication; Fast Multiplication; Integer Division; Floating-Point Numbers & Operations.	
IV	**Machine Instruction and Programs:** Basic operational concepts, Memory Location and Addresses, Memory Operations; Instructions & Instruction Sequencing; Addressing Modes, Stacks and Queues, Subroutines, Subroutine nesting and processor stack, parameter passing	

V	**Input / Output Organization:** **Input / Output Organization:** Accessing I/O Devices, Interrupts, Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Buses, Direct Memory Access. **Memory Systems:** Memory System: Some Basics Concepts; Semiconductor RAM Memories; Read-Only Memories; Cache Memories - Mapping Functions	
Course Outcomes as per Bloom's Taxonomy		
CO1	● **Learn**[2] the number systems and fundamentals of logic gates.	
CO2	● **Simplify**[4] Boolean expressions and use data processing circuits.	
CO3	● **Understand**[2] working of Arithmetic Logic Unit.	
CO4	● **Apply**[3] different addressing modes.	
CO5	● **Interpret**[2] Input/ Output Organization, interrupts and memory system.	
Text Books:	● Roger L Tokheim : Digital Electronics Principles and Applications, Sixth Edition, McGraw Hill, 2004 ● M Morris Mano, "Digital Logic and Computer Design", 10th Edition, Pearson, 2008 ● Carl Hamacher, Z Varnesic and S Zaky : Computer Organization, Fifth Edition, McGraw Hill, 2002	
Reference Books:	● Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital Logic Design with VHDL", 2nd Edition, Tata McGraw Hill, 2005. ● Donald P Leach, Albert Paul Malvino& Goutam Saha, "Digital Principles and ● Computer Organization and Architecture Books Collection Free Download – Learnengineering.in	

COURSE CODE	DOCUMENT AND FINGERPRINT EXAMINATION	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS002		**3-0-2**
Learning Objectives:	After studying this paper the students will know – ● Understand the fundamental concepts of document examination ● Understand the basis of documents and different writing instrument. ● Analysis of Questioned Document and Handwriting examination. ● Learn the fundamental principles on which the science of fingerprinting is based. ● Examine the Development of Fingerprints and Advancements. ● Understanding the role of document and fingerprint examination in forensic investigations and the ● criminal justice system. ● Exploring emerging trends and advancements in document examination and fingerprint analysis..	
Pre- requisite:	Basics of Forensic Science	

UNIT	CONTENT	HOURS
I	Documents: Definition, Types, Preliminary examination of documents, Questioned document and their types. Instruments used to prepare documents, ink and its types & analysis, paper & its type, manufacturing & analysis, collection, handing, Preservation and forwarding of documents seized from the scene of crime. Preliminary examination of documents. Basic tools needed for forensic documents' examination – ultraviolet, visible, infrared and fluorescence spectroscopy, photography of questioned documents, visible spectral comparator (VSC), electrostatic detection apparatus (ESDA). Reproduction of documents through photographic and mechanical means and their examination, Examination of Alterations such as Erasures, Obliterations & Additions, Indentations.	**9**
II	Handwriting Examination: Development of handwriting, master pattern, physiology of handwriting, difference between mature and immature writings, different vernacular Indian languages and scripts, Simon New Comb theory of probability. Definition of natural variations, disguise handwriting. Various methods adopted for disguise. Comparison of Handwriting & Signature. Class and individual characteristics of handwriting & signature, Report making. Secret writings and Charred documents, Inks, Papers and their scientific examinations with modern methods. Age of document, Examination of Typescripts, Printed matter including currency notes and lottery tickets. Identification of hand writings, signatures, detection of forged signature and forgeries, Examination of Credit Cards and Similar materials	**9**
III	Fingerprinting and Classification: Introduction and history, with special reference to India. Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns. Fingerprint characters/minutiae. Plain and rolled fingerprints. Henry's Classification, Single Digit Classification, Extended Henry's System, Automated Fingerprint Identification System. Significance of poroscopy and edgeoscopy. Examination of Chance Prints, Computerization of Fingerprints, AFIS	**9**

IV	Development of Fingerprints and Advancements: Latent prints. Constituents of sweat residue. Latent fingerprints' detection by physical and chemical techniques. Mechanism of detection of fingerprints by different developing reagents. Application of light sources in fingerprint detection. Preservation of developed fingerprints. Digital imaging for fingerprint enhancement. Fingerprinting the deceased. Developing fingerprints on gloves. Recent techniques (Digital Imaging & Enhancement, Laser & other radiation-based techniques, Preservation, and photography of fingerprints on various surfaces.	**9**
V	Other Impressions: Importance of footprints. Casting of footprints, Electrostatic lifting of latent footprints. Palm prints. Lip prints - Nature, location, collection, and examination of lip prints. Ear prints and their significance. Palm prints and their historical importance. Marks: Foot Prints, Shoe Prints, Tire Marks, Their Preservation & Casting, Comparison, Skid marks. Gait pattern, Biometric Systems of Identification and its relevance. Palm prints	**9**

List of Practical-

1. Examination of various ink samples using chromatography techniques.
2. Decipherment of secret, erased, obliterated, indented handwriting using physical techniques.
3. Decipherment of secret, erased, obliterated, indented handwriting using chemical techniques.
4. Matching of hand writing (genuine/forged)
5. Matching of signatures (genuine/forged)
6. Handling and examination of Charred document.
7. To record plain and rolled fingerprints.
8. To carry out ten-digit classification of fingerprints.
9. To identify different fingerprint patterns.
10. To investigate physical methods of fingerprint detection.
11. To investigate chemical methods of fingerprint detection.
12. To use different light sources for enhancing developed fingerprints.

Course Outcomes as per Blooms Taxonomy

CO1	**Identify**[3] the questioned document at the crime scene.
CO2	**Evaluate**[5] and examine the questioned document using different basic tools
CO3	**Compare** and **analyze**[3] various handwriting and signature samples.
CO4	**Evaluate**[5] various advancements in the development of fingerprints
CO5	**Examine**[4] the various types of prints and their applications
Text Books:	● O. Hilton, Scientific Examination of Questioned Documents, CRC Press, Boca Raton. ● R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, ● Academic Press, London ● Albert Osborn; The Problem of Proof – Second Ed.; Universal Law Publishing Delhi
Reference Books:	● Charles C. Thomas, Typewriting Identification I.S.Q.D. Billy Bates; Springfield, Illinois, USA ● Charles C. Thomas, I.S.Q.D. Identification system for Questioned documents; Billy Prior Bates ● Springfield, Illinois, USA ● Wilson R. Harrison; Suspect documents – Their Scientific Examination; Universal Law ● Publishing, Delhi. ● Hard less, H.R.: Disputed documents, handwriting and thumbs- print identification: profusely ● illustrated, Law book Co., Allahabad.

COURSE CODE	OPERATING SYSTEMS	Total Hrs.: 60 Lecture: 45 Practical:15
SC23FS014		**3-0-2**
Learning Objectives:	After studying this paper the students will know – ● To explain the fundamental principles and functions of an operating system. ● To summarize the different types of system calls and their purposes. ● To interpret and explain the concepts of process management, memory management, and file systems. ● To apply knowledge of operating systems to solve practical problems and scenarios. ● To utilize system commands and utilities to manage processes, memory, and files. ● To demonstrate the ability to configure and manage various operating system settings.	
Pre-requisite:	Basics of Computer	

UNIT	CONTENT	HOURS
I	**Introduction to Operating System:** Introduction, Objectives and Functions of OS, Evolution of OS, OS Structures, OS Components, OS Services, System calls, System programs, Virtual Machines. History of UNIX, Features & Benefits, Versions of UNIX, Features of UNIX File System, Commonly Used Commands and getting Started (Login/Logout). Creating and viewing files using cat, file comparisons, View files, disk related commands, checking disk free spaces.	**9**
II	**Process Management – Processes and Threads:** Processes: Process concept, Process scheduling, Co-operating processes, Inter process Communication. Threads: Introduction to Threads, Single and Multi-threaded processes. CPU Scheduling: Basic concepts, scheduling criteria, Scheduling Algorithms, Multiple Processor Scheduling, Real-time Scheduling, UNIX Process Management- The Structure of Processes: Process States and Transitions - Layout of system memory - Context of a process. Process Control: Process Creation – Signals – Process Termination – Invoking other programs – PID & PPID – Shell on a Shell.	**9**
III	**Process Management – Synchronization and Deadlocks:** Central Processing Unit: Introduction, General Register Organization, Stack Organization: Register stack, Memory stack; Instruction Formats, Addressing Modes. CISC & RISC**.**	**9**
IV	**Storage Managements:** Memory Management: Logical and physical Address Space, Swapping, Contiguous Memory Allocation, Paging, Segmentation with Paging. Virtual Memory Management: Demand paging, Process creation, Page Replacement Algorithms, Allocation of Frames, Thrashing, File-System Interface: File concept, Access Methods, Directory structure, File- system Mounting, File sharing, Protection and consistency semantics.	**9**
V	**Protection and Security:** Protection**:** Goals of Protection, Domain of Protection Security: Security Problem, User Authentication, One – Time Password, Program Threats, System Threats.	**9**

List of Experiments:

1 Execute 25 basic commands of UNIX.
2 Basics of functionality and modes of VI Editor.
3 WAP that accepts user name and reports if user is logged in.
4 WAP which displays the following menu and executes the option selected by user: 1. ls 2. Pwd 3. ls –l 4. ps –fe
5 WAP to print 10 9 8 7 6 5 4 3 2 1 .
6 WAP that replaces all "*.txt" file names with "*.txt.old" in the current
7 WAP that echoes itself to stdout, but backwards.
8 WAP that takes a filename as input and checks if it is executable, if not make it executable.
9 WAP to take string as command line argument and reverse it.
10 Create a data file called employee in the format given below:

a. EmpCode Character
b. EmpName Character
c. Grade Character
d. Years of experience Numeric
e. Basic Pay Numeric

$vi employee

A001	ARJUN	E1	01	12000.00
A006	Anand	E1	01	12450.00
A010	Rajesh	E2	03	14500.00
A002	Mohan	E2	02	13000.00
A005	John	E2	01	14500.00
A009	Denial Smith	E2	04	17500.00
A004	Williams	E1	01	12000.00

Perform the following functions on the file:

a. Sort the file on EmpCode.
b. Sort the file on
   (i) Decreasing order of basic pay
   (ii) Increasing order of years of experience.
c. Display the number of employees whose details are included in the file.
d. Display all records with 'smith' a part of employee name.
e. Display all records with EmpName starting with 'B'.
f. Display the records on Employees whose grade is E2 and have work experience of 2 to 5 years.
g.Store in 'file 1' the names of all employees whose basic pay is between 10000 and 15000.
h.Display records of all employees who are not in grade E2.

Course Outcomes as per Bloom's Taxonomy	
CO1	Learn to **understand** the structure and functions of OS.
CO2	**Outline** the basics of basic concepts and functions of operating systems.
CO3	Gain **knowledge** about Processes, Threads and Scheduling algorithms.
CO4	**Explore** the principles of concurrency, deadlocks and various memory management schemes.
CO5	**Interpret** the various I/O management and File systems.
Text Books:	● Milan Milonkovic, Operating System Concepts and design, II Edition, McGraw Hill 1992. ● Tanenbaum, Operation System Concepts, 2nd Edition, Pearson Education. ● Silberschatz / Galvin / Gagne, Operating System,6th Edition, WSE (WILEY Publication)
Reference Books:	● Albert S. Osborn; "Questioned Documents", 2nd Ed., Universal Law Pub., Delhi, 1998 ● Charles C. Thomas; "I.S.Q.D. Identification System for Questioned Documents", Billy Prior Bates Springfield, Illinois, USA, 1971. ● Wilson R. Harrison; "Suspect Documents and their Scientific Examination", Universal Law Pub. Delhi Indian Reprint, 2001. ● B.S. Nabar, Forensic Science in Crime Investigation, 3rd Ed., 2019, Asia Law House.

COURSE CODE	CRIME SCENE MANAGEMENT	Total Hrs: Lecture: 45 Practical: 15
SC23FS003		3-0-2
Learning Objectives:	After studying this paper, the students will know – ● The methods of securing, searching and documenting crime scenes. ● The art of collecting, packaging and preserving different types of physical evidence. ● Trace evidence at crime scenes. ● The legal importance of chain of custody. ● The tools and techniques for analysis of different types of crime scene evidences	
Pre-requisite :	Basic understanding of forensic science and its principles.	

UNIT	CONTENT	HOURS
I	**Crime Scene:** Introduction to Crime Scene, Classifications of Crime Scenes (Primary and Secondary, Indoor, Outdoor and Mobile, Macroscopic and Microscopic, other Specific type of Crime Scene), securing and Isolating the Crime Scene, Physical Evidence in Criminal Investigation.	9
II	**Crime Scene Procedure:** Role of the First Responding Officer (First Officer at the Scene, Recording the Time, Assisting the Victim, Search for and Apprehension of Accused, Securing the Crime Scene),Initial Crime Scene Response, Crime Scene Communication, Legal Implications for Crime Scene Searches.	9
III	**Crime Scene Documentation:** Plan of Action, Note Taking, Crime Scene Search, Crime Scene Photography, Types of Cameras, Types of Media, Number of Photographs, Admissibility of Photographs, Videography of the Crime Scene. Sketching the Crime Scene, Information Included in Crime Scene Sketches, Equipment, Types of Sketches, Locating Objects in the Sketch, Admissibility of Sketches, Comparison of Sketching and Photography. Reconstruction of crime scene through sketching methods by triangulation method & coordinate method	9
IV	**Collection & Preservation of Physical Evidence-** Fingerprints, Impression Evidence, Hair and Fiber Evidence, other Trace Evidence (Glass, Paint and Soil), Firearms and Tool Marks, Biological Evidence (Blood, Body Fluids and Tissue), Accelerants and Flammable Fluids, Explosive Material, Questioned Document, Drug Evidence, Bite Mark Evidence, Entomological Evidence. Evidence collection from crime scene, victim & deceased in cases of - Homicide Investigation; Investigation of Death due to fall from height, sexual offences and sex related homicide, Hanging (suicidal, accidental and homicidal), Paint, Glass, Soil, Fibre, Metals	9

V	**Evidence packaging:** Sources of Exhibits, Goals of Evidence Packaging- Protection of Evidence from possible hazards; Elements of Packaging Evidence – Packing Material, Sealing of Evidence; Precautions, General Directions, Directions for Specific type of Exhibits – Weapons and tools, Hair and Fibres, Dust or Soil, Arson Cases and Cases of Burning, Tool Marks.	**9**

List of Practical-

1. Photography of Scene of Crime Using Manual & Digital Camera.
2. Methods for Searching of Physical Evidences at Scene of Crime.
3. Sketching of Outdoor Scene of Crime (Homicide)
4. Sketching of indoor of crime scene (Suicide)
5. Sketching of Outdoor Scene of Crime (Accident)
6. Sketching of Indoor Scene of Crime (Theft)
7. Sketching of indoor scene of crime (Dacoity or Robbery)
8. Sketching of Indoor Scene of Crime (Murder)
9. Sketching of Mobile Scene of Crime (Hit & Run Case)
10. Collection, Packing, Labeling and Forwarding of Physical Evidence from Scene of Crime to Forensic Science Laboratory.

Course Outcomes as per Bloom's Taxonomy	
CO1	The student will be able to **define**[1]the principles of crime science.
CO2	The student will be able to **relate**[2]the organizational setup of crime science. laboratories in India.
CO3	The student will be able to acquire an **understanding**[2]of the fundamentals of Criminal Justice System and its structure.
CO4	The student will be able to **determine**[5]the importance of efficient crime scene investigation.
CO5	The student will be able to **define**[1]the principles and techniques used in criminal investigation.
Text Books:	● Aitken C.G.G. and Stoney D.A. (1991). The use of Statistics in Forensic Science. England: Ellis Harwood Limited. ● Horswell J. (2016). The Practice of Crime Scene Investigation. USA: CRC Press. ● James S.H. (2014). Forensic Science: An Introduction to Scientific and Investigative Techniques. UK: Taylor & Francis. ● James, S.H. and Nordby J.J. (2003). Forensic Science; an Introduction to Scientific and Investigative Techniques. USA: CRC Press.
Reference Books:	● O' Hara &Osterberg (1949). An Introduction to Criminalistics. New York: The Macmillan Company. ● Saferstein R. (1995). Criminalistics – An Introduction to Forensic Science. USA: Prentice hall Inc. ● Sharma B. R. (2003). Forensic Science in Criminal Investigation and Trials. India: Universal Law Publishing Company. ● Sharma J. D. (1988). VidhivigyanAvem Vish Vigyan. India: Madhya Pradesh Hindi Granth Academy. ● Sharma J. D. (2011). Apradhon ka Vigyanik Anveshan. India: Madhya Pradesh Hindi Granth Academy.

COURSE CODE	COMPUTER NETWORKS	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS015		(3-0-2)
Learning Objectives:	After studying this paper the students will know – ● Explain the principles of data transmission and network communication. ● Interpret network diagrams and identify the components and connections. ● Describe the advantages and disadvantages of wired and wireless network technologies. ● Understand the concept of subnetting and how it is used in IP addressing. ● Implement network security measures, including setting up firewalls and access control lists.	
Pre-requisite:	Basic understanding of Data Communication.	

UNIT	CONTENT	Hours
I	Basics of Network & Networking, Advantages of Networking, Types of Networks, Network Terms- Host, Workstations, Server, Client, Node, Types of Network Architecture- Peer-to-Peer & Client/Server, Workgroup Vs. Domain. Network Topologies, Types of Topologies, Logical and physical topologies, selecting the Right Topology, Types of Transmission Media, Communication Modes, Wiring Standards and Cabling- straight through cable, crossover cable, rollover cable, media connectors (Fiber optic, Coaxial, and TP etc.) Introduction of OSI model, Seven layers of OSI model, Functions of the seven layers, Introduction of TCP/IP Model, TCP, UDP, IP, ICMP, ARP/RARP, Comparison between OSI model & TCP/IP model.	9
II	Network Devices- NIC- functions of NIC, installing NIC, Hub, Switch, Bridge, Router, Gateways, And Other Networking Devices, Repeater, CSU/DSU, and modem, Data Link Layer: Ethernet, Ethernet standards, Ethernet Components, Point-to-Point Protocol (PPP),PPP standards, Address Resolution Protocol, Message format, transactions, Wireless Networking: Wireless Technology, Benefits of Wireless Technology, Types of Wireless Networks, Wireless network Components, Wireless LAN standards, Wireless security Protocols.	9
III	Network Layer: Internet Protocol (IP), IP standards, versions, functions, The IPv4 and IPv6 Datagram Format, IPv4 addressing, IPv4 Subnetting, CIDR and VLSM, IPv6 Addressing, , Internet Control Message Protocol , Internet Group Management Protocol ,Introduction to Routing and Switching concepts, Transport Layer: Transmission Control Protocol(TCP), User Datagram Protocol (UDP), Overview of Ports & Sockets, Application Layer Protocols.	9
IV	Introduction to WAN, WAN Switching techniques, connecting to the Internet, Satellite-Based Services, Cellular Technologies, Technologies used for Connecting LANs, Remote Access Connections and technologies, Authentication and Authorization, Tunnelling and Encryption Protocols, Security Appliances and Security Threats.	9
V	Trouble Shooting Networks: Command-Line Interface Tools, Network and Internet Troubleshooting, Troubleshooting Model, identify the affected area, probable cause, implement a solution, test the result, recognize the potential effects of the solution, document the solution, Using Network Utilities: ping, traceroute, tracert, ipconfig, arp, nslookup, netstat, nbtstat, Hardware trouble shooting tools, system monitoring tools**.**	9

List of Practical-

1. Briefing on NS2/NS3 simulation platform along with is working.
2. Switch Configuration - Basic Commands and Switch Port Security.
3. Router – Configuration and Setting up of Passwords.
4. PPP Encapsulation, PPP PAP Authentication, PPP CHAP Authentication.
5. A configuration of default, Static and Dynamic Routing.
6. VLAN Configuration.
7. Configuration of Access-lists - Standard and Extended ACLs.
8. DHCP, DHCP Relay and DHCP Exclusions.
9. Configuring Logging to a Remote Syslog Server.
10. Design and analyse network with a router, Switch and Hub to find the number of broadcast domains and collision domain using packet tracer
11. Configure a wireless network for ad-hoc and infrastructure mode.
12. Configure point to site and site to site VPN.

Course Outcomes as per Bloom's Taxonomy	
CO1	Describe the functions of each layer in OSI and TCP/IP model
CO2	Explain the functions of Application layer and Presentation layer paradigms and Protocols
CO3	Discover the Session layer design issues and Transport layer services
CO4	Classify the routing protocols and analyse how to assign the IP addresses for the given network
CO5	Demonstrate the functions of data link layer and explain the protocols
Text Books:	● CCNA Cisco Certified Network Associate: Study Guide (With CD) 7th Edition (Paperback), Wiley India, 2011 ● CCENT/CCNA ICND1 640-822 Official Cert Guide 3 Edition (Paperback), Pearson, 2013 ● Behrouz A. Forouzan, (2007). Data Communications and Networking (4 ed.). McGraw Hill
Reference Books:	● CCNA Exploration Course Booklet: Routing Protocols and Concepts, Version 4.0 (Paperback), Pearson, 2010

COURSE CODE	FORENSIC PHYSICS AND SPEAKER IDENTIFICATION	Total Hrs: Lecture: 45 Practical: 15
SC23FS004		(3-0-2)
Learning Objectives:	After this course the students will be able to know: ● The significance of forensic science to human society. ● The importance of physical evidence in forensic science. ● The fundamental principles and functions of forensic science. ● The fundamental principles of crime scene investigation	
Pre-requisite:	Elementary knowledge of physics, chemistry and biology/ mathematics.	

UNIT	CONTENT	HOURS
I	Soil examinations, Glass and glass fractures examination, Paint and pigment examination, Fibre examination, Cement and other constituents of Building materials and their properties, analysis of cement, cement mortar and cement concrete, Methods of analysis of different constituents of Building materials, Steel bars and metal physics, Faults and failure of evidence of Arson & Fire due to electrical & mechanical faults/failure, Power Physics: Voltage, current generation and transmission, Current and Power Transformers, 3-phase electricity and Earth faults. Road evidence, road engineering and design, Grit, Bitumen, soling and paving of cemented roads, identification and interpretation of road obstructions, defects, marks and damage, tyre marks, skid marks Vehicle examination: Automobile common component and failure analysis, damage assessment, Hit and run investigation- examination of suspect vehicle	09
II	Pattern Evidence Tool marks- Types, Class and Individual Characteristics, Comparisons, Impression Marks, Compression Marks, Striated Marks, Combination of Impression and Striated Marks, Repetitive Marks, Materials for making Test Tool Marks, Methods of preparation of Test Tool Marks, Comparison of test and evidence tool marks, Rubber Stamp Impressions, Metallic Seal Impressions, Embossed Impressions and Indentation marks, Mechanical Impressions. Cast, Engraved and Punched Marks – Methods of their restoration. Restoration: Restoration of erased numbers, methods of marking-cast, punch and engraved, methods used for removal of serial numbers, theory behind number restoration, restoration of marks on cast iron, Aluminum, brass, wood, leather etc., chemical methods of restoration (etching), reagents used for various metals, electrolytic methods of restoration-reagents used, ultrasonic cavitation for restoration, magnetic particle method for restoration, other methods of restoration, laser etched serial numbers and bar codes and their restoration, recording of restored marks	09

III	**Introduction to speaker identification:** Introduction to speaker identification, application of speaker identification in various types of crime, audio tape authentication and examination. Physics of sound: waves and sound, analysis and synthesis of complex waves, Human and non-human utterances, anatomy of vocal tract, vocal formants, analysis of vocal sound, frequencies and overtones Electronics of Audio Recording, Transmission and Playback devices, noise and distortion, voice storage and preservation. **Forensic Linguistics:** Phonetics, Morphology, Syntax, Semantics, Stylistics, Pragmatics, Script, orthography and graphology, Difference between language and speech, Psycholinguistics, Neurolinguistics, Sociolinguistics, Scientific approaches; Reliability and admissibility of evidence in the court, linguistic profile, language register Discourse Analysis: Connivance, acceptance, listening feedback and rejection in the context of Mens-Rea, Narrative, Dialectology, Linguistic variety as a geographical marker, Idiolects and speaker characterization, Phonology, Morphology and Word formation processes as individual linguistic abilities	09
IV	**Voice identification and authentication:** principles of voice identification and its forensic importance, history, and scope of voice analysis, voice production theory, components of voice identification- feature extraction, speaker profiling, normalization techniques, enhancement of speech signal/ audio recordings, pattern matching and comparison **Various approaches in Forensic Speaker Identification** Instrumental Analysis of speech sample, Interpretation of result, Statistical interpretation of probability scale, Objective/Subjective methods, discriminating tests, closed test, open test, likelihood ratio calculation, Concept of test and errorin Speaker Identification, case studies. Source filters theory	09
V	**Techniques and Best Practices for examination of Audio recording authentication and case studies.** Automatic speaker identification and verification system based on fuzzy logics, neural network, MPCC etc., Voice Biometrics VoIP and other modes of speech communication and their forensic analysis Options, Types of Evidence, The Rules of Evidence, Volatile Evidence, General Procedure, Collection and Archiving, Methods of Collection ,Artifacts. Collection Steps, Controlling Contamination.	09

List of Practical-

1. Methods of collection , collection Steps, controlling Contamination
2. Analysis of tyre marks/ tool marks
3. Foot print casting
4. Restoration of erased marks
5. Density gradient Analysis of glass/soil
6. Calculate the refractive index of glass by abbe's refractometer
7. Use of Forensic Linguistic in Speaker Identification
8. Analysis of voice samples using Voice Biometrics.
9. Investigation of Tape Authentication Process.
10. Instrumental Analysis of speech samples
11. Interpretation of result and report writing

Course Outcomes as per Bloom's Taxonomy	
CO1	The student will be able to **define**[1] the principles of forensic physics and voice analysis as well as **develop**[6] the knowledge of forensic physics and voice analysis

CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of forensic physics and voice analysis
CO3	They will be able to **determine**[5] the significant role of forensic physics and voice analysis
CO4	The students will be able to **distinguish**[4] between importance of the culprit, scene of crime and the victim by examining the physical evidence.
CO5	The students will be able to **define**[1] forensic physics and voice analysis and its use in a criminal investigation.
Text Books:	● Aitken, C.G.G., and Stoney, D.A. (1991). The Use of Statistics in Forensic Science. England, Ellis Harwood Limited. ● Horswell J. (2016).The Practice of Crime Scene Investigation. USA, CRC Press ● James S.H. (2014). Forensic Science: An Introduction to Scientific and Investigative Techniques. UK,Taylor & Francis. ● James, S.H. and Nordby, J.J. (2003). Forensic Science: An Introduction to Scientific and Investigative Techniques. USA, CRC Press. ● LNJN National Institute of Criminology and Forensic Science; "A forensic Guide for Crime Investigators", LNJN NICFS, 2015.
Reference Books:	● O' Hara & Osterberg (1949). An Introduction to Criminalistics. New York, The Macmillan Company. ● Saferstein R. (1995). Criminalistics – An Introduction to Forensic Science. USA, Prentice hall Inc. ● Sharma B. R. (2003). Forensic Science in Criminal Investigation and Trials. India, Universal Law Publishing Company. ● Sharma J. D. (2011). Apradhon ka Vigyanik Anveshan. India, Madhya Pradesh Hindi Granth Academy. ● James S.H and Nordby J.J. (2003), Forensic Science: An introduction to scientific and investigative techniques, CRC Press, USA ● Austerberg David; "The Technology of Video & Audio Streaming", Focal Press, 2013 ● Arora, S. P. &Bindra, S. P., "A Text Book of Building Construction", DhanpatRai& Sons, Delhi, 2010 ● B.P.Saville; "Physical Testing of Textiles", The Textile Institute CRC Press and wood head Pub., 2000 ● Harold Franck; "Forensic Engineering Fundamentals", CRC Press, Taylor and Francis Group, 2013 ● Harry Hollien; "The Acoustics of Crime- The New Science of Forensic Phonetics", Plenum Press, New York and London (1990)

COURSE CODE	DIGITAL FORENSICS AND INVESTIGATION	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS016		**(3-0-2)**
Learning Objectives:	After studying this paper, the students will know – ● The introduction of cyber forensic and its components. ● The extraction of data from the electronic evidence, process it into actionable intelligence and present the findings for prosecution. ● The concepts of Computer Forensics, deals with the development of tools and software. ● The gathering of evidences from computers, without corrupting the information contained. ● A relatively new field, it is quickly gaining momentum as the complexities in the crimes are on the rise and it has become imperative to treat each cybercrime with diligence.	
Pre-requisite:	Basic understanding of Computer fundamentals and its principles.	

UNIT	CONTENT	HOURS
I	**Computer Forensics:** Introduction to Computer Forensics, Forms of Cyber Crime, First Responder Procedure- Non-technical staff, Technical Staff, Forensics Expert and Computer Investigation procedure.	**9**
II	**Storage Devices & Data Recovery Methods:** -Storage Devices- Magnetic Medium, Non-magnetic medium and Optical Medium. Working of Storage devices-Platter, head assembly, spindle motor. Data Acquisition, Data deletion and data recovery method and techniques.	**9**
III	**Forensics Techniques** - Windows forensic, Linux Forensics, Mobile Forensics, Steganography, Application Password Cracking-Brute force, Dictionary attack, Rainbow attack. Email Tacking – header option of SMTP, POP3, IMAP.	**9**
IV	**Cyber Law -**Corporate espionage, Evidence handling procedure, Chain of custody, Main features of Indian IT Act 2008 (Amendment).	**9**
V	**Forensic Analysis of Web Server:**Developing, administering and managing a remotely hosted web site, Use of HTML browsers on ports other than 80, Control Panel – Forensics traces left on web site admin machine, traces left on hosting servers. Anti-Forensics Techniques – Methods used to thwart subsequent forensics analysis, Forensics traces left, Approaches that may be used to reduce the effectiveness of these methods. Internet and Web attack forensics.	**9**

List of practical-

1. Dismantling and re-building PCs in order to access the storage media safely
2. Data Acquisition or Dead Analysis using the tools such as FTK Imager, Linux DD, IXI_Imageretc
3. Monitoring of Computer System using Key Logger & Report Generation
4. Finding MD5 & SHA values of multiple files by using FTK Tool
5. Creating image of logical/physical drive by using FTK Tool
6. Recovering deleted data from USB by using Power Data Recovery Tool

7. Recovering the data from formatted USB/disk by using Power Data Recovery Tool
   Preservation of gathered information or image files using the tools such Cryptool or Quick Hash.
8. Evidence or Digital Foot Print Preservations using Software Write Blockers or Windows Registry for Windows platform
9. Memory analysis of Windows and Linux machine using volatility framework
10. Website forensic analysis using FAW ((Forensic Acquisition of Website)
11. Network Forensic using XPLICO tool
12. Log file analysis use Log Analyzer tool.
13. Cloud forensics using FROST and UFED Cloud Analyzer
14. Email header forensic using MailXaminer and eMailTracker Pro
15. Storage media analysis of mobile phone using Autopsy or Sleuth Kit
16. Operating System Forensicusing SANS INVETIGATIVE FORENSIC TOOLKIT (SIFT).

Course Outcomes as per Blooms Taxonomy	
CO1	The students will **understand**[2]basic concepts of digital forensics and its principals.
CO2	They will be able to **explain**[2]the importance of digital artifacts, such as file systems, network logs, emails, and databases.
CO3	They will be able to **understand**[2]the principle and applications of digital forensics and investigations.
CO4	They will be able to **explain**[3]Investigate digital crimesincluding cyberattacks, data breaches, online fraud, and intellectual property theft.
CO5	They will **develop**[3]the knowledge on forensic and able to demonstrate critical thinking and problem-solving skills to analyze complex scenario.
Text Books:	● Hacking Exposed Computer Forensics – Aaron Philipp, David Cowen, Chris Davis, Pub: McGraw hill-2011. ● John R, 'Computer Forensics', Vacca Firewall Media Publication. ● Rukmani Krishnamurthy, 'Introduction to Forensic Science in Crime Investigation'. ● B.S. Nabar, Forensic Science in Crime Investigation, 3rd Ed., 2019, Asia Law House.
Reference Books:	● Suresh T. Vishwanathan, 'The Indian Cyber Law', Bharat Law House, New Delhi. ● by P.M. Bukshi and R.K. Suri, 'Guide to Cyber and E- Commerce Laws', Bharat Law House,New Delhi. ● B. R. Sharma, Forensic Science in Criminal Investigation and Trials, 2020, 6th Ed., Lexis Nexis. ● Cyber Forensics from data to digital evidence –Albert J. Marcella Jr., Frederic Guillossou, 2012

COURSE CODE	FORENSIC MEDICINE AND TOXICOLOGY	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS005		(3-0-2)
Learning Objectives:	After studying this paper the students will know – • About Forensic Medicine and Toxicology and their application in crime investigation. • To learn how to approach, assess and document the crime scene of death and collect relevant information and evidence. • To develop skills in evaluating the type, cause and manner of death and injuries in different scenarios. • To gain knowledge of the principles, branches and significance of forensic toxicology and the analysis of poisons. • To acquire practical skills in isolating and identifying various types of poisons from biological samples using pharmacokinetic and pharmacodynamic concepts.	
Pre-requisite:	Basics of forensic science	

UNIT	CONTENT	HOURS
I	**Introduction to forensic medicine:** Legal procedures: Inquest: police inquest, magistrate inquest, Courts structure of India, Evidence, Types of Evidence, Dying declaration, Dying deposition, Witnesses, Types of witnesses, Procedure in courts: Oath, Examination in chief, cross examination, re-examination, questions asked by judge.	9
II	**Death Investigations:** Modes & Manner of deaths, types of death, Stages of death, Signs of death and changes following death. Estimation of PM Interval, Exhumation, Suspended animation, Sexual offenses and its medicolegal importance, unnatural and naturalsSexual offences, Amendments in law related to sexual offenses and POCSO, Injuries & Wounds: Types, Medicolegal importance, Gunshot wounds	9
III	**Forensic Toxicology** Introduction and History, Branches of Forensic Toxicology, Significance, Scope, Duties and Responsibilities of Forensic Toxicologist, Analysis Report. Poisons: Definition, Classification of Poisons, Types of Poisoning, Mode of Action, Factors Modifying the Action of Poisons.	9
IV	Narcotics drugs and psychotropic substances act, Scope and significance NDPS drugs in forensic science, NDPS Act, classification and characterization of NDPS drugs, Drug Law Enforcement, search and seizure, sampling procedure, forwarding of sample to FSL, sample preparation for analysis, preliminary analysis of drugs, reporting of drug cases, drug abuse, drug addiction and its problems. Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances. Crime scene search for narcotics, drugs and psychotropic substances – searching a suspect, searching a dwelling, searching a vehicle. Collection and preservation of drug evidence.	9

V	**Isolation and Clean-up Procedures of Poison from Viscera** Introduction of Pharmacokinetics (Absorption, Distribution, Metabolism and Elimination) And Pharmacodynamics (Receptors And Their Classification). Volatile Poisons, Non-Volatile Organic Poisons, Toxic Cations and Anions, Metallic, Plant and Animal Poison.	**9**

List of Practical-

1. Colour Tests for identification of poisons, drugs.
2. Analysis of alcohol from blood.
3. Identification of NDPS drugs by color tests
4. Identification of NDPS drugs by TLC.
5. To carry out extraction of inorganic poisons from matrix.
6. To carry out extraction of volatile organic poisons from matrix
7. To carry out extraction of non volatile organic poisons from matrix
8. Examination of extracted poisons using colour tests and TLC.

Course Outcomes as per Bloom's Taxonomy	
CO1	The students will **understand**[2] basic concepts of Forensic Medicine and Toxicology.
CO2	They will be able to **understand**[2] the investigation of death.
CO3	They will be able to **explain**[2] the assessment of crime scene in death investigation.
CO4	They will **develop**[5] the knowledge of forensic toxicology
CO5	The students will **apply**[4] the knowledge of toxicology in extraction of poison from viscera.
Text Books:	● The Essentials of Forensic Medicine & Toxicology by K.S. Narayan Reddy and O.P. Murty. ● Textbook of Forensic Medicine and Toxicology by Anil Agrawal.
Reference Books:	● Modi JS: medical jurisprudence and Toxicology. ● Taylor: Medical jurisprudence ● Parikh CK: Chikitsa Nyaya Shastra Aur Vish Vigyan. ● Keith Simpsen& Bernard Knight : Forensic Medicine ● Poison, CJ, DJ Gee, B. Knight : Forensic Medicine ● Reddy: Forensic Medicine

COURSE CODE	FORENSIC GENETICS AND ANTHROPOLOGY	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS006		(3-0-2)
Learning Objectives:	After studying this paper, the students will know – ● Learn the methods and techniques for identifying and analyzing human skeletal remains in forensic contexts. ● Understand the principles of taphonomy and its application in interpreting postmortem changes to human remains. ● Gain proficiency in estimating age, sex, stature, and ancestry from skeletal remains. ● Develop skills in recognizing and interpreting skeletal trauma and understanding the mechanisms of injury. ● Acquire knowledge of human identification methods, including dental records, DNA analysis, and craniofacial reconstruction. methods, including dental records, DNA analysis, and craniofacial reconstruction.	
Pre-requisite:	Background in biological sciences or anthropology.	

UNIT	CONTENT	HOURS
I	**Forensic anthropology**: Introduction and scope of forensic anthropology. Study of the human skeleton. Nature, formation, and identification of human bones. Cranial sutures and their closure: Anterior aspect of skull: Frontonasal suture , Frontozygomatic suture , Zygomaticomaxillary suture, Intermaxillary suture, Metopic suture, Sagittal suture, Lambdoid suture, Lambda. Posterior aspect of the skull, Lateral aspect of the skull, Inferior aspect of the skull, Physical anthropology, and its forensic aspects. Role of forensic anthropology in mass disaster cases. Side & site determination from bones. Bones and their types: Human bones and their types: Long bones: Femur, Tibia, fibula, humerus, radius, ulna, metacarpals, metatarsals and phalanges. Short bones: carpal bones of wrist and tarsal bones of foot. Flat bones: Frontal, parietal, and occipital bones of cranium, ribs, and hip bones. Irregular bones: vertebrate, sacrum, coccyx, sphenoid, ethmoid and zygomatic Sesamoid bones patella and pisiform. Animal bones and their classification: classification based on shape structure and Development difference between animal and human bone	9
II	**Personal identification**: Personal identification between the living and dead. somatotopy – observation of hair on the head, forehead, eyes, the root of the nose, nasal bridge, nasal tip, chin, Darwin's tubercle, ear lobes, supraorbital ridges, physiognomic ear breadth, the circumference of the head. Polydactyly and frontal eminences. Scar marks, tattoo marks, and occupational marks. Determination of age and sex from skull, and pelvis. Racial differences in the human skeleton. Determination of age from teeth. Osteometry **Somatometry**: Measurements of head, face, nose, cheek, ear, hand and foot, body weight, and height. Indices - Cephalic Index, Nasal Index, Cranial Index, Upper Facial Index. Techniques of Measurements. Concept of Frankfurt Plane. Important landmarks of Head & Face, Trunk & Extremities. Instruments used for the Measurements.	9

III	**Facial Reconstruction:** Its Method & Technique. Forensic Importance of Facial Reconstruction. Limitations of Facial Reconstruction. ComputerAided Facial Reconstruction: 2D and 3D Facial Reconstruction Software, Facial superimposition techniques. Craniofacial superimposition techniques. Photographic superimposition, video superimposition, Roentgenographic superimposition. Use of somatotopic and craniometric methods in reconstruction. Importance of tissue depth in facial reconstruction. Genetic and congenital anomalies – causes, types, identification, and their forensic significance. Portrait Parle/ Bertillon system. Photo fit/identikit. Legal Admissibility. **Bio-archaeology**: Field recovery methods, Laboratory processing, curation and chain of custody, Age at death, sex, ancestry, height and weight, premortem injury and disease, taphonomy, peri-mortem trauma, post-mortem trauma, DNA Kinship and identity. Biological anthropology: The natural history of humankind: Craig Stanford, John S Allen Susan C Anton.	**9**
IV	**Forensic Odontology**: Definition and Scope of Forensic Odontology, Types of dentition, Basic structure of human teeth, types of teeth & their morphology, and determination of age from teeth using various methods, dental anomalies and their role in Personal Identification. Bite marks: Types & forensic importance. Collection and preservation of samples, analysis of Bite marks, presentation of bite mark evidence in court of law. Role of Forensic Odontology in mass disaster victim identification. Dental Charting. Comparison of Ante- mortem and postmortem dental records. **Basic Concepts of Genetics:** History of genetics & its development. Mendelian Principles, Genetic Material– Discovery, Experiments, Composition and Structure of DNA and RNA, Organization of DNA In Chromosomes, Genetic Code, Chargaff's Rule, Watson-Crick's Double Helical Model of DNA, Types of DNA. Introduction to Human Genome, Introduction to Recombinant DNA Technology, Its Applications in Health, Agriculture, Industries & Forensics	**9**
V	**Basics of DNA and its Qualitative and Quantification Methods:** Basic Principles DNA as biological blueprint of life. Extraction of DNA for analysis, PCR & RFLP. Quantization of DNA – yield gel quantization and slot blot quantization. Mitochondrial DNA – sequence analysis. Chromosomal mapping and karyotyping. Replication, Transcription and Translation. Chromosomal mutations, Chromosomal basis of Inheritance. An overview of molecules involved in the flow of genetic information, double helical structure of DNA, denaturation and renaturation of DNA, types and structure of RNA. Replication of DNA in prokaryotes and eukaryotes, genetic code, degeneracy and universality of genetic code, transcription and translation machinery. Nature and structure of the human genome and its diversity, Y Chromosomes. Concept of sequence variation - VNTRs, STRs, Mini STRs, SNPs. RNA and its application in forensics. History of DNA profiling applications in disputed paternity cases, child swapping, missing person‟s identity, civil immigration, veterinary, wildlife and agriculture cases. legal perspectives – legal standards for admissibility of DNA profiling – procedural & ethical concerns, status of development of DNA profiling in India & abroad. limitations of DNA profiling. Isolation, quantification and quality assessment of DNA from hard and soft tissues, Touch and /trace DNA. Collection, preservation and packaging of exhibits for DNA analysis.	**9**

List of Practical-

1. To determine age from skull and teeth.
2. To determine of sex from the skull.
3. To determine sex from the pelvis.
4. To study identification and description of bones and their measurements.
5. To investigate the differences between animal and human bones.
6. To perform somatometric measurements on living subjects.
7. To carry out craniometric measurements of the human skull.
8. To estimate stature from long bone length.
9. To extract DNA from biological sample

Course Outcomes as per Bloom's Taxonomy

CO1	**Design**[6] a basic biological profile from a set of human skeletal remains.
CO2	**How** [1] to recover forensic evidence using archaeological methods as part of a mock excavation in the field
CO3	**Analyses**[4] and report forensic evidence in a written format- Describe, explain, and critically evaluate methods used in Forensic Anthropology.
CO4	**Determine**[5] the bone for individualization of person.
CO5	**Understand** [2] the application of DNA Fingerprinting.
Text Books:	● The use of Forensic Anthropology, Robert Pickering & David Bachman CRC Press, ● Physical Anthropology, B.R.K. Shukla & Sudha Rastogi Palaka Prakasha ● The Forensic Anthropology Laboratory, Michael W. Warren, Heather A.Haney& Laurel E. Freas; CRC Press,(2008)
Open Learning Source:	● Forensic recovery of human remains: Dopras, Schultz, Whirler, Williams ● Advances in Forensic Taphonomy, Method theory and Archaeological perspective ● An Introduction to Forensic DNA Analysis, Rudin, Norah CRC Leviw Publishers, (2002) ● Ancient DNA, Herrmann, Bernd Springer Publishing Co., (1994) ● Basics of DNA and Evidentiary Issues, Vij, Krishan Jaypee Brothers, (2004) ● DNA Fingerprinting: Approaches and applications. T. Burke, Terry Birkhauser Verlage

COURSE CODE	FILE SYSTEM AND STORAGE FORENSIC ANALYSIS	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS017		(3-0-2)
Learning Objectives:	● Understand the fundamentals of different file systems and their structure for forensic analysis. ● Gain proficiency in analyzing various types of storage devices encountered in digital investigations. ● Learn techniques for recovering deleted files and fragmented data from storage devices. ● Develop skills in file system analysis to reconstruct file information and metadata. ● Acquire knowledge of forensic tools and methodologies used in file system and storage analysis. ● Apply learned concepts and techniques to real-world scenarios through hands-on exercises and case	
Pre-requisite:	Understanding of computer operating systems and basic knowledge of digital forensics.	

UNIT	CONTENT	HOURS
I	**Volume Analysis** Introduction, background, analysis basics, summary. PC-based partitions, DOS partitions, analysis considerations, apple partitions, removable media, server-based partitions, BSD partitions, Sun Solaris slices, GPT partitions, multiple disk volumes, RAID, disk spanning	9
II	**File System Analysis–FAT Concepts and Analysis** What is a file system?, file system category, content category, metadata category, file name category, application category, application-level search techniques, specific file systems FAT concepts and analysis: introduction, file system category, content category, metadata category, file name category, the big picture, other topics. FAT data structures: boot sector, FAT32 FSINFO, FAT, directory entries, long file name directory entries	9
III	**NTFS Concepts and Analysis** NTFS concepts: introduction, everything is a file, MFT concepts, MFT entry attribute concepts, other attribute concepts, indexes, analysis tools NTFS analysis: file system category, content category, metadata category, file name category, application category, the big picture, NTFS data structures, basic concepts, standard file attributes, index attributes and data structures, file system and meta data files	9
IV	**Ext2 and Ext3 Concepts and Analysis** Introduction, file system category, content category, metadata category, file name category, application category. the big picture, Ext2 and Ext3 data structures, superblock, group descriptor tables, block bitmap, inodes, extended attributes, directory entry, symbolic link, hash trees, journal data structures	9
V	**UFS1 and UFS2 Concepts and Analysis** Introduction, file system category, content category, metadata category, file name category, the big picture. UFS1 and UFS2 data structures, UFS1 superblock, UFS2 superblock, cylinder group summary, UFS1 group descriptor, UFS2 group descriptor, block and fragment bitmaps, UFS1 inodes, UFS2 inodes, UFS2 extended attributes, directory entries	9

List of Practicals-

1. Create a forensic image of a disk or a specific partition using tools like dd or specialized forensic imaging software.

2. Analyzing PC-Based Partitions:

    a) Identify and analyze the partition table of a PC-based disk, such as an MBR (Master Boot Record) or GPT (GUID Partition Table).

    b) Use tools like fdisk, Disk Management (Windows), or gdisk to view and manipulate partitions.

    c) Extract information about partition types, sizes, and filesystems.

3. Analyzing BSD Partitions:Understand the BSD partitioning scheme, commonly used in Unix-like operating systems such as FreeBSD or OpenBSD. Analyze disk slices, partition tables, and filesystems specific to BSD systems.

4. Conducting File Carving:

    a) Perform file carving experiments on a FAT file system to recover deleted or fragmented files.

    b) Use file carving tools such as Foremost, Scalpel, or PhotoRec to extract files based on their signatures or file header/footer information.

5. Use tools like binwalk or file to identify file types based on their signatures.

6. File System Recovery:

    a) Simulate a scenario where the FAT file system is corrupted or damaged, and perform file system recovery techniques.

    b) Use tools like TestDisk or specialized forensic software to repair the file system structure and recover files.

7. Analyzing NTFS Data Structures:

    a) Explore the data structures used in NTFS, including the Master File Table (MFT), attribute lists, attribute headers, and data runs.

    b) Use forensic tools like The Sleuth Kit, FTK Imager, or specialized NTFS analysis tools to analyze these data structures.

8. Analyzing Content:

    a) Perform content analysis on files within an NTFS file system to extract meaningful data, identify artifacts, or uncover hidden information.

    b) Use tools like strings, hex editors, or specialized content analysis tools to explore file content.

9. Use automated forensic tools like Autopsy or Encase to conduct the triage analysis on a live system or disk image to identify and prioritize potentially relevant files or artefacts for further investigation.

10. Understanding Ext2 and Ext3 Data Structures:

    a) Explore the data structures used in Ext2 and Ext3 file systems, including the superblock, group descriptor tables, block bitmap, inodes, extended attributes, directory entries, symbolic links, hash trees, and journal data structures.

b) Use forensic tools like The Sleuth Kit, extundelete, or debugfs to analyze these data structures.	
Course Outcomes as per Bloom's Taxonomy	
CO1	**Define**[1] the different file systems for storing information
CO2	**Analyze**[4] the FAT file system concepts and analysis.
CO3	**Illustrate**[2] the concept of NTFS file system an analysis.
CO4	**Organise**[3] Ext file system category and Ext Data structure.
CO5	**Interpret**[5] the concept of UFS file system and analysis.
Text Books:	● Brian Carrier, File System Forensic Analysis, Addison Wesley, 2005, ISBN-10: 0321268172. ISBN-13: 978-0321268174
Reference book:	● Machtelt Garrels, Introduction to Linux A Hands-On Guide, TSTC Publishing, 2009. ISBN-13: 9781934302620. ISBN-10: 1934302627

COURSE CODE	FORENSIC BIOLOGY AND SEROLOGY	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS007		(3-0-2)
Learning Objectives:	After studying this paper the students will – ● To learn the basic concepts and principles of serology, including the study of bodily fluids, blood typing, and antigen-antibody reactions. ● To develop skills to identify and differentiate various bodily fluids commonly encountered in forensic investigations, such as blood, semen, saliva, and urine. ● To gain knowledge of different concepts of wildlife forensics and microbial forensics ● To gain the ability to interpret the results of forensic entomology ● To understand the principles and techniques used in bloodstain pattern analysis, including the interpretation of spatter patterns, transfer stains, and impact patterns to reconstruct events.	
Pre-requisite:		

UNIT	CONTENT	HOURS
I	Immune system, immune response, innate and acquired immunity, antigens, antibodies, haptens and adjuvants, immunoglobulin- types, physico-chemical properties and function, raising of antisera, Lectins - their forensic significance. Buffers and serological reagents, methods of sterilization employed for serological work.	9
II	Composition of blood, Formation of blood, Blood groups – history, biochemistry and genetics of ABO, Rh, Mn and other systems. Methods of ABO blood grouping (absorption-inhibition, mixed agglutination and absorption elution) from blood stains and other body fluids/stains viz. menstrual blood, semen, saliva, sweat, tear, pus, vomit, hair, bone, nail etc., blood group specific ABH substances. Secretors and non-secretors. Blood groups that make racial distinctions. Lewis antigen, Bombay Blood groups. HLA antigens and HLA typing. Role of sero-genetic markers in individualization and paternity disputes. Pitfalls in red cell typing, Antibody profiling in Forensic testing. Presumptive and confirmatory test for body fluids (Blood, Semen, Saliva, Urine, fecal matter), Bloodstain pattern analysis and its forensic significance, Collection, preservation and packaging of Biological exhibits.	9
III	Determination of human and animal origin from bones, hair, flesh, nails, skin, teeth, body tissue, fluids/ stains viz. blood, menstrual blood, semen, saliva, sweat, tear, pus, vomit, etc., through immunodiffusion and immuno - electrophoresis, cross reactivity among closely related species. Individualization of blood stains: Determination of blood groups, sex age and racial origin from dried bloodstains. Red cell enzymes: Genetics, polymorphism and typing of PGM, GLO-I, ESD, EAP, AK, ADA etc. and their forensic significance. Serum proteins: Genetics, polymorphism and typing of - Hb, HP, Tf, Bf, C3 etc. and their forensic significance	9

IV	Forensic Entomology and Forensic Botany- History, significance, determination of time since death Dipteran larval development, Life cycles of Blowfly, Flash fly and Housefly, successional colonization of body, Entomology as an evidentiary tool in child and senior abuse cases and animal abuse cases, collection of entomological evidence, Rearing of insects. Various types of woods, timbers, seeds and leaves and their forensic importance. . Identification and matching of various types of wood, timber varieties, seeds and leaves. Types of fibers – forensic aspects of fiber examination- fluorescent, optical properties, refractive index, birefringence, dye analysis etc. Identification and comparison of man–made and natural fibres. Various types of Planktons and diatoms and their forensic importance Diatoms types morphology, methods of isolation from different tissue. Study and identification of pollen grains, Identification of starch grains, powder and stains of spices etc. Paper and Paper Pulp identification, Microscopic and biochemical examination of pulp material.	**9**
V	WILDLIFE FORENSICS AND MICROBIAL FORENSICSIntroduction and importance of wildlife. Protected and endangered species of animals and plants. Sanctuaries and their importance. Relevant provision of wildlife and environmental act. Types of wildlife crimes, different methods of killing and poaching of wildlife animals. Microorganism encountered in biological warfare	**9**

List of Practical-

1. Microorganism encountered in biological warfare
2. Identification of seminal stains using presumptive test, crystal test and detection of spermatozoa.
3. Identification of body fluids - saliva and urine stains
4. Preliminary and confirmatory analysis of blood
5. Microscopic examination of human and animal hairs.
6. To study and analyze pug marks in wildlife forensics
7. To examine the structure of diatoms using microscope
8. To examine the structure of pollen grains
9. Perform ABO blood grouping.

Course Outcomes	
CO1	**Understand** [2] concept of forensic analysis of body fluids
CO2	**Apply**[3] concept of forensic entomology
CO3	They will **understand**[4] the applications of wildlife forensics
CO4	They will **understand**[4] the applications of microbial forensics
CO5	**Discover**[4] knowledge of blood groups and different types of markers.
Text Books:	● Handbook of forensic Science by Richard Saferstein ● The elements of Immunology: Fahim Halim Khan ● Fundamental immunology William E. Paul ● Human blood groups-Chemical and biochemical basis of antigen specificity (Second edition): Helmut Schenkel –Brunner, Springer Wien New York ● Culliford, B.E., (1971), The Examination and Typing of Blood Stains, US Deptt. of Justice, Washington ● Jason H. Byrd, James L. Castner (2nd Edition) (2012), Forensic Entomology: The Utility of Arthropods in Legal Investigation, CRC Press INC.

Reference Books:	● David B. Rivers and Gregory A. Dahlem (2014), The Science of Forensic Entomology, John Wiley & Sons, Ltd. ● David Hall, Jason Byrd (2012), Forensic Botany: A Practical Guide, John Wiley & Sons Ltd. ● Dorothy E. Gennard, (2007), Forensic Entomology: An Introduction, John Wiley & Sons Ltd. ● Julie Roberts, Nicholas Marquez-Grant, (2012), Forensic Ecology: From Crime Scene to Court, John Wiley & Sons Ltd. ● Bruce Budowle, Roger G. Breeze, Steven E. Schutzer (2011), Microbial Forensics, Academic Press.

COURE CODE	FORENSIC BALLISTICS	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS008		3-0-2
Learning Objectives:	After studying this paper, the students will know about– ● The basic knowledge of ballistics. ● The classification of firearms and their firing mechanisms. ● The methods of identifying firearms. ● The methods for characterization of gunshot residue.	
Pre-requisite:	Basic principles of forensic science and its techniques	

UNIT	CONTENT	HOURS
I	Firearms and Ammunitions, their classification, details of various small arms used in crime – shotguns, rifles, revolvers, pistols, carbines, improvised firearms. Bore and caliber, choke, automatic mechanisms employed in small arms, rifling - class characteristics of rifled bore, purpose of rifling, types of rifling, methods to produce rifling, various locks used in small arms. Various types of primers/ priming mixtures, propellants, shotgun ball ammunition, various kinds of bullets, head-stamp markings. Various physical, ballistic & functional tests of ammunitions. Physical evidence and other clues, Handling of evidence, various precautions. Arms Act and Arms Rule, 2016	9
II	Internal Ballistics: Ignition and burning of propellants, degressive and progressive powders, rate of burning propellants, factors affecting internal ballistics of projectiles, internal ballistics of 12-bore guns, recoil.	9
III	External Ballistics: Equations of motion of projectiles, principal problem of exterior ballistics, vacuum trajectory – calculation of various elements, effect of air resistance on trajectory, points of difference between trajectories in air and vacuum, nature of air resistance phenomena, base-drag, yaw, cross-wind force, overturning moments, stability – fin stabilization and gyroscopic stability, stability factor, nutation and precessional motions of bullets, drift, Magnus effect, Greenhill formula, shape of projectile – form factor, ballistic coefficient, calculation of trajectories of various small arm bullets, calculation of trajectories of shotgun projectile, use of ballistic tables, projectile velocity determination, determination of velocity of shot-charge, Doppler-radar method. Automated system of trajectory computation. Falling bullets – limiting velocity, drop, use of lead as bullet material.	9
IV	Terminal Ballistics: Interaction and penetration of various small arm projectiles in various tissues. Threshold velocity for penetration of skin, flesh and bones, threshold energy/ casualty criteria, energy density, ricochet, various aspects of wound ballistics including wounds of entrance/ exit/ track of projectile, gunshot injuries caused by different types of firearm ammunitions. Temporary and permanent cavities, materials simulating human body, gunshot wound as a function of shape of nose of bullet, striking velocity, nature of target, tumbling of bullet, effect of instability of bullet, effect of intermediate target. Influence of range, identification of gunshot injuries, motion of projectile in dense medium. Class and Individual characteristics of fired bullets and cartridge cases and their linkage with the suspected firearms, comparison microscope, photomicrography, source correspondence, linkage of fired shots with shotguns. Automated bullet-cartridge identification system – IBIS and NIBIN.	9
V	Determination of range of firing in cases of firing by smooth-bore and rifled firearms, factors affecting range of firing, stringing of shots, effect of string on pattern, Cart-wheel pattern, balling, Walkers' Test, IR photography. Chemical tests for examination and identification of shotgun holes in various targets. Gunshot	9

	residue. Identification of shooter. Scientific methods of shooting reconstruction, suicide, murder, accident, self defense and encounter cases. Medico-legal report, basic ballistic facts, laboratory examination reports, Documentation and evaluation of bullet holes in various materials, ricochet marks, pellet pattern in various targets.	

List of practical-

1. Comparison of tool marks and fired cartridge/ bullet using comparison microscope.
2. Lifting methods for gun-shot residue.
3. Analysis of GSR
4. Analysis of individual characteristics of cartridge case
5. Analysis of individual characteristics of bullets
6. Reconstruction of crime scene involving firearm

Course Outcomes	
CO1	The student will be able to **understand**[2] the basics of forensic ballistics and concept of internal ballistics
CO2	They will be able to **link**[4] the concept of external ballistics with internal and terminal ballistics.
CO3	They will be able to **determine**[3] the concept of terminal ballistics.
CO4	The student will be able to **distinguish**[4] between various types of ammunitions.
CO5	They will be able to **analyze**[4] the firearm evidence on different parameters.
Text Books:	● Sharma, B.R.; "Firearms in Criminal Investigation & Trials", Universal Law Publishing Co Pvt Ltd, New Delhi, 4th Edition,2011. ● Hatcher, Jury and Weller; "Firearms Investigation, Identification and Evidence", Stackpole Books, Harrisburg, Pa,1997. ● Heard, B.J; "Handbook of Firearms and Ballistics", John Wiley, England, 1997
Reference Books:	● Jauhari M; "Identification of Firearms, Ammunition, & Firearms Injuries", BPR&D, New Delhi. ● Hogg, I.V; "The Cartridge guide – A Small arms Ammunition Identification Manual", The Stackpole publishing Co., Harrisburg, Pa,1982. ● Silverstein, R.M., and Webster, F.X.; "Spectroscopic Identification of Organic Compounds", 6th Edition., Wiley,1997 ● Saferstein, R.; "Criminalistics, An Introduction to Forensic Science", 5th Edition, Prentice Hall,1998.

COURSE CODE	FORENSICS REGULATIONS, IT ACT AND CYBER LAW	Total Hours: Lecture: 60
SC23FS018		4-0-0
Learning Objective:	After studying this paper the students will – ● Understand legal and regulatory Framework. ● Familiarity with cybercrime categories. ● Investigative procedure and technique.	
Pre-requisite:	Basic demonstrate of Information Technology.	

UNIT	CONTENT	HOURS
I	**Introduction to Cyberspace, Cybercrime and Cyber Law:** Cyber World: An Overview: The internet and online resources, Security of information, Digital Signature. Cyber Crimes- Cyber Squatting, Cyber Espionage, Cyber Warfare, Cyber Terrorism, Cyber Defamation. Social Media-Online Safety for women and children, Misuse of Private Information. The World Wide Web, Web-Centric Business, e-Business Architecture, Models of e-Business, e- Commerce, online Contracts; PRs(copyright, trademarks and software patenting- taxation). Threats to the virtual world. IT Act 2000 - Objectives, Applicability, Non- applicability, Definitions, Amendments and Limitations.	12
II	**Regulatory Framework of Information and Technology Act:** Information Technology Act 2000, Digital Signature, E-Signature, Electronic Records, Electronic Evidence and Electronic Governance. Regulation of Certifying Authorities; Controller, Duties of Subscribers, Penalties, Adjudications; offences under the act; Making of Rules and Regulations and Cyber Appellate Tribunal. (Rules announced under the Act), Network and Network Security, Access and Unauthorized Access, Data Security, E Contracts and EForms.	12
III	**Offences and Penalties**: Information Technology (Amendment) Act 2008 – Objective, Applicability and Jurisdiction; Various cyber-crimes under Sections 43 (a) to (j), 43A, 65, 66, 66A to 66F, 67, 67A, 67B, 70, 70A, 70B,71, 80-elaboration and respective penalties, punishment and fines, Penal Provisions for Phishing, Spam, Virus, Worms, Malware, Hacking, Trespass and Stalking; Human rights in cyberspace, International Co-operation in investigating cybercrimes.	12
IV	**Indian Evidence Act:** Classification – civil, criminal cases. Essential elements of criminal law. Constitution and hierarchy of criminal courts. Criminal Procedure Code. Cognizable and non-cognizable offences. Bailable and non-bailable offences. Sentences which the court of Chief Judicial Magistrate may pass. Indian Evidence Act – Evidence and rules of relevancy in brief. Expert witness. Cross-examination and re- examination of witnesses. Sections 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, 138, 141. Section 293 in the code of criminal procedure. Secondary Evidence- Section 65-B	12
V	**International Regulation Framework:** International Legal Regime; International legal regime relating to Cyber Crimes, European Convention on Cyber Crimes, Hague Convention on Jurisdiction and Foreign Judgments: Jurisdiction Agreement. International legal regime relating to E- Commerce; UNCITRAL Model Law on Electronic Commerce 1996, International legal regime relating to Intellectual Property Rights; Berne Convention, Rome Convention, WIPO Copyright Treaty, WIPO Performance and Phonograms Treaty, UDRP, OECD Convention on Database protection.	12

Course Outcomes	
CO1	**Understand** [2] legal and regulatory frameworks.
CO2	**Apply**[3] and interpret law and regulation related to cybersecurity.
CO3	**Illustrate**[2]legal aspects of cybercrimes.
CO4	**Solve**[3] legal and ethical implication of IT.
CO5	**Discover**[4]and address cyber-security challenge.
Text Books:	● H Computers, Internet and New Technology Laws Lexis Nexis Butterworth Wadhwa,2012 ● Law and practice of intellectual property in India Vikas Vashishth Prentice Hall of India Pv1. Ltd ● Cyber Law: The Law of Internet", Springer- Verlag, New York Jonathan Rosenoer 1997
Reference Books:	● Sreenivasulu N.S Nandan Kamath Patridge Publishing, 2013. ● Cyber Law – The Indian Perspective Pavan Duggal Saakshar Law Publications. ● Cyber Laws and IT Protection Harish Chander PHI Learning Pvt. Ltd, 2012.

COURSE CODE	FORENSIC CHEMISTRY AND EXPLOSIVES	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS009		3-0-2
Learning Objectives:	After studying this paper the students will know – ● Understand and to appreciate the breadth and diversity of analytical science in respect of Forensic science. ● The fundamental principles and functions of forensic chemistry. ● The working & principal of different analytical technique. ● The importance of chromatographic and spectroscopic techniques in processing crime scene evidence. ● The classification of explosives and methods of examination through analytical techniques.	
Pre-requisite:	Basic understanding of chemistry principles.	

UNIT	CONTENT	HOURS
I	**Analysis of beverages & Petroleum products**: Alcohols and alcoholic beverages, Analysis of alcohols, country made liquor, illicit liquor and medicinal preparations, Analysis of various denaturants of alcohol, detection and determination of ethanol, methanol, aldehyde, ester by colour test and instrumental technique, Relevant sections of Excise Act. Petroleum products and their adulterations: Analysis of petrol, kerosene, diesel, lubricants by BIS methods and ASTM methods. Distillation and fractionation of petroleum. Commercial uses of different petroleum fractions. Detection of adulterants of gasoline, diesel and engine oils. Analysis of residues in forensic exhibits, chromatography analysis of petrol, kerosene, diesel and other solvents for detection of adulteration.	9
II	**Fire & Arson:** Cases Involving Arson Chemistry of fire. Conditions for fire. Fire scene patterns. Location of point of ignition. Recognition of type of fire. Searching the fire scene. Collection and preservation of arson evidence. Analysis of fire debris. Analysis of ignitable liquid residue. Post-flash over burning. Scientific investigation and evaluation of clue materials. Information from smoke staining. Centrifuge, Filtration, Evaporation, Crystallization Distribution Law, Solvent extraction technique like LLE, SPE, SPME.	9

III	**Dyes & Pesticides** Analysis of trap case:- Mechanism of colour reaction, factor affecting the colour, detection of phenolphthalein and alkali used, method of detection of degraded products. Dyes: Role of dyes in crime investigation, comparison of dyes in fibres and different inks by TLC and UV-VIS Spectrophotometer. Pesticides: Different types of pesticide, formulation, identification of pesticide, standard or sub-standard or substituted pesticides. Determination of purity by analysis by chemical test, thin layer chromatography, ultra-violet - visible spectrophotometry and gas liquid chromatography. Determination of level of pesticide in water, cold drinks, milk, food materials.	**9**
IV	**Explosive & Explosions** Explosives Classification of explosives – low explosives and high explosives. Homemade explosives. Military explosives. Synthesis and characteristics of TNT, PETN and RDX. Detonators pyro technique propellant IEDs and firing mechanism of IEDs. Explosion process. Blast waves Blasting agents. Bomb scene management. Searching the scene of explosion. Mechanism of explosion. Post blast residue collection and analysis. Blast injuries. Detection of hidden explosives	**9**
V	**Analytical Techniques in Explosives** Role of Forensic scientist in Post blast investigation, Explosion effects, Collection of samples, technical report framework, Home-made crude bombs, Evaluation and assessment of explosion site and reconstruction of sequence of events. Analysis of explosive: Methods for extraction of explosive from post blast material/ debris, Qualitative analysis of explosives and explosion residue by colour test, TLC/HPTLC/ GCMS.	**9**

List of practical:

1. Colour Tests for identification of chemicals, poisons, drugs.
2. Identification of commonly encountered inorganic poisons arsenic, antimony, bismuth, mercury by color test and microscopic examination.
3. Identification of ethyl alcohol and methyl alcohol by color tests and microscopic examination.
4. Analysis of accelerants and incendiary in Arson cases by TLC
5. Analysis of accelerants and incendiary in Arson cases by UV visible spectrophotometry
6. Identification of explosives by color tests & group analysis..
7. Analysis of illicit liquor
8. To carry out separation of organic compounds by paper chromatography.
9. To observe any coloured compound using Colorimeter

Course Outcomes as per Bloom's Taxonomy

CO1	**Apply**[3] basics principles and forensic application of analytical methods
CO2	**Examine**[2] various chemical methods for detection of adulterations.

CO3	**Identify**[3] Crime scene developing method, analysis.
CO4	**Design**[6] Role of polymers & fibres in crime scene for reconstruction
CO5	**Utilized**[3] Use different technique of analysis in criminal cases
Text Books:	● **(Skoog, Douglas A. West, Donald M. Hollar, James F.)** Fundamentals of Analytical Chemistry. ● **Dr. B. K. Sharma** Instrumental Methods of Chemical Analysis ● **John M. Chalmers, Howell G. M. Edwards, Michael D. Hargreaves**Infrared & Raman Spectroscopy in Forensic Science. ● **James Robertson, Claude Roux, Kenneth G. Wiggin**, Forensic Examination of Fiber
Reference Books:	● Instrumental Method of Chemical Analysis. Chatwal & Anand, Himalya ● Publication, 5th edition ● Settle F. A.: Handbook of Instrumental Technique for Analytical ● Chemistry, Prentice Hall ● Introduction of Forensic Science in Crime Investigation by Dr. (Mrs.) R. ● Krishnamurthy, Selective & Scientific Books ● Handbook of Instrumental Technique for Analytical Chemistry by Settle F. A, ● Prentice Hall; Har/Cdr edition ● Laboratory Procedure Manual: Petroleum Products, Directorate of ● Forensic Science, MHA, Govt. of India, ● Working Procedure Manual on Chemistry; Directorate of Forensic Science MHA. Govt. of India.

COURSE CODE	INSTRUMENTAL METHODS-PHYSICAL AND CYBER	Total Hrs.: 60 Lecture: 45 Practical: 15
SC23FS010		3-0-2
Learning Objectives:	After studying this paper the students will know to– ● Learn basic concepts of microscopy. ● Learn the Basic concept of Spectroscopy. ● Understand Sophisticated Instruments working. ● Understand and acknowledge the principles of cryptography. ● Acknowledge the principles of mobile and computer forensics.	
Pre-requisite:		

UNIT	CONTENT	HOURS
I	**Microscope:** Compound Microscope, Polarized Light Microscopy, Fluorescence Microscopy, Comparison Microscope, Stereo-zoom Microscope. Transmission Electron Microscope, Video-zoom Microscope. Scanning Electron Microscope – Energy Dispersive X-Ray. Atomic Force Microscope. Introduction to spectrophotometry, Interaction of electromagnetic radiations with matter: phenomena of absorption, emission, reflection, fluorescence, phosphorescence. Detection of radiations: Photographic detectors, thermal detectors, photoelectric detectors. Basic concepts of atomic spectra, energy levels, quantum numbers, designation of states, selection rules, atomic spectra, rotational, vibrational and electronic spectra, spectra of polyatomic molecules.	9
II	**Spectroscopy:** Elements of X-ray spectrometry: Energy Dispersive X-ray Analysis (EDX), wavelength Dispersive X-ray analysis (WDX), X-ray diffraction, Auger emission spectroscopy and applications Radiochemical techniques: Basic principles and theory introduction about nuclear reactions and radiations, Neutron sources, Role of microscope. ESCA and its applications. Fluorescence and phosphorescence spectroscopy: Types of sources, structural factors, instrumentation, comparison of luminescence and UV-visible absorption methods and applications.	9
III	**Introduction, Principle & Forensic Application Of Neutron Activation Analysis**. Basics of Electrostatic Effect of Chemical Structure and solvent on absorption spectra, qualitative and quantitative analysis and limitations. Raman Spectroscopy: Basic principles, Instrumentation, sample handling and illumination, structural analysis, polarization measurements and Dispersive & FT analysis and Advantage of Raman over IR and vice versa,, Nuclear Magnetic Resonance Spectroscopy: Basic principles, theory and Instrumentation and applications, Thermal Techniques- TGM and D.T.A., VSC, ESDA	9
IV	**Introduction to Cryptography**: Symmetric and Asymmetric Cryptosystem Encryption Techniques– Substitutional Cipher and Transpositional Ciphers. Types of keys – Public Key and Private Key. Advanced Encryption Techniques and Security Issues. Various types of attacks including Cipher Text-Only attack, Known-Plaintext Attack, Chosen-Plaintext Attack, Chosen-Cipher text Attack. Symmetric Cryptosystem – AES, DES, RC4, Blowfish. Asymmetric Cryptosystems – RSA, DSA, Elliptic Curve cryptography. Introduction to Cryptanalysis – Differential and Linear Cryptanalysis. Hashing Algorithms – MD5, SHA-1, SHA-2, SHA-3, One-Way Hash, Hash Message Authentication Code	9

V	**Overview of Mobile Forensics**: Seizure and Preservation of mobile phones and PDA. Types of Evidence present in mobile phones - Files present in SIM card, external memory dump, and evidences in memory card. Mobile phone evidence extraction process, Data Acquisition Methods – Physical, File System, Logical and Manual Acquisition. Mobile Forensic Investigation Toolkit. Tracking of mobile phone location **COMPUTER FORENSICS-** First responder – role and toolkit. Procedure for search and seizure of digital evidences. Search and Seizure of Volatile and Non-volatile Digital Evidence. Imaging and Hashing Digital Evidence. Analyzing and Recovery of Deleted, Hidden and Altered files.	**9**

List of Practicals-

1. Demonstration of different parts of microscope
2. Demonstration of different types of microscope
3. Measurement of Absorption Maxima of some Organ insolently Visible Spectrophotometer.
4. Calculation of Strength of some Organic Solvent by UV Visible Spectrophotometer.
5. To create a disk image of a digital device.
6. Demonstration of Hiren Boot CD and DEFT Forensic CD
7. Acquiring volatile memory using FTK imager

Course Outcomes	
CO1	**Apply** [3] the knowledge of microscopic technique in analysis of specimens.
CO2	**Utilize**[3] the Spectroscopy techniques in Forensic Examination.
CO3	They will **understand**[4] the applications of cyber forensics
CO4	**Ability** [2] to handle the Sophisticated Instruments.
CO5	**Utilize** [3] the Microscopic and spectrophotometric Techniques in Forensic Examination.
Text Books:	● Chatwal and Anand (2016). Instrumental Methods of Chemical Analysis. India, Hph. ● Kalri P.S. (2001). Spectroscopy of Organic Compounds. India, New Age International Pub. ● Sharma B.K.(2000).Instrumental Methods of Chemical Analysis. India, Krishna Prakashan Media. ● Skoog D. A., Holler F.J.&Crouch S.R.(2017).Principles of Instrumental Analysis. USA, Cengage Learning. ● Willard H. &Lynne L.M. (1986).Instrumental Methods of Analysis. India, CBS Publishers & Distributors. ● Lee Reiber. Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation, 1st edition, McGraw-Hill 2016 .
Reference Books:	● James W. R. (1996). Atomic Spectroscopy. Revised & Expanded. NY, Marcel Dekkar, Inc. ● Patania B. (2004). Spectroscopy. India, Campus Books International, ● Silverstein R.M. & Francis X. W. (1997). Spectrometric Identification of Organic ● Compounds, USA, John Wiley & Sons, Inc. ● Special Report (2nd Edition), Electronic Crime Scene Investigation: A Guide for First Responders, NIJ publication ● Sridhar S. (2011), Digital Image Processing, Oxford University Press

COURSE CODE	QUALITY CONTROL, NABL ACCREDITATION AND RECENT ADVANCEMENT IN FORENSIC SCIENCE	Total Hrs: 60 Lecture: 45 Practical: 15
SC23FS011		3-0-2
Learning Objectives:	After studying this paper the students will know– ● The student will learn about about ISO standards ● The student will learn about accreditation and its bodies ● The student will learn about report writing ● The student will learn about court procedures	
Pre-requisite:		

UNIT	CONTENT	HOURS
I	Introduction to NABL, International Organization for standardization (ISO), International Electrotechnical Commission(IEC), testing laboratories, Calibration laboratories, reference materials, Proficiency testing, ISO/IEC 17025 Accreditation applicable on Forensic Science laboratories, Accreditation applicable on academic institutions of forensic science, Accreditation applicable on private forensic science firms, different divisions of forensic sciences and accreditation applicable on them	9
II	Preliminary testing/point of care testing/presumptive testing, confirmatory testing, calibration parameters, internal calibration, external calibration, method development and testing, Method validation, Standards operating procedures of equipments and laboratory methods, making of laboratory manuals	9
III	Foldscope, 3D Technology to Determine Physical Fit , Drone Forensics, Alternative Light Photography, Crime scene investigation using virtual reality technology, Portable testing units, Google Glass, Fingerprint protection**,** Time-Tracing Fingerprint Technology, 3-D Photography Technology, Photogrammetry Recent advancements in forensic Physical sciences, comparison microscope applicability in forensic physics, stereomicroscope applicability in forensic physics, Abbes refectrometer, Forensic Glass Analysis with LA-ICP-MS, Digital Vehicle Forensics, High-Speed Ballistics Photography, 3D Forensic Facial Reconstruction**,** reconstruction of crime scene using VR technology	9
IV	Recent advancements in questioned document, fingerprints and cyber forensics, Carbon Dot Powders, Artificial Intelligence, Nanotechnology, Geolocating a Suspect or Victim using Stable Isotopes of Water, Blockchain-Based Solutions Cloud Forensics, Social Network Forensics, Video Spectral Comparator 2000, Digital Surveillance For Xbox (XFT Device), Magnetic Fingerprinting and Automated Fingerprint Identification (AFIS), Link Analysis Software forForensic Accountants	9

V	Recent advancements in forensic chemical sciences, Date rape drugs and its analysis, designer drugs and its analysis, metabolite detection and its correlation, fluorescence spectrometry, Time of flight instruments, Randox toxicology, hyphenated techniques, spectrogram interpretation, chromatogram interpretation, voltaamogram interpretation, testing methods and calibration of equipments used in forensic chemistry, components of a chemical report and its interpretation, Isotope Detection, Carbon Dating Recent advancements in forensic biological sciences, Biosensors for forensic analysis**,** Forensic Palynology, DNA Sequencing, Next generation sequencing, Immunochromatography, SEM, TEM, Proteomes**,** mitochondrial DNA, Touch DNA, Hair Bacteria Assessment POCSO act and its applicability in forensic science, assault cases and their applicability in forensic science , Amendments in laws related to women, electrophoresis findings interpretation, testing methods and calibration of equipments used in forensic biology , components of a biological report and its interpretation	**9**

List of Practical-

1. Cleaning, disinfection and sterilization procedures inside a laboratory
2. Calibration and testing of glasswares
3. calibration and testing of minor equipments
4. calibration and testing of sophisticated equipments
5. Standard operating mechanisms of minor equipments
6. Standard operating mechanisms of sophisticated equipments
7. NABL accreditation demonstrations

Course Outcomes	
CO1	**Apply**[3] the knowledge of Distillation Technique in separation of various compound.
CO2	**Utilize**[3] the Spectroscopy techniques in Forensic Examination.
CO3	**Ablity**[2] to handle the Sophisticated Instruments.
CO4	**Perform**[6] chromatographic techniques in Forensic Examination.
CO5	**Utilize**[3] the Electrophoretic Techniques and Microscopic technique in Forensic Examination.
Text Books:	● NABL grants accreditation to Testing Laboratories in accordance with ISO/ IEC 17025 “General Requirements for the Competence of Testing and Calibration Laboratories ● NABL grants accreditation to Calibration Laboratories in accordance with ISO/ IEC 17025 ‘General Requirements for the Competence of Testing and Calibration Laboratories’ ● NABL grants accreditation to medical testing laboratories in accordance with ISO 15189 “Medical laboratories- requirements for quality and competence” ● Chatwal and Anand, Instrumental Methods of Chemical Analysis, 2016, India, Hph. ● Max M Houck, Materials Analysis in Forensic Science, 1st Ed, 2016, Academic Press. ● Sharma B K, Instrumental Methods of Chemical Analysis, 2015, India, Krishna Prakashan Media.
Reference Books:	● NABL grants accreditation to Proficiency Testing Providers (PTP) in accordance with ISO/ IEC 17043 “Conformity assessment – General requirements for Proficiency Testing” ● NABL grants accreditation to Reference Material Producers (RMP) in accordance with ISO 17034 “General requirements for the competence of Reference Material Producers” ● Barbara H Stuart, Forensic Analytical Techniques, I Ed., 2021, Wiley Publication. ● Patania B, Spectroscopy, 2004, India, Campus Books International. ● Skoog D A, Holler F J & Crouch S R, Principles of Instrumental Analysis, 2017, USA, Cengage Learning. ● Thompson K C & Renolds R J, Atomic Absorption Fluorescence & Flame Emission Spectroscopy: A Practical Approach, 2014, London, Charles Griffin & Co.

COURSE CODE	INSTRUMENTAL METHODS-CHEMICAL AND BIOLOGICAL	Total Hrs.:60 Lecture: 45 Practical: 15
SC23FS012		**(3-0-2)**
Learning Objectives:	After studying this paper the students will know– ● After studying this paper the students will know – ● Understand the basis of analytical chemistry in investigation. ● Analysis of Gas Chromatography for analysis of volatile poison. ● Examine the need for HPLC's role in forensic science. ● Handle the sophisticated Biological Instruments. ● Apply biological instrumentation techniques in Forensic Examination	
Pre-requisite :		

UNIT	CONTENT	HOURS
I	**Simple Separation Techniques:** General Idea and Basic Principle of Distillation and Various Types of Distillation Techniques. Centrifugation; Centrifuge and its Types. Filtration, Evaporation and Crystallization. Solvent Extraction Technique Like LLE, SPE, Micro SPE and Distribution Law. **Introduction to Chromatography and Measurements** Definition of separation, Origin of Chromatography (definition of chromatography, similarity of Chromatography to Separation Methods, Separation in Nature). Introduction and historical aspect of chromatography, classification of chromatography (mobile phase mode, technique, development mode, separation mechanism & other systems of classification).	**9**
II	Measurements: Introduction, chromatographic retention (parameters for column and planar techniques), peak shape, zone broadening and measures of efficiency, optimizing resolution, and overall systems performance**Gas and High-Performance Liquid Chromatography Gas Chromatography**: Introduction to Gas Chromatography. Retention Indices. Forensic scope of GC analysis, Limitations of GC. **High-Performance Liquid Chromatography**: Introduction to HPLC advances in HPLC leading to present-day instrumentation with special reference to UPLC, Instrumentation of HPLC (injectors, column, and detectors). Derivatization in HPLC. Forensic scope of HPLC analysis. Limitations of HPLC	**9**
III	**Principle & Forensic Application Of Spectrophotometry** -Principles, Techniques and Application in Forensic science - U.V., Visible, I.R. FTIR, Atomic Absorption Spectroscopy, Mass Spectrometry. Raman Spectroscopy, Hyphenated techniques in HPLC (LC-MS, LC-MS-MS). Hyphenated GC techniques (GC-MS, GC-IR, GC-GC, or 2D GC).	**9**
IV	**Microscopy** Theory and basic principles, setup and Forensic applications of Compound, Comparison, Fluorescence, Polarized, Stereo-zoom microscope. Introduction, Geometrical optics, Image formation, Magnification and Resolution, Lens aberrations, Distortion of image and curvature of field. Electron Microscopy- Theory and basic principles of Electron Microscopy, Structure and Forensic applications of Scanning Electron microscope (SEM), Transmission Electron Microscope (TEM).	**9**

V	**Electrophoresis:** Electrophoretic Techniques General Principles and Classification of Electrophoresis Factors Affecting Electrophoresis, Preparative, Horizontal, Vertical, Two Dimensional Electrophoresis, General Idea of Low Voltage Electrophoresis, High Voltage Electrophoresis, Gel Electrophoresis, Isoelectric Focusing and Capillary Electrophoresis, Forensic Application of Electrophoresis	**9**

List of practical-

1. Preparation of thin layer chromatographic plates using silica Gel-G.
2. Analysis of Various Ink Samples by PC and TLC.
3. Separation of Pharmaceutical Compounds by HPLC.
4. Separation of Agrochemicals by TLC and HPLC.
5. Separation of petroleum products by GC.
6. Separation of Ethanol products by GC.
7. Separation of Dyes by High-Performance Thin Layer Chromatography.
8. To perform species Origin Identification using Precipitin Test.
9. To Perform a Microscopic Examination of Pollen Grains.
10. To Perform a Microscopic Examination of Epithelial Cells
11. To Perform Separation of RBC WBC and Plasma from whole blood using Centrifuge.

Course Outcomes	
CO1	**Apply**[3] the concept of analytical chemistry in investigation
CO2	**Examine**[2] the use of Gas Chromatography for analysis of volatile poison.
CO3	**Identify**[3] HPLC's role in forensic science.
CO4	**Design**[6] Microscopic Examination of Specimens.
CO5	**Utilized**[3] specialized techniques and can apply the knowledge in forensic examination
Text Books:	● R.S. Khandpur; Handbook of Analytical Instruments; Tata McGraw Hill Pub. Co. New Delhi (India) (2004) ● Sharma B K; Instrumental Methods of chemical Analysis; Krishna Prakashan Media (India) (2000) ● Chatwal and anand; Instrumental Methods of chemical Analysis; Hph pub, (2016) ● Willard, Merrit and Dean; Instrumental methods of analysis; Van Nostrand, (1974)
Reference Books:	● Smith and Bogusz M. (2007).Handbook of Analytical Separation. Germany, Elsevier Pub. ● Srivastava M. (2010). High-Performance Thin-Layer Chromatography (HPTLC). Germany, Springer Science & Business Media.

Bachelor of Science (BSc)

Program Educational Objectives (PEOs) Biotechnology:

PEO-1: Prospective Employment and Career Prospects-Developing the potential for vertical career growth in Biotech-oriented industries, service sectors and related avenues.

PEO-2: Proficiency- Inculcating technical and managerial skills crucial for real time scenarios through the enhancement of problem-solving skills and advanced technical documentation ability.

PEO-3: Affectionate Objective- Grooming the students with technical proficiency to equip them for the emergence of sustainable technology and solutions for prevailing environmental, societal and cultural concerns.

PEO-4: Research Methods-Nurturing the research aptitude to provide solutions for global challenges and abilities to explore hidden potential of the matter

PEO-5: Continuous Learning-Instilling knowledge and awareness on professional ethics, bioethical and health issues, intellectual property rights and life-long learning through career oriented courses

Program Outcomes (POs) Biotechnology:

By the end of the program the students will be able to:

PO 1. Understand concepts of Biotechnology/Microbiology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, and molecular biology.

PO 2. Demonstrate the Laboratory skills in cell biology, basic and applied microbiology with emphasis on technological aspects

PO 3. Be competent to apply the knowledge and skills gained in the fields of plant biotechnology, animal biotechnology and microbial technology in pharma, food, agriculture, beverages, herbal and nutraceutical industries.

PO 4. Critically analyze environmental issues and apply the biotechnology knowledge gained for conserving the

environment and resolving environmental problems.

PO 5. Demonstrate comprehensive innovations and skills in the fields of biomolecules, cell and organelles, molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare.

PO 6. Apply the knowledge and skills of immunology, bioinformatics, computational modelling of proteins, drug design and simulations to test models and aid in drug discovery.

PO 7. Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of biotechnology.

PO 8. Learn and practice professional skills in handling microbes, animals and plants and demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animals handling, intellectual property rights, biosafety, and biohazards.

PO 9. Demonstrate thorough knowledge and application of good laboratory and good manufacturing practices in biotech industries

PO 10. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up of small-scale enterprises or CROs

Bachelor of Science (BSc)

CURRICULUM COMPONENTS

Components		Credits
University Core (Table 1)	Ability Enhancement Courses (06 Courses)	**12**
	Skill Enhancement Courses (06 Courses)	**12**
Discipline Core Courses (8 Courses) (Table 2)		**32**
Discipline Specific Major Electives (8+4 Courses) (Table 3)		**32R/48H***
Discipline Specific Minor Electives (6 Courses) (Table 3)		**24**
Interdisciplinary Minor Electives (04 Courses) (Table 4)		**16**
Project/Field Internship/Skill Based Project		**28H/44R***
Total		**172**

*** Opt either 04 Specialized Courses (for Honors Degree) or Research Based Industrial Project (for Research Degree)**

** Note: Any student opting out after I year / II year will obtain undergraduate Certificate/Diploma respectively in the specific discipline subject to mandatory 450hrs (8-10 week) ,10 credit Internship in SUB/Industry/Research organization.

COURSE CODE SC23BT001	Principles of Microbiology	Total Lec.: Hours 4-0-0
Learning Objectives:	• Aim of the course to introduce the students with microbial world and get them familiarize with the routine tools of Microbiology	
Pre-requisites:	Elementary knowledge of Cell organelles	

UNIT	CONTENT	HOURS
I	Development of microbiology as a discipline: Spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation, establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of following scientists : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner,Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky,Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty	15
II	Systems of classification: Binomial Nomenclature, Whittaker's five kingdoms and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms General characteristics of different groups: Acellular microorganisms (Viruses,Viroids, Prions) and Cellular microorganisms (Bacteria- Gram positive, Gram negative, archaebacteria, Algae, Fungi and Protozoa) with emphasis cell structure, distribution, occurrence, mode of reproduction, cultural characteristics, biochemical characteristics and economic importance.	10
III	Staining: Principle of staining, Types of staining– Simple, Differential (Gram, Spore, AFB), Negative staining, Capsule staining, Giemsa Staining, LPCB, KOH Mount Sterilization and Disinfection- Principles- Methods of Sterilization – Physical methods – Dry heatMoist heat, Filtration (Membrane & HEPA) - Radiation sterilization and mechanism– Chemical Sterilization -Chemical agents & Mode of action – Phenol coefficient test- Sterility testing	10
IV	Nutritional diversity of microbes: Culture & -Media preparation - Solid and Liquid-Types of Media – Semi-Synthetic, Synthetic, Enriched, Enrichment, Selective and Differential media, Natural components as media and Special Purpose Media (one eg for each type). Anaerobic culture 11 technique – Wright's tube, Roll tube, Mclntostfildes jar method. Pure culture techniques – Tube dilution, Pour, Spread, Streak plate	15
V	Preservation of pure culture: Periodic subculture methods, cold storage, freezing, deep-freezing, lyophilization methods, storage using liquid nitrogen, comparative advantages and disadvantages of different methods	10

Course Outcomes	
CO1	The student will be able to **understand**[2] different types of staining.
CO2	The student will be able to know about contribution of scientists.
CO3	The student will be able to **characters of different groups.**
CO4	The student will be able to know about nutrition of microorganisms.
CO5	They will be able to **perform**[4] basic laboratory experiments of preservation of pure culture.
Text Books Reference Books	• Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons, Inc. • Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.

	● Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited. ● Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition.Pearson/Benjamin Cummings. ● Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company. ● Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition.McMillan. ● Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education. ● Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd. ● Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Limited, New Delhi. ● Willey JM, Sherwood LM, and Woolverton CJ. (2008). ● Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

COURSE CODE	MICROBIAL PHYSIOLOGY AND METABOLISM	Total Lec: 45
SC23MB002		3 – 0 – 2
Learning Objectives:	● The course will provide students fundamental knowledge and methodologies for microbial studies and be able to relate knowledge to various microbial applications. ● Develop a clear understanding of various aspects of microbial physiology along with diverse metabolic pathways and to enable students to better understand the microbial world.	
Pre-requisites :	Elementary Biology	
UNIT	CONTENT	HOURS
I	Microbial nutrition and transport: Classification of microorganisms based on nutrient and energy source. Nutrient uptake and transport: passive and facilitated diffusion, primary and secondary active transport, iron uptake, concept of uniport, symport, antiport, group translocation.	10
II	Microbial growth and influence of environmental factors: Bacterial growth curve (generation time and specific growth rate), diauxic growth, synchronous growth, batch and continuous cultures. Effect of temperature, pH, oxygen concentration, solute and water activity on growth.	10
III	Carbon metabolism and energy generation: Concept of aerobic respiration, anaerobic respiration and fermentation. Glucose degradation/catabolism by microbes via: Embden-MeyerhofParnas (EMP) pathway /glycolysis, Entner-Doudoroff (ED) pathway, Pentose phosphate pathway (PPP), Krebs Cycle /Tricarboxylic Acid Cycle, Glyoxylate cycle. Electron transport during aerobic respiration: components of mitochondrial electron transport chain (ETC), chemiosmotic hypothesis, oxidative phosphorylation and ATP generation, uncouplers and inhibitors of respiratory chain, comparison of mitochondrial and bacterial electron transport, branched respiratory chain in bacteria (E. coli) under high and low levels of O2. Anaerobic respiration with nitrate as final electron acceptor: dissimilatory nitrate reduction (denitrification, nitrate /nitrite and nitrate/ammonia respiration).	10
IV	Bacterial fermentations: Alcohol fermentation and Pasteur effect, lactate fermentation (homofermentative and heterofermentative pathways). Concept of linear and branched fermentation pathways	5
V	Chemolithotrophic and phototrophic metabolism: Definition, physiological groups of chemolithotrophs, aerobic chemolithotrophy with details of H2 oxidizers and anaerobic chemolithotrophy with details of methanogens. Families of phototrophic bacteria. Anoxygenic photosynthesis with reference to purple and green bacteria and oxygenic photosynthesis with reference to cyanobacteria: photosynthetic pigments and photophosphorylation (cyclic and noncyclic). C1 metabolism: CO2 fixation by Calvin cycle, reductive TCA and methanogenesis	10
Course Outcomes as per Bloom's Taxonomy		
CO1	They will **understand**[2] the nutritional requirement of Microorganisms	
CO2	The student will be capable of **describing**[4] the growth characteristics of the microorganisms	

CO3	They will be able to critically **evaluate**[5] the growth under unusual environmental conditions of temperature, oxygen, and solute and water activity.
CO4	The students will be able to **analyse**[4] concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.
CO5	They will be able to **understand**[2] the associated mechanisms of microbes to energy generation for their survival
Text Books:	● MT Madigan, and JM Martinko, Biology of Microorganisms. 14th edition, 2014, Prentice Hall International Inc. ● S. R. Reddy and S. M.Reddy., Microbial Physiology, 2005, Scientific Publishers India ● J.M Willey, L.M Sherwood, and C.J Woolverton, Prescott's Microbiology. 9th edition, 2013, McGraw Hill Higher Education.
Reference Books:	● Stanier, Ingraham, et.al, The Microbial world, 2010, McMillan Educational Ltd., London ● Franklin and Snow, Biochemistry of Antimicrobial Action, 1989, Chapman and Hall, New York. ● Stuart. Harris and Harris. The Control of Antibiotic Resistance in Bacteria, 2002.

COURSE CODE	**MICROBIAL PHYSIOLOGY AND METABOLISM**	**Practical:30 hours**
SC23MB002P		**1**
	1. Study and plot the growth curve of E. coli by turbidimetric method. 2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data. 3. Effect of temperature and pH on growth of E. coli or Aspergillus 4. Demonstration of alcoholic fermentation. 5. Effect of carbon and nitrogen on microbial growth.	

COURSE CODE SC23BT003	Cell Biology and Genetics	Total Lec.:45 Hours
		3-0-2
Learning Objectives:	• Develop a very good understanding of several microbiological techniques in students. • Basic instruments which are commonly used in a microbiology laboratory and their principles are discussed. • They also introduce a variety of modifications in the microscopes for specialized viewing. • Concepts learnt can be applied to perform basic experimental techniques.	
Pre-requisites:	Elementary knowledge OF Cell organelles	

UNIT	CONTENT	HOURS
I	Structural organization and function of intracellular organelles: cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	05
II	Organization of genes and chromosomes: operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.	10
III	Cell division and cell cycle: mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.	08
IV	Mendelian principles: dominance, segregation, independent assortment, deviation from Mendelian inheritance.Concept of gene: allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles: codominance, incomplete dominance, gene interactions, pleiotropy, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.	12
V	Mutation: types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal vs somatic mutants, insertional. Mutagenesis. Microbial genetics: methods of genetic transfers – transformation, conjugation, transduction and sex-duction, fine structure of gene-rII locus.	10

Course Outcomes	
CO1	The student will be able to **understand**[2] cell signaling
CO2	The student will be able to **characterize**[3] cell organelles, cell membrane composition and various cellular
CO3	The student will be able to **differentiate**[3] a large number of common bacteria by their salient characteristics
CO4	The student will be able to correlate[5] structure function of cell and its components
CO5	They will be able to **perform**[4] basic laboratory experiments to study cells; methods to preserve cells in the laboratory;
Text Books	• GM Cooper and Hausman RE, The Cell: A Molecular Approach, 5th edition. 2009, ASMPress& Sunderland, Washington, D.C, Sinauer Associates, MA. • WM Kleinsmith, LJ Hardin and GP Bertoni, The World of the Cell.7th edition.,2009. Pearson Benjamin Cummings Publishing, San Francisco.
Reference Books	• G Karp, Cell and Molecular Biology: Concepts and Experiments, 6th Edition, 2010. JohnWiley&Sons.Inc. • EDP Robertis and De RobertisEMF,Cell and Molecular Biology, 2006, 8th edition, Lippincott Williams and Wilkins, Philadelphia.

Course Code	CELL Biology & Genetics LAB	Practicals:30 Hours
SC23BT003P		
	1. Demonstration of dialysis. 2. Study of plasmolysis and deplasmolysis. 3. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source. 4. Study of structure of any Prokaryotic and Eukaryotic cell. 5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues. 6. Cell division in onion root tip. 7. Permanent and temporary mount of mitosis. 8. Permanent and temporary mount of meiosis. 9. Mendelian deviations in dihybrid crosses 10. Demonstration of - Barr Body-Rhoeo Translocation. 11. Pedigree charts of some common characters like blood group and color blindness	

COURSE CODE	IMMUNOLOGY	Total Lec:45	
SC23BT004		**3-0-2**	
Learning Objectives:	● Understand the basics of immunology ● Widen their knowledge in classical and molecular immunology ● Become familiar with immunization practices and their importance ● Enabling their knowledge in techniques of immunology		
Pre-requisites:	Elementary Biology, Elementary Chemistry.		
UNIT	**CONTENT**		
I	Introduction, Concept of Innate and Adaptive immunity; Immune Cells and Organs, Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT		5
II	Antigens, Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants, Antibodies Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic)		10
III	Antigen processing and presentation (Cytosolic and Endocytic pathways) Complement System, Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation		10
IV	Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance		10
V	Immunological Disorders, Types of Autoimmunity and Hypersensitivity; Types of tumors. Immunological Techniques , Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.		10
Course Outcomes as per Bloom's Taxonomy			
CO1	They will u**nderstand**[2]the Innate and Adaptive immunity and the components.		
CO2	The student will know the **relevance**[2]of basic concepts and components in immunology.		
CO3	Students will be able to critically **evaluate**[5]the concepts of immunology.		
CO4	They will **know**[1]the scope of immunology.		
CO5	Understand mechanisms of Immune response C2 and learn to apply basic techniques of antigen-antibody interactions		
Text Books:	● Kuby Immunology, Richard A.Goldsby, Thomas J.Kindt, Barbara A Osborne, 2000, 4th Edi. W.H. Freeman & Co. ● Immunology: An Introduction, lanTizard, 1995, Thomson Learning. ● Hybridoma technology in the Biosciences and Medicine – Timothy Springer (1985) Plenum Press.		
Reference Books:	● Essentials of Infectious Diseases by Lionel A. Mandell, Edward D. Ralph (1985) Black Well Science Inc. ● Vaccines 86 : New approaches to immunization : Developing vaccines against Parasitic, bacterial & viral diseases, Robert M. Chanock, Fred Brown, Richard A. Lerner, 1986, Cold Spring Lab. Press.		

COURSE CODE	IMMUNOLOGY LAB	Practical:30 hours
SC23BT004P		**1**
	1. Identification of human blood groups. 2. Perform Total Leukocyte Count of the given blood sample. 3. Perform Differential Leukocyte Count of the given blood sample. 4. Separate serum from the blood sample (demonstration). 5. Perform immunodiffusion by Ouchterlony method. 6. Perform DOT ELISA. 7. Perform immunoelectrophoresis.	

COURSE CODE	BIOINFORMATICS	Total Lec: 45
SC23BT005		3 – 0 – 0
Learning Objectives:	● Apply reasoning about core biological concepts with emphases on the cellular and molecular scale of biology ● Design, implement and evaluate computer-based systems, processes, components or programs in relation to the contexts of molecular and cellular biology and genomics research. ● Analyze and evaluate bioinformatics data to discover patterns, critically evaluate conclusions and generate predictions for subsequent experiments.	
Pre-requisites:	Elementary Biology, Basics of Computers.	
UNIT	**CONTENT**	**HOURS**
I	History of Bioinformatics, The notion of Homology, Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.	10
II	Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web, Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.	10
III	Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments,	10
IV	Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.	07
V	Searching Databases, SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, and Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools	08
Course Outcomes as per Bloom's Taxonomy		
CO1	They will be able to **understand**[2] and Critically **evaluate**[5] the biological data.	
CO2	The students will be able to **evaluate**[5] biological information relating to bioinformatics in both written and oral forms	
CO3	They will be able to **relevance**[2] of historical events and major discoveries in Bioinformatics.	
CO4	They will be able to **know**[1] the scope of Bioinformatics.	
CO5	They will be able to **collaborate**[6] in a group on biological concepts in relation to bioinformatics and demonstrate comprehension of basic concepts of biological literacy.	
Text Books:	● J Pevsner , Bioinformatics and functional genomics. II Edition, 2009, Wiley-Blackwell. ● Zvelebil, Marketa and Baum O. Jeremy, Understanding bioinformatics, 2008, Garland Science, Taylor and Francis Group, USA. ● D Mount, Bioinformatics: sequence and genome analysis, 2004, Cold spring harbor laboratory press, New York. ● A.D Baxevanis, and Francis Ouellellette, Bioinformatics- A practical guide to the analysis of genes and proteins, 2009, Wiley India Pvt Ltd.	
Reference Books:	● Z. Ghosh and M. Bibekanand, Bioinformatics: principles and applications, 2008, Oxford University Press. ● A.M Campbell, L.J Heyer, Discovering Genomics, Proteomics and Bioinformatics. II Edition, 2006, Benjamin Cummings.	

COURSE CODE	**BIOINFORMATICS LAB**	**Practicals: 30**
SC23BT005P		**1**
	1. Sequence information resource. 2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR) 3. Understanding and using: PDB, Swissprot, TREMBL 4. Using various BLAST and interpretation of results. 5. Retrieval of information from nucleotide databases. 6. Sequence alignment using BLAST. 7. Multiple sequence alignment using Clustal W.	

COURSE CODE	Bioanalytical Tools	Total Lec:45
SC23BT006		3-0-2
Learning Objectives:	● Understand the basics of pH ● Widen their knowledge in Centrifuge. ● Become familiar with Microscopy ● Enabling their knowledge about radioisotopes	
Pre-requisites:	Elementary Biology, Elementary Chemistry.	HOURS
UNIT	**CONTENT**	
I	Preparation of solutions, concept of pH and buffer, types of buffers and their preparation, pH meter.	5
II	Principle of centrifugation, rotors, different types of centrifuges, preparative and analytical centrifugation, ultra centrifugation.	10
III	Optical microscopy, Bright field, Dark field, phase contrast and fluorescence microscopy.Electron microscopy: Transmission and scanning electron microscopy, Atomic force microscopy.	10
IV	Study of radioisotopes in biological samples, proportional and GM counter, scintillation counters, autoradiography, radio –immunoassay.	10
V	Cell Disruption techniques, ultra filtration, dialysis and reverse osmosis.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	They will u**nderstand**[2]the Immunology.	
CO2	The student will know the **relevance**[2]of basic concepts and pH.	
CO3	Students will be able to critically **evaluate**[5]the concepts of Microscopy.	
CO4	They will **know**[1]the scope of Bioanalytical tool.	
CO5	Understand mechanisms of Cell Disruption.	
Text Books, **Reference Books:**	● Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall. ● Essentials of Biophysics, P. Narayanan, New Age International Publishers ● Advanced Instrumentation, Data Interprtation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic ● Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press ● Crystallography made Crystal Clear, G. Rhodes, Academic Press ● Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd. ● NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.	

COURSE CODE	Bioanalytical Tools	Practical:30 hours
SC2BT006P		1
	1. Cell disruption techniques 2. Centrifugation – low speed and high speed. 3. Spectrophotometer techniques 4. Chromatography –Paper Chromatography 5. Thin Layer Chromatography 6. Electrophoresis –SDS PAGE 7. Agarose gel electrophoresis.	

COURSE CODE	PLANT BIOTECHNOLOGY	Total Lec:45
SC23BT007		3-0-2
Learning Objectives:	● Understand the basics in Vitro methods ● Widen their knowledge in embryogenesis and organogenesis ● Enabling their knowledge protoplast isolation	
Pre-requisites:	Elementary Biology, Elementary Chemistry.	**HOURS**
UNIT	**CONTENT**	
I	Introduction to in vitro methods Terms and definitions. Beginning of in vitro cultures in our country (ovary and ovule culture, in vitro pollination and fertilization. Embryo culture, embryo rescue after wide hybridization, and its applications. Endosperm culture and production of triploids.	5
II	Introduction to the processes of embryogenesis and organogenesis and their practical applications . Micropropagation, axillary bud, shoot-tip and meristem culture. Haploids and their applications. Somaclonal variations and applications.	10
III	Introduction to protoplast isolation Principles of protoplast isolation and applications. Testing of viability of isolated protoplasts. Various steps in the regeneration of protoplasts. Introduction of somatic hybridization. Various methods for fusing protoplasts, chemical and electrical. Cybrids-definition and application.	10
IV	Use of plant cell, protoplasts and tissue culture for genetic manipulation of plants. Introduction to A. tumefaciens. Tumor formation on plants using A.tumefaciens (Monocots vs. Dicots). Practical application of genetic transformation.	10
V	Methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agrobacterium mediated gene transfer.GM crops: Insect and herbicide resistance, Bt and non Bt genes. Molecular farming of proteins; Production systems and medically related proteins; edible vaccines, antibodies.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will have an enhanced **understanding**[2] and appreciation of plant biotechnology.	
CO2	Students should be able to gain knowledge of fundamental **experiments**[4]in plant biotechnology.	
CO3	They will be able to **describe**[1] the applications of plant biotechnology.	
CO4	They will **know**[1] the scope of plant biotechnology.	
CO5	Students are able to **summarize**[4] different aspects of plant biotechnology.	
Text Books: **References Books :**	● An Introduction to Plant Tissue Culture, M.K. Razdan, Oxford and IBH Publishing ● Experiments in Plant Tissue Culture, J.H. Dodds and L.K. Roberts, Cambridge University Press ● Plant Biotechnology and Transgenic Plants, K.M.O. Caldenty, W.H. Barz and H.L. Wills, Marcel Dekker	

	● Plant Biotechnology, J. Hammond, P. McGarvy and V. Yusibov, Springer Verlag. ● Plant Cell & Tissue Culture for the production of Food Ingredients, T-J Fu, G. Singh and W.R. Curtis, Kluwer Academic/Plenum Press ● Plant Tissue Culture: Theory & Practice, S.S. Bhojwani and M.K. Razdan, Elsevier Health Sciences	

COURSE CODE	**PLANT BIOTECHNOLOGY**	**Practical:30 hours**
SC23BT007P		**1**
	1. Sterilization of glasswares and equipments. 2. Preparation of cotton plugs and culture media. 3. Preparation of stocks for culture media. 4. Preparation of culture media. 5. Preparation and sterilization of different explants. 6. Inoculation of explants on culture media. 7. Study of viability of seeds. 8. Embryo culture.	

COURSE CODE	Industrial Biotechnology	Total Lec:45
SC23BT008	**3-0-2**	
Learning Objectives:	● The course will provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body. ● To learn to properly and safely use animals and modern laboratory equipment to conduct research. ● The course includes tissues, muscle, and nervous system. Primary literature to develop the ability to think critically about issues in animal physiology and write about those in an effective manner.	
Pre-requisites:	Elementary Biology, Elementary Chemistry.	HOURS
UNIT	**CONTENT**	
I	Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.	5
II	Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.	10
III	Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.	10
IV	Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.	10

V	Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	To explain the steps involved in the production of bio products and methods to improve modern biotechnology.	
CO2	To apply basic biotechnological principles, methods and models to solve biotechnological tasks.	
CO3	To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.	
CO4	To design and deliver useful modern biotechnology products to the Society.	
CO5	Recognize the concepts of industrial biotechnology	
Text & References:	• Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005. • Kumar, H.D. "A Textbook on Biotechnology" IInd Edition. Affiliated East West Press Pvt.Ltd., 1998. • Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004. • Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" IInd Edition Cambridge University Press, 2001. • Dubey, R.C. "A Textbook of Biotechnology" S.Chand& Co. Ltd., 2006.	
Reference Books:	• Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968. • Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005. • Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology",IInd Edition, Panima Publishing, 2000. • Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprintof Elsevier) 2004.	

COURSE CODE	**Industrial Biotechnology Lab**	**Practical:30 hours**
SC23BT008P		**1**
	1. Microbial production, detection and estimation of enzymes: Amylase /Protease/ Lipase 2. Microbial production, detection and estimation of amino acid: Glutamic acid 3. Microbial production, detection and estimation of organic acid: Citric acid 4. Microbial production, detection and estimation of alcohol: Ethanol 5. A visit to any educational institute/industry to see different parts of an industrial fermenter and downstream processing techniques.	

COURSE CODE	MOLECULAR BIOLOGY	Total Lec:45
SC23BT009		**3 – 0 – 2**
Learning Objectives:	● Understanding of the different types viruses. ● Gain knowledge of the structure and other salient characteristics of viruses. ● The course will describe at the molecular level the replication strategies of representative DNA and RNA viruses and the effects of virus infection on cell growth control and survival. ● The cognitive and methodological tools necessary to understand the pathogenesis of viral infections.	
Pre-requisites:	Elementary Biology, DNA, RNA	
UNIT	**CONTENT**	**HOURS**
I	Structures of DNA and RNA / Genetic Material, DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.	10
II	Replication of DNA (Prokaryotes and Eukaryotes) Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair	10
III	Transcription in Prokaryotes and Eukaryotes. Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors	10
IV	Post-Transcriptional Processing, Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, Regulation of gene Expression in Prokaryotes and Eukaryotes Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus,Yeast mating type switching.	08
V	Translation (Prokaryotes and Eukaryotes), Translational machinery, Charging of tRNA, aminoacyltRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote	07
Course Outcomes as per Bloom's Taxonomy		
CO1	They will **Understand**[2] cell structure and function. happing at molecular level.	

CO2	Students will understand the **relevance**[2] of events
CO3	They will know the scope of cell biology and **understand**[2] the flow of genetic information.
CO4	They will **know**[1] the scope of Biotechnology.
CO5	They will learn to apply knowledge gained to **design**[5] experiments to manipulate cellular and molecular processes.
Text Books:	• Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication • Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco • De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia • Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
Reference Books:	• Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press. • Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning • Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

COURSE CODE	MOLECULAR BIOLOGY (PRACTICAL)	Practical:30 hours
SC23BT009P		
	1. Study of different typves of DNA and RNA using micrographs and model /schematic representations 2. Study of semi-conservative replication of DNA through micrographs /schematic representations 3. Isolation of genomic DNA from E. coli 4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement) 5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement) 6. Resolution and visualization of DNA by Agarose Gel Electrophoresis. 7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE)	

COURSE CODE	VIROLOGY	Total Lec:60
SC23BT010		4 – 0 – 0
Learning Objectives:	● Understanding of the different types of viruses. ● Gain knowledge of the structure and other salient characteristics of viruses. ● The course will describe at the molecular level the replication strategies of representative DNA and RNA viruses and the effects of virus infection on cell growth control and survival. ● The cognitive and methodological tools necessary to understand the pathogenesis of viral infections.	
Pre-requisites:	Elementary Biology	
UNIT	**CONTENT**	**HOURS**
I	Viral taxonomy: Classification and nomenclature of different groups of viruses. Nature and properties of viruses: Introduction of viruses, concept of viroids, virusoids, satellite viruses, prions, giant viruses (mama and mimi virus), virophages (Sputnik). Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses.	15
II	Bacteriophages: Diversity, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins.	10
III	Viral transmission and salient features of viral nucleic acids: Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral nucleic acid: unusual bases (T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV).	15
IV	Viral replication, maturation and release: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses: phi X 174, HIV, Vaccinia, Picorna, Assembly with example of Polio virus and T4 phage, maturation and release of Virions.	10
V	Prevention and control of viral diseases: Antiviral compounds and their mode of action: AZT, aciclovir, ganciclovir. Interferons and their mode of action. General principles of viral vaccines: live attenuated vaccines, inactivated viral vaccine, subunit vaccine, recombinant viral vaccine.	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will **understand**[2] what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages)	
CO2	They will be able to **compare**[4] about the biology of bacteriophages with other organisms.	
CO3	They will be able to **illustrate**[4] the characteristics of plant viruses and animal viruses.	
CO4	They will gain ability to **describe**[4] role of viruses in the causation of the cancer.	
CO5	They will **know**[1] the scope of mammalian physiology.	
Text Books:	● M Pelczar, E.C.S. Chan and N.R. Krieg, Microbiology, 2001, Tata Mc Grew Hill Publishing Co. Ltd., New Delhi. ● R.V Stainier, J.L Ingraham, The Microbial World, 2010, Printice-Hall of India (Pvt.) Ltd., New Delhi 3 ● J. Kenneth, Medical microbiology, Sherri's an introduction to infectious diseases. 2016, Mc. Graw Hill.	
Reference Books:	● NJ Dimmock, AL Easton, KN Leppard, Introduction to Modern Virology. 6th edition, 2007, Blackwell Publishing Ltd. ● J Carter and V Saunders, Virology: Principles and Applications, 2007, John Wiley and Sons. ● SJ Flint, LW Enquist, RM Krug, VR Racaniello, AM Skalka, 2004, Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition, ASM presses Washington DC. ● JA Levy, HF Conrat, RA Owens, Virology. 3rd edition, 2000, Prentice Hall publication, New Jersey.	

COURSE CODE	RECOMBINANT DNA TECHNOLOGY	Total Lec: 45
SC23BT011		**3 – 0 – 2**
Learning Objectives:	● To familiarize the student with emerging field of biotechnology i.e. Recombinant DNA Technology ● Create understanding and expertise in wet lab techniques in genetic engineering. ● Briefing the methods and tools associated with recombinant DNA technology.	
Pre-requisites:	Elementary Biology	
UNIT	**CONTENT**	**HOURS**
I	Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase, Gene Recombination and Gene transfer, Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.	10
II	Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription. Genome mapping, DNA fingerprinting.	10
III	Applications of Genetic Engineering, Genetic engineering in animals, Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines.	10
IV	Random and site-directed mutagenesis, Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples.	07
V	Genetic engineering in plants, Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.	08
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to**understat**[2]the development of rDNA technology.	
CO2	They will be able to**know**[1] the scope of rDNA technology.	
CO3	They will be able to**relevance**[2] of historical events and major discoveries in Bioinformatics.	
CO4	They will be able to**experiment**[3]withtools and techniques in rDNA technology- DNA manipulative enzymes.	
CO5	They will be able to**articulate**[3]application of Recombinant DNA techniques in Life Sciences Research.	
Text Books:	● T.A Brown, Gene Cloning and DNA Analysis. 5th edition, 2006, Blackwell Publishing, Oxford, U.K. ● DP Clark and NJ Pazdernik, Biotechnology-Applying the Genetic Revolution, 2009, Elsevier Academic Press, USA. ● B.R Glick, J.J Pasternak, Molecular Biotechnology- Principles and Applications of recombinant DNA, 2003, ASM Press, Washington.	
Reference Books:	● SB Primrose and RM Twyman, Principles of Gene Manipulation and Genomics, 7th edition, 2006, Blackwell Publishing, Oxford, U.K. ● J Sambrook, EF Fritsch and T. Maniatis, Molecular Cloning-A Laboratory Manual. 3rd edition, 2001, Cold Spring HarborLaboratoryPress.	

COURSE CODE	RECOMBINANT DNA TECHNOLOGY LAB	Practical:30 hours
SC23BT011P		**1**
	1. Isolation of chromosomal DNA from plant cells. 2. Isolation of chromosomal DNA from E.coli 3. Qualitative and quantitative analysis of DNA using spectrophotometer. 4. Plasmid DNA isolation. 5. Restriction digestion of DNA. 6. Making competent cells. 7. Transformation of competent cells. 8. Demonstration of PCR.	

COURSE CODE	Animal Biotechnology	Total Lec: 60
SC23BT012		4 – 0 – 0
Learning Objectives:	● The course will provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body. ● To learn to properly and safely use animals and modern laboratory equipment to conduct research. ● The course includes tissues, muscle, and nervous system. Primary literature to develop the ability to think critically about issues in animal physiology and write about those in an effective manner.	
Pre-requisites:	Elementary Biology, Elementary Zoology.	
UNIT	**CONTENT**	**HOURS**
I	Animal tissue culture requirements and methods: Introduction, Types of culture- Organ culture, cell culture, organotypic culture, histotypic culture. Design and layout of animal tissue culture laboratory, maintenance of sterile condition Equipments – Essential, beneficial and useful equipments, consumable items.	15
II	Culture medium- Physico-chemical properties, complete media, serum, serum free media, balanced salt solutions, selection of medium and serum. Preparation and sterilization – Apparatus, Reagents and media, storage Contamination- Source and types of contamination	10
III	Primary culture- Types (Primary explant and primary cell cultures). Primary explant culture method (mouse/chick embryo tissues). Primary cell culture method- disaggregation (enzymatic, mechanical) and culturing. Lymphocyte culture method (Suspension culture)	10
IV	Cell-lines, Organ culture, large scale cultures and applications of animal tissue culture: Cell lines: Definition, Evolution of cell lines, continuous cell lines, cell line designation, maintenance, subculture, maintenance records. Cell line banking, cryopreservation, cell viability assays	10
V	Organ culture - Methods, Raft and grid methods, Watch glass technique, Maximow single slide technique, agar gel technique, histotypic culture ; Gel and sponge technique, hollow fibres, spheroids Large scale cultures – Fermentor design, scaleup in suspension and monolayer. Downstream processing. Commercial application of animal tissue culture – Uses of animal cells in vaccine production	15
Course Outcomes as per Bloom's Taxonomy		
CO1	They will **Understand**[2] scope of mammalian physiology.	
CO2	Students will be able to **summarize** major components of mammalian physiology.	
CO3	Students are able to **describe**[1] the role and functions of different biomolecules	
CO4	They will be able to **analyse**[4] the functions of important physiological systems	
CO5	Students are able to **compare**[4]different functions of mammalian body	
Text Books:	● H.R Singh, Text Book of Animal Physiology and Biochemistry, 2017, Vishal Publishing Co. ● Nagabhushanam, Comparative Animal Physiology, 2008, Oxford &Ibh. ● Veer Bal Rastogi, Text Book of Animal Physiology, 2019, New age international.	
Reference Books:	● G.J Tortora & S. Grabowski, Principles of Anatomy & Physiology, 2006, XI Edition, John Wiley & sons ● P. Victor, Atlas of Histology with Functional correlations. XII Edition, 2008, Lippincott W. & Wilkins.	

Syllabus

SEMESTER I

COURSE CODE	Analytical and Organic Chemistry - I	Total Lec 45
SC23CH001		3-0-2
Learning Objectives:	After studying this course the students will know – ● Prepare graduates with the skills of sampling with accuracy and who will be able to evaluate the data analytically. ● To produce graduates whose basic concepts are clear in different methods of analytical chemistry. ● Prepare graduates with the skills to critically assess and solve problems requiring the application of chemical principles. ● To produce graduates whose basic concepts are clear in both organic chemistry.	
Pre- requisite:	Elementary chemistry (10+2)	
UNIT	CONTENT	HOURS
I	Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	8
II	Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer- Lambert's law. UV-Visible spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument. Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers,determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques,structural illustration through interpretation of data, effect and importance of isotope substitution. Flame atomic absorption and emission spectrometry:Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs,techniques of atomization and sample introduction; method of background correction, sources of chemical interferences and their method of removal,techniques for the quantitative estimation of trace level of metal ions from water samples.	12
III	Fundamentals of organic chemistry: Physical effects, electronic displacements: inductive effect, electromeric effect, resonance and hyperconjugation, cleavage of bonds: homolysis and heterolysis, structure, shape and reactivity of organic molecules: nucleophiles and electrophiles, reactive intermediates: carbocations, carbanions and free radicals, strength of organic acids and bases: comparative study with emphasis on factors affecting pk values.	9
IV	Stereochemistry: Conformations with respect to ethane, butane and cyclohexane, interconversion of wedge formula, Newmann, sawhorse and Fischer repretentations, concept of chirality (up to two carbon atoms) and configuration: geometrical and optical isomerism (enantiomerism, diastereomerism and meso compounds), threo and erythro; D and L; *cis – trans* nomenclature; CIP rules: R/S (for upto 2 chiral carbon atoms) and E/Z nomenclature (for up to two C=C systems).	8

V	Aliphatic hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure, alkanes: (up to 5 Carbons) preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent, reactions: free radical substitution: halogenations, alkenes: (up to 5 Carbons), preparation: elimination reactions: dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule), *cis* alkenes (partial catalytic hydrogenation) and *trans* alkenes (Birch reduction), reactions: *cis* addition (alk. $KMnO_4$) and *trans* addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, ozonolysis, oxymecuration-demercuration, hydroboration-oxidation, alkynes: (up to 5 Carbons), preparation: acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetra halides and dehydrohalogenation of vicinal- dihalides, reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	8
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will gain a firm knowledge in and **understanding** in analytical data with errors, accuracy and precision.	
CO2	They will be able to **evaluate**[5] several optical methods of analysis.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	
Text Books:	● SM Khopkar, Basic Concepts of Analytical Chemistry, 2009, New Age, International Publisher. ● D Gary, Analytical Chemistry, 6th Ed., Christian, 2004, John Wiley & Sons, New York. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models in InorganicChemistry, John Wiley and Sons Publications. ● E L Eliel, Stereochemistry of Carbon Compounds, 2017, Cyber Tech Publications. ● I L Finar,OrganicChemistry(Vol. I & II), E L B S.	
Reference Books:	● S. Hook, P. Kurtz, M. Todorovich, The Ethics of Teaching and Scientific Research, Prometheus Books, 1977. ● B. Stanley, J.E. Sieber, G. B. Nelton, Research Ethics: A Psychological Approach, University of Nebraska Press, 1996.	

COURSE CODE	Analytical and Organic Chemistry – I (Practical)
SC23CH001P	**2**
	Section A: Analytical Chemistry 1. Calibration of glassware, pipette, burette and volumetric flask. 2. Determination of sodium carbonate and sodium bicarbonate in a mixture by titrimetry. 3. Estimation of total hardness of a given sample of water by complexometric titration. 4. Determination of alkali present in soaps/detergents. 5. Determination of Fe^{2+} in Fe_2O_3. **Section B**: Organic Chemistry 1. Preparation of Benzamide 2. Preparation of Benzophenone Oxime 3. Purification of organic compounds by crystallization (from water and alcohol) distillation. 4. Hydrolysis of methyl salicylate. 5. Preparation of dibenzyledineacetone.

Syllabus

SEMESTER II

COURSE CODE	Inorganic and Physical Chemistry - I	Total Lec.: 45
SC23CH002		3-0-2
Learning Objectives:	After studying this course the students will know – ● Prepare graduates with the skills to critically assess and solve problems requiring theapplication of chemical principles. ● To produce graduates whose basic concepts are clear in fundamental inorganic chemistry. ● To produce graduates who will have clear understanding about concepts of physical chemistry like states of matter and chemical kinetics	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	CONTENT	HOURS
I	Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg uncertainty principle. hydrogen atom spectra, need of a new approach to atomic structure, quantum mechanics, time independent Schrodinger equation and meaning of various terms in it, significance of ψ and ψ^2, Schrödinger equation for hydrogen atom, radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (only graphical representation), radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals, significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s, shapes of s, p and d atomic orbitals, nodal planes, discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s), rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.	10
II	Chemical Bonding and Molecular Structure: Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculationof lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, concept of resonance and resonating structures in various inorganic and organic compounds. MO approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+, comparison of VBT and MOT.	10
III	Kinetic Theory of Gases: Postulates of kinetic theory of gases and derivation of the kinetic gas equation, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases, Boyle temperature (derivation not required), critical phenomena, critical constants and their calculation from van der Waals equation.	8

IV	Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effectof temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). Solids: Forms of solids, symmetry elements, unit cells, crystal systems, Bravais latticetypes and identification of lattice planes, laws of crystallography - law of constancy of interfacial angles, law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law, structures of NaCl, KCl and CsCl (qualitative treatment only),defects in crystals glasses and liquid crystals.	9
V	Chemical Kinetics: The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates, order and molecularity of a reaction, derivation of integratedrate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants),half–life of a reaction, general methods for determination of order of a reaction	8
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **define**[1] about the structure of atoms.	
CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of bonding for both ionic and covalent compounds.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	
Text Books:	● R L Madan, Chemistry for Degree Students (Semester I), 2016 S Chand PublishingHouse; First edition. ● R Sarkar, General and Inorganic Chemistry (Vol I), 2011, New Central Book Agency, 3rd Ed. ● P. Atkins and J. De Paul, 8th Edition, 2006, International Student Edition, Oxford UniversityPress. ● B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition,1998, Shoban Lal Nagin Chand & Co., Jalandhar.	
Referenc e Books:	● J E Huheey, E A Keiter, R L Keiter and O K Medhi, Inorganic Chemistry: Principlesof Structure and Reactivity, 2006 Pearson Education India. ● J D Lee, A new Concise Inorganic Chemistry, 5th Ed, 2016 Wiley Publication. ● F A Cotton, G Wilkinson, and P L Gaus, Basic Inorganic Chemistry, 3rd ed. WileyPublication. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models inInorganic Chemistry, John Wiley and Sons Publications. ● K. J. Laidler and J. M. Meiser, Physical Chemistry, 1999, 3rd Edition, Houghton Mifflin Comp.,New York, International Edition.	

COURSE CODE	Inorganic and Physical Chemistry – I (Practical)
SC23CH002P	2
	Section A: Inorganic Chemistry 1. Determination of carbonate and hydroxide present in amixture. 2. Determination of oxalic acid and sodium oxalate in a mixture by titrating it with standard $KMnO_4$/NaOH solution. 3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$. 4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 5. Soil Analysis-Determination of pH of soil. **Section B**: Physical Chemistry 1. Determination of density using specific gravity bottle 2. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non- hazardous liquids) 3. Study of the variation of viscosity of sucrose solution with the concentration of a solute. 4. Determination of the surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids) 5. Study of variation of surface tension of detergent solution with concentration.

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SEMESTER III

COURSE CODE	Analytical and Organic Chemistry - II	Total Lec.: 45
SC23CH003		3-0-2
Learning Objectives:	After studying this course the students will know – ● Prepare graduates with the skills of sampling with accuracy and who will be able to evaluate the data analytically. ● Prepare graduates with the skills to critically assess and solve problems requiring the application of chemical principles. ● To produce graduates whose basic concepts are clear in organic chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation, Techniques for quantitative estimation of Ca and Mg from their mixture.	12
II	Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations, techniques used for the determination of equivalence points, techniques used for the determination of pKa values.	12
III	Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of enantiomeric excess (ee)/diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents, chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.	12
IV	Aromaticity: Aromaticity and Huckel rule - A general concept, molecular orbital picture of benzene, aromatic electrophilic substitution, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts (alkylation and acylation).	12
V	Chemistry of Carbonyl compounds: Preparations and reactions: addition and condensation reactions; Cannizzaro, Perkin, aldol, benzoin, haloform,Phenols: General methods of preparation and reactions, Reimer-Tiemannand Kolbe reactions, relative acidity of phenol, alcohol and carboxylic acid. Nitrogen Containing compounds: Nitrobenzene and reduction products, Comparative basicity of aliphatic and aromatic amines, Diazonium Salts: Preparation and synthetic applications.	12

Course Outcomes as per Bloom's Taxonomy	
CO1	They will acquire an **understanding[2]** about thermal methods of analysis.
CO2	They will be able to **evaluate[5]** several separation techniques of analysis.
CO3	They will acquire an **understanding[2]** about electroanalytical method
CO4	Students will be able to **understand[2]** basic concept of aromaticity.
CO5	They will be able to **explain[2]** the chemistry of carbonyl compounds.
Text Books:	● SM Khopkar, Basic Concepts of Analytical Chemistry, 2009, New Age, International Publisher. ● D Gary, Analytical Chemistry, 6th Ed., Christian, 2004, John Wiley & Sons, New York. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models in InorganicChemistry, John Wiley and Sons Publications. ● E L Eliel, Stereochemistry of Carbon Compounds, 2017,Cyber Tech Publications. ● I L Finar,OrganicChemistry(Vol. I & II), E L B S.
Reference Books:	● H H Willard, et al., Instrumental Methods of Analysis, 7th Ed. 1988, Wardsworth Publishing Company, Belmont, California, USA. ● A I Vogel, A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery andothers), 5th Ed. 1989, The English Language Book Society of Longman ● R T Morrison and R N Boyd,Organic Chemistry, Prentice Hall. ● T W Graham Solomon,Organic Chemistry, John Wiley and Sons. ● P Sykes,A Guide Book to Mechanism in Organic Chemistry, Orient Longman. A Bahl and B S Bahl, Advanced Organic Chemistry,2012, S Chand Publishing House.

COURSE CODE	Analytical and Organic Chemistry – II (Practical)
SC23LM003P	1
	Section A: Analytical Chemistry 1. Identification and separation of the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography. Measure the Rf value in each case. 2. Identify and separate the sugars present in the given mixture by paper chromatography. 3. Paper chromatographic separation of Fe^{3+}, Co^{2+} and Cu^{2+}. 4. Determination of the Exchange Capacity of a Cation Ion Exchange Resin. **Section B**: Organic Chemistry 1. Aldol condensation reaction between benzaldehyde and acetone. 2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method). 3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture. 4. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method). 5. Synthesis of diazoaminobenzene from aniline (conventional method). 6. Preparation of dibenzalacetone (Green method).

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SEMESTER IV

COURSE CODE	Inorganic and Physical Chemistry - II	Total Lec.: 45
SC23CH004		3-0-2
Learning Objectives:	After studying this course the students will know – ● To produce graduates whose basic concepts are clear in fundamental inorganic chemistry. ● To produce graduates who will have clear understanding about concepts of physical chemistry like states of matter and chemical kinetics and also about the coordination chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Transition Elements (3d series):General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.	9
II	Coordination Chemistry: Valence Bond Theory (VBT): inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6),structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT, IUPAC system of nomenclature. Crystal Field Theory: crystal field effect, octahedral symmetry, crystal field stabilization energy (CFSE), crystal field effects for weak and strong fields. tetrahedral symmetry, f Factors affecting the magnitude of D,spectrochemical series, comparison of CFSE for Oh and Td complexes,	9
III	Phase Equilibria: Thermodynamics of phase transition-Clapeyron-Clausius equation and its applications, phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one- component system (water), two component systems (phenol-water, lead-silver), equilibrium constant from distribution coefficient ($KI + I_2 = KI_3$).	9
IV	Chemical Equilibrium: Free energy change in a chemical reaction, thermodynamic derivation of the law of chemical equilibrium, distinction between ΔG and ΔG^o, Le Chatelier's principle, relationship between *Kp, Kc & Kx* for reactions involving ideal gases.	9
V	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, buffer solutions, solubility and solubility product of sparingly soluble salts – applications.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **define**[1] about the structure of atoms.	
CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of bonding for both ionic and covalent compounds.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	

Text Books:	● R L Madan, Chemistry for Degree Students (Semester I), 2016 S Chand PublishingHouse; First edition. ● R Sarkar, General and Inorganic Chemistry (Vol I), 2011, New Central Book Agency,3rd Ed. ● P. Atkins and J. De Paul, 8th Edition, 2006, International Student Edition, Oxford UniversityPress. 2. ● B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition,1998, Shoban Lal Nagin Chand & Co., Jalandhar.
Referenc e Books:	● J E Huheey, E A Keiter, R L Keiter and O K Medhi, Inorganic Chemistry: Principlesof Structure and Reactivity, 2006 Pearson Education India. ● J D Lee, A new Concise Inorganic Chemistry, 5th Ed, 2016 Wiley Publication. ● F A Cotton, G Wilkinson, and P L Gaus, Basic Inorganic Chemistry, 3rd ed. WileyPublication. ● B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models inInorganic Chemistry, John Wiley and Sons Publications. ● K. J. Laidler and J. M. Meiser, Physical Chemistry, 1999, 3rd Edition, Houghton Mifflin Comp.,New York, International Edition.

COURSE CODE	Inorganic and Physical Chemistry – II (Practical)
SC23CH004P	2
	Section A: Inorganic Chemistry 1. Determination of Acid-neutralizing power of a Commercial Antacid. 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA. 3. Determination of concentration of Potassium Permanganate solution using Ferrous Ammonium sulphate. 4. Determination of chlorine in bleaching powder using iodometric method. 5. Preparation of potash alum. **Section B**: Physical Chemistry 1. Saponification of ethyl acetate. 2. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate. 3. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (using dilute solutions of soaps and shampoos to preventdamage to the glass electrode) using pH-meter. 4. Preparation of buffer solution of sodium acetate-acetic acid and ammonium chloride-ammonium hydroxide. 5. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

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SEMESTER V

COURSE CODE	BIOLOGICAL CHEMISTRY	Total Lec: 60
SC23CH005		4-0-0
Learning Objectives	● Prepare students with the knowledge of enzymes, coenzymes and their mechanism. ● To produce students whose concepts are clear in nuclic acids and bio-synthesis	
Pre-requisite	None.	
UNIT	CONTENT	HOURS
I	Enzymes, co-enzymes and their mechanism of action: enzymes, classification, inhibition, mechanism of action of chymotrypsin, aldolase, alcohol, lysozyme, cofactors as derived from vitamins, co-enzymes, prosthetic, prosthetic group and apoenzymes.	12
II	Structure and biological functions of coenzyme-A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FAD, lipoic acid, mechanisms of reactions catalyzed by the above cofactors.	12
III	Nucleic Acids: Retro-synthetic analysis of Nucleic Acids - nucleotides, nucleosides, nucleobases (A, T, G, C and U), sugars (Ribose and deoxyribose), assembly of oligonucleotide chain: synthesis of polymer support, nucleosides and nucleotides, solid phase synthesis of oligo-nucleotides (DNA/RNA) through phosphoramidite and phosphorothionate approach.	12
IV	Application of protecting groups (-NH_2 and –OH functions, Base and Acid labile) and their deprotection and purification, concept of depurination.	12
V	Bio-synthesis: Terpenoids - C5, C10, C15, C20 units; alkaloids - quinine and morpholine.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand**[2] themechanism and action of enzymes and co-enzymes.	
CO2	They will be able to **illustrate**[2]structure and biological function of some enzymes.	
CO3	Students will **understand**[2] the details of nucleic acid.	
CO4	They will **learn**[2] the application of protecting groups.	
CO5	They will **develop**[3] the knowledge ofbio-synthesis.	
Text Books:	● A L Lehninger, **Principles of Biochemistry**, 1992CBS Publishers, Delhi. ● DVoet, J G Voet & CW Pratt, **Fundamentals of Biochemistry**, 1999 John Wiley & Sons, New York. ● H R Mahler and E H Cordes, **Biological Chemistry**, 1971, 2nd Edition, Harper and Row Pub., New York	
Reference Books:	● C Walsh, **Enzymatic Reaction Mechanisms**(1979), W.H. Freeman & Co., New York. ● I L Finar, **Organic Synthesis**, 1975, 5th edition. Vol.2, Longman Press, USA.	

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SEMESTER V

COURSE CODE	APPLIED CHEMISTRY	Total Lec.: 60
SC23CH006		4-0-0
Learning Objectives :	● Prepare students with the in-depth understanding of industrial chemistry ● To gain the knowledge in applied chemistry.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Soaps and Detergents: Theory of surface action, soap manufacture: raw materials, characteristics of cold process, semi boiled process and boiled process, additives of soap, detergent action of soap, influence of fatty acid composition of the oil on properties of soap, manufacture of soap for different purposes-laundry soaps, toilet soaps, liquid soaps, transparent soaps, baby soaps, shaving soaps, medicated soaps, textile soaps, naphtha soaps, marine soaps. T.F.M value of soaps, shampoos	12
II	Paints and Varnishes: Paints as protective coatings, paints and enamels, materials for paint manufacture, oils used-unmodified oils and their pre-treatment, modified drying oils, resins and copolymers, natural resins, phenolic resins, alkyd resins, urethane resins, epoxy resins - Driers, thinners, pigments and miscellaneous ingredients, mechanism of polymerization and drying of oils; varnishes and lacquers: composition and uses, oleo resinous varnishes, defects in varnish films.	12
III	Flavour and Perfume Chemistry: Concept of flavor, difference between perfumes and flavour, flavour characterisation, sensory analysis-descriptive and discriminant sensory analysis, flavour of coffee, tea, cocoa, onion and garlic, synthetic ingredients of food flavourings, odour, odorants, olfaction, classification of odour, general physiology of olfaction, perfume raw materials - terpeneless and sesquiterpeneless oils, concrete oils, absolute oils, isolates from essential oils, tincture, balsams and resins, source and c hemical nature of commercially important gums (gum Arabic, gum tragacanth, karaya gum, British gum, gum myrrh), balsams (balsam of Peru, balsam of Tolu, styrax) and resins.	12
IV	Dairy Chemistry: Milk definition, general composition of milk, constituents of milk - lipids, proteins, carbohydrates, vitamins and minerals, physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity. Factors affecting the composition of milk: Adulterants, preservatives and neutraliser, examples and their detection, estimation of fat, acidity and total solids in milk. Processing of Milk: Destruction of microorganisms in milk, physicochemical changes taking place in milk due to processing - boiling, pasteurisation, types of pasteurisations - bottle, batch and HTST (High Temperature Short Time) - vacuum pasteurisation - Ultra High Temperature Pasteurisation. Milk products: Cream, definition, composition, chemistry of creaming process, gravitational and centrifugal methods of separation of cream, estimation of fat in cream, butter: definition, composition, theory of churning, estimation of acidity and moisture content in butter, ghee: major constituents, common adulterants added to ghee and their detection.	12
V	Basic principles of Nanochemistry: Brownian motion, surface forces, self-assembly, general methods of synthesis of nanomaterials: Top-down production, bottom-up production, types of nanomaterials, carbon nanotubes, fullerenes, quantum dots, nanowires, nanocones, haeckelites, graphenes and metal nanoparticles.	12

	Applications of nanomaterials in medicine: Immunogold labelling, applications in medical diagnosis, nano based drug delivery, biomimetic nanotechnology, DNA nanotechnology	
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will **understand**[2] the preparation and properties of soaps and detergents.	
CO2	They will be able to **demonstrate**[2] kinetics and mechanism of polymerisation.	
CO3	They will be able to **explain**[3] the applications of polymers.	
CO4	They will be able to **develop**[3] the procedure of characterization of polymers.	
CO5	They will be able to **analyse**[4] the morphology and applications of polymers	
Text Books:	● B. Somdavi: Applied Chemistry, MJP Publications, 2006. ● N. Groom, The Perfume Handbook, Chapman and Hall, 1992. ● D. J. Rowe, The chemistry of flavours and fragrances, Blackwell publishing ltd., 2005. ● B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut, 2011.	
Reference Books:	● C.N.R. Rao, Muller and A. K. Cheetham, Chemistry of Nanomaterials, Vol. I & II, Wiley VCH Verlag GmbH KGaA, 2002.	

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SEMESTER

VI

COURSE CODE	MATERIALS CHEMISTRY	Total Lec.: 60
SC23CH007		**4-0-0**
Learning Objectives	● Prepare students with the concept of materials chemistry ● To produce students with knowledge of various inorganic and organic materials.	
Pre-requisite	None.	
UNIT	**CONTENT**	**HOURS**
I	Introduction: Materials and their classification, inorganic and organic materials.	8
II	Inorganic materials: Design and synthesis of inorganic materials, requirements and constraints, combination properties of composites, functional materials, active materials; solid state reactions for synthesis of inorganic materials: ceramic methods, precursor method and sol-gel synthesis, physical and chemical vapour depositions;	14
III	Properties of inorganic materials: carbides, nitrides, structural and functional ceramics, intermetallics; intrinsic and extrinsic properties: electrical, optical and magnetic properties; ceramic superconductors, magnetic ceramics.	12
IV	Molecular electronics: molecular materials for electronics and molecular scale electronics: Molecular properties, molecular arrangement and molecular interactions, piezoelectric and pyroelectric organic materials; molecular magnets based on transition metal complexes and organic ferromagnets.	14
V	Organic non-linear optical materials: photochromic organic materials and their classes; conducting polymers: polyacetylene, polypyrrole, polyaniline and polythiophene; conductive change transfer materials: TTFTCNQ, metal–dithiolate systems, fullerenes.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand**[2] the concept of material chemistry	
CO2	They will be able to **illustrate**[2] techniques for synthesis of inorganic materials.	
CO3	Students will **understand**[2] the properties of inorganic materials.	
CO4	They will learn to **apply**[3] the knowledge of molecular material wherever required.	
CO5	They will **develop**[3] the knowledge of properties of organic materials.	
Text Books:	● E. Sambandan, Short Notes on Applied and Advanced Inorganic Materials Chemistry, 2006, iUniverse. ● C. N. R. Rao, K Biswas, Essentials of Inorganic Materials Synthesis, 2015, Wiley Pulication. ● D. Sangeeta, J R. LaGraff, Inorganic Materials Chemistry Desk Reference, 2nd Edition, 2005, CRC Press. ● P. J. Vander Put, Inorganic Chemistry of Materials, 1998, Plenum Press, New York.	
Reference Books:	● M.C. Petty, M.R. Bryce and D. Bloor, An Introduction to Molecular Electronics, 1995, Edward Arnold, London. ● U. S. Schubert, N. Hüsing, Synthesis of Inorganic Materials, 4th Edition, 2019, Wiley Publication.	

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SEMESTER

VI

COURSE CODE	TOXICOLOGY	Total Lec.: 60
SC23CH008		4-0-0
Learning Objectives :	● Prepare students with the in-depth understanding of polymer chemistry ● To gain the knowledge in the preparation, properties, characterization and applications of polymers.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Food Toxicology: Introduction, Food Toxicology, Toxicology of food additives, legal and regulatory aspects	12
II	Cosmetic Toxicology: Introduction, potential exposures, toxicity of shampoos and conditioners, permanent wave treatment, colorants, bleachers and sprays, cutaneous diseases, respiratory diseases, regulatory aspects	12
III	Medical Toxicology: Introduction, Mission of medical toxicology, Nomenclature, Toxicological fact sheets and databases, Human risk assessment, ecotoxicology, conclusion	12
IV	Wildlife Toxicology: Introduction, environmental and ecological toxicology, Wildlife susceptibity to poisons, Comparative toxicology, Integrated problem saving	12
V	Pestiside Toxicology: Introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will **understand**[2] the preparation and properties of polymers.	
CO2	They will be able to **demonstrate**[2] kinetics and mechanism of polymerisation.	
CO3	They will be able to **explain**[3] the applications of polymers.	
CO4	They will be able to **develop**[3] the procedure of characterization of polymers.	
CO5	They will be able to **analyse**[4] the morphology and applications of polymers	
Text Books:	● F. W. Bill Meyer, Text book of polymer science, III Edition, John Wiley and sons, New York. ● Curtis Klaassen, Toxicology: The Basic Science of Poisons, 9th Edition, Mc Grow Hill Education ● A. Wallace Hayes, Claire L. Kruger, Hayes' Principles and Methods of Toxicology, 6th Edition, CRC Press ● Ali S. Faqi, A Comprehensive Guide to Toxicology in Nonclinical Drug Development, 2nd Edition ● Raktim Pal, Effect of Pesticide on Soil Microbial Properties Paperback, 2008	
Reference Books:	● Esther Haugabrooks and A. Hayes, History of Food and Nutrition Toxicology, 1st Edition 2023. ● Personal Care Products and Human Health, 1st Edition, Philippa Darbre, 2023 ● Ronald J. Kendall, Thomas E. Lacher, George C. Cobb, Stephen Boyd Cox Wildlife Toxicology: Emerging Contaminant and Biodiversity Issues, 2016, CRC Press.	

Syllabus

SEMESTER VIII

COURSE CODE	Analytical Chemistry-III	Total Lec.: 45
SC23CH009		3-0-2
Learning Objectives :	● Prepare students with the in-depth understanding of analytical chemistry ● To gain the knowledge in the preparation, properties, characterization and applications of polymers.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Introduction: Scope & objectives, analytical chemistry and chemical analysis, classification of analytical methods, sample selection, sample processing, steps in a quantitative analysis, quantitative range (bispartite classification), data organisation, analytical validations, errors, type of errors, gross errors and their sources, the tools of analytical chemistry and good lab practices.	9
II	Calculations used in Chemistry: Chemical stoichiometry, molarity, molality, etc. Preparing samples for analysis: primary, secondary standard etc., classical methods of analysis: gravimetric, volumetric, titrimetric, potentiometric methods.	9
III	Analytical Chemometrics: Propagation of measurement uncertainties (accuracy and precision), mean, mode, median, range, standard deviation, useful statistical test: the F test, the student 'T' test, the 'Chi' test, 'Q' test the correlation coefficient, significant figures, regression analysis (least square method for linear and non-linear plots),	9
IV	Automation in the Laboratory: Principles of automation, process control through automated instruments, autoanalyzers (single channel and multi-channel),basic sequences of multi-fold operational analyzers in segmented and non-segmented flows.	9
V	Polarography: Origin of polargraphy, Current-voltage relationship, Theory of polarographic waves (DC and sampled DC (tast) polarograms), Instrumentation, Ilkovic equation, qualitative and quantitative applications.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will **understand**[2]nuclear chemistry and radioactive equilibrium.	
CO2	They will be able to **define**[1]learn the separation techniques.	
CO3	They will **build**[3] knowledge of thermal methods.	
CO4	They will **understand**[2]theprinciple of polarography.	
CO5	They will be able to **demonstrate**[2] polarographic methods.	
Text Books:	● S M Khopkar, Basic Concepts of Analytical Chemistry, 3rd Ed, 2008 New Age International Publishers. ● J. A. Dean, Analytical Chemistry Notebook, 2nd Edition 2004, McGraw Hill. ● R. M. Berma, Analytical Chemistry Theory and Practice, 3rd Edition, 2019, CBS Pulication. ● G. D. Christian, Analytical Chemistry, 6th Edition, 2007, Wiley pulication. ● P. Malhotra, Analytical Chemistry - Basic Concepts, 2016, Anne Book Publishers.	
Reference Books:	● D A Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 2000, 7th Edition, Saunders College Publishing, Philadelphia, London. ● J H Kennedy, Analytical Chemistry: Principles, 1990, 2nd Edition, Saunders Holt, London.	

COURSE CODE	Analytical Chemistry – III (Practical)
SC23CH009P	**2**
	1. Separation of Co^{2+} & Ni^{2+} by Ion Exchange chromatography. 2. Separation of Ni^{2+} & Fe^{3+} by Ion Exchange chromatography. 3. Separation of Zn^{2+} & Mg^{2+} by Ion Exchange chromatography. 4. To determine the amount of Iron/Calcium in milk powder. 5. Detection of Caffeine in commercial products (Tablet) by TLC. 6. Separation of blue or black Ink/ chlorinated insecticides by paper chromatography. 7. To determine Iodine value of an oil. (Coconut oil, Castor oil, Soybean Oil, Cotton seed oil, etc) 8. To determined % purity of the given sample of Aspirin. 9. Separation of mixture of drugs by TLC & column chromatography 10. To determine the acidity of lubricating oil sample.

Syllabus

SEMESTER VIII

COURSE CODE	ORGANIC CHEMISTRY III	Total Lec.: 45
SC23CH0010		3-0-2
Learning Objectives	● Prepare students with the in-depth knowledge of organometallic chemistry. ● To produce students with increased familiarity with modern research topics in organometallic chemistry	
Pre-requisite	Organic chemistry reaction mechanism.	
UNIT	CONTENT	HOURS
I	Conformation and reactivity of acyclic and cyclic systems: Acyclic compounds, the Felkin-Anh model, the Hawk model and Sharpless asymmetric epoxidation; cyclic compounds: monocyclic (3- to 8-membered rings) and bicyclic compounds (bridged, fused and spiro).	9
II	Basic of Photochemistry: Photochemical laws, quantum yield, electronically excited states- life times-measurements of the times, flash photolysis, stopped flow techniques, energy dissipation by radiative and non-radiative processes, absorption spectra, photochemical stages - primary and secondary processes, photochemistry of aromatic compounds, isomerisation, additions and substitutions,	9
III	Nucleophilic Substitution at Saturated Carbon: Mechanism and stereochemistry of S_N1, S_N2, S_Ni reactions, reactivity: the effect of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambient nucleophiles: regioselectivity, competition between S_N1 and S_N2 mechanisms. Neighbouring Group Participation: evidences of N.G.P.; the phenonium ion, participation by pi and σ bonds, anchimeric assistance, classical versus non-classical carbonium ions – the present status.	12
IV	E1 mechanism, E2 mechanism, E1 vs E2 mechanism, aromatic electrophilic substitution reaction mechanism, aromatic nucleophilic substitution reaction mechanism, nucleophilic addition mechanism, electrophilic addition mechanism, free radical addition mechanism, rearrangements	6
V	Pericyclic Reactions: Conservation of orbital symmetry, Woodward-Hoffmann rules, frontier molecular orbital (FMO) theory, orbital overlap effects in cycloadditions, electrocyclizations, sigmatropic rearrangements and chelotropic reactions, Paterno-Buchi, Norrish type I and II reactions.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will have an advanced **understanding**[2] of conformation and reactivity of cyclic and acyclic systems.	
CO2	They will be able to **apply**[3] their knowledge of reaction intermediates.	
CO3	They will **understand**[2]thestructure-reactivity relationship.	
CO4	They will **build**[3] the in-depth knowledge of polymerization.	
CO5	They will be able to **analyze**[4]enantioselective reaction and their applications.	

Text Books:	● A Bahl, B S Bahl, Advanced Organic Chemistry: Reactions and Mechanism, 2012, 2nd Edition, S. Chand Publishing. ● M B Smith & J March, March's Advanced Organic Chemistry, 2001, 5th Edition, John Wiley & Sons, New York. ● Clayden, Greeves, Warren and Wothers, Organic Chemistry, 2001, Oxford University Press.

	● P Sykes, A Guide book to Mechanism in Organic Chemistry, 1997, 6th Edition, Orient Longman Ltd., New Delhi. ● M S Singh, Advanced Organic Chemistry: Reactions and Mechanism: Pearson Education (Singapore) Pte. Ltd. (2005)
Reference Books:	● S M Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, 1990, 1st Edition, Macmillan India Ltd., New Delhi. ● T H Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition (1998), Addison – Wesley Longman Inc (IS Edition). ● G SZweifel and M. H. Nantz, Modern Organic Synthesis, 2007, Freeman and Company, New York. ● M S Singh, Advanced Organic Chemistry: Reactions and Mechanism: 2005, Pearson Education (Singapore) Pte. Ltd.

COURSE CODE	Organic Chemistry – III (Practical)
SC23CH0010P	2
	1. Preparation and characterization of two steps organic compounds I Step- Dil HNO_3 + Phenol 4-Aminophenol II Step- 4-Aminophenol+ Acetic Anhydride Paracetamol 2. Benzilic acid from benzoin Synthesis (Benzilic acid rearrangement). 3. Stilbene from benzyl chloride - Wittig reaction. 4. Quinoline from aniline - Skraup synthesis. 5. Lycopene from tomatoes. 6. Eucalyptus oil from leaves (Steam distillation). 7. Isolation and crystallization of terpene from tomato puree. 8. Extraction of caffeine from tea leaves. 9. Synthesis of aspirin/paracetamol. 10. Synthesis of oil of wintergreen.

Syllabus

SEMESTER VIII

COURSE CODE	INORGANIC CHEMISTRY-III	Total Lec.: 45
SC23CH0011		3-0-2
Learning Objectives:	● Prepare students with the fundamentals of main group chemistry and transition metal chemistry. ● To produce students whose basic concepts are clear in symmetry based concepts.	
Pre-requisite:	Knowledge about main group elements and transition metals.	
UNIT	**CONTENT**	**HOURS**
I	Main Group Chemistry: Periodic trends in properties of elements, atomic size, ionization potential, electron affinity, electro negativity, diagonal relationship, inert-pair effect, shielding effect, octet rule, hydrides and their classification: ionic, covalent and interstitial, basic beryllium acetate and nitrate, study of the following compounds with emphasis on structure, bonding, preparation, properties and uses, boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine, peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and properties of halogens	12
II	Metal-Ligand Bonding in Transition Metal Complexes: Crystal field splitting diagrams in complexes of low symmetry; spectrochemical and nephelauxetic series; thermodynamic and structural effects; site selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory, molecular orbital theory as applied to metal complexes. Electronic spectra of Transition Metal Complexes: Spectroscopic ground states; Term symbols, Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes; charge transfer spectra; electronic spectra of d^1 to d^{10} O_h and T_d systems, O_h and T_d Co(II) and Ni(II) complexes	10
III	Organometallic Chemistry: Organometallic Chemistry: Structure and bonding, brief overview of transition metal orbitals, types of ligands and their properties, metal-carbonyl complexes - synthesis - structure and reactions of metal carbonyls - the nature of M- CO bonding - binding mode of CO and IR spectra of metal carbonyls, soft vs hard ligands, electron counting, formal oxidation state, 18-e rule and its exceptions. Reactions of organometallic complexes: Ligand substitution/ exchange/dissociation processes and thermochemical considerations, catalyzed and assisted ligand substitution reactions, oxidative addition (definition, mechanism, thermodynamic consideration), oxidative addition of non-polar and polar electrophilic reagents, reductive elimination (bite angle effects, π-acid effects), transmetallation (definition, mechanism, utility)	10
IV	Chemistry of Lanthanides and Actinides: Introduction, chemistry of 'f' block elements, position in periodic table, oxidation states and their stability, lanthanide and actinide contraction, magnetic properties, spectral properties, separation technologies in lanthanides: (a) ion exchange, (b) solvent extraction	6

V	Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX2, ABX3 type compounds, spinels, band theory, metals and semiconductors.	8

Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **define**[1]main group elements, their properties and bonding.
CO2	Students will be able to **apply**[3] the knowledge about different compounds of main group elements.
CO3	They will acquire an **understanding**[2] of metal ligand bonding in transition metal complexes.
CO4	They will be able to **analyze**[4] the electronic spectra of transition metal complexes.
CO5	They will **understand**[2] the symmetry based concepts for inorganic molecules.
Text Books:	● R Sarkar, General and Inorganic Chemistry (vol I), 2011, 3rd Edition, New Central Book Agency. ● F A Cotton and G. Wilkinson,Advanced Inorganic Chemistry, 1999, 6th Edition, John Wiley & Sons, New York. ● J E Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, 2006, 4th Edition,Addison-Wesley Pub. Co., New York. ● A Kar, Advanced Inorganic Chemistry, 2017, Vol I & II, CBS. ● J D Lee, Concise Inorganic Chemistry, 5th edition, 2008, Oxford University Press.
Reference Books:	● R S Drago, Physical Methods in Inorganic Chemistry, 197, International Edition, Affiliated East-West Press, New Delhi, ● K F Purcell and John C. Kotz, Inorganic Chemistry, 1987, W. B. Sauders Com., Hong Kong. ● K. Veera Reddy, Symmetry and Spectroscopy of Molecules, 1999, New Age International Pvt. Ltd.

COURSE CODE	Inorganic Chemistry – III (Practical)
SC23CH0011P	2
	1. Preparation of Cuprous Chloride, Cu_2Cl_2 2. Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$ 3. Preparation of Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ 4. Synthesis of Cis and trans Potassium dioxalatodiaquachromate (III) $K[Cr(C_2O_4)_2.(H_2O)_2]$ 5. Synthesis of Tetraamminecarbonatocobalt (III) ion 6. Synthesis of Potassium tris(oxalate)ferrate(III). 7. Synthesis and catalytic application of a solid acid, 12-tungstosilicic acid. 8. Synthesis, purification and metalation of a bio-inorganically important porphyrine ligand. 9. Determination of zinc oxide in pharmaceutical preparations by EDTA titration. 10. The preparation of hexamminecobalt(III) chloride and pentammineaquocobalt(III) chloride: Synthesis, isolation and characterization of the complex.

Syllabus

SEMESTER VIII

COURSE CODE	PHYSICAL CHEMISTRY-III	Total Lec.: 45
SC23CH0012		3-0-2
Learning Objectives:	● Prepare students with the basic knowledge of symmetry and group theory and molecular spectroscopy. ● To produce students whose basic concepts are clear in quantum mechanics and nanotechnology.	
Pre-requisite:	Basic knowledge of thermodynamics.	
UNIT	CONTENT	HOURS
I	Symmetry and group theory: Symmetry based concepts: Energy level diagrams of metal complexes, symmetry elements and operations, determination of point group of a molecule, group representations, features of specific character tables Point symmetry operations, groups and group multiplication tables, similarity transformation and conjugate classes, identification of point groups, representation of symmetry operators and groups, rules (without derivation) for construction of character tables with illustrations, symmetry elements and symmetry operations of the platonic solids, symmetry of the fullerene structure. The Great Orthogonality Theorem: statement and interpretation, construction of character tables of simple molecules projection operators (without derivations)	12
II	Quantum mechanics: Overview of experimental findings; identification of classical and quantum systems, Bohr's correspondence principle, postulates of quantum mechanics, properties of wave functions, operators and related theorems; degeneracy, spread of observation and uncertainty principle, Ehrenfest's theorem, exactly solvable problems: step potential and tunnelling, harmonic oscillator, rigid rotator; elementary discussion of the H-atom solution.	8
III	Principles of molecular spectroscopy: Fundamentals; rotational spectra: classification of molecules into spherical, symmetric and asymmetric tops; diatomic molecules as rigid rotors - energy levels, selection rules and spectral features, isotope effect, intensity distribution, effect of non-rigidity on spectral features. Vibrational spectra of diatomics: potential energy of an oscillator, Harmonic Oscillator approximation, energy levels and selection rules, anharmonicity and its effect on energy levels and spectral features: overtones and hot bands, vibration-rotation spectra of diatomics: origin; selection rules; P, Q and R branches. Raman spectra: origin, selection rules, classical and quantum treatment of rotational and vibrational Raman spectra of diatomics, resonance Raman spectroscopy. NMR spectra: theory, relaxation process, spin interactions - its origin, equivalent protons, a few representative examples.	10

IV	Thermodynamics and statistical mechanics: Maxwell-Boltzmann distribution with degeneracy (for both distinguishable and indistinguishable particles), partition function and its properties, interpretation of thermodynamic laws, thermodynamic function in terms of partition functions, molecular partition functions (translational, rotational, vibrational and electronic) for ideal gas, calculation of thermodynamic functions for monoatomic and diatomic gases, equipartition principle, equilibrium constant in terms of partition function.	8

V	Elementary nanotechnology: Principles and practices, density of states – zero dimensional solid, one-dimensional quantum wire, thin film and three-dimensional box; some special nanomaterials – fullerenes, carbon nanotubes and nanodiamonds; optical properties of metallic nanoparticles; nanolithography.	7

Course Outcomes as per Bloom's Taxonomy	
CO1	The students will be able to **demonstrate**[2] the symmetries of physical systems.
CO2	They will **understand**[2] of the Quantum Mechanics postulate on the physical systems.
CO3	Students will learn to **classify**[2] the combination of spectroscopic methods and techniques are optimal for solving the specific scientific problem.
CO4	They will **understand**[2] the concepts of statistical thermodynamics.
CO5	They will **develop**[3]theknowledge of common applications for nanotectnology.
Text Books:	● A K Mukherjee, Group Theory in Chemistry: Bonding and Molecular Spectroscopy, 2018, 1st Edition, The Orient Blackswan. ● C N R Rao, A Müller, A K Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, 2004Wiley-VCH, Weinheim. ● C N Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 1994, 4th Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi. ● R. C. Mukherjee, Modern Approach to Physical Chemistry I, 2016, Bharati Bhawan Publishers & Distributors. ● T. Varghese, K. M. Balakrishna, Nanotechnology: an Introduction to Synthesis Properties and Applications of Nanomaterials, 2012, Atlantic Publishers & Distributors Pvt Ltd.
Reference Books:	● F A Cotton, Chemical Applications of Group Theory, 3rd Edition, John Wiley & Sons, New York, 1999. ● S C Rakshit, Molecular Symmetry Group and Chemistry, The New Book Stall, Kolkata, 1988. ● R Taylor, The Chemistry of Fullerenes, Advanced Series in Fullerenes, Vol 4, 1995, World Scientific, Singapore ● C. Poole, Introduction to Nanotechnology, Wiley Student Edition, 2016, Wiley.

COURSE CODE	Physical Chemistry – III (Practical)
SC23CH0012P	**2**
	1. Determination of dissociation constants of weak acid and weak base. 2. Conductometric titration of an acid and a base. 3. Potentiometric titration of acid and base. 4. Kinetics of catalytic decomposition of H_2O_2. 5. Kinetics of acid catalysed hydrolysis of sugar. 6. Study the kinetics of the following reactions. a. Initial rate method: Iodide-persulphate reaction b. Integrated rate method: 7. Acid hydrolysis of methyl acetate with hydrochloric acid. 8. Determination of molar mass of non-electrolyte by Walker-Lumsden method 9. Determination of partition/distribution coefficient of Benzoic acid in water and toluene 10. Determination of composition of liquid mixtures by refractometry. (toluene and alcohol, water and sucrose)

SANJEEV AGRAWAL GLOBAL EDUCATIONAL UNIVERSITY, BHOPAL

Proposed Scheme & Syllabus

For

Bachelor of Science (BSc)

Certificate/Diploma/Degree/Honors Degree/ Research Degree

in

Chemistry

w.e.f. 2023-24 (According to NEP 2020)

School of Sciences

CHEMISTRY

Program Educational Objectives (PEOs) Chemistry:

PEO-1: Prospective Employment and Career Prospects-Developing the potential for vertical career growth in investigation laboratories, service sectors and related avenues.

PEO-2: Proficiency- Inculcating technical and managerial skills crucial for real time scenarios through the enhancement of problem-solving skills and advanced technical documentation ability.

PEO-3: Affectionate Objective- Grooming the students with technical proficiency to equip them for the emergence of sustainable technology and solutions for prevailing environmental, societal and cultural concerns.

PEO-4: Research Methods-Nurturing the research aptitude to provide solutions for global challenges and abilities to explore hidden potential of the matter.

PEO-5: Continuous Learning-Instilling knowledge and awareness on professional ethics related to crime prevention and evidence analysis and life-long learning through career-oriented courses.

Program Outcomes (POs) Chemistry:

By the end of the program the students will be able to:

PO 1. Understand the fundamentals of various branches of chemistry.

PO 2. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups.

PO 3. Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO 4. Apply the key concepts and standard methodologies to solve problems related to Chemistry.

PO 5. Apply their skill in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO 6. Apply the knowledge and skills to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

PO 7. Possess the level of proficiency in subject required for post-graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects.

PO 8. Apply methodologies to the solution of unfamiliar types of problems.

PO 9. Design solutions stemming from the application of Chemistry to the local issues.

PO 10. Explore new areas of research in pure chemistry and applied chemistry.

Syllabus

SEMESTER I

COURSE CODE	Analytical and Organic Chemistry - I	Total Lec.: 45
SC23CH001		3-0-2
Learning Objectives:	After studying this course the students will know – • Prepare graduates with the skills of sampling with accuracy and who will be able to evaluate the data analytically. • To produce graduates whose basic concepts are clear in different methods of analytical chemistry. • Prepare graduates with the skills to critically assess and solve problems requiring the application of chemical principles. • To produce graduates whose basic concepts are clear in both organic chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	8
II	Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument. Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers,determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques,structural illustration through interpretation of data, effect and importance of isotope substitution. Flame atomic absorption and emission spectrometry:Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs,techniques of atomization and sample introduction; method of background correction, sources of chemical interferences and their method of removal,techniques for the quantitative estimation of trace level of metal ions from water samples.	12
III	Fundamentals of organic chemistry: Physical effects, electronic displacements: inductive effect, electromeric effect, resonance and hyperconjugation, cleavage of bonds: homolysis and heterolysis, structure, shape and reactivity of organic molecules: nucleophiles and electrophiles, reactive intermediates: carbocations, carbanions and free radicals, strength of organic acids and bases: comparative study with emphasis on factors affecting pk values.	9
IV	Stereochemistry: Conformations with respect to ethane, butane and cyclohexane, interconversion of wedge formula, Newmann, sawhorse and Fischer repretentations, concept of chirality (up to two carbon atoms) and configuration: geometrical and optical isomerism (enantiomerism, diastereomerism and meso compounds), threo and erythro; D and L; *cis – trans* nomenclature; CIP rules: R/S (for upto 2 chiral carbon atoms) and E/Z nomenclature (for up to two C=C systems).	8

V	Aliphatic hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure, alkanes: (up to 5 Carbons) preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent, reactions: free radical substitution: halogenations, alkenes: (up to 5 Carbons), preparation: elimination reactions: dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule), *cis* alkenes (partial catalytic hydrogenation) and *trans* alkenes (Birch reduction), reactions: *cis* addition (alk. $KMnO_4$) and *trans* addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, ozonolysis, oxymecuration-demercuration, hydroboration-oxidation, alkynes: (up to 5 Carbons), preparation: acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides, reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	8
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will gain a firm knowledge in and **understanding** in analytical data with errors, accuracy and precision.	
CO2	They will be able to **evaluate**[5] several optical methods of analysis.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	
Text Books:	• SM Khopkar, Basic Concepts of Analytical Chemistry, 2009, New Age, International Publisher. • D Gary, Analytical Chemistry, 6th Ed., Christian, 2004, John Wiley & Sons, New York. • B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models in InorganicChemistry, John Wiley and Sons Publications. • E L Eliel, Stereochemistry of Carbon Compounds, 2017, Cyber Tech Publications. • I L Finar,OrganicChemistry(Vol. I & II), E L B S.	
Reference Books:	• S. Hook, P. Kurtz, M. Todorovich, The Ethics of Teaching and Scientific Research, Prometheus Books, 1977. • B. Stanley, J.E. Sieber, G. B. Nelton, Research Ethics: A Psychological Approach, University of Nebraska Press, 1996.	

COURSE CODE	Analytical and Organic Chemistry – I (Practical)
SC23CH001P	**2**
	Section A: Analytical Chemistry 1. Calibration of glassware, pipette, burette and volumetric flask. 2. Determination of sodium carbonate and sodium bicarbonate in a mixture by titrimetry. 3. Estimation of total hardness of a given sample of water by complexometric titration. 4. Determination of alkali present in soaps/detergents. 5. Determination of Fe^{2+} in Fe_2O_3. **Section B**: Organic Chemistry 1. Preparation of Benzamide 2. Preparation of Benzophenone Oxime 3. Purification of organic compounds by crystallization (from water and alcohol) distillation. 4. Hydrolysis of methyl salicylate. 5. Preparation of dibenzyledineacetone.

Syllabus

SEMESTER II

COURSE CODE	Inorganic and Physical Chemistry - I	Total Lec.: 45
SC23CH002		3-0-2
Learning Objectives:	After studying this course the students will know – • Prepare graduates with the skills to critically assess and solve problems requiring theapplication of chemical principles. • To produce graduates whose basic concepts are clear in fundamental inorganic chemistry. • To produce graduates who will have clear understanding about concepts of physical chemistry like states of matter and chemical kinetics	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	CONTENT	HOURS
I	Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg uncertainty principle. hydrogen atom spectra, need of a new approach to atomic structure, quantum mechanics, time independent Schrodinger equation and meaning of various terms in it, significance of ψ and ψ^2, Schrödinger equation for hydrogen atom, radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (only graphical representation), radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals, significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s, shapes of s, p and d atomic orbitals, nodal planes, discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s), rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.	10
II	Chemical Bonding and Molecular Structure: Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculationof lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, concept of resonance and resonating structures in various inorganic and organic compounds. MO approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+, comparison of VBT and MOT.	10
III	Kinetic Theory of Gases: Postulates of kinetic theory of gases and derivation of the kinetic gas equation, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases, Boyle temperature (derivation not required), critical phenomena, critical constants and their calculation from van der Waals equation.	8

IV	Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effectof temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). Solids: Forms of solids, symmetry elements, unit cells, crystal systems, Bravais latticetypes and identification of lattice planes, laws of crystallography - law of constancy of interfacial angles, law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law, structures of NaCl, KCl and CsCl (qualitative treatment only),defects in crystals glasses and liquid crystals.	9
V	Chemical Kinetics: The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates, order and molecularity of a reaction, derivation of integratedrate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants),half–life of a reaction, general methods for determination of order of a reaction	8
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **define**[1] about the structure of atoms.	
CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of bonding for both ionic and covalent compounds.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	
Text Books:	• R L Madan, Chemistry for Degree Students (Semester I), 2016 S Chand PublishingHouse; First edition. • R Sarkar, General and Inorganic Chemistry (Vol I), 2011, New Central Book Agency, 3rd Ed. • P. Atkins and J. De Paul, 8th Edition, 2006, International Student Edition, Oxford UniversityPress. 2. • B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition,1998, Shoban Lal Nagin Chand & Co., Jalandhar.	
Reference Books:	• J E Huheey, E A Keiter, R L Keiter and O K Medhi, Inorganic Chemistry: Principlesof Structure and Reactivity, 2006 Pearson Education India. • J D Lee, A new Concise Inorganic Chemistry, 5th Ed, 2016 Wiley Publication. • F A Cotton, G Wilkinson, and P L Gaus, Basic Inorganic Chemistry, 3rd ed. WileyPublication. • B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models inInorganic Chemistry, John Wiley and Sons Publications. • K. J. Laidler and J. M. Meiser, Physical Chemistry, 1999, 3rd Edition, Houghton Mifflin Comp.,New York, International Edition.	

COURSE CODE	Inorganic and Physical Chemistry – I (Practical)
SC23CH002P	**2**
	Section A: Inorganic Chemistry 1. Determination of carbonate and hydroxide present in amixture. 2. Determination of oxalic acid and sodium oxalate in a mixture by titrating it with standard $KMnO_4$/NaOH solution. 3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$. 4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 5. Soil Analysis-Determination of pH of soil. **Section B**: Physical Chemistry 1. Determination of density using specific gravity bottle 2. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids) 3. Study of the variation of viscosity of sucrose solution with the concentration of a solute. 4. Determination of the surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids) 5. Study of variation of surface tension of detergent solution with concentration.

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SEMESTER III

COURSE CODE	Analytical and Organic Chemistry - II	Total Lec.: 45
SC23CH003		3-0-2
Learning Objectives:	After studying this course the students will know – • Prepare graduates with the skills of sampling with accuracy and who will be able to evaluate the data analytically. • Prepare graduates with the skills to critically assess and solve problems requiring the application of chemical principles. • To produce graduates whose basic concepts are clear in organic chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation, Techniques for quantitative estimation of Ca and Mg from their mixture.	12
II	Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations, techniques used for the determination of equivalence points, techniques used for the determination of pKa values.	12
III	Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of enantiomeric excess (ee)/diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents, chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.	12
IV	Aromaticity: Aromaticity and Huckel rule - A general concept, molecular orbital picture of benzene, aromatic electrophilic substitution, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts (alkylation and acylation).	12
V	Chemistry of Carbonyl compounds: Preparations and reactions: addition and condensation reactions; Cannizzaro, Perkin, aldol, benzoin, haloform,Phenols: General methods of preparation and reactions, Reimer-Tiemannand Kolbe reactions, relative acidity of phenol, alcohol and carboxylic acid. Nitrogen Containing compounds: Nitrobenzene and reduction products, Comparative basicity of aliphatic and aromatic amines, Diazonium Salts: Preparation and synthetic applications.	12

Course Outcomes as per Bloom's Taxonomy	
CO1	They will acquire an **understanding[2]** about thermal methods of analysis.
CO2	They will be able to **evaluate[5]** several separation techniques of analysis.
CO3	They will acquire an **understanding[2]** about electroanalytical method
CO4	Students will be able to **understand[2]** basic concept of aromaticity.
CO5	They will be able to **explain[2]** the chemistry of carbonyl compounds.
Text Books:	• SM Khopkar, Basic Concepts of Analytical Chemistry, 2009, New Age, International Publisher. • D Gary, Analytical Chemistry, 6th Ed., Christian, 2004, John Wiley & Sons, New York. • B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models in InorganicChemistry, John Wiley and Sons Publications. • E L Eliel, Stereochemistry of Carbon Compounds, 2017,Cyber Tech Publications. • I L Finar,OrganicChemistry(Vol. I & II), E L B S.
Reference Books:	• H H Willard, et al., Instrumental Methods of Analysis, 7th Ed. 1988, Wardsworth Publishing Company, Belmont, California, USA. • A I Vogel, A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery andothers), 5th Ed. 1989, The English Language Book Society of Longman • R T Morrison and R N Boyd,Organic Chemistry, Prentice Hall. • T W Graham Solomon,Organic Chemistry, John Wiley and Sons. • P Sykes,A Guide Book to Mechanism in Organic Chemistry, Orient Longman. A Bahl and B S Bahl, Advanced Organic Chemistry,2012, S Chand Publishing House.

COURSE CODE	Analytical and Organic Chemistry – II (Practical)
SC23LM003P	**1**
	Section A: Analytical Chemistry 1. Identification and separation of the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography. Measure the Rf value in each case. 2. Identify and separate the sugars present in the given mixture by paper chromatography. 3. Paper chromatographic separation of Fe^{3+}, Co^{2+} and Cu^{2+}. 4. Determination of the Exchange Capacity of a Cation Ion Exchange Resin. **Section B**: Organic Chemistry 1. Aldol condensation reaction between benzaldehyde and acetone. 2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method). 3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture. 4. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method). 5. Synthesis of diazoaminobenzene from aniline (conventional method). 6. Preparation of dibenzalacetone (Green method).

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SEMESTER IV

COURSE CODE	Inorganic and Physical Chemistry - II	Total Lec.: 45
SC23CH004		3-0-2
Learning Objectives:	After studying this course the students will know – • To produce graduates whose basic concepts are clear in fundamental inorganic chemistry. • To produce graduates who will have clear understanding about concepts of physical chemistry like states of matter and chemical kinetics and also about the coordination chemistry.	
Pre-requisite:	Elementary chemistry (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Transition Elements (3d series):General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.	9
II	Coordination Chemistry: Valence Bond Theory (VBT): inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6),structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT, IUPAC system of nomenclature. Crystal Field Theory: crystal field effect, octahedral symmetry, crystal field stabilization energy (CFSE), crystal field effects for weak and strong fields. tetrahedral symmetry, f Factors affecting the magnitude of D,spectrochemical series, comparison of CFSE for Oh and Td complexes,	9
III	Phase Equilibria: Thermodynamics of phase transition-Clapeyron-Clausius equation and its applications, phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one- component system (water), two component systems (phenol-water, lead-silver), equilibrium constant from distribution coefficient ($KI + I_2 = KI_3$).	9
IV	Chemical Equilibrium: Free energy change in a chemical reaction, thermodynamic derivation of the law of chemical equilibrium, distinction between ΔG and ΔG^o, Le Chatelier's principle, relationship between *Kp*, *Kc* & *Kx* for reactions involving ideal gases.	9
V	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, buffer solutions, solubility and solubility product of sparingly soluble salts – applications.	9
	Course Outcomes as per Bloom's Taxonomy	
CO1	Student will be able to **define**[1] about the structure of atoms.	
CO2	They will acquire an **understanding**[2] of major concepts and fundamentals of bonding for both ionic and covalent compounds.	
CO3	They will **apply**[3] fundamentals of organic chemistry.	
CO4	They will be able to **apply**[3] the nucleophiles, electrophiles, reactive intermediates and also they will have clear understanding of stereochemistry.	
CO5	They will be able to **analyze**[4] reactions of organic functional groups and be able to predict the mechanisms for organic reactions.	

Text Books:	• R L Madan, Chemistry for Degree Students (Semester I), 2016 S Chand PublishingHouse; First edition. • R Sarkar, General and Inorganic Chemistry (Vol I), 2011, New Central Book Agency,3rd Ed. • P. Atkins and J. De Paul, 8th Edition, 2006, International Student Edition, Oxford UniversityPress. 2. • B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition,1998, Shoban Lal Nagin Chand & Co., Jalandhar.
Reference Books:	• J E Huheey, E A Keiter, R L Keiter and O K Medhi, Inorganic Chemistry: Principlesof Structure and Reactivity, 2006 Pearson Education India. • J D Lee, A new Concise Inorganic Chemistry, 5th Ed, 2016 Wiley Publication. • F A Cotton, G Wilkinson, and P L Gaus, Basic Inorganic Chemistry, 3rd ed. WileyPublication. • B E Douglas, D H McDaniel andJ J Alexander, Concepts and Models inInorganic Chemistry, John Wiley and Sons Publications. • K. J. Laidler and J. M. Meiser, Physical Chemistry, 1999, 3rd Edition, Houghton Mifflin Comp.,New York, International Edition.

COURSE CODE	Inorganic and Physical Chemistry – II (Practical)
SC23CH004P	**2**
	Section A: Inorganic Chemistry 1. Determination of Acid-neutralizing power of a Commercial Antacid. 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA. 3. Determination of concentration of Potassium Permanganate solution using Ferrous Ammonium sulphate. 4. Determination of chlorine in bleaching powder using iodometric method. 5. Preparation of potash alum. **Section B**: Physical Chemistry 1. Saponification of ethyl acetate. 2. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate. 3. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (using dilute solutions of soaps and shampoos to preventdamage to the glass electrode) using pH-meter. 4. Preparation of buffer solution of sodium acetate-acetic acid and ammonium chloride-ammonium hydroxide. 5. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

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SEMESTER V

COURSE CODE	BIOLOGICAL CHEMISTRY	Total Lec: 60
SC23CH005		4-0-0
Learning Objectives	• Prepare students with the knowledge of enzymes, coenzymes and their mechanism. • To produce students whose concepts are clear in nuclic acids and bio-synthesis	
Pre-requisite	None.	
UNIT	CONTENT	HOURS
I	Enzymes, co-enzymes and their mechanism of action: enzymes, classification, inhibition, mechanism of action of chymotrypsin, aldolase, alcohol, lysozyme, cofactors as derived from vitamins, co-enzymes, prosthetic, prosthetic group and apoenzymes.	12
II	Structure and biological functions of coenzyme-A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FAD, lipoic acid, mechanisms of reactions catalyzed by the above cofactors.	12
III	Nucleic Acids: Retro-synthetic analysis of Nucleic Acids - nucleotides, nucleosides, nucleobases (A, T, G, C and U), sugars (Ribose and deoxyribose), assembly of oligonucleotide chain: synthesis of polymer support, nucleosides and nucleotides, solid phase synthesis of oligo-nucleotides (DNA/RNA) through phosphoramidite and phosphorothionate approach.	12
IV	Application of protecting groups (-NH_2 and –OH functions, Base and Acid labile) and their deprotection and purification, concept of depurination.	12
V	Bio-synthesis: Terpenoids - C5, C10, C15, C20 units; alkaloids - quinine and morpholine.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand**[2] themechanism and action of enzymes and co-enzymes.	
CO2	They will be able to **illustrate**[2]structure and biological function of some enzymes.	
CO3	Students will **understand**[2] the details of nucleic acid.	
CO4	They will **learn**[2] the application of protecting groups.	
CO5	They will **develop**[3] the knowledge ofbio-synthesis.	
Text Books:	• A L Lehninger, **Principles of Biochemistry**, 1992CBS Publishers, Delhi. • DVoet, J G Voet & CW Pratt, **Fundamentals of Biochemistry**, 1999 John Wiley & Sons, New York. • H R Mahler and E H Cordes, **Biological Chemistry**, 1971, 2nd Edition, Harper and Row Pub., New York	
Reference Books:	• C Walsh, **Enzymatic Reaction Mechanisms**(1979), W.H. Freeman & Co., New York. • I L Finar, **Organic Synthesis**, 1975, 5th edition. Vol.2, Longman Press, USA.	

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SEMESTER V

COURSE CODE	APPLIED CHEMISTRY	Total Lec.: 60
SC23CH006		4-0-0
Learning Objectives:	• Prepare students with the in-depth understanding of industrial chemistry • To gain the knowledge in applied chemistry.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Soaps and Detergents: Theory of surface action, soap manufacture: raw materials, characteristics of cold process, semi boiled process and boiled process, additives of soap, detergent action of soap, influence of fatty acid composition of the oil on properties of soap, manufacture of soap for different purposes-laundry soaps, toilet soaps, liquid soaps, transparent soaps, baby soaps, shaving soaps, medicated soaps, textile soaps, naphtha soaps, marine soaps. T.F.M value of soaps, shampoos	12
II	Paints and Varnishes: Paints as protective coatings, paints and enamels, materials for paint manufacture, oils used-unmodified oils and their pre-treatment, modified drying oils, resins and copolymers, natural resins, phenolic resins, alkyd resins, urethane resins, epoxy resins - Driers, thinners, pigments and miscellaneous ingredients, mechanism of polymerization and drying of oils; varnishes and lacquers: composition and uses, oleo resinous varnishes, defects in varnish films.	12
III	Flavour and Perfume Chemistry: Concept of flavor, difference between perfumes and flavour, flavour characterisation, sensory analysis-descriptive and discriminant sensory analysis, flavour of coffee, tea, cocoa, onion and garlic, synthetic ingredients of food flavourings, odour, odorants, olfaction, classification of odour, general physiology of olfaction, perfume raw materials - terpeneless and sesquiterpeneless oils, concrete oils, absolute oils, isolates from essential oils, tincture, balsams and resins, source and c hemical nature of commercially important gums (gum Arabic, gum tragacanth, karaya gum, British gum, gum myrrh), balsams (balsam of Peru, balsam of Tolu, styrax) and resins.	12
IV	Dairy Chemistry: Milk definition, general composition of milk, constituents of milk - lipids, proteins, carbohydrates, vitamins and minerals, physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity. Factors affecting the composition of milk: Adulterants, preservatives and neutraliser, examples and their detection, estimation of fat, acidity and total solids in milk. Processing of Milk: Destruction of microorganisms in milk, physicochemical changes taking place in milk due to processing - boiling, pasteurisation, types of pasteurisations - bottle, batch and HTST (High Temperature Short Time) - vacuum pasteurisation - Ultra High Temperature Pasteurisation. Milk products: Cream, definition, composition, chemistry of creaming process, gravitational and centrifugal methods of separation of cream, estimation of fat in cream, butter: definition, composition, theory of churning, estimation of acidity and moisture content in butter, ghee: major constituents, common adulterants added to ghee and their detection.	12
V	Basic principles of Nanochemistry: Brownian motion, surface forces, self-assembly, general methods of synthesis of nanomaterials: Top-down production, bottom-up production, types of nanomaterials, carbon nanotubes, fullerenes, quantum dots, nanowires, nanocones, haeckelites, graphenes and metal nanoparticles.	12

	Applications of nanomaterials in medicine: Immunogold labelling, applications in medical diagnosis, nano based drug delivery, biomimetic nanotechnology, DNA nanotechnology	
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will **understand**[2] the preparation and properties of soaps and detergents.	
CO2	They will be able to **demonstrate**[2] kinetics and mechanism of polymerisation.	
CO3	They will be able to **explain**[3] the applications of polymers.	
CO4	They will be able to **develop**[3] the procedure of characterization of polymers.	
CO5	They will be able to **analyse**[4] the morphology and applications of polymers	
Text Books:	• B. Somdavi: Applied Chemistry, MJP Publications, 2006. • N. Groom, The Perfume Handbook, Chapman and Hall, 1992. • D. J. Rowe, The chemistry of flavours and fragrances, Blackwell publishing ltd., 2005. • B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut, 2011.	
Reference Books:	• C.N.R. Rao, Muller and A. K. Cheetham, Chemistry of Nanomaterials, Vol. I & II, Wiley VCH Verlag GmbH KGaA, 2002.	

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SEMESTER VI

COURSE CODE	MATERIALS CHEMISTRY	Total Lec.: 60
SC23CH007		**4-0-0**
Learning Objectives	• Prepare students with the concept of materials chemistry • To produce students with knowledge of various inorganic and organic materials.	
Pre-requisite	None.	
UNIT	**CONTENT**	**HOURS**
I	Introduction: Materials and their classification, inorganic and organic materials.	8
II	Inorganic materials: Design and synthesis of inorganic materials, requirements and constraints, combination properties of composites, functional materials, active materials; solid state reactions for synthesis of inorganic materials: ceramic methods, precursor method and sol-gel synthesis, physical and chemical vapour depositions;	14
III	Properties of inorganic materials: carbides, nitrides, structural and functional ceramics, intermetallics; intrinsic and extrinsic properties: electrical, optical and magnetic properties; ceramic superconductors, magnetic ceramics.	12
IV	Molecular electronics: molecular materials for electronics and molecular scale electronics: Molecular properties, molecular arrangement and molecular interactions, piezoelectric and pyroelectric organic materials; molecular magnets based on transition metal complexes and organic ferromagnets.	14
V	Organic non-linear optical materials: photochromic organic materials and their classes; conducting polymers: polyacetylene, polypyrrole, polyaniline and polythiophene; conductive change transfer materials: TTFTCNQ, metal–dithiolate systems, fullerenes.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **understand**[2] the concept of material chemistry	
CO2	They will be able to **illustrate**[2] techniques for synthesis of inorganic materials.	
CO3	Students will **understand**[2] the properties of inorganic materials.	
CO4	They will learn to **apply**[3] the knowledge of molecular material wherever required.	
CO5	They will **develop**[3] the knowledge of properties of organic materials.	
Text Books:	• E. Sambandan, Short Notes on Applied and Advanced Inorganic Materials Chemistry, 2006, iUniverse. • C. N. R. Rao, K Biswas, Essentials of Inorganic Materials Synthesis, 2015, Wiley Pulication. • D. Sangeeta, J R. LaGraff, Inorganic Materials Chemistry Desk Reference, 2nd Edition, 2005, CRC Press. • P. J. Vander Put, Inorganic Chemistry of Materials, 1998, Plenum Press, New York.	
Reference Books:	• M.C. Petty, M.R. Bryce and D. Bloor, An Introduction to Molecular Electronics, 1995, Edward Arnold, London. • U. S. Schubert, N. Hüsing, Synthesis of Inorganic Materials, 4th Edition, 2019, Wiley Publication.	

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SEMESTER VI

COURSE CODE	TOXICOLOGY	Total Lec.: 60
SC23CH008		**4-0-0**
Learning Objectives:	• Prepare students with the in-depth understanding of polymer chemistry • To gain the knowledge in the preparation, properties, characterization and applications of polymers.	
Pre-requisite:	None.	
UNIT	**CONTENT**	**HOURS**
I	Food Toxicology: Introduction, Food Toxicology, Toxicology of food additives, legal and regulatory aspects	12
II	Cosmetic Toxicology: Introduction, potential exposures, toxicity of shampoos and conditioners, permanent wave treatment, colorants, bleachers and sprays, cutaneous diseases, respiratory diseases, regulatory aspects	12
III	Medical Toxicology: Introduction, Mission of medical toxicology, Nomenclature, Toxicological fact sheets and databases, Human risk assessment, ecotoxicology, conclusion	12
IV	Wildlife Toxicology: Introduction, environmental and ecological toxicology, Wildlife susceptibity to poisons, Comparative toxicology, Integrated problem saving	12
V	Pestiside Toxicology: Introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides	12
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will **understand**[2] the preparation and properties of polymers.	
CO2	They will be able to **demonstrate**[2] kinetics and mechanism of polymerisation.	
CO3	They will be able to **explain**[3] the applications of polymers.	
CO4	They will be able to **develop**[3] the procedure of characterization of polymers.	
CO5	They will be able to **analyse**[4] the morphology and applications of polymers	
Text Books:	• F. W. Bill Meyer, Text book of polymer science, III Edition, John Wiley and sons, New York. • Curtis Klaassen, Toxicology: The Basic Science of Poisons, 9th Edition, Mc Grow Hill Education • A. Wallace Hayes, Claire L. Kruger, Hayes' Principles and Methods of Toxicology, 6th Edition, CRC Press • Ali S. Faqi, A Comprehensive Guide to Toxicology in Nonclinical Drug Development, 2nd Edition • Raktim Pal, Effect of Pesticide on Soil Microbial Properties Paperback, 2008	
Reference Books:	• Esther Haugabrooks and A. Hayes, History of Food and Nutrition Toxicology, 1st Edition 2023. • Personal Care Products and Human Health, 1st Edition, Philippa Darbre, 2023 • Ronald J. Kendall, Thomas E. Lacher, George C. Cobb, Stephen Boyd Cox Wildlife Toxicology: Emerging Contaminant and Biodiversity Issues, 2016, CRC Press.	

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SEMESTER VIII

COURSE CODE	Analytical Chemistry-III	Total Lec.: 45
SC23CH009		3-0-2
Learning Objectives:	• Prepare students with the in-depth understanding of analytical chemistry • To gain the knowledge in the preparation, properties, characterization and applications of polymers.	
Pre-requisite:	None.	
UNIT	CONTENT	HOURS
I	Introduction: Scope & objectives, analytical chemistry and chemical analysis, classification of analytical methods, sample selection, sample processing, steps in a quantitative analysis, quantitative range (bispartite classification), data organisation, analytical validations, errors, type of errors, gross errors and their sources, the tools of analytical chemistry and good lab practices.	9
II	Calculations used in Chemistry: Chemical stoichiometry, molarity, molality, etc. Preparing samples for analysis: primary, secondary standard etc., classical methods of analysis: gravimetric, volumetric, titrimetric, potentiometric methods.	9
III	Analytical Chemometrics: Propagation of measurement uncertainties (accuracy and precision), mean, mode, median, range, standard deviation, useful statistical test: the F test, the student 'T' test, the 'Chi' test, 'Q' test the correlation coefficient, significant figures, regression analysis (least square method for linear and non-linear plots),	9
IV	Automation in the Laboratory: Principles of automation, process control through automated instruments, autoanalyzers (single channel and multi-channel),basic sequences of multi-fold operational analyzers in segmented and non-segmented flows.	9
V	Polarography: Origin of polargraphy, Current-voltage relationship, Theory of polarographic waves (DC and sampled DC (tast) polarograms), Instrumentation, Ilkovic equation, qualitative and quantitative applications.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will **understand**[2]nuclear chemistry and radioactive equilibrium.	
CO2	They will be able to **define**[1]learn the separation techniques.	
CO3	They will **build**[3] knowledge of thermal methods.	
CO4	They will **understand**[2]theprinciple of polarography.	
CO5	They will be able to **demonstrate**[2] polarographic methods.	
Text Books:	• S M Khopkar, Basic Concepts of Analytical Chemistry, 3rd Ed, 2008 New Age International Publishers. • J. A. Dean, Analytical Chemistry Notebook, 2nd Edition 2004, McGraw Hill. • R. M. Berma, Analytical Chemistry Theory and Practice, 3rd Edition, 2019, CBS Pulication. • G. D. Christian, Analytical Chemistry, 6th Edition, 2007, Wiley pulication. • P. Malhotra, Analytical Chemistry - Basic Concepts, 2016, Anne Book Publishers.	
Reference Books:	• D A Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 2000, 7th Edition, Saunders College Publishing, Philadelphia, London. • J H Kennedy, Analytical Chemistry: Principles, 1990, 2nd Edition, Saunders Holt, London.	

COURSE CODE	Analytical Chemistry – III (Practical)
SC23CH009P	**2**
	1. Separation of Co^{2+} & Ni^{2+} by Ion Exchange chromatography. 2. Separation of Ni^{2+} & Fe^{3+} by Ion Exchange chromatography. 3. Separation of Zn^{2+} & Mg^{2+} by Ion Exchange chromatography. 4. To determine the amount of Iron/Calcium in milk powder. 5. Detection of Caffeine in commercial products (Tablet) by TLC. 6. Separation of blue or black Ink/ chlorinated insecticides by paper chromatography. 7. To determine Iodine value of an oil. (Coconut oil, Castor oil, Soybean Oil, Cotton seed oil, etc) 8. To determined % purity of the given sample of Aspirin. 9. Separation of mixture of drugs by TLC & column chromatography 10. To determine the acidity of lubricating oil sample.

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SEMESTER VIII

COURSE CODE	ORGANIC CHEMISTRY III	Total Lec.: 45
SC23CH0010		**3-0-2**
Learning Objectives	• Prepare students with the in-depth knowledge of organometallic chemistry. • To produce students with increased familiarity with modern research topics in organometallic chemistry	
Pre-requisite	Organic chemistry reaction mechanism.	
UNIT	**CONTENT**	**HOURS**
I	Conformation and reactivity of acyclic and cyclic systems: Acyclic compounds, the Felkin-Anh model, the Hawk model and Sharpless asymmetric epoxidation; cyclic compounds: monocyclic (3- to 8-membered rings) and bicyclic compounds (bridged, fused and spiro).	9
II	Basic of Photochemistry: Photochemical laws, quantum yield, electronically excited states- life times-measurements of the times, flash photolysis, stopped flow techniques, energy dissipation by radiative and non-radiative processes, absorption spectra, photochemical stages - primary and secondary processes, photochemistry of aromatic compounds, isomerisation, additions and substitutions,	9
III	Nucleophilic Substitution at Saturated Carbon: Mechanism and stereochemistry of S_N1, S_N2, S_Ni reactions, reactivity: the effect of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambient nucleophiles: regioselectivity, competition between S_N1 and S_N2 mechanisms. Neighbouring Group Participation: evidences of N.G.P.; the phenonium ion, participation by pi and σ bonds, anchimeric assistance, classical versus non-classical carbonium ions – the present status.	12
IV	E1 mechanism, E2 mechanism, E1 vs E2 mechanism, aromatic electrophilic substitution reaction mechanism, aromatic nucleophilic substitution reaction mechanism, nucleophilic addition mechanism, electrophilic addition mechanism, free radical addition mechanism, rearrangements	6
V	Pericyclic Reactions: Conservation of orbital symmetry, Woodward-Hoffmann rules, frontier molecular orbital (FMO) theory, orbital overlap effects in cycloadditions, electrocyclizations, sigmatropic rearrangements and chelotropic reactions, Paterno-Buchi, Norrish type I and II reactions.	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will have an advanced **understanding[2]** of conformation and reactivity of cyclic and acyclic systems.	
CO2	They will be able to **apply[3]** their knowledge of reaction intermediates.	
CO3	They will **understand[2]**thestructure-reactivity relationship.	
CO4	They will **build[3]** the in-depth knowledge of polymerization.	
CO5	They will be able to **analyze[4]**enantioselective reaction and their applications.	
Text Books:	• A Bahl, B S Bahl, Advanced Organic Chemistry: Reactions and Mechanism, 2012, 2nd Edition, S. Chand Publishing. • M B Smith & J March, March's Advanced Organic Chemistry, 2001, 5th Edition, John Wiley & Sons, New York. • Clayden, Greeves, Warren and Wothers, Organic Chemistry, 2001, Oxford University Press.	

	• P Sykes, A Guide book to Mechanism in Organic Chemistry, 1997, 6th Edition, Orient Longman Ltd., New Delhi. • M S Singh, Advanced Organic Chemistry: Reactions and Mechanism: Pearson Education (Singapore) Pte. Ltd. (2005)
Reference Books:	• S M Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, 1990, 1st Edition, Macmillan India Ltd., New Delhi. • T H Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition (1998), Addison – Wesley Longman Inc (IS Edition). • G SZweifel and M. H. Nantz, Modern Organic Synthesis, 2007, Freeman and Company, New York. • M S Singh, Advanced Organic Chemistry: Reactions and Mechanism: 2005, Pearson Education (Singapore) Pte. Ltd.

COURSE CODE	Organic Chemistry – III (Practical)
SC23CH0010P	**2**
	1. Preparation and characterization of two steps organic compounds I Step- Dil HNO_3 + Phenol----------4-Aminophenol II Step- 4-Aminophenol+ Acetic Anhydride ----------Paracetamol 2. Benzilic acid from benzoin Synthesis (Benzilic acid rearrangement). 3. Stilbene from benzyl chloride - Wittig reaction. 4. Quinoline from aniline - Skraup synthesis. 5. Lycopene from tomatoes. 6. Eucalyptus oil from leaves (Steam distillation). 7. Isolation and crystallization of terpene from tomato puree. 8. Extraction of caffeine from tea leaves. 9. Synthesis of aspirin/paracetamol. 10. Synthesis of oil of wintergreen.

Syllabus

SEMESTER VIII

COURSE CODE	INORGANIC CHEMISTRY-III	Total Lec.: 45
SC23CH0011		3-0-2
Learning Objectives:	• Prepare students with the fundamentals of main group chemistry and transition metal chemistry. • To produce students whose basic concepts are clear in symmetry based concepts.	
Pre-requisite:	Knowledge about main group elements and transition metals.	
UNIT	CONTENT	HOURS
I	Main Group Chemistry: Periodic trends in properties of elements, atomic size, ionization potential, electron affinity, electro negativity, diagonal relationship, inert-pair effect, shielding effect, octet rule, hydrides and their classification: ionic, covalent and interstitial, basic beryllium acetate and nitrate, study of the following compounds with emphasis on structure, bonding, preparation, properties and uses, boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine, peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and properties of halogens	12
II	Metal-Ligand Bonding in Transition Metal Complexes: Crystal field splitting diagrams in complexes of low symmetry; spectrochemical and nephelauxetic series; thermodynamic and structural effects; site selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory, molecular orbital theory as applied to metal complexes. Electronic spectra of Transition Metal Complexes: Spectroscopic ground states; Term symbols, Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes; charge transfer spectra; electronic spectra of d^1 to d^{10} O_h and T_d systems, O_h and T_d Co(II) and Ni(II) complexes	10
III	Organometallic Chemistry: Organometallic Chemistry: Structure and bonding, brief overview of transition metal orbitals, types of ligands and their properties, metal-carbonyl complexes - synthesis - structure and reactions of metal carbonyls - the nature of M- CO bonding - binding mode of CO and IR spectra of metal carbonyls, soft vs hard ligands, electron counting, formal oxidation state, 18-e rule and its exceptions. Reactions of organometallic complexes: Ligand substitution/ exchange/dissociation processes and thermochemical considerations, catalyzed and assisted ligand substitution reactions, oxidative addition (definition, mechanism, thermodynamic consideration), oxidative addition of non-polar and polar electrophilic reagents, reductive elimination (bite angle effects, π-acid effects), transmetallation (definition, mechanism, utility)	10
IV	Chemistry of Lanthanides and Actinides: Introduction, chemistry of 'f' block elements, position in periodic table, oxidation states and their stability, lanthanide and actinide contraction, magnetic properties, spectral properties, separation technologies in lanthanides: (a) ion exchange, (b) solvent extraction	6
V	Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX2, ABX3 type compounds, spinels, band theory, metals and semiconductors.	8

Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **define**[1] main group elements, their properties and bonding.
CO2	Students will be able to **apply**[3] the knowledge about different compounds of main group elements.
CO3	They will acquire an **understanding**[2] of metal ligand bonding in transition metal complexes.
CO4	They will be able to **analyze**[4] the electronic spectra of transition metal complexes.
CO5	They will **understand**[2] the symmetry based concepts for inorganic molecules.
Text Books:	• R Sarkar, General and Inorganic Chemistry (vol I), 2011, 3rd Edition, New Central Book Agency. • F A Cotton and G. Wilkinson,Advanced Inorganic Chemistry, 1999, 6th Edition, John Wiley & Sons, New York. • J E Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, 2006, 4th Edition,Addison-Wesley Pub. Co., New York. • A Kar, Advanced Inorganic Chemistry, 2017, Vol I & II, CBS. • J D Lee, Concise Inorganic Chemistry, 5th edition, 2008, Oxford University Press.
Reference Books:	• R S Drago, Physical Methods in Inorganic Chemistry, 197, International Edition, Affiliated East-West Press, New Delhi, • K F Purcell and John C. Kotz, Inorganic Chemistry, 1987, W. B. Sauders Com., Hong Kong. • K. Veera Reddy, Symmetry and Spectroscopy of Molecules, 1999, New Age International Pvt. Ltd.

COURSE CODE	Inorganic Chemistry – III (Practical)
SC23CH0011P	**2**
	1. Preparation of Cuprous Chloride, Cu_2Cl_2 2. Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$ 3. Preparation of Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ 4. Synthesis of Cis and trans Potassium dioxalatodiaquachromate (III) $K[Cr(C_2O_4)_2.(H_2O)_2]$ 5. Synthesis of Tetraamminecarbonatocobalt (III) ion 6. Synthesis of Potassium tris(oxalate)ferrate(III). 7. Synthesis and catalytic application of a solid acid, 12-tungstosilicic acid. 8. Synthesis, purification and metalation of a bio-inorganically important porphyrine ligand. 9. Determination of zinc oxide in pharmaceutical preparations by EDTA titration. 10. The preparation of hexamminecobalt(III) chloride and pentammineaquocobalt(III) chloride: Synthesis, isolation and characterization of the complex.

Syllabus

SEMESTER VIII

COURSE CODE	PHYSICAL CHEMISTRY-III	Total Lec.: 45
SC23CH0012		3-0-2
Learning Objectives:	• Prepare students with the basic knowledge of symmetry and group theory and molecular spectroscopy. • To produce students whose basic concepts are clear in quantum mechanics and nanotechnology.	
Pre-requisite:	Basic knowledge of thermodynamics.	
UNIT	CONTENT	HOURS
I	Symmetry and group theory: Symmetry based concepts: Energy level diagrams of metal complexes, symmetry elements and operations, determination of point group of a molecule, group representations, features of specific character tables Point symmetry operations, groups and group multiplication tables, similarity transformation and conjugate classes, identification of point groups, representation of symmetry operators and groups, rules (without derivation) for construction of character tables with illustrations, symmetry elements and symmetry operations of the platonic solids, symmetry of the fullerene structure. The Great Orthogonality Theorem: statement and interpretation, construction of character tables of simple molecules projection operators (without derivations)	12
II	Quantum mechanics: Overview of experimental findings; identification of classical and quantum systems, Bohr's correspondence principle, postulates of quantum mechanics, properties of wave functions, operators and related theorems; degeneracy, spread of observation and uncertainty principle, Ehrenfest's theorem, exactly solvable problems: step potential and tunnelling, harmonic oscillator, rigid rotator; elementary discussion of the H-atom solution.	8
III	Principles of molecular spectroscopy: Fundamentals; rotational spectra: classification of molecules into spherical, symmetric and asymmetric tops; diatomic molecules as rigid rotors - energy levels, selection rules and spectral features, isotope effect, intensity distribution, effect of non-rigidity on spectral features. Vibrational spectra of diatomics: potential energy of an oscillator, Harmonic Oscillator approximation, energy levels and selection rules, anharmonicity and its effect on energy levels and spectral features: overtones and hot bands, vibration-rotation spectra of diatomics: origin; selection rules; P, Q and R branches. Raman spectra: origin, selection rules, classical and quantum treatment of rotational and vibrational Raman spectra of diatomics, resonance Raman spectroscopy. NMR spectra: theory, relaxation process, spin interactions - its origin, equivalent protons, a few representative examples.	10
IV	Thermodynamics and statistical mechanics: Maxwell-Boltzmann distribution with degeneracy (for both distinguishable and indistinguishable particles), partition function and its properties, interpretation of thermodynamic laws, thermodynamic function in terms of partition functions, molecular partition functions (translational, rotational, vibrational and electronic) for ideal gas, calculation of thermodynamic functions for monoatomic and diatomic gases, equipartition principle, equilibrium constant in terms of partition function.	8

V	Elementary nanotechnology: Principles and practices, density of states – zero dimensional solid, one-dimensional quantum wire, thin film and three-dimensional box; some special nanomaterials – fullerenes, carbon nanotubes and nanodiamonds; optical properties of metallic nanoparticles; nanolithography.	7
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will be able to **demonstrate**[2] the symmetries of physical systems.	
CO2	They will **understand**[2] of the Quantum Mechanics postulate on the physical systems.	
CO3	Students will learn to **classify**[2] the combination of spectroscopic methods and techniques are optimal for solving the specific scientific problem.	
CO4	They will **understand**[2] the concepts of statistical thermodynamics.	
CO5	They will **develop**[3]theknowledge of common applications for nanotectnology.	
Text Books:	• A K Mukherjee, Group Theory in Chemistry: Bonding and Molecular Spectroscopy, 2018, 1st Edition, The Orient Blackswan. • C N R Rao, A Müller, A K Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, 2004Wiley-VCH, Weinheim. • C N Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 1994, 4th Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi. • R. C. Mukherjee, Modern Approach to Physical Chemistry I, 2016, Bharati Bhawan Publishers & Distributors. • T. Varghese, K. M. Balakrishna, Nanotechnology: an Introduction to Synthesis Properties and Applications of Nanomaterials, 2012, Atlantic Publishers & Distributors Pvt Ltd.	
Reference Books:	• F A Cotton, Chemical Applications of Group Theory, 3rd Edition, John Wiley & Sons, New York, 1999. • S C Rakshit, Molecular Symmetry Group and Chemistry, The New Book Stall, Kolkata, 1988. • R Taylor, The Chemistry of Fullerenes, Advanced Series in Fullerenes, Vol 4, 1995, World Scientific, Singapore • C. Poole, Introduction to Nanotechnology, Wiley Student Edition, 2016, Wiley.	

COURSE CODE	Physical Chemistry – III (Practical)
SC23CH0012P	**2**
	1. Determination of dissociation constants of weak acid and weak base. **2.** Conductometric titration of an acid and a base. **3.** Potentiometric titration of acid and base. **4.** Kinetics of catalytic decomposition of H_2O_2. **5.** Kinetics of acid catalysed hydrolysis of sugar. **6.** Study the kinetics of the following reactions. a. Initial rate method: Iodide-persulphate reaction b. Integrated rate method: **7.** Acid hydrolysis of methyl acetate with hydrochloric acid. **8.** Determination of molar mass of non-electrolyte by Walker-Lumsden method **9.** Determination of partition/distribution coefficient of Benzoic acid in water and toluene **10.** Determination of composition of liquid mixtures by refractometry. (toluene and alcohol, water and sucrose)

TRACK - PHYSICS (MINOR)

Syllabus SEMESTER I

COURSE CODE	MATHEMATICAL PHYSICS	Total Lec. :45
SC23PH001		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To introduce the students to vector calculus, partial differential equation, curvilinear coordinates, and Fourier series. ● To be able to understand and apply the vector differentiation and integration to physical problems. ● To be able to understand and analyze the solution of partial differential equations. ● To be able to understand the green's theorem, Stokes the oremandits application to physical problems. ● To be able to understand and apply the beta function and gamma function in physical problems.	
Pre-re quisite:	Physics &Mathematics(10+2)	
UNIT	CONTENT	HOURS
I	Properties of vectors, scalar product and vector product, scalar triple product and their interpretation in term so far area and volume respectively, scalar and vector fields, vector differentiation: directional derivatives and normal derivative, gradient of a scala field and its geometrical interpretation, divergence and curl of a vector field ,Del and Laplaci an operators, vector identities.	10
II	Ordinary integrals of vectors, double and triple integrals, change of order of integration, Jacobian, notion of infinite simalline, surface and volume elements, line, surface and volume integrals of vector fields, flux of a vector field, Gauss ' divergence theorem, Green's and Stokes theorems and the verification (no rigorous proofs).	12
III	Solutions to partial differential equations using separation of variables :Laplace's equation in problems of rectangular geometry, solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes, solution of 1D heat flow equation, plotting of functions,approximation:Taylorandbinomialseries(statementsonly),firstorder differential equations(variables reparable, homogeneous, non-homogeneous), exact and in exact differential equations and integrating factor.	6
IV	Some special integrals : eta and Gamma functions and relation between them, expression of Integrals in terms of Gamma functions, orthogonal curvilinear coordinates, derivation of gradient, divergence, Curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems	7
V	Periodic functions, orthogonality of sine and cosine functions, dirichlet conditions (statement only), expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, evenandoddfunctionsandtheirfourierexpansions,application,summingof infinite series, parseval's identity and its application to summation of infinite series.	10
Course Out comes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1]the partial differential equation, Beta function, and Gamma	

	function.
CO2	They will be able to **analyze**[4]thesolutionofordinary,and partial differential equation.
CO3	They will be able to identify the Beta function, Gamma function and **apply**[3] it in physical Problems.
CO4	They will be able to **calculate**[4] the gradient, curl, divergence, and,1dimensional,2 Dimensional and 3dimensional vector integration.
CO5	They will be able to **understand**[2] the Green's theorem, Stokes the oremandits **application**[3] to physical problems.
Text Books:	● S. Paland S .C. Bhunia, Engineering Mathematics,2015,OxfordUniversityPress. ● M.R.S piegel, Fourier Analysis,2004,TataMcGraw-Hill. ● Arfken, Weber, Mathematical Methods for Physicists, 2005, Harris, Elsevier.
Reference Books:	● Susan M. Lea, Mathematics for Physicists, 2004, Thoms on Brooks/Cole. ● George F .Simmons, Differential Equations, 2006, Tata McGraw-Hill. ● Erwin Kreyszig, Advanced Engineering Mathematics, 2015, Wiley.

Practical

COURSECODE	**PHYSICSLAB-I**	**Practicals:**
SC23PH001P		**1**
	1. Measurements of length (or diameter)using vernier caliper, screw gauge and travelling microscope. 2. To study the random error in observations. 3. To determine the height of a building using a sextant. 4. To determine the moment of inertia of a Fly wheel. 5. To determine g and velocity for are ely falling body using digital timing technique. 6. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method). 7. To determine the Young's modulus of a wire by optical lever method. 8. To determine the modulus of rigidity of a wire by Maxwell's needle. 9. To determine the elastic on stants of a wire by Searle's method. 10. To determine the value of g using bar pendulum. 11. To determine the value of g using Kater's pendulum.	

Syllabus SEMESTER II

COURSECODE	MECHANICS	Total Lec.:45
SC23PH002		3-0-2
Learning Objectives:	The course provides deep knowledge about the following: ● The students will be introduced about the frame of reference (inertial and non-inertial), transformation, Invariance, and its use in analysis of a moving system. ● The course will give knowledge about the important on concept like center of mass, moment of inertia, fictions (pseudo)forces and its use in describing rotational motion. ● The course provides the students about the knowledge of understanding the properties of fluid and fluid motion through concepts like surface tension and viscosity. ● The understanding of physics of vibration and oscillation.	
Pre-requisites:	Elementary Idea of Calculus, Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, introduction to special relativity And relative is trick in mathematics.	

UNIT	CONTENT	HOURS
I	Reference frames, inertial frames; Galilean transformations; Galilean invariance, many system of particles dynamics, center of mass, principle of conservation of momentum,variable-mass system:motion of rocket,work-energy theorem, conservative and non-conservative forces, elastic and inelastic collisions between particles, center of mass and laboratory frames, two body problem and its reduction to the one-body problem and its solution, law of gravitation, gravitational potential energy, potential and field due to spherical shell and solid sphere, Kepler's laws.	10
II	Angular momentum of a particle and system of particles, torque, principle of conservation of angular momentum, rotation about a fixed axis, moment of inertia ,moment of inertia for rectangular, cylindrical and spherical bodies, kinetic energy of rotation, motion involving both translation and rotation, non-inertial frames and fictitious forces,uniformly rotating frame,laws of physics in rotating coordinate systems, centrifugal force, coriolis force and its applications.	10
III	Molecular model of matter, surface tension, surface energy, the angle of contact between surfaces, capillary phenomena ,excess pressure on a curved liquid membrane, dependence of surface tension on external factors ,elastic moduli and their relations, twisting torque on a cylinder or wire, kinematics of moving fluids , Poiseuille's equation for flow of a liquid through a capillary tube.	7
IV	Simple harmonic oscillations, differential equation of SHM and its solution, kinetic energy ,potential energy ,total energy and their time-average values ,damped oscillation, forced oscillations: transient and steady states; resonance, sharpness of resonance ;power dissipation and quality factor, a pair of linearly coupled oscillators – Eigen frequencies and normal modes (matrix m ode of analysis not required here),super position of perpendicular oscillations, Lissajous figures	8
V	Michelson-Morley experiment and its outcome ,postulates of special theory of relativity, Lorentz transformations, simultaneity and order of events, Lorentz contraction, time dilation, relativistic transformation of velocity, frequency and wave number. relativistic addition of velocities, variation of mass with velocity ,mass less particles, mass-energy equivalence, relativistic Doppler effect, relative stick in ematics , transformation of energy and momentum.	10
Course Outcomes as per Bloom's Taxonomy		

CO1	Students will be able to **define**[1]referenceframeanditssignificanceinconnectionwith mechanics.
CO2	They will beabletoTheywillbeableto**nterpret**[2]thelawofgravitation and Kepler's law and Their **application**[3] in problem related with physics.
CO3	They will be able to **understand** [2]the concept of elasticity ,surface tension ,viscosity and Fluid flow.
CO4	They will be able to **distinguish** various types of simple harmonic motion.
CO5	They will be able to **understand**[1] the concept of time dilation ,length contraction and the concept Of simultaneity.
Text Books:	● DSMathur,2000, S. Chandand Company Limited, ● C. Kittel, W.Knight, et.al,Mechanics, Berkeley Physics, vol.1, 2007,TataMcGraw-Hill. ● GR Fowles and G.L. Cassiday Analytical Mechanics,2005,CengageLearning,
Reference Books:	● RP Feynman , R.B. Leighton, M. Sands, Feynman Lectures, Vol. I,2008, PearsonEducation. ● RR esnick, Introduction to Special Relativity, 2005, John Wiley and Sons. ● RL Reese, University Physics,2003,ThomsonBrooks/Cole,

Practical

COURSE CODE	PHYSICSLAB-II	Practicals:
SC23PH002P		1
	● Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope. ● To study the random error in observations. ● To determine the height of a building using a Sextant. ● To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. ● To determine the Moment of Inertia of a Flywheel. ● To determine g and velocity for a freely falling body using Digital Timing Technique ● To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).	

Syllabus SEMESTER III

COURSE CODE	THERMAL AND STATISTICAL PHYSICS	Total Lec.:45
SC23PH003		3-0-2
Learning Objectives:	The course provides deep knowledge about the following: ● This paper deals with the study of Thermodynamics and Statistical Physics. ● Course provides the concepts of heat, work, and energy. ● Student learns the different laws of thermodynamics. ● Students learns the concept of thermo-dynamical functions and there relations, and also about the Statistical Physics and its implementations. ● Students learn about the contributions of Physicists.	
Pre-requisites:	Fundamentals of thermodynamics.	

UNIT	CONTENT	HOURS
I	Thermodynamics-I: Reversible and irreversible process. Heat engines. Definition of efficiency, Carnot's ideal heat engine, Carnot's cycle. Effective way to increase efficiency, Carnot's engines and refrigerator, Coefficient of performance, Second law of thermodynamics, Various statements of Second law of thermodynamics, Carnot's theorem, Clapeyron's latent heat equation, Carnot's cycle and its applications. Steam engine, Otto engine. Petrol engine. Diesel engine.	10
II	Thermodynamics-II: Concept of entropy. Change in entropy in adiabatic process. Change in entropy in reversible cycle. Principle of increase of entropy. Change in entropy in irreversible process. T-S diagram. Physical significance of Entropy, Entropy of a perfect gas. Kelvin's thermodynamic scale of temperature, The size of a degree. Zero of absolute scale, Identity of a perfect gas scale and absolute scale. Third law of thermodynamics. Zero point energy, Negative temperatures (not possible), Heat death of the universe. Relation between thermodynamic variables (Maxwell's relations).	10
III	Statistical Physics-IDescription of a system : Significance of statistical approach, Particle-states, System-states, Micro-states and Macro-states of a system, Equilibrium states, Fluctuations, Classical and statistical probability, The equi-probability postulate, Statistical ensemble, Number of states accessible to a system, Phase space. Micro canonical ensemble, Canonical ensemble, Helmholtz free energy, Enthalpy, First law of thermodynamics, Gibbs free energy, Grand canonical ensemble.	7
IV	Statistical Physics-II: Statistical Mechanics: Phase space. The probability of a distribution. The most probable distribution and its narrowing with increase in number of particles. Maxwell-Boltzmann statistics. Molecular speeds. Distribution and mean, r.m.s. and most probable velocity. Constraints of accessible and inaccessible states. Quantum Statistics: Partition Function. Relation between Partition Function and Entropy, Bose-Einstein statistics. Black-body radiation, The Rayleigh-Jeans formula, ThePlanck radiation formula, Fenni-Dirac statistics. Comparison of results. Concept of Phase transitions.	8
V	Contributions of Physicists: S.N. Bose, M.N. Saha, Maxwell. Clausius, Boltzmann, Joule. Wien, Einstein, Planck, Bohr. Heisenberg,Fermi, Dirac, Max Born. Bardeen.	10

Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **define**[1] thermodynamics laws.
CO2	They will be able to **interpret** [2]the law thermodynamics and their **application**[3] in problem related with physics.
CO3	They will be able to **understand** [2]the concept of thermodynamics and statistical physics
CO4	The will be able to **distinguish**[4]between thermal and statistical physics
CO5	They will be able to **understand**[1]theconceptofradiations and different thermal statistics

Text Books:	● Unified Physics, R. P. Goyal, Shiva lal Agarwala & Company ● Heat, Thermodynamics and Statistical Physics, Brijlal, Dr. N. Subrahmanyam, P. S. Hemne, S. Chand Publications.
Reference Books:	● Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill. ● A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. ● Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications. ● Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill 14 ● Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa ● University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. ● Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

Practical

COURSE CODE	**PHYSICS LAB-III**	**Practicals:**
SC23PH003p		**1**
	● To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. ● To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus. ● To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method. ● To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. ● To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). ● To study the variation of Thermo- Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	

Syllabus SEMESTER IV

COURSE CODE	**WAVES AND OPTICS**	**TotalLec.:45**
SC23PH004		**3-0-2**

Learning Objectives:	● The Course provides knowledge of SHM ,superposition of two SHMs, Lissajous figure and various types of oscillation. ● In this course, students will be introduced to fundamental concepts of waves and optics ● It develops understanding about Fermat's and Huygens's principles and their applications and related phenomena like Interference and diffraction of light. ● It give knowledge about the construction and working of LASER and its applications	
Pre-requisites:	Elementary idea of mechanics, mathematics, and optics.	
UNIT	**CONTENT**	**HOURS**
I	**Simple Harmonic Motion (SHM): S**uperposition of SHMs (superposition of twocollinearandtwoperpendicularSHMshavingequalfrequenciesanddifferentfrequencies, Beats and Lissajous Figures). **Free Damped Oscillations**: Introduction, damping forces, brief quantitative and qualitative description of damped oscillation of a system having one DoF (equation of motion, solution, large, critical &small damping, energy of a weakly damped oscillator , logarithmic decrement ,relaxation time and Q-factor). **Forced Oscillations and Resonance** :Introduction, brief quantitative and qualitative description of forced oscillation of a system having one degree of freedom(DoF) (equation of motion, solution ,resonance).	10
II	**Mechanical Waves:** Types of mechanical waves, mathematical description of wave (i,e,, classical wave equation), speed of transverse wave, energy in wave motion, wave interference, boundary conditions, and superposition, standing waves In a string, normal modes of a string. **Sound and Hearing:** Sound waves, speed of sound waves, sound intensity and decibal, standing sound waves & normal modes, resonance and sound ,interference Of waves and Beats ,Doppler Effect ,shockwaves.	10
III	**Fermat's and Huygens's principles:**Light is an electromagnetic spectrum, Fermat's principle and its application, Huygens's principle its application. **Interference:**Young'sexperiment-coherence,intensitydistributionandvisibility offringes, Fresnel's Biprism, Interference in thin films, Interference at anair wedge, Newton' srings, Michelson's interferometer.	9
IV	**Diffraction:** Fraunh offer and Fresnel Diffraction: Diffraction at a single slit, double slit, Diffraction by multiple slits, Diffraction grating, Resolving power- Rayleigh' scriterion, Resolving power of a grating and telescope, Fresnel diffraction-halfperiodzone,Zoneplate,Diffractionatacircularapertureandatastraightedge (qualitative treatment only).	9
V	**Lasers:** Spontaneous emission, absorption, and stimulated emission, Einstein's AandBcoefficientsandrelationbetweenthem,conditionforamplification,population inversion, methods of optical pumping, energy level schemes of Ruby laser and He-Ne laser, properties and uses of lasers.	7
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define** [1]Lissajousfigure,damped and forced oscillator, Doppler effect, Fermat' s principle ,interference & diffraction ,Einstein A and B coefficients.	
CO2	They will be able to **interpret**[2] various types of oscillation s, interference &diffractions Through various apertures.	
CO3	They will be able to **understand**[2] various optical phenomena, principles ,working ,and Applications of optical instruments ,spontaneous and stimulated emission of radiation ,optical	
	Pumping and population in version ,basic lasing ,various types of lasers in details and their applications.	
CO4	The y will be able to **distinguish** [4]various types of oscillations, lasers ,diffractions(Fresnel & Fraunh offer)	
CO5	They will be able to **understand**[1] the concept of interference ,diffraction, working principle of Various types of lasers.	

Text Books:	● P. Tipler, Physics for Scientists & Engineers,6th Edition, 2007, W.H. Freeman. ● A. Ghatak, Optics,7th Edition, 2020, Mc Graw Hill Education India Private Limited. ● K. Thyagrajan &A.K. Ghatak, Lasers: Fundamentals & Applications, 2nd Edition, 2016 , Laxmi Publications Private Limited.
Reference Books:	● A. Lipson, S.G. Lipson, &H. Lipson, Optical Physics,4th Edition, 2010,Cambridge University Press. ● B.B. Laud, Lasers &Non-line r Optics,2011, New Age International Private Limited. ● H. Parthasarathy, 1stEdition, 2021, Harish Parthasarathy, CRC Press.

Practical

COURSE CODE	**PHYSICS LAB-IV**	**Practicals:**
SC23PH004P		**1**
	● To determine the wavelength of sodium source using Michelson's interferometer. ● To determine wavelength of sodium light using Fresnel Biprism. ● To determine wavelength of sodium light using Newton's Rings. ● To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. ● To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating. ● To determine dispersive power and resolving power of a plane diffraction grating.	

Syllabus SEMESTER V

COURSE CODE	**CLASSICAL ELECTRODYNAMICS**	**Total Lec.:45**
SC23PH005		**3-0-0**

Learning Objectives:	● Interpret the deeper meaning of the Max wellian field equations and account for their symmetry and transformation properties, domain of validity, and limitations ● Formulate of electromagnetic problems with the help of electrodynamics potentials and super potentials, and make a detailed account for gauge transformations and their use ● Master the technique of deriving and evaluating formulae for the electromagnetic fields from very general charge and current distributions ● Calculate the electromagnetic radiation from radiating systems (aerials, localized charge and current distributions) at rest ● Calculate the electromagnetic radiation from localised charges which move arbitrarily in time and space, taking into account retardation effects. Account for the underlying approximations and assumptions	
Pre-requisites:	Physics + Mathematics (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Electrostatics: Electric potential, Poisson and Laplace's equations. Boundary value problems, Uniqueness theorems, Green's theorem. Method of images, Method of separation of variables (Cartesian Coordinates, Spherical and Cylindrical Coordinates), Multiple expansion.	10
II	Electromagnetic Waves: Maxwell's equations, Boundary conditions, Wave equation and its complex notation, Electromagnetic waves in vacuum, Electromagnetic waves in non conducting and linear media, Electromagnetic waves in linear conducting media. Poynting theorem, Reflection, refraction and polarization of electromagnetic waves.	10
III	Waveguides and Cavities: Metallic boundary conditions, Electromagnetic waves confined to hallow metallic pipe, TE, TM and TEM modes, TE and TM modes in rectangular waveguides, Bessel's function, TE and TM modes in cylindrical waveguides, Dielectric waveguides, TE and TM modes in rectangular and cylindrical Resonant cavities.	9
IV	Potential, Fields and Radiations: Scalar and vector potentials, Gauge transformation, Coulomb and Lorentz gauge, Retarded potential, Lienard-Wiechert potentials, Fields due to moving charge, Power radiated by an accelerated charge and angular distribution, Bremstrahlung Cerenkov and Synchrotron radiations.	9
V	Relativistic Electrodynamics: Four vectors, Lorentz transformation in terms of Four vectors, Lorentz transformation matrix, Transformation of electromagnetic fields, Field Tensor, Dual field strength tensor, Maxwell's equations in terms of strength tensors,	7
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1] terms related to electrostatics..	
CO2	They will be able to **interpret**[2] electromagnetic waves .	
CO3	They will be able to **understand**[2] various wave guides and cavities.	
CO4	They will be able to **distinguish**[4] potential, fields and radiations.	
CO5	They will be able to **understand**[1] theconceptof relativistic electrodynamics.	
Text Books:	● David J. Griffith; Introduction to Electrodynamics, PHI Private Limited, 1999 2. ● John D. Jackson; Classical Electrodynamics, Wiley Eastern Limited, 1998 3. ● F.F. Chen; Plasma Physics and Controlled Fusion,Springer,2006	
Reference Books:	● Edward C. Jordan and Heith G. Balmain; Electromagnetic Waves and Radiating Systems, PHI, 1991 2. ● W.K.H. Panofsky and M. Phillips; Classical Electricity and Magnetism, Dover Publications; 2nd Ed., 2005 3. ● J A Bittencourt; Fundamentals of Plasma Physics, 3rd Ed, Springer, 2004	

Syllabus SEMESTER V

COURSE CODE	ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM	Total Lec . :45
SC23PH006		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To describe, in words, the ways in which various concepts in electromagnetism come into play in particular situations; ● To represent these electromagnetic phenomena and fields mathematically in those situations; ● And to predict outcomes in other similar situations. ● The overall goal is to use the scientific method to come to understand the enormous variety of	

	electromagnetic phenomena in terms of a few relatively simple laws.	
Pre-re quisite:	Physics & Mathematics(10+2)	
UNIT	**CONTENT**	**HOURS**
I	Electrostatics Coulomb's inverse square law – Gauss theorem and its applications (Intensity at a point due to a charged sphere & cylinder) – Principle of a capacitor – Capacity of a spherical and cylindrical capacitors –Energy stored in a capacitor – Loss of energy due to sharing of charges.	10
II	Current Electricity Ampere's circuital law and its applications - Field along the axis of a circular coil and Solenoid – Force on a conductor in a magnetic field – Theory of Ballistic Galvanometer – Figure of merit – Damping Correction – Wheatstone network – Carey Foster's Bridge – Potentiometer - Measurement of current, resistance and low voltage.	12
III	Magnetism Intensity of magnetization - Susceptibility – Types of magnetic materials – Properties para, dia and ferromagnetic materials – Cycle of magnetization – Hysteresis – B-H curve – application of BH curve–Magnetic energy per unit volume.	6
IV	Electromagnetic Induction Laws of electromagnetic induction – Self and mutual induction – Self-inductance of a solenoid – Mutual inductance of a pair of solenoids – Coefficient of coupling – Experimental determination of self and mutual inductance (Rayleigh's method) Growth decay of current in circuit containing Land R – Growth and decay of charge in circuit containing C and R – High resistance by leakage – Charging and discharging of capacitor through Land R.	7
V	AC Circuits Alternating EMF – Alternating EMF applied to circuits containing L and R – C and R – Alternating EMF applied to circuits containing L, C and R – Series and Parallel resonance circuits – Sharpness of resonance– Q factor – Power in AC circuits – Power factor – Watt less current	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1]the electrostatics and its theorem.	
CO2	They will be able to **analyze**[4]theampere's circuital law.	
CO3	They will be able to identify the magnetism and **apply**[3]it in physical problems.	
CO4	They will be able to calculate 4 the electromagnetic inductions and practical applications.	
CO5	They will be able to **understand**[2] the AC Circuitsits **application**[3] to physical problems.	
Text Books:	● Brijlal and Subramaniyam – Electricity and Magnetism – S. Chand & Co. ● R. Murugesan, Electricity and Magnetism, S.Chand & Co.	
Reference Books:	● Narayana moorthy and Nagaratnam, Electricity and Magnetism NPC, Chennai ● Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education. ● Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.	

Practical

COURSE CODE	**PHYSICS LAB-V**	**Practicals:**
SC23PH006P		**1**

	● To study the characteristics of a series RC Circuit. ● To determine an unknown Low Resistance using Potentiometer. ● To determine an unknown Low Resistance using Carey Foster's Bridge. ● To compare capacitances using De'Sauty's bridge. ● Measurement of field strength B and its variation in a solenoid (determine dB/dx ● Determine output characteristics of a LVDT & measure displacement using LVDT ● Measurement of Strain using Strain Gauge. ● Measurement of level using capacitive transducer. ● To study the characteristics of a Thermostat and determine its parameters. ● Study of distance measurement using ultrasonic transducer. ● Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75) ● To measure the change in temperature of ambient using Resistance Temperature Device (RTD).

Syllabus SEMESTER VI

COURSE CODE	QUANTUM MECHANICS	TotalLec. :45
SC23PH007		3-0-0
Learning Objectives:	After studying this paper the students will know– ● Foundation of quantum mechanics–failure of classical mechanics. ● Concept of operator formalism - position, momentum and energy operators, operator algebra. ● Schrodinger equation and its applications (e.g., particle in one- & three-dimensional potential box, quantum mechanical tunneling ,potential barrier, delta potential, potential step, transmission coefficient, Hydrogen atom. ● Concept of identical particles.	
Pre-re quisite:	Foundations of Physics & Mathematics	
UNIT	CONTENT	HOURS
I	**Dirac Delta Function and Kronecker Delta Function:** Dirac delta function and Kronecker delta function, phase and group velocity, wave packet, Gaussian wave packet. **Blackbody Radiation:** Blackbody radiation, Planck's quantum hypothesis, explanation of black body radiation.	10
II	**Fundamental Concepts:** Photoelectric effect, Compton effect, specific heat of solids,deBrogliewavelength/ wave-particle duality,Davison-Germer experiment, wave packets/Gaussian wave packet, phase and group velocity ,concept of wave function,differences between classical & quantum mechanics,Heisenberg's uncertainty principle,Fourier transform and momentum - spacewave function(i.e. expansion of a wave function in terms of position and momentum wave functions).	12
III	**Operator Formalism:** Operator formalism, position, momentum and energy operators ,operator algebra,commutator,expectationvalue,Ehrenfesttheorem,Hermitianoperators,Hermitianadjoint,variouspr opertiesof Hermitianoperator,operatorscommutingwithH,simultaneouseigenfunctionsof commuting operators, postulates of quantum mechanics,	6
IV	**Schrödinger Equation:** Schrodinger equation ,free particle solution ,super position of wave functions ,stationary states, orthogonality of eigen funtions, degenerate & non degenerate eigen values ,probability current density, time dependent and time independent Schrödinger equation.	7
V	**Applications of Schrodinger equation in simple cases:** One dimension-infinite square well potential, both one and three dimensional cases of a particle in a box ,finite square well, attractive delta function potential, harmoni coscillator, potential step, and potential barrier, simple harmonic oscillator.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Dirac delta function and Kronecker delta function, black body radiation, photo electric effect, various quantum mechanical operator and Schrodinger equation.	
CO2	They will be able to **interpret**[2] various operators, wave function.	
CO3	They will be able to **understand**[2] the theory of quantum measurements, wave packets and Uncertainty principle.	
CO4	They will be able to **distinguish**[4] various types of oscillations, lasers, diffractions(Fresnel & Fraunh offer)	
CO5	They will be able to **understand**[1] the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, timed ependent and Time independent cases, probability density and the normalization techniques.	
Text Books:	● Donald B Grey, Quantum Physics for Beginners,2020,Han Global Trading Pt Ltd. ● P.W.Mathewsand K.Venkatesan, A Textbook of Quantum Mechanics, 2nd Edition, 2017,Tata Mc Graw Hill. ● Ghatak and Loknathan,QuantumMechanics-Theory and Applications, 5th Edition, 2015, Laxmi Publications.	
Reference Books:	● L.I. Schiff, Quantum Mechanics,4thEdition,2017, Mc Graw Hill Education. ● D.J.Griffiths,Introduction to Quantum Mechanics, 2019, Cambridge University Press. ● P.A.M. Dirac, The Principles of Quantum Mechanics, 4thEdition, 1981, Oxford Science Publications.	

SEMESTER VI

COURSE CODE	PLASMA PHYSICS	TotalLec. :45
SC23PH008		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To introspect the plasma parameters and various phenomena associated with its applications. ● Interpret the basics of the plasma parameters and related fluid equations ● Analyze the behavior of electromagnetic waves and electron beam with plasma ● Introspect the particle motions under the influence of external electric and magnetic field	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Introduction Basic concepts of plasma, concept of temperature, Debye length, plasma frequency, criteria for plasmas	10
II	Fluid equations Response of plasma to the fields, DC conductivity, AC conductivity, RF conductivity, collisions	12
III	Waves in Plasma: Plasma in relation with electromagnetic waves, electromagnetic wave propagation, propagation in inhomogeneous plasma, electrostatic waves in plasma, energy flow	6
IV	Interaction of plasmas with electron beam Two-stream instability, relativistic electron beam-plasma interaction, growth rate, Cerenkov free electron laser, free electron laser and energy gain	7
V	Particle motion in uniform electric fields, particle motion in uniform magnetic fields, non-uniform electric and magnetic fields, time-varying electric and magnetic fields, curvature drifts, adiabatic invariance, magnetic mirror, Tokomak	10
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will beableto**define**[1]Plasma and its criteria	
CO2	They will be able to **interpret**[2] various fluid equation..	
CO3	They will be able to **understand**[2] the waves in plasma.	
CO4	They will be able to **distinguish**[4] various types of plasma with electron beam	
CO5	They will be able to **understand**[1 the] Particle motion in electric fields.	
Text Books:		
Reference Books:	● Introduction to Plasma Physics and Controlled Fusion by F. F. Chen, 3rd edition (2016), Springer International Publishing. ● Interaction of electromagnetic waves with electron beams and plasmas by C.S. Liu and V.K. Tripathi, (1994) World Scientific. ● Principles of Plasma Discharges and Materials Processing by Michael A. Lieberman and Alan J. Lichtenberg, 2nd edition (2005) Wiley	

Practical

COURSECODE	PHYSICSLAB-VI	Practicals:
SC23PH008P		1
	● Measurement of Planck's constant using black body radiation and photo-detector ● Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light ● To determine work function of material of filament of directly heated vacuum diode. ● To determine the Planck's constant using LEDs of at least 4 different colours. ● To determine the wavelength of H-alpha emission line of Hydrogen atom. ● To determine the ionization potential of mercury. ● To determine the absorption lines in the rotational spectrum of Iodine vapour. ● To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet. ● To setup the Millikan oil drop apparatus and determine the charge of an electron. ● To show the tunneling effect in tunnel diode using I-V characteristics. ● To determine the wavelength of laser source using diffraction of single slit	

Syllabus SEMESTER VIII

COURSE CODE	SOLID STATE PHYSICS	TotalLec. :45
SC23PH009		3-0-0
Learning Objectives:	After studying this paper the students will know– ● Knowledge and understanding of crystal structure, electronic and vibrational properties of solid-state systems. ● Basic properties of metals, insulators and semiconductors. ● Semiconducting elements for the use in electronic devices. Low-dimensional semiconductors.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Crystal Structure: Introduction, Crystal lattice and translation vectors, unit cell, Basis, Symmetry operations ,point groups and space groups, types of lattices (Plane lattice and Space lattice with bcc and fcc), Lattice directions and planes, Miller indices, simple Crystal structure.	10
II	Bonding and Band Theory of Solids: Introduction, Concept of inter-atomic forces, Cohesive energy and types of bonding, Primary bonds (ionic bonds, Covalent bond and metallic bond), secondary bonds(Vander walls bond andhydrogen bonds)The Bloch theorem (only statement and properties), The Kroning Perry model, Energy versus Wave Vector relationship - different representations (Brillouin Zones).	12
III	Introduction, construction, working and characteristics of semiconductor diode, Zenerdiode, transistor (n-p-n and p-n-p transistor), Transistor Characteristics (CB, CE, CC), JFET (Construction and its characteristics).	6
IV	Schottky diode, MIS structures, basic equations in flat band conditions, MIS capacitances, current flow mechanisms in MS junction and MIS junction, depletion and enhancement type MOS FETS, capacitances in MOS FETs, quantitative analysis of I - V characteristics, thresholds in MOSFETS, charge trapping and flat band voltage, study of CMOS devices	7
V	Power diodes, ratings, reverses recovery characteristics, fast recovery diodes, Power transistors, Switching characteristics, construction of SCR, two transistors analogy, I- V characteristics, gate trigger characteristics, turn on and turn - off times, losses, reverse recovery characteristics, SCR ratings, dv/dt and di/dt characteristics, thyristor types, construction and characteristics of DIACs and TRIACs, static induction, thyristors, , light activated thyristors, Gate turn off thyristors (GTO), MOS controlledthyristors, programmable Unijunction transistors, Silicon Unidirectional switch (SUS), IGBT	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Crystal structure	
CO2	They will be able to **interpret**[2]bonding and band theory	
CO3	They will be able to **understand**[2]thesemiconductor diode.	
CO4	They will be able to **distinguish**[4]varioustypesofsemiconductor devices.	
CO5	They will be able to **understand**[1] the power electronic devices.	
Text Books:	● M. H. Rashid: Power Electronics. ● P. C. Sen: Power electronics ● B. G. Streetman and S. Banergee : Solid state Electronic Devices D.A. Roustan : Bipolar Semiconductor Devices.	
Reference Books:	● Karl Hess: Advanced theory of semiconductors devices. ● S. M. Sze: Physics of Semiconductor Devices 2nd edition. ● A Dir - Bar - Lev: Semiconductor and Electronic Devices.	

Syllabus SEMESTER VIII

COURSE CODE	NUCLEAR, ATOMIC AND MOLECULAR PHYSICS	Total Lec.: 45
SC23PH010		3-0-0
Learning Objectives:	• Objective of this course is to learn atomic, molecular and spin resonance spectroscopy	
Pre-requisite	General and Basic atomic structure	
UNIT	CONTENT	HOURS
I	One Electron Atom: Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, and Hyperfine structure. Two valance Electron Atom: Vector model for two valance electrons atom, LS coupling, Pauli Exclusion Principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling.	10
II	Atom in Magnetic Field: Zeeman Effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field.	7
III	Molecular Spectroscopy: Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions. Electron spin and nuclear magnetic resonance spectroscopy	7
IV	Nuclear forces and Models: Introduction of nuclear forces, nuclear binding energy, theoretical and practical estimate of dependence of binding energy, saturation, short range type, Nuclear fission and fusion, magic number, shell models, Liquid drop model	12
V	Particle Accelerators: Particle accelerator, linear resonance accelerator, cyclotron, synchro cyclotron, Vande-graff generator	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Describe the atomic spectra of one and two valance electron atoms.	
CO2	Explain the change in behavior of atoms in external applied electric and magnetic field.	
CO3	Explain rotational, vibrational, electronic and Raman spectra of molecules	
CO4	Describe electron spin and nuclear magnetic resonance spectroscopy and their Applications	
CO5	Able to understand the concept of particle accelerators	
Text Books:	• Introduction of Atomic spectra- White • Atomic and Nuclear Physics – N.Subramanayam and Brijlal • Elements of nuclear physics – M.L Pandya, R.P. Yadhave	
Reference Books:	• White, H.E., Introduction to Atomic Spectra, McGraw Hill, (1934). • Banwell, C.N. and McCash, E.M., Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007)	

Syllabus SEMESTER VIII

COURSE CODE	ANALOG AND DIGITAL CIRCUITS	TotalLec. :45
SC23PH011		3-0-0
Learning Objectives:	After studying this paper the students will know– ● To know the characteristics of various components. ● To understand the utilization of components. ● To design and analyze small signal amplifier circuits. ● To learn Postulates of Boolean algebra and to minimize combinational functions ● To design and analyze combinational and sequential circuits ● To know about the logic families and realization of logic gates.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Differential amplifier Circuit Configurations, Dual Input Balanced Output Differential amplifier, DC analysis, AC analysis, Inverting and Non Inverting Inputs, Constant Current Bias Circuit. Block diagram of a typical Op-Amp, Open loop configuration, Inverting and Non-inverting amplifiers, Op-amp with negative feedback, Voltage Series Feedback, Effect of feedback on closed loop gain, Input resistance, Output resistance, Bandwidth and Output offset voltage, Voltage follower. Practical Op-amp, Input Offset Voltage, Input bias current- input offset current, total output offset voltage, CMRR frequency response.	10
II	Applications of Op amps (15) DC and AC amplifier, Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Integrator and Differentiator. Oscillator: Principles , Oscillator types, Frequency stability, Response , Phase Shift oscillator ,Wein Bridge Oscillator, LC Tunable Oscillator , Multivibrators, Monostable and Astable, Comparators, Square Wave and Triangle wave generators. Voltage regulations: Fixed regulators, Adjustable voltage regulators, Switching regulators.	12
III	FETs and Digital Circuits: FETs: JFET, V-I characteristics, MOSFET, low frequency CS and CD amplifiers. Digital Circuits: Digital (binary) operations of a system, OR gate, AND gate, NOT, EXCLUSIVE OR gate, De Morgan Laws, NAND and NOR DTL gates, modified DTL gates, HTL and TTL gates, output stages, RTL and DCTL, CMOS, Comparison of logic families	6
IV	Combinational Logic Circuits: Basic Theorems and Properties of Boolean Algebra, Canonical and Standard Forms, Digital Logic Gates, The Map Method, Product-of-Sums Simplification, Don't-Care Conditions, NAND and NOR Implementation, Exclusive-OR Function, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers.	7
V	Sequential Logic Circuits: Sequential Circuits, Storage Elements: Latches and flip flops, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Shift Registers, Ripple Counters, Synchronous Counters, Random-Access Memory, Read-Only Memory.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Differential amplifier and its applications	
CO2	They will be able to **interpret**[2] applications of OPAMP	
CO3	They will be able to **understand**[2] the FETs and Digital Circuits.	
CO4	They will be able to **distinguish**[4] various types of combinational logic circuits.	
CO5	They will be able to **understand**[1] the sequential logic circuits..	
TextBooks:	● Integrated Electronics: Analog and Digital Circuits and Systems, 2/e, Jaccob Millman, Christos Halkias and Chethan D. Parikh, Tata McGraw-Hill Education, India, 2010. ● Digital Design, 5/e, Morris Mano and Michael D. Cilette, Pearson, 2011.	
ReferenceBooks:	● Electronic Devices and Circuits, Jimmy J Cathey, Schaum's outline series, 1988. ● Digital Principles, 3/e, Roger L. Tokheim, Schaum's outline series, 1994.	

Syllabus SEMESTER VIII

COURSE CODE	ELEMENTS OF CONDENSED MATTER PHYSICS	TotalLec. :45
SC23PH012		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To study some of the basic properties of the condensed phase of matter especially solids. Condensed matter physics (CMP) is the fundamental science of solids and liquids. ● As the largest branch of physics, it has the greatest impact on our daily lives by providing foundations for technology developments.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Basic Structures; symmetry properties, packing fractions, directions and position orientation of planes in crystal, concept of reciprocal lattice, concept of brillouin zones, closed packed structure, and structures of some binary/ternary compounds. Elementary concepts of polycrystalline, Nano crystalline and amorphous materials. Elementary concepts of defects in solids. X-ray scattering from solids including Laue conditions and line intensities.	10
II	Energy bands: Electron in periodic potential, Bloch function, solution of wave equation of electron in periodic potential, reduced, periodic and extended zone schemes. Construction of Fermi surfaces in brillouin zones for two - dimensional lattices, Introduction to methods for calculations of energy bands and their features. Semiconductors: Direct and indirect band gap semiconductors effective mass, intrinsic carrier concentration, impurity conductivity thermal ionization Revision on p-n junction and rectification, metal- semiconductor contacts, schotky barrier.	12
III	Dielectric properties of Solids, electronic, ionic, orientational, polarzabilities, static dielectric constant for gases, internal field in solids, dielectric constant of solids, dielectric relaxation in alternating fields, dielectric losses, complex dielectric constant.	6
IV	Concept of Energy Band: Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, Bloch theorem and crystal momentum, Classification of metal, insulator and semiconductors.	7
V	Super conductivity: Basic concepts, Meissner effect, heat capacity, energy gap, London equation, coherence length Josephson effect (flux quantization), type I and II superconductors, BCS theory, Introduction to high Tc Superconductors.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] basic structure of crystals.	
CO2	They will be able to **interpret**[2] energy bands.	
CO3	They will be able to **understand**[2] the dielectric properties of solids..	
CO4	They will be able to **distinguish**[4] various types of energy band.	
CO5	They will be able to **understand**[1] the super conductivity.	
Text Books:	● Srivastava, J.P., Elements of Solid State Physics, Prentice Hall of India, (2008).	
Reference Books:	● Introduction to Solid State Physics 4 th Ed. C. Kittel, ● Solid State Physics by A .J. Dekker ● Solid State Physics by N. W. Ashoroff &N. D. Mermin ● Solid State Physics S.O. Pillai ● Solid state Physics by R. L. Singhal	

Practical

COURSE CODE	PHYSICSLAB-VIII	Practicals:
SC23PH012P		1
	● To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO. ● To test a Diode and Transistor using a Multimeter. ● To design a switch (NOT gate) using a transistor. ● To verify and design AND, OR, NOT and XOR gates using NAND gates. ● To design a combinational logic system for a specified Truth Table. ● To convert a Boolean expression into logic circuit and design it using logic gate ICs. ● To minimize a given logic circuit. 8. Half Adder, Full Adder and 4-bit binary Adder. ● Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C. ● To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates. ● To build JK Master-slave flip-flop using Flip-Flop ICs. ● To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram	

SANJEEV AGRAWAL GLOBAL EDUCATIONAL UNIVERSITY, BHOPAL

Proposed Scheme & Syllabus
For

Bachelor of Science (B.Sc.)

Certificate/Diploma/Degree/Honors Degree/ Research Degree

in

Mathematics

w.e.f. 2023-24 (According to NEP 2020)

School of Sciences

MATHEMATICS

Program Educational Objectives (PEOs) Mathematics:

Program Educational Objectives (PEOs) Mathematics:

PEO-1: Prospective Employment and Career Prospects-Developing the potential for vertical career growth in Investigation laboratories, service sectors and related avenues.

PEO-2: Proficiency- Inculcating technical and managerial skills crucial for real time scenarios through the enhancement of problem-solving skills and advanced technical documentation ability.

PEO-3: Affectionate Objective- Grooming the students with technical proficiency to equip them for the emergence of Sustainable technology and solutions for prevailing environmental, societal and cultural concerns.

PEO-4: Research Methods-Nurturing the research aptitude to provide solutions for global challenges and abilities to explore hidden potential of the matter**.**

PEO-5: Continuous Learning-Instilling knowledge and awareness on professional ethics related to crime prevention and evidence analysis and life-long learning through career-oriented courses.

Program Outcomes (POs) Mathematics:

By the end of the program the students will be able to:

PO-1: Recall basic facts about mathematics and display knowledge of conventions such as notations, terminology etc.

PO-2: Think in a critical manner and develop a problem solving skill which leads in-depth knowledge of Algebra, Calculus, Geometry, differential equations and several other branches of pure and applied mathematics.

PO-3: Be competent to apply the knowledge and skills to critical thinking and logical reasoning and capable of recognizing and distinguishing the various aspects of real-life problems.

PO-4: Analyze the problems, identify and define appropriate computing requirements for its solutions.

PO 5: Able to inquire about appropriate questions relating to the Mathematical concepts in different areas of mathematics.

PO-6: Use appropriate software to solve system of algebraic equation and differential equations.

PO-7: Work independently and to make an in-depth study of various notions of Mathematics.

PO-8: Develop algorithms and computational skills for solving real world problems.

PO-9: Apply their skills and knowledge in various fields of studies including, science, engineering, commerce and management etc.

PO-10: Peruse advanced studies and research in pure and applied Mathematical sciences.

Bachelor of Science (B.Sc.)

CURRICULUM COMPONENTS

Components		Credits
University Core (Table 1)	Ability Enhancement Courses (06 Courses)	**12**
	Skill Enhancement Courses (06 Courses)	**12**
Discipline Core Courses (8 Courses) (Table 2)		**32**
Discipline Specific Major Electives (8+4 Courses) (Table 3)		**32R/48H***
Discipline Specific Minor Electives (6 Courses) (Table 3)		**24**
Interdisciplinary Minor Electives (04 Courses) (Table 4)		**16**
Project/Field Internship/Skill Based Project		**28H/44R***
Total		**172**

*** Opt either 04 Specialized Courses (for Honors Degree) or Research Based Industrial Project (for Research Degree)**

** Note: Any student opting out after I year / II year will obtain undergraduate Certificate/Diploma respectively in the specific discipline subject to mandatory 450hrs (8-10 week) ,10 credit Internship in SUB/Industry/Research organization.

Distribution of credits across all components

SEM.	University Core Courses. (one course = 02 credit) (Table 1)		Discipline Courses (DC) [one course = 4 credit] (Table 2)	Main Faculty (as per prerequisite)		Interdisciplinary Minor Elective Tracks (Employment Oriented) (Table 4)	Project/ Field Internship/ Skill Based Projects/Research Projects/industrial Projects	Total
	AEC	SEC		Discipline Specific Elective (one course = 4 credit) (Table 3)				
				(Major)	(Minor)			
I	2	2	4	4	4	4	3(PBL)	23
II	2	2	4	4	4	4	3(PBL)	23
III	2	2	4	4	4	4	3(PBL)	23
IV	2	2	4	4	4	4	3(PBL)	23
V	2	2	-	4+4	4		4(SIP)	20
VI	2	2	-	4+4	4		4(Minor Project)	20
VII			12				8(Major)	20
VIII*			4	16*			16*(Research/Internship Project)	20(4+16*)
Total	**12**	**12**	**32**	**32R/32+16*H**	**24**	**16**	**28H/28+16*R**	**172**

*** Opt either 04 Specialized Courses (For Honor Degree) or Research Based Industrial Project (For Research Degree)**
Note: PBL- Project Based Learning, SIP- Summer internship Project, SEC- Skill Enhancement Courses, AEC- Ability Enhancement Courses.

SEMESTER I

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA001	ALGEBRA AND CALCULUS -I	L-T-P 3-1-0
Learning Objectives	The main objectives of the course ● To give foundation knowledge for the students to understand basics of mathematics including applied aspect. ● To equip the student with necessary analytic and technical skills by applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.	
Prerequisites	Elementary idea about calculus	
UNIT	CONTENT	HOURS
I	Determinants and Matrices, Matrix- Definition. Types, Basic Operation on Matrices, Transpose of Matrix. Elementary operations on matrices, Determinants, Minors and Co factor, Ad joint and Inverse of Matrix. Singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix.	12
II	Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices. Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations. Cramer's Rule.	12
III	Functions of one variable, Limit of a function (ε-δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of singe variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. Successive Differentiation, nth Differential coefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.	12
IV	Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normal of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula).	12
V	Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **understand**[2] basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.	
CO2	Students will be able to **understand**[2] wide ranging application of the subject and have the knowledge of matrices and basics of differentiation	
CO3	The student is **equipped**[3] with necessary analytic and technical skills by applying the principles of differentiation; he/she learns to solve a variety of practical problems in science and engineering.	
CO4	The student is **equipped**[3] with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.	
CO5	The students will also be able to **compute**[1]nth derivative of various functions .	
Text Books:	● Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008 2. Fuzhen Zhang, ● Matrix Theory- Basic Results and Techniques, Springer, 1999 3. ● Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010	
Reference Books:	● John Wiley & Sons, 1999 2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.,1974 . ● S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication. 1992 ● H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007 ● Suggested digital platform: NPTEL/SWAYAM/MOOCs	

Semester II

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA002	ALGEBRA AND CALCULUS -II	L-T-P 3-1-0
Learning Objectives	The main objectives of the course ● To give foundation knowledge for the students to understand basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics. ● To equip the student with necessary analytic and technical skills by applying the principles of differentiation, he learns to solve a variety of practical problems in science and engineering.	
Prerequisites:	Elementary idea about calculus.	
UNIT	CONTENT	HOURS
I	Introduction to Sets. Forms and Types of set, Venn diagram, Basic Operations on Set, Union and Intersection of Set, Demorgan's Law for two sets. Cartesian product of Sets, Functions or mappings, Binary operations, Relation, Equivalence relations and partitions, Congruence Modulo n, Definition of a group with examples and simple properties, Abelian group, Finite and infinite group, Order of a finite group, General properties of groups, Composition table for finite groups. An Alternative set of postulates of groups, Subgroups, Permutations, Cyclic Permutations, Even and odd permutations, group of Permutations alternating group, Integral power of an element of a group, Order of an element of a group.	12
II	Group homomorphism, Isomorphism on groups, the relation of isomorphism in the set of all groups Complexes and subgroup of a group, theorems on subgroups, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem, Cyclic group, generating system of group.	12
III	Normal subgroups, Simple group, Conjugate elements, Normalizer of an element of a group, Class equation of a group, Centre of a group, Conjugate subgroups, Invariant sub groups, Quotient group, Homomorphism and Isomorphism on groups, Kernel of a Homomorphism and related theorems.	12
IV	Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Drichlet's theorem. Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	14
V	Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions	10
	Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to understand[2] basics of mathematics including applied aspect for developing enhanced quantitative skills and pursuing higher mathematics and research as well.	
CO2	Students will be able to understand[2] wide ranging application of the subject and have the knowledge of Algebra.	
CO3	The student is equipped[3] with necessary analytic and technical skills by applying the principles of differentiation; he/she learns to solve a variety of practical problems in science and engineering.	
CO4	The student is equipped[3] with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics.	
CO5	The student is equipped with standard concepts and tools at an intermediate to advance level that will serve him well towards taking more advance level course in mathematics	
Text Books:	● Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008 2. Fuzhen Zhang, ● Matrix Theory- Basic Results and Techniques, Springer, 1999 3. ● Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010	
Reference Books:	● John Wiley & Sons, 1999 2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.,1974 . ● S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication. 1992 ● H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007 ● Suggested digital platform: NPTEL/SWAYAM/MOOCs	

Semester III

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA003	DIFFERENTIAL EQUATIONS	L-T-P 3-1-0
Learning Objectives	The objective is to provide main concepts of differential equations: Ordinary differential equations and Partial differential equations. Specific course objectives are the following: ● Learn to evaluate first order linear and non-linear differential equations. ● Learn to solve second order and higher order linear differential equations using appropriate methods. ● Learn to solve linear systems of ordinary differential equations. ● Learn to solve linear and non-linear partial differential equations using appropriate methods. ● Learn to classify and solve second order partial differential equations using appropriate methods.	
Prerequisites	Elementary idea about Differential and Integral Calculus.	
UNIT	CONTENT	HOURS
I	Ordinary Differential equations: Degree and order of a differential equation, Formation of differential equation, Differential equations of first order and first degree: Variable separable, Homogeneous, Reducible to homogeneous, Linear, Reducible to linear, first order exact differential equations, Differential equations of first order and higher degree: Solvable for x, y, p, Clairaut's form.	12
II	Differential Equation of First Order and Higher Degree, Linear Differential Equation with Constant Coefficient of Higher Order, Cauchy's Differential Equation, Method of Variation of Parameter, Simultaneous Differential Equation, Introduction to series solution method.	12
III	Order and degree of partial differential equations, concept of linear and non-linear partial differential equations, formation of partial differential equations, linear partial differential equation of first order: Lagrange's method, non-linear partial differential equation: the four standard forms, Charpit's general method of solution.	12
IV	Formation of first and second order partial differential equations: Linear & Non-Linear Partial differential equation of First Order, Homogeneous & Non-Homogeneous Linear P. D.E with constant coefficient of Higher Order, Separation of Variables	12
V	Partial differential equations of second and higher orders, classification of linear second order partial differential equations: elliptic, parabolic and hyperbolic through illustrations only, homogeneous linear equations with constant coefficients: complimentary functions and particular integrals, non-homogeneous equations with constant coefficients, partial differential equations reducible to equations with constant coefficients.	12
Course Outcomes as per Bloom's Taxonomy		
CO1	Student will be able to **understand[2]** first order ordinary differential equations utilizing the standard Techniques for separable, homogeneous, linear or exact cases.	
CO2	Student will be able to **understand[2]** Differential Equation of First Order and Higher Degree	
CO3	They will be able to **analyze[4]** the solution of higher order ordinary differential equation using either of applicable methods.	
CO4	They will be able to **understand[2]** and will be able to solve linear and non-linear partial differential equations of first order.	
CO5	They will be able to **classify[4]** partial differential equations of second order and solve them using applicable technique.	
Text Books:	● M D Raisinghania, Ordinary and partial Differential Equations, 2017, S Chand, I9th Edition. ● N P Bali, Differential Equations, 2006, Lakshmi Publications 10th Edition. ● V Sundarapandian, Ordinary and partial Differential Equations, 2012,Tata McGraw Hill Education private Ltd.	
Reference Books:	● S L Ross, Differential Equations, 1984, John Wiley and Sons, 3rd Edition, ● I Sneddon, Elements of Partial Differential Equations, 1967, McGraw-Hill, International Edition. ● S Guruprasad, A Textbook of Partial Differential Equations, 2017, New Age Publication.	

Semester IV

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA004	DISCRETE MATHEMATICS	L-T-P 3-1-0
Learning Objectives	• To Develop a solid understanding of fundamental concepts: Gain a deep understanding of foundational concepts in discrete mathematics • To Analyze and solve problems using graph theory: Understand the fundamental concepts of graph theory. • To Explore the theory of computation: Understand the basic concepts of computational complexity, algorithm analysis, and the classification of computational problems.	
Prerequisites	12th with Mathematics Stream	
Unit	**CONTENTS**	**HOURS**
I	**Logic**: Propositional equivalence, predicates and quantifiers, Methods of proofs, proof strategy, sequences and summation, mathematical induction, recursive definitions and structural induction, program correctness. **Counting**: The basics of counting, the pigeonhole principle, permutations and combinations, recurrence relations, solving recurrence relations, generating functions, inclusion-exclusion principle, and application of inclusion-exclusion. Mathematical Induction **Set Theory:** Definitions and the Element Method of Proof, Properties of Sets, Algebraic Proofs, Boolean Algebra.	**14**
II	**Sequence:** Describing a sequence, Arithmetic and geometric sequence, sum of Arithmetic and geometric sequence. Solving Recurrence relation, the characteristic root technique	**8**
III	**Relations:** Relations and their properties, n-array relations and their applications, representing relations, closure of relations, equivalence of relations, partial orderings. **Graph theory:** Introduction to graphs, graph terminology, representing graphs and graph isomorphism, connectivity, Euler and Hamilton paths, planar graphs, graph coloring, introduction to trees, application of trees.	**12**
IV	**Group theory:** Groups, subgroups, generators and evaluation of powers, cosets and Lagrange's theorem, permutation groups and Burnside's theorem, isomorphism, automorphisms, homomorphism and normal subgroups, rings, integral domains and fields.	**12**
V	**Lattice theory**: Lattices and algebras systems, principles of duality, basic properties of algebraic systems defined by lattices, distributive and complimented lattices, Boolean lattices and Boolean algebras, uniqueness of finite Boolean expressions, prepositional calculus. Coding theory: Coding of binary information and error detection, decoding and error correction	**14**
Course Outcomes as per Bloom's Taxonomy		
CO 1	At the end of the course the students should be able to**:** **Understand**[1] the key concepts and structures in discrete mathematics, such as sets, relations, functions, logic, proof techniques, and mathematical induction.	
CO 2	**Learn**[2] the fundamental concepts and techniques in graph theory, including graph representation, connectivity, paths, cycles, trees, and basic graph algorithms.	
CO 3	**Understand**[1] various discrete structures, such as sets, relations, and sequences, and understand their properties and applications.	
CO 4	**Explore**[4]propositional and predicate logic, and develop skills in constructing and evaluating logical arguments. Also, learn about Boolean algebra and its applications in digital circuits.	
CO 5	**Enhance**[3] analytical thinking skills by solving complex problems using discrete mathematics techniques, including identifying patterns, formulating solutions, and evaluating their correctness.	
Text Books	1. K.H. Rosen: Discrete Mathematics and its application, 5th edition, Tata McGraw Hill. 2. C. L. Liu: Elements of Discrete Mathematics, 2nd edition, TMH 2000 3. B.Kalman: Discrete Mathematical Structure, 3rd edition, Chapter	
Reference Books	1. Discrete Mathematics: Elementary and Beyond" by László Lovász, József Pelikán, and Katalin L. Vesztergombi, Springer. 2. "Mathematical Structures for Computer Science" by Judith L. Gersting, W.H. Freeman and Company.	

Semester V

COURSE CODE	COURSE NAME	Total Lec.:60
SC23MA005	**REAL ANALYSIS**	**L-T-P 3-1-0**
Learning Objectives:	● To understand infinite sets and completeness property of R ● To learn Concept of cluster points and statement of Bolzano-Weierstrass theorem ● To evaluate Cauchy convergence criterion for sequences. ● To Learn Comparison test, convergence of p-series, Root test, Ratio test, alternating series and Leibnitz's test.	
Pre-requisites:	12th Passed with Mathematics Stream	
UNIT	**CONTENT**	**HOURS**
I	Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, supremum and infimum, completeness property of R, Archimedean property of R, intervals. Continuity and Differentiability of functions: Continuity of functions, Uniform continuity, Differentiability, Taylor's theorem with various forms of remainders.	**12**
II	**Sequence and Series:** Sequences, theorems on limit of sequences Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences and series. Cauchy's theorem on limits. Concept of cluster points and statement of Bolzano-Weierstrass theorem. **Integration:** Riemann integral-definition and properties, integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.	**12**
III	Absolute convergenceMonotone sequences and their convergence (monotone convergence theorem without proof). Infinite series. Cauchy convergence criterion for series, positive term series, geometric series.	**12**
IV	Tests for convergence, comparison test, convergence of p-series Cauchy's root Test, ratio Test, Rabbe's, Logarithmic test, Alternating series, Leibnitz's theorem. (Tests of Convergence without proof) Definition and examples of absolute and conditional convergence.	**12**
V	Uniform Convergence: Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Dritchlet's test, Convergence and uniform convergence of sequences and series of functions. Differentiability of functions, Power series and radius of convergence.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	Students will be able to **describe**[1] the fundamental properties of the real numbers that underpin the formal development of real analysis;	
CO2	They will be able to**demonstrate**[3] an understanding of the theory of sequences and series, continuity, differentiation and integration;	
CO3	They will be able to**demonstrate**[3] skills in constructing rigorous mathematical arguments.	
CO4	They will be able to**apply**[3] the theory in the course to solve a variety of problems at an appropriate level of difficulty;	
CO5	They will be able to**demonstrate**[3] skills in communicating mathematics.	
Text Books:	● H.K. Pathak, Real Analysis, 2019, Shree ShikshaSahityaPrakashan. ● B.R. Thakur & R.S. Chandel, 2020, Real Analysis, Ram Prasad and Sons. ● R.G. Bartle and D.R. Sherbert,2000, Introduction to Real Analysis, John Wiley and Sons (Asia) P. Ltd.	
Reference Books:	● E. Fischer, Intermediate Real Analysis, 1983, Springer Verlag. ● K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, 2003, Springer Verlag. ● R. Kumar and B. Sharma, Principle of Real Analysis, 2020, Mahaveer Publications.	

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA006	INTEGRAL CALCULUS AND VECTOR ANALYSIS	L-T-P 3-1-0
Learning Objectives:	• The objectives of the course typically aim to provide students with a strong foundation in calculus and its application to vector analysis. • To develop a deep understanding of the concepts of integration and applications of integration • To develop a solid understanding of vector concepts and their applications, including vector operations • To study partial derivatives, gradients, directional derivatives, optimization of multivariable functions, and multiple integrals.	
Pre-requisites:	A solid foundation in pre-calculus topics such as sequences and series, complex numbers, and conic sections can be helpful for a smoother transition into integral calculus and vector analysis.	
UNIT	**CONTENT**	**HOURS**
I	Multiple Integrals- definition of the double integrals- evaluation of the double integrals double integrals in polar coordinates – triple integrals – applications of multiple integrals volumes of solids of revolution – areas of curved surfaces – change of variables – Jacobians.	**12**
II	Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	**12**
III	Operations with vectors. Scalar and vector product of three vectors. Product of four vectors. Reciprocal vectors. Scalar-valued functions over the plane and the space. Vector function of a scalar variable: Curves and Paths. Vector fields	**12**
IV	The vector deferential operator del. The gradient of a scalar point function. The derivative of function. Properties of gradient of vector function. Directional derivative, Divergence and curl of a vector point function. Properties of divergence and curl. Solenoidal and irrotational vectors.	**12**
V	Line, surface and volume integrals - Integral Theorems - Gauss, Greens and Stokes (Without proof) – Problems.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	The completion of the course will enable the students to: **Develop**[1] a solid understanding of fundamental concepts in integral calculus	
CO2	**Apply**[2] integral calculus to solve problems in various fields, such as finding areas between curves	
CO3	**Learn**[3] the basic concepts of vector calculus, including vector fields, vector functions, limits, continuity, and differentiability of vector functions.	
CO4	**Study**4 the concepts of gradient, divergence, and curl of vector fields and their applications in physics, engineering, and other disciplines.	
CO5	**Develop**[3] problem-solving skills by applying integral calculus and vector analysis techniques to solve real-world problems in physics, engineering, and related fields.	
Text Books:	1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc. 2007 2. Murray R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill. 3. Suggested digital platform: NPTEL/SWAYAM/MOOCs	
Reference Books:	1. "Vector Calculus" by Jerrold E. Marsden and Anthony J. Tromba, W.H. Freeman and Company). 2. "Advanced Calculus" by Patrick M. Fitzpatrick, American Mathematical Society	

Semester VI

COURSE CODE	COURSE NAME	Total Lecture: 60
SC23MA007	LINEAR ALGEBRA	L-T-P 3-1-0
Learning Objectives:	• The objective of this course is to introduce the fundamental theory of two objects, namely - rings and vector spaces, and their corresponding homomorphisms. • The course introduces the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers, used in finite fields with applications • This course emphasizes the application of techniques using the ad-joint of a linear operator and their properties to least squares approximation and minimal solutions to systems of linear equations.	
Prerequisites:	Basics of Algebra	
UNIT	**CONTENT**	**HOURS**
I	**Introduction of Rings and Ring Homomorphism**: Definition and examples of rings, Properties of rings, Sub-ring, Integral domains and fields, Characteristic of a ring, Ideals, Ideal generated by a subset of a ring, Factor rings, Operations on ideals, Prime and maximal ideals. Ring homomorphism, Properties of ring homomorphism, First, Second and Third Isomorphism theorems for rings, The Field of quotients.	**12**
II	**Introduction of Vector Spaces**: Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence and dependence of vectors, Basis and dimension, Dimension of subspaces.	**12**
III	**Linear Transformations**: Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Isomorphism, Isomorphism theorems, Invertibility and the change of coordinate matrix.	**12**
IV	**Inner Product Spaces:** Inner product spaces and norms, Ortho-normal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality	**12**
V	**Dual Spaces and Diagonalizable Operators:** Dual spaces, Double dual, Dual basis, Transpose of a linear transformation and its matrix in the dual basis, Eigenvalues, Eigenvectors, and characteristic polynomial of a linear operator; Diagonalizability, Invariant subspaces and Cayley-Hamilton theorem; The minimal polynomial for a linear operator.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	Students will be able to **describe**[1] the significance of unique factorization in rings and integral domains.	
CO2	They will be able to **acquire**[1] knowledge of important concepts such Ring homomorphism & isomorphism from discrete mathematics to advanced abstract mathematics	
CO3	They will be able to **demonstrate**[3] with the characteristic polynomial, eigen-values, eigenvectors, as well as the geometric and the algebraic multiplicities of an eigen-value and **apply**[2] the basic diagonalization result.	
CO4	They will be able to **demonstrate**[3] inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain ortho-normal basis.	
CO5	They will be able to **apply**[3] the theory in the course to solve a variety of problems at an appropriate level of difficulty	
Text Books:	H.K. Pathak, Linear Algebra, 2019, Shree Shiksha Sahitya Prakashan B.R. Thakur & R.S. Chandel, Linear Algebra, 2019, RAM PRASHAD & SONS	
Reference Books:	Kenneth Hoffman and Ray Kunze, Second Edition, Linear Algebra PEARSON Education India Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Forth Edition, Linear Algebra PEARSON Education India	

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA008	PROBABILTY AND STATISTICS	L-T-P 3-1-0
Learning Objectives:	The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.	
Prerequisites:	Basic Concepts of Mathematics	
UNIT	CONTENT	HOURS
I	Introduction to Probability: Sample space, Types of Events related to probability,Basic notions of probability.Additive and multiplicative law of probability, Conditional Probability and Independence: Conditional probability, Bayes' theorem, Dependent and Independent events.	12
II	Probability Distribution: Random Variables, Continuous and discrete random variables. Binomial, Poisson, Normal, and Exponential distributions.	12
III	Measure of central tendency, Measures of dispersion, Moments, Expectation skewness, kurtosis, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression.	16
IV	Curve fitting by the numerical method: Curve fitting by of method of least squares, fitting of straight lines, second degree parabola and more general curves.	8
V	Formation of Hypothesis, Test of significance: Large sample test for single proportion, Difference of proportions, Single mean, Difference of means, and Difference of standard deviations. Test of significance for Small samples:t- Test for single mean, difference of means, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attributes	12
Course Outcomes as per Blooms Taxonomy		
CO1	Students will be able to **understand**[2] the basic knowledge on fundamental probability concepts, including random variable, probability of an event, additive rules and conditional probability	
CO2	They will be able to **understand**[2]several well-known distributions, including Binomial, Geometrical, Negative Binomial, Pascal, Normal and Exponential Distribution	
CO3	They will be able to **understand**[2] the basic statistical concepts and measures.	
CO4	They will be able to understand the fitting of various curves by method of least square.	
CO5	They will be able to apply[4] the statistics for testing the significance of the given large and small sample data by using t- test, F- test and Chi-square test They will be able to understand the fitting of various curves by method of least square.	
Text Books:	● R.E. Walpole, R.H. Myers, S.L. Myers and K. Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, 2007, Pearson International Edition. ● M. Spiegel, J. Schiller and R. Srinivasan, Schaum's Outline of Probability and Statistics, 2000, McGraw Hill. ● W. Mendenhall and R. Beaver, Introduction to Probability and Statistics, 1994, Wadsworth Publishing.	
Reference Books:	● S. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 1988, John Wiley. ● M. Berger, An Introduction to Probability and Stochastic Processes, 1992, SpringerVerlag.	

Semester VII

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA009	**COMPLEX ANALYSIS**	**L-T-P** **3-1-0**
Learning Objectives:	● To present students the elements and importance of the Complex analysis. ● Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations. ● Learn some elementary functions and valuate the contour integrals. ● To enable the students to the differentiability of complex functions and its related.	
Prerequisites:	12th with Mathematics	
UNIT	**CONTENT**	**HOURS**
I	**Analytic Functions and Cauchy−Riemann Equations** Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy−Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.	**12**
II	Elementary Functions and Integrals Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals, Complex integration: Line integrals Rectifiable Arcs - Line Integrals as Functions of Arcs Cauchy's theorem for a rectangle Cauchy's integral formula.	**12**
III	The Calculus of Residues: The Residue theorem - The Argument principle - Evaluation of definite integrals - Harmonic functions: The Definitions and basic Properties - Mean value property - Poisson's Formula. Singularities and classifications- Isolated singularities: Removable singularity Pole and essential singularity-Residues-Cauchy's Residue theorem-problems	**12**
IV	Series and Residues Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.	**12**
V	The Riemann Mapping Theorem - Statement and Proof- Boundary Behavior - Use of the reflection principle - Analytic arcs - Conformal mapping of Polygons: The Behavior at an angle - the Schwartz - Christoffel Formula - Mapping on a rectangle.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	**The completion of the course will enable the students to:** **Learn and Describe**[1] the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations.	
CO2	**Evaluate**[2] line integrals, curve integrals, singularities and determine the values of integrals using residues.	
CO3	**Apply** and **understand**[3] about limits and to know how they are used in series and problems	
CO4	**Analyze**[4] functions of complex variable in terms of continuity, differentiability and analyticity. Apply Cauchy-Riemann equations and harmonic functions to solve problems	
CO5	**Expand**[4] some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.	
Text Books:	● S. Ponnusamy Foundations of Complex Analysis Narosa Publisher 2003 ● A.R.Vasistha and Etal Complex Analysis Krishna prakashan media pvt ltd 2008. ● A.F.Beardon Complex Analysis John Wiley and Sons 1979	
Reference Books:	L.V.Ahlfors Complex Analysis Mc Graw Hill, NewYork 2013	

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA010	NUMERICAL METHODS	L-T-P 3-1-0
Learning Objectives:	• This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering. • The objective is to provide a basic understanding of the derivation, analysis, and use of these numerical methods, along with an elementary understanding of finite precision arithmetic and the conditioning and stability of the various problems and methods. • This will help you choose, develop and apply the appropriate numerical techniques for your problem, interpret the results, and assess accuracy.	
Prerequisites:	A strong understanding of mathematical concepts	
UNIT	**CONTENT**	**HOURS**
I	**Errors in Numerical computations**: Errors and their Accuracy'. Mathematical Preliminaries, Errors and their Analysis. Absolute. Relative and Percentage Errors. A General error formula. **Solution of Algebraic and Transcendental Equations**: The bisection method. The iteration method, The Method of False position. Newton Raphson method, Generalized Newton Raphson method	**12**
II	**System of linear equations**: Iteration methods, rate of convergence. Matrix factorization methods. Least square method for inconsistent system. Gaussian elimination. Gaussian elimination with scaled partial pivoting. Gauss Jordan Method. LU decomposition.	**12**
III	**Operators** –finite differences, average, differential, etc., their inter-relations. Difference of polynomials. Difference equation. Interpolation. Lagrange's methods, error terms. Newton's fundamental interpolation. Forward, backward and central difference interpolations. Interpolation by iteration.	**12**
IV	**Interpolation:** Difference schemes, interpolation formulas using differences. Lagrange and Newton interpolation. Hermite interpolation. Divided differences. **Numerical differentiation:** Based on interpolation, the method of undetermined coefficients, Error estimates.	**12**
V	**Numerical integration:** Trapezoidal, Simpson's, and Weddle's rules. Gauss Quadrature Formulas. **Ordinary differential equations**: Euler's method, Single-step methods, Runge-Kutta's method	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	**The completion of the course will enable the students to:** Student will be able to apply[1] appropriate theories, principles and concepts relevant to the numerical analysis.	
CO2	Student will be able to analyze[2] and interpret information from a variety of sources relevant to Numerical Analysis.	
CO3	They would be able to demonstrate[3] numerical methods for solving various problems.	
CO4	Student will be able to establish[2] the limitations, advantages, and disadvantages of different numerical methods.	
CO5	Student will be able demonstrate[3] competence with understanding the theoretical and practical aspects of the use of numerical methods.	
Text Books:	(i) S. Rangnatham, M.V.S.S.N. Prasad, V.Ramesh Babu Numerical Analysis Fourth Edition, S. Chand. (ii) S.S. Sastry Fifth Edition PHI Learning	
Reference Books:	(i) Numerical Mathematics and Computing by W. Cheney and D. Kincaid, 3 rd edition, Brooks/Cole Pub. Co. 1994. (ii) Elementary Numerical Analysis by K. Atkinson, 2nd edition, John Wiley & Sons, Inc., 1993.	

Semester VIII

COURSE CODE	COURSE NAME	Total Lec.: 60
SC23MA011	LINEAR PROGRAMMING AND OPTIMIZATION TECHNIQUES	L-T-P 3-1-0
Learning Objectives:	The main objective is to introduce the most widely used optimization method, linear programming to the students. Specific course objectives are the following: ● Explain basic concepts of optimization, modeling and linear modeling (LP). ● Define the LP's assumptions and explain the different methods, such as graphical approach and Simplex method of solving Linear Programming Problem. ● Explain the various mathematical models of LPP and different methods of solving.	
Pre-requisites:	Basic Concepts of Matematics	
UNIT	CONTENT	HOURS
I	Basics of OR and LPP: Development of OR, Definition, characteristics, scope, objectives and limitations of OR, convex sets, Basic feasible solutions, Formulation of LPP, Graphical Method to solve LPP, General LPP, Canonical and Standard forms, Properties of solutions and theory of Simplex method.	12
II	Introduction to artificial variables, two-phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal- dual relationships, Dual Simplex method, economic interpretation of the dual.	12
III	Transportation Problem: Formulation of Transportation problem, degeneracy in transportation problem, Balanced and Unbalanced transportation Problems. Various methods of solving Transportation problem: Starting Solution and Optimization of initial solution.	12
IV	Assignment Problems: Formulation of Assignment Problem, Hungarian method of Solving Assignment problem: finding initial solution, condition of optimality check, balanced and unbalanced Assignment problems.	12
V	Sequencing Problems: Introduction – Basic Assumptions – Sequencing n Jobs on 2 Machines – Sequencing n Jobs on 3 machines – Sequencing 2 Jobs on n Machines. Queuing Theory : General Concepts and Definitions – Classification of queues – Poisson Process, Properties of Poisson Process – Queuing Models: 1. (M/M/1):(∞/FCFS), 2. (M/M/1):(N/FCFS), 3. (M/M/c):(∞/FCFS)	12
Course Outcomes as per Bloom's Taxonomy		
CO1	**The completion of the course will enable the students to:** Students will be able to **formulate**[3] the LPP.	
CO2	They will be able to **conceptualize**[4] the feasible region.	
CO3	They will be able to **solve**[3] the LPP with two variables using graphical Simplex and Big-M Methods	
CO4	They will be able to **solve**[3] the Transportation problem with different Methods.	
CO5	They will be able to **Understand**[2] the Concept of Assignment Problem and Queuing -Theory.	
Text Books:	● S D Sharma and Himanshu Sharma, Operation research: Theory, Methods and Applications, 2010, KedarNath Ram Nath publishers, ● R K Gupta, 2014, Linear Programming, Krishna Prakashan Media. ● G S Sandhu, , 2019, Linear Programming, First World Publications.	
Reference Books:	● F S Hillier and G.J. Lieberman, Introduction to Operations Research, 2004, 8th Ed., Tata McGraw Hill, Singapore. ● HA Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.	

COURSE CODE	COURSE NAME	Total Lecture: 60
SC23MA012	MATHEMATICAL TRANSFORMS AND TECHNIQUES	L-T-P 3-1-0
Learning Objectives:	• Express non periodic function to periodic function using Fourier series and Fourier transforms. • Course intends to deliver the concept of Laplace transforms, Fourier series, separation method techniques for ordinary and partial differential equation and apply it to various levels.	
Prerequisites:	12th with Mathematics Stream	
UNIT	**CONTENT**	**HOURS**
I	**Laplace Transforms I:** Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications.	**12**
II	**Laplace Transforms II**: Definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) and problems. Solution of linear differential equations using Laplace transforms. Transform of standard function, finds Inverse LT by different methods, Partial fraction method, convolution theorem, solving ODEs by Laplace Transform method.	**12**
III	**Fourier Series:** Fourier integral representation, Fourier sine and cosine integral, Fourier Transform and Inverse Fourier transform of constant and exponential function. Properties and its application	**8**
IV	**Fourier Transforms:** Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms**.** **Z –Transforms:** Elementary properties, inverse Z-transform, convolution theorem, formation and solution of difference equations.	**16**
V	**Partial Differential Equations and Applications:** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method; Charpit's method; method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.	**12**
Course Outcomes as per Blooms Taxonomy		
CO1	**The completion of the course will enable the students to:** Solve Laplace transforms using integrals and Evaluate inverse of Laplace transforms by the method of convolution.	
CO2	Solve the linear differential equations using Laplace transform	
CO3	Summarize the concept of Laplace transforms to the real-world problems of engineering.	
CO4	Understand the nature of the Fourier series that represent even and odd functions and Determine Half- range Fourier sine and cosine expansions	
CO5	Possess the knowledge and skills for employability and to succeed in competitive examinations	
Text Books:	1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.	
Reference Books:	1.G. Shanker Rao, "Mathematical Methods", I. K. International Publications, 1st Edition, 2009. 2. G. Shanker Rao, "Engineering Mathematics-1", I. K. International Publications, 1st Edition, 2009.	

TRACK - PHYSICS (MINOR)

Syllabus SEMESTER I

COURSE CODE	MATHEMATICAL PHYSICS	Total Lec. :45
SC23PH001		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To introduce the students to vector calculus, partial differential equation, curvilinear coordinates, and Fourier series. ● To be able to understand and apply the vector differentiation and integration to physical problems. ● To be able to understand and analyze the solution of partial differential equations. ● To be able to understand the green's theorem, Stokes the oremandits application to physical problems. ● To be able to understand and apply the beta function and gamma function in physical problems.	
Pre-re quisite:	Physics &Mathematics(10+2)	
UNIT	CONTENT	HOURS
I	Properties of vectors, scalar product and vector product, scalar triple product and their interpretation in term so far area and volume respectively, scalar and vector fields, vector differentiation: directional derivatives and normal derivative, gradient of a scala field and its geometrical interpretation, divergence and curl of a vector field ,Del and Laplaci an operators, vector identities.	10
II	Ordinary integrals of vectors, double and triple integrals, change of order of integration, Jacobian, notion of infinite simalline, surface and volume elements, line, surface and volume integrals of vector fields, flux of a vector field, Gauss ' divergence theorem, Green's and Stokes theorems and the verification (no rigorous proofs).	12
III	Solutions to partial differential equations using separation of variables :Laplace's equation in problems of rectangular geometry, solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes, solution of 1D heat flow equation, plotting of functions,approximation:Taylorandbinomialseries(statementsonly),firstorder differential equations(variables reparable, homogeneous, non-homogeneous), exact and in exact differential equations and integrating factor.	6
IV	Some special integrals : eta and Gamma functions and relation between them, expression of Integrals in terms of Gamma functions, orthogonal curvilinear coordinates, derivation of gradient, divergence, Curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems	7
V	Periodic functions, orthogonality of sine and cosine functions, dirichlet conditions (statement only), expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, evenandoddfunctionsandtheirfourierexpansions,application,summingof infinite series, parseval's identity and its application to summation of infinite series.	10
Course Out comes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1]the partial differential equation, Beta function, and Gamma	

	function.
CO2	They will be able to **analyze**[4]thesolutionofordinary,and partial differential equation.
CO3	They will be able to identify the Beta function, Gamma function and **apply**[3] it in physical Problems.
CO4	They will be able to **calculate**[4] the gradient, curl, divergence, and,1dimensional,2 Dimensional and 3dimensional vector integration.
CO5	They will be able to **understand**[2] the Green's theorem, Stokes the oremandits **application**[3] to physical problems.
Text Books:	● S. Paland S .C. Bhunia, Engineering Mathematics,2015,OxfordUniversityPress. ● M.R.S piegel, Fourier Analysis,2004,TataMcGraw-Hill. ● Arfken, Weber, Mathematical Methods for Physicists, 2005, Harris, Elsevier.
Reference Books:	● Susan M. Lea, Mathematics for Physicists, 2004, Thoms on Brooks/Cole. ● George F .Simmons, Differential Equations, 2006, Tata McGraw-Hill. ● Erwin Kreyszig, Advanced Engineering Mathematics, 2015, Wiley.

Practical

COURSECODE	**PHYSICSLAB-I**	**Practicals:**
SC23PH001P		**1**
	1. Measurements of length (or diameter)using vernier caliper, screw gauge and travelling microscope. 2. To study the random error in observations. 3. To determine the height of a building using a sextant. 4. To determine the moment of inertia of a Fly wheel. 5. To determine g and velocity for are ely falling body using digital timing technique. 6. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method). 7. To determine the Young's modulus of a wire by optical lever method. 8. To determine the modulus of rigidity of a wire by Maxwell's needle. 9. To determine the elastic on stants of a wire by Searle's method. 10. To determine the value of g using bar pendulum. 11. To determine the value of g using Kater's pendulum.	

Syllabus SEMESTER II

COURSECODE	MECHANICS	Total Lec.:45
SC23PH002		3-0-2
Learning Objectives:	The course provides deep knowledge about the following: ● The students will be introduced about the frame of reference (inertial and non-inertial), transformation, Invariance, and its use in analysis of a moving system. ● The course will give knowledge about the important on concept like center of mass, moment of inertia, fictions (pseudo)forces and its use in describing rotational motion. ● The course provides the students about the knowledge of understanding the properties of fluid and fluid motion through concepts like surface tension and viscosity. ● The understanding of physics of vibration and oscillation.	
Pre-requisites:	Elementary Idea of Calculus, Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, introduction to special relativity And relative is trick in mathematics.	

UNIT	CONTENT	HOURS
I	Reference frames, inertial frames; Galilean transformations; Galilean invariance, many system of particles dynamics, center of mass, principle of conservation of momentum,variable-mass system:motion of rocket,work-energy theorem, conservative and non-conservative forces, elastic and inelastic collisions between particles, center of mass and laboratory frames, two body problem and its reduction to the one-body problem and its solution, law of gravitation, gravitational potential energy, potential and field due to spherical shell and solid sphere, Kepler's laws.	10
II	Angular momentum of a particle and system of particles, torque, principle of conservation of angular momentum, rotation about a fixed axis, moment of inertia ,moment of inertia for rectangular, cylindrical and spherical bodies, kinetic energy of rotation, motion involving both translation and rotation, non-inertial frames and fictitious forces,uniformly rotating frame,laws of physics in rotating coordinate systems, centrifugal force, coriolis force and its applications.	10
III	Molecular model of matter, surface tension, surface energy, the angle of contact between surfaces, capillary phenomena ,excess pressure on a curved liquid membrane, dependence of surface tension on external factors ,elastic moduli and their relations, twisting torque on a cylinder or wire, kinematics of moving fluids , Poiseuille's equation for flow of a liquid through a capillary tube.	7
IV	Simple harmonic oscillations, differential equation of SHM and its solution, kinetic energy ,potential energy ,total energy and their time-average values ,damped oscillation, forced oscillations: transient and steady states; resonance, sharpness of resonance ;power dissipation and quality factor, a pair of linearly coupled oscillators – Eigen frequencies and normal modes (matrix m ode of analysis not required here),super position of perpendicular oscillations, Lissajous figures	8
V	Michelson-Morley experiment and its outcome ,postulates of special theory of relativity, Lorentz transformations, simultaneity and order of events, Lorentz contraction, time dilation, relativistic transformation of velocity, frequency and wave number. relativistic addition of velocities, variation of mass with velocity ,mass less particles, mass-energy equivalence, relativistic Doppler effect, relative stick in ematics , transformation of energy and momentum.	10
Course Outcomes as per Bloom's Taxonomy		

CO1	Students will be able to **define**[1]referenceframeanditssignificanceinconnectionwith mechanics.
CO2	They will beabletoTheywillbeableto**nterpret**[2]thelawofgravitation and Kepler's law and Their **application**[3] in problem related with physics.
CO3	They will be able to **understand** [2]the concept of elasticity ,surface tension ,viscosity and Fluid flow.
CO4	They will be able to **distinguish** various types of simple harmonic motion.
CO5	They will be able to **understand**[1] the concept of time dilation ,length contraction and the concept Of simultaneity.
Text Books:	● DSMathur,2000, S. Chandand Company Limited, ● C. Kittel, W.Knight, et.al,Mechanics, Berkeley Physics, vol.1, 2007,TataMcGraw-Hill. ● GR Fowles and G.L. Cassiday Analytical Mechanics,2005,CengageLearning,
Reference Books:	● RP Feynman , R.B. Leighton, M. Sands, Feynman Lectures, Vol. I,2008, PearsonEducation. ● RR esnick, Introduction to Special Relativity, 2005, John Wiley and Sons. ● RL Reese, University Physics,2003,ThomsonBrooks/Cole,

Practical

COURSE CODE	PHYSICSLAB-II	Practicals:
SC23PH002P		1
	● Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope. ● To study the random error in observations. ● To determine the height of a building using a Sextant. ● To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. ● To determine the Moment of Inertia of a Flywheel. ● To determine g and velocity for a freely falling body using Digital Timing Technique ● To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).	

Syllabus SEMESTER III

COURSE CODE	THERMAL AND STATISTICAL PHYSICS	Total Lec.:45
SC23PH003		3-0-2
Learning Objectives:	The course provides deep knowledge about the following: ● This paper deals with the study of Thermodynamics and Statistical Physics. ● Course provides the concepts of heat, work, and energy. ● Student learns the different laws of thermodynamics. ● Students learns the concept of thermo-dynamical functions and there relations, and also about the Statistical Physics and its implementations. ● Students learn about the contributions of Physicists.	
Pre-requisites:	Fundamentals of thermodynamics.	

UNIT	CONTENT	HOURS
I	Thermodynamics-I: Reversible and irreversible process. Heat engines. Definition of efficiency, Carnot's ideal heat engine, Carnot's cycle. Effective way to increase efficiency, Carnot's engines and refrigerator, Coefficient of performance, Second law of thermodynamics, Various statements of Second law of thermodynamics, Carnot's theorem, Clapeyron's latent heat equation, Carnot's cycle and its applications. Steam engine, Otto engine. Petrol engine. Diesel engine.	10
II	Thermodynamics-II: Concept of entropy. Change in entropy in adiabatic process. Change in entropy in reversible cycle. Principle of increase of entropy. Change in entropy in irreversible process. T-S diagram. Physical significance of Entropy, Entropy of a perfect gas. Kelvin's thermodynamic scale of temperature, The size of a degree. Zero of absolute scale, Identity of a perfect gas scale and absolute scale. Third law of thermodynamics. Zero point energy, Negative temperatures (not possible), Heat death of the universe. Relation between thermodynamic variables (Maxwell's relations).	10
III	Statistical Physics-IDescription of a system : Significance of statistical approach, Particle-states, System-states, Micro-states and Macro-states of a system, Equilibrium states, Fluctuations, Classical and statistical probability, The equi-probability postulate, Statistical ensemble, Number of states accessible to a system, Phase space. Micro canonical ensemble, Canonical ensemble, Helmholtz free energy, Enthalpy, First law of thermodynamics, Gibbs free energy, Grand canonical ensemble.	7
IV	Statistical Physics-II: Statistical Mechanics: Phase space. The probability of a distribution. The most probable distribution and its narrowing with increase in number of particles. Maxwell-Boltzmann statistics. Molecular speeds. Distribution and mean, r.m.s. and most probable velocity. Constraints of accessible and inaccessible states. Quantum Statistics: Partition Function. Relation between Partition Function and Entropy, Bose-Einstein statistics. Black-body radiation, The Rayleigh-Jeans formula, ThePlanck radiation formula, Fenni-Dirac statistics. Comparison of results. Concept of Phase transitions.	8
V	Contributions of Physicists: S.N. Bose, M.N. Saha, Maxwell. Clausius, Boltzmann, Joule. Wien, Einstein, Planck, Bohr. Heisenberg,Fermi, Dirac, Max Born. Bardeen.	10

Course Outcomes as per Bloom's Taxonomy	
CO1	Students will be able to **define**[1] thermodynamics laws.
CO2	They will be able to **interpret** [2]the law thermodynamics and their **application**[3] in problem related with physics.
CO3	They will be able to **understand** [2]the concept of thermodynamics and statistical physics
CO4	The will be able to **distinguish**[4]between thermal and statistical physics
CO5	They will be able to **understand**[1]theconceptofradiations and different thermal statistics

Text Books:	● Unified Physics, R. P. Goyal, Shiva lal Agarwala & Company ● Heat, Thermodynamics and Statistical Physics, Brijlal, Dr. N. Subrahmanyam, P. S. Hemne, S. Chand Publications.
Reference Books:	● Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill. ● A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press. ● Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications. ● Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill 14 ● Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa ● University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole. ● Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

Practical

COURSE CODE	**PHYSICS LAB-III**	**Practicals:**
SC23PH003p		**1**
	● To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method. ● To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus. ● To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method. ● To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method. ● To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT). ● To study the variation of Thermo- Emf of a Thermocouple with Difference of Temperature of its Two Junctions.	

Syllabus SEMESTER IV

COURSE CODE	**WAVES AND OPTICS**	**TotalLec.:45**
SC23PH004		**3-0-2**

Learning Objectives:	● The Course provides knowledge of SHM ,superposition of two SHMs, Lissajous figure and various types of oscillation. ● In this course, students will be introduced to fundamental concepts of waves and optics ● It develops understanding about Fermat's and Huygens's principles and their applications and related phenomena like Interference and diffraction of light. ● It give knowledge about the construction and working of LASER and its applications	
Pre-requisites:	Elementary idea of mechanics, mathematics, and optics.	
UNIT	**CONTENT**	**HOURS**
I	**Simple Harmonic Motion (SHM): S**uperposition of SHMs (superposition of twocollinearandtwoperpendicularSHMshavingequalfrequenciesanddifferentfrequencies, Beats and Lissajous Figures). **Free Damped Oscillations**: Introduction, damping forces, brief quantitative and qualitative description of damped oscillation of a system having one DoF (equation of motion, solution, large, critical &small damping, energy of a weakly damped oscillator , logarithmic decrement ,relaxation time and Q-factor). **Forced Oscillations and Resonance** :Introduction, brief quantitative and qualitative description of forced oscillation of a system having one degree of freedom(DoF) (equation of motion, solution ,resonance).	10
II	**Mechanical Waves:** Types of mechanical waves, mathematical description of wave (i,e,, classical wave equation), speed of transverse wave, energy in wave motion, wave interference, boundary conditions, and superposition, standing waves In a string, normal modes of a string. **Sound and Hearing:** Sound waves, speed of sound waves, sound intensity and decibal, standing sound waves & normal modes, resonance and sound ,interference Of waves and Beats ,Doppler Effect ,shockwaves.	10
III	**Fermat's and Huygens's principles:**Light is an electromagnetic spectrum, Fermat's principle and its application, Huygens's principle its application. **Interference:**Young'sexperiment-coherence,intensitydistributionandvisibility offringes, Fresnel's Biprism, Interference in thin films, Interference at anair wedge, Newton' srings, Michelson's interferometer.	9
IV	**Diffraction:** Fraunh offer and Fresnel Diffraction: Diffraction at a single slit, double slit, Diffraction by multiple slits, Diffraction grating, Resolving power- Rayleigh' scriterion, Resolving power of a grating and telescope, Fresnel diffraction-halfperiodzone,Zoneplate,Diffractionatacircularapertureandatastraightedge (qualitative treatment only).	9
V	**Lasers:** Spontaneous emission, absorption, and stimulated emission, Einstein's AandBcoefficientsandrelationbetweenthem,conditionforamplification,population inversion, methods of optical pumping, energy level schemes of Ruby laser and He-Ne laser, properties and uses of lasers.	7
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define** [1]Lissajousfigure,damped and forced oscillator, Doppler effect, Fermat' s principle ,interference & diffraction ,Einstein A and B coefficients.	
CO2	They will be able to **interpret**[2] various types of oscillation s, interference &diffractions Through various apertures.	
CO3	They will be able to **understand**[2] various optical phenomena, principles ,working ,and Applications of optical instruments ,spontaneous and stimulated emission of radiation ,optical	
	Pumping and population in version ,basic lasing ,various types of lasers in details and their applications.	
CO4	The y will be able to **distinguish** [4]various types of oscillations, lasers ,diffractions(Fresnel & Fraunh offer)	
CO5	They will be able to **understand**[1] the concept of interference ,diffraction, working principle of Various types of lasers.	

Text Books:	● P. Tipler, Physics for Scientists & Engineers,6th Edition, 2007, W.H. Freeman. ● A. Ghatak, Optics,7th Edition, 2020, Mc Graw Hill Education India Private Limited. ● K. Thyagrajan &A.K. Ghatak, Lasers: Fundamentals & Applications, 2nd Edition, 2016 , Laxmi Publications Private Limited.
Reference Books:	● A. Lipson, S.G. Lipson, &H. Lipson, Optical Physics,4th Edition, 2010,Cambridge University Press. ● B.B. Laud, Lasers &Non-line r Optics,2011, New Age International Private Limited. ● H. Parthasarathy, 1stEdition, 2021, Harish Parthasarathy, CRC Press.

Practical

COURSE CODE	**PHYSICS LAB-IV**	**Practicals:**
SC23PH004P		**1**
	● To determine the wavelength of sodium source using Michelson's interferometer. ● To determine wavelength of sodium light using Fresnel Biprism. ● To determine wavelength of sodium light using Newton's Rings. ● To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film. ● To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating. ● To determine dispersive power and resolving power of a plane diffraction grating.	

Syllabus SEMESTER V

COURSE CODE	**CLASSICAL ELECTRODYNAMICS**	**Total Lec.:45**
SC23PH005		**3-0-0**

Learning Objectives:	● Interpret the deeper meaning of the Max wellian field equations and account for their symmetry and transformation properties, domain of validity, and limitations ● Formulate of electromagnetic problems with the help of electrodynamics potentials and super potentials, and make a detailed account for gauge transformations and their use ● Master the technique of deriving and evaluating formulae for the electromagnetic fields from very general charge and current distributions ● Calculate the electromagnetic radiation from radiating systems (aerials, localized charge and current distributions) at rest ● Calculate the electromagnetic radiation from localised charges which move arbitrarily in time and space, taking into account retardation effects. Account for the underlying approximations and assumptions	
Pre-requisites:	Physics + Mathematics (10+2)	
UNIT	**CONTENT**	**HOURS**
I	Electrostatics: Electric potential, Poisson and Laplace's equations. Boundary value problems, Uniqueness theorems, Green's theorem. Method of images, Method of separation of variables (Cartesian Coordinates, Spherical and Cylindrical Coordinates), Multiple expansion.	10
II	Electromagnetic Waves: Maxwell's equations, Boundary conditions, Wave equation and its complex notation, Electromagnetic waves in vacuum, Electromagnetic waves in non conducting and linear media, Electromagnetic waves in linear conducting media. Poynting theorem, Reflection, refraction and polarization of electromagnetic waves.	10
III	Waveguides and Cavities: Metallic boundary conditions, Electromagnetic waves confined to hallow metallic pipe, TE, TM and TEM modes, TE and TM modes in rectangular waveguides, Bessel's function, TE and TM modes in cylindrical waveguides, Dielectric waveguides, TE and TM modes in rectangular and cylindrical Resonant cavities.	9
IV	Potential, Fields and Radiations: Scalar and vector potentials, Gauge transformation, Coulomb and Lorentz gauge, Retarded potential, Lienard-Wiechert potentials, Fields due to moving charge, Power radiated by an accelerated charge and angular distribution, Bremstrahlung Cerenkov and Synchrotron radiations.	9
V	Relativistic Electrodynamics: Four vectors, Lorentz transformation in terms of Four vectors, Lorentz transformation matrix, Transformation of electromagnetic fields, Field Tensor, Dual field strength tensor, Maxwell's equations in terms of strength tensors,	7
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1] terms related to electrostatics..	
CO2	They will be able to **interpret**[2] electromagnetic waves .	
CO3	They will be able to **understand**[2] various wave guides and cavities.	
CO4	They will be able to **distinguish**[4] potential, fields and radiations.	
CO5	They will be able to **understand**[1] theconceptof relativistic electrodynamics.	
Text Books:	● David J. Griffith; Introduction to Electrodynamics, PHI Private Limited, 1999 2. ● John D. Jackson; Classical Electrodynamics, Wiley Eastern Limited, 1998 3. ● F.F. Chen; Plasma Physics and Controlled Fusion,Springer,2006	
Reference Books:	● Edward C. Jordan and Heith G. Balmain; Electromagnetic Waves and Radiating Systems, PHI, 1991 2. ● W.K.H. Panofsky and M. Phillips; Classical Electricity and Magnetism, Dover Publications; 2nd Ed., 2005 3. ● J A Bittencourt; Fundamentals of Plasma Physics, 3rd Ed, Springer, 2004	

Syllabus SEMESTER V

COURSE CODE	ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM	Total Lec . :45
SC23PH006		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To describe, in words, the ways in which various concepts in electromagnetism come into play in particular situations; ● To represent these electromagnetic phenomena and fields mathematically in those situations; ● And to predict outcomes in other similar situations. ● The overall goal is to use the scientific method to come to understand the enormous variety of	

	electromagnetic phenomena in terms of a few relatively simple laws.	
Pre-re quisite:	Physics & Mathematics(10+2)	
UNIT	**CONTENT**	**HOURS**
I	Electrostatics Coulomb's inverse square law – Gauss theorem and its applications (Intensity at a point due to a charged sphere & cylinder) – Principle of a capacitor – Capacity of a spherical and cylindrical capacitors –Energy stored in a capacitor – Loss of energy due to sharing of charges.	10
II	Current Electricity Ampere's circuital law and its applications - Field along the axis of a circular coil and Solenoid – Force on a conductor in a magnetic field – Theory of Ballistic Galvanometer – Figure of merit – Damping Correction – Wheatstone network – Carey Foster's Bridge – Potentiometer - Measurement of current, resistance and low voltage.	12
III	Magnetism Intensity of magnetization - Susceptibility – Types of magnetic materials – Properties para, dia and ferromagnetic materials – Cycle of magnetization – Hysteresis – B-H curve – application of BH curve–Magnetic energy per unit volume.	6
IV	Electromagnetic Induction Laws of electromagnetic induction – Self and mutual induction – Self-inductance of a solenoid – Mutual inductance of a pair of solenoids – Coefficient of coupling – Experimental determination of self and mutual inductance (Rayleigh's method) Growth decay of current in circuit containing Land R – Growth and decay of charge in circuit containing C and R – High resistance by leakage – Charging and discharging of capacitor through Land R.	7
V	AC Circuits Alternating EMF – Alternating EMF applied to circuits containing L and R – C and R – Alternating EMF applied to circuits containing L, C and R – Series and Parallel resonance circuits – Sharpness of resonance– Q factor – Power in AC circuits – Power factor – Watt less current	10
Course Outcomes as per Bloom's Taxonomy		
CO1	Students will be able to **define**[1]the electrostatics and its theorem.	
CO2	They will be able to **analyze**[4]theampere's circuital law.	
CO3	They will be able to identify the magnetism and **apply**[3]it in physical problems.	
CO4	They will be able to calculate 4 the electromagnetic inductions and practical applications.	
CO5	They will be able to **understand**[2] the AC Circuitsits **application**[3] to physical problems.	
Text Books:	● Brijlal and Subramaniyam – Electricity and Magnetism – S. Chand & Co. ● R. Murugesan, Electricity and Magnetism, S.Chand & Co.	
Reference Books:	● Narayana moorthy and Nagaratnam, Electricity and Magnetism NPC, Chennai ● Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education. ● Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.	

Practical

COURSE CODE	**PHYSICS LAB-V**	**Practicals:**
SC23PH006P		**1**

	● To study the characteristics of a series RC Circuit. ● To determine an unknown Low Resistance using Potentiometer. ● To determine an unknown Low Resistance using Carey Foster's Bridge. ● To compare capacitances using De'Sauty's bridge. ● Measurement of field strength B and its variation in a solenoid (determine dB/dx ● Determine output characteristics of a LVDT & measure displacement using LVDT ● Measurement of Strain using Strain Gauge. ● Measurement of level using capacitive transducer. ● To study the characteristics of a Thermostat and determine its parameters. ● Study of distance measurement using ultrasonic transducer. ● Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75) ● To measure the change in temperature of ambient using Resistance Temperature Device (RTD).

Syllabus SEMESTER VI

COURSE CODE	QUANTUM MECHANICS	TotalLec. :45
SC23PH007		3-0-0
Learning Objectives:	After studying this paper the students will know– ● Foundation of quantum mechanics–failure of classical mechanics. ● Concept of operator formalism - position, momentum and energy operators, operator algebra. ● Schrodinger equation and its applications (e.g., particle in one- & three-dimensional potential box, quantum mechanical tunneling ,potential barrier, delta potential, potential step, transmission coefficient, Hydrogen atom. ● Concept of identical particles.	
Pre-re quisite:	Foundations of Physics & Mathematics	
UNIT	CONTENT	HOURS
I	**Dirac Delta Function and Kronecker Delta Function:** Dirac delta function and Kronecker delta function, phase and group velocity, wave packet, Gaussian wave packet. **Blackbody Radiation:** Blackbody radiation, Planck's quantum hypothesis, explanation of black body radiation.	10
II	**Fundamental Concepts:** Photoelectric effect, Compton effect, specific heat of solids,deBrogliewavelength/ wave-particle duality,Davison-Germer experiment, wave packets/Gaussian wave packet, phase and group velocity ,concept of wave function,differences between classical & quantum mechanics,Heisenberg's uncertainty principle,Fourier transform and momentum - spacewave function(i.e. expansion of a wave function in terms of position and momentum wave functions).	12
III	**Operator Formalism:** Operator formalism, position, momentum and energy operators ,operator algebra,commutator,expectationvalue,Ehrenfesttheorem,Hermitianoperators,Hermitianadjoint,variouspr opertiesof Hermitianoperator,operatorscommutingwithH,simultaneouseigenfunctionsof commuting operators, postulates of quantum mechanics,	6
IV	**Schrödinger Equation:** Schrodinger equation ,free particle solution ,super position of wave functions ,stationary states, orthogonality of eigen funtions, degenerate & non degenerate eigen values ,probability current density, time dependent and time independent Schrödinger equation.	7
V	**Applications of Schrodinger equation in simple cases:** One dimension-infinite square well potential, both one and three dimensional cases of a particle in a box ,finite square well, attractive delta function potential, harmoni coscillator, potential step, and potential barrier, simple harmonic oscillator.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Dirac delta function and Kronecker delta function, black body radiation, photo electric effect, various quantum mechanical operator and Schrodinger equation.	
CO2	They will be able to **interpret**[2] various operators, wave function.	
CO3	They will be able to **understand**[2] the theory of quantum measurements, wave packets and Uncertainty principle.	
CO4	They will be able to **distinguish**[4] various types of oscillations, lasers, diffractions(Fresnel & Fraunh offer)	
CO5	They will be able to **understand**[1] the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, timed ependent and Time independent cases, probability density and the normalization techniques.	
Text Books:	● Donald B Grey, Quantum Physics for Beginners,2020,Han Global Trading Pt Ltd. ● P.W.Mathewsand K.Venkatesan, A Textbook of Quantum Mechanics, 2nd Edition, 2017,Tata Mc Graw Hill. ● Ghatak and Loknathan,QuantumMechanics-Theory and Applications, 5th Edition, 2015, Laxmi Publications.	
Reference Books:	● L.I. Schiff, Quantum Mechanics,4thEdition,2017, Mc Graw Hill Education. ● D.J.Griffiths,Introduction to Quantum Mechanics, 2019, Cambridge University Press. ● P.A.M. Dirac, The Principles of Quantum Mechanics, 4thEdition, 1981, Oxford Science Publications.	

SEMESTER VI

COURSE CODE	PLASMA PHYSICS	TotalLec. :45
SC23PH008		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To introspect the plasma parameters and various phenomena associated with its applications. ● Interpret the basics of the plasma parameters and related fluid equations ● Analyze the behavior of electromagnetic waves and electron beam with plasma ● Introspect the particle motions under the influence of external electric and magnetic field	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Introduction Basic concepts of plasma, concept of temperature, Debye length, plasma frequency, criteria for plasmas	10
II	Fluid equations Response of plasma to the fields, DC conductivity, AC conductivity, RF conductivity, collisions	12
III	Waves in Plasma: Plasma in relation with electromagnetic waves, electromagnetic wave propagation, propagation in inhomogeneous plasma, electrostatic waves in plasma, energy flow	6
IV	Interaction of plasmas with electron beam Two-stream instability, relativistic electron beam-plasma interaction, growth rate, Cerenkov free electron laser, free electron laser and energy gain	7
V	Particle motion in uniform electric fields, particle motion in uniform magnetic fields, non-uniform electric and magnetic fields, time-varying electric and magnetic fields, curvature drifts, adiabatic invariance, magnetic mirror, Tokomak	10
Course Outcomes as per Bloom's Taxonomy		
CO1	The students will beableto**define**[1]Plasma and its criteria	
CO2	They will be able to **interpret**[2] various fluid equation..	
CO3	They will be able to **understand**[2] the waves in plasma.	
CO4	They will be able to **distinguish**[4] various types of plasma with electron beam	
CO5	They will be able to **understand**[1 the] Particle motion in electric fields.	
Text Books:		
Reference Books:	● Introduction to Plasma Physics and Controlled Fusion by F. F. Chen, 3rd edition (2016), Springer International Publishing. ● Interaction of electromagnetic waves with electron beams and plasmas by C.S. Liu and V.K. Tripathi, (1994) World Scientific. ● Principles of Plasma Discharges and Materials Processing by Michael A. Lieberman and Alan J. Lichtenberg, 2nd edition (2005) Wiley	

Practical

COURSECODE	PHYSICSLAB-VI	Practicals:
SC23PH008P		1
	● Measurement of Planck's constant using black body radiation and photo-detector ● Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light ● To determine work function of material of filament of directly heated vacuum diode. ● To determine the Planck's constant using LEDs of at least 4 different colours. ● To determine the wavelength of H-alpha emission line of Hydrogen atom. ● To determine the ionization potential of mercury. ● To determine the absorption lines in the rotational spectrum of Iodine vapour. ● To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet. ● To setup the Millikan oil drop apparatus and determine the charge of an electron. ● To show the tunneling effect in tunnel diode using I-V characteristics. ● To determine the wavelength of laser source using diffraction of single slit	

Syllabus SEMESTER VIII

COURSE CODE	SOLID STATE PHYSICS	TotalLec. :45
SC23PH009		3-0-0
Learning Objectives:	After studying this paper the students will know– ● Knowledge and understanding of crystal structure, electronic and vibrational properties of solid-state systems. ● Basic properties of metals, insulators and semiconductors. ● Semiconducting elements for the use in electronic devices. Low-dimensional semiconductors.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Crystal Structure: Introduction, Crystal lattice and translation vectors, unit cell, Basis, Symmetry operations ,point groups and space groups, types of lattices (Plane lattice and Space lattice with bcc and fcc), Lattice directions and planes, Miller indices, simple Crystal structure.	10
II	Bonding and Band Theory of Solids: Introduction, Concept of inter-atomic forces, Cohesive energy and types of bonding, Primary bonds (ionic bonds, Covalent bond and metallic bond), secondary bonds(Vander walls bond andhydrogen bonds)The Bloch theorem (only statement and properties), The Kroning Perry model, Energy versus Wave Vector relationship - different representations (Brillouin Zones).	12
III	Introduction, construction, working and characteristics of semiconductor diode, Zenerdiode, transistor (n-p-n and p-n-p transistor), Transistor Characteristics (CB, CE, CC), JFET (Construction and its characteristics).	6
IV	Schottky diode, MIS structures, basic equations in flat band conditions, MIS capacitances, current flow mechanisms in MS junction and MIS junction, depletion and enhancement type MOS FETS, capacitances in MOS FETs, quantitative analysis of I - V characteristics, thresholds in MOSFETS, charge trapping and flat band voltage, study of CMOS devices	7
V	Power diodes, ratings, reverses recovery characteristics, fast recovery diodes, Power transistors, Switching characteristics, construction of SCR, two transistors analogy, I- V characteristics, gate trigger characteristics, turn on and turn - off times, losses, reverse recovery characteristics, SCR ratings, dv/dt and di/dt characteristics, thyristor types, construction and characteristics of DIACs and TRIACs, static induction, thyristors, , light activated thyristors, Gate turn off thyristors (GTO), MOS controlledthyristors, programmable Unijunction transistors, Silicon Unidirectional switch (SUS), IGBT	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Crystal structure	
CO2	They will be able to **interpret**[2]bonding and band theory	
CO3	They will be able to **understand**[2]thesemiconductor diode.	
CO4	They will be able to **distinguish**[4]varioustypesofsemiconductor devices.	
CO5	They will be able to **understand**[1] the power electronic devices.	
Text Books:	● M. H. Rashid: Power Electronics. ● P. C. Sen: Power electronics ● B. G. Streetman and S. Banergee : Solid state Electronic Devices D.A. Roustan : Bipolar Semiconductor Devices.	
Reference Books:	● Karl Hess: Advanced theory of semiconductors devices. ● S. M. Sze: Physics of Semiconductor Devices 2nd edition. ● A Dir - Bar - Lev: Semiconductor and Electronic Devices.	

Syllabus SEMESTER VIII

COURSE CODE	NUCLEAR, ATOMIC AND MOLECULAR PHYSICS	Total Lec.: 45
SC23PH010		3-0-0
Learning Objectives:	• Objective of this course is to learn atomic, molecular and spin resonance spectroscopy	
Pre-requisite	General and Basic atomic structure	
UNIT	CONTENT	HOURS
I	One Electron Atom: Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, and Hyperfine structure. Two valance Electron Atom: Vector model for two valance electrons atom, LS coupling, Pauli Exclusion Principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling.	10
II	Atom in Magnetic Field: Zeeman Effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field.	7
III	Molecular Spectroscopy: Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions. Electron spin and nuclear magnetic resonance spectroscopy	7
IV	Nuclear forces and Models: Introduction of nuclear forces, nuclear binding energy, theoretical and practical estimate of dependence of binding energy, saturation, short range type, Nuclear fission and fusion, magic number, shell models, Liquid drop model	12
V	Particle Accelerators: Particle accelerator, linear resonance accelerator, cyclotron, synchro cyclotron, Vande-graff generator	9
Course Outcomes as per Bloom's Taxonomy		
CO1	Describe the atomic spectra of one and two valance electron atoms.	
CO2	Explain the change in behavior of atoms in external applied electric and magnetic field.	
CO3	Explain rotational, vibrational, electronic and Raman spectra of molecules	
CO4	Describe electron spin and nuclear magnetic resonance spectroscopy and their Applications	
CO5	Able to understand the concept of particle accelerators	
Text Books:	• Introduction of Atomic spectra- White • Atomic and Nuclear Physics – N.Subramanayam and Brijlal • Elements of nuclear physics – M.L Pandya, R.P. Yadhave	
Reference Books:	• White, H.E., Introduction to Atomic Spectra, McGraw Hill, (1934). • Banwell, C.N. and McCash, E.M., Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007)	

Syllabus SEMESTER VIII

COURSE CODE	ANALOG AND DIGITAL CIRCUITS	TotalLec. :45
SC23PH011		3-0-0
Learning Objectives:	After studying this paper the students will know– ● To know the characteristics of various components. ● To understand the utilization of components. ● To design and analyze small signal amplifier circuits. ● To learn Postulates of Boolean algebra and to minimize combinational functions ● To design and analyze combinational and sequential circuits ● To know about the logic families and realization of logic gates.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Differential amplifier Circuit Configurations, Dual Input Balanced Output Differential amplifier, DC analysis, AC analysis, Inverting and Non Inverting Inputs, Constant Current Bias Circuit. Block diagram of a typical Op-Amp, Open loop configuration, Inverting and Non-inverting amplifiers, Op-amp with negative feedback, Voltage Series Feedback, Effect of feedback on closed loop gain, Input resistance, Output resistance, Bandwidth and Output offset voltage, Voltage follower. Practical Op-amp, Input Offset Voltage, Input bias current- input offset current, total output offset voltage, CMRR frequency response.	10
II	Applications of Op amps (15) DC and AC amplifier, Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Integrator and Differentiator. Oscillator: Principles , Oscillator types, Frequency stability, Response , Phase Shift oscillator ,Wein Bridge Oscillator, LC Tunable Oscillator , Multivibrators, Monostable and Astable, Comparators, Square Wave and Triangle wave generators. Voltage regulations: Fixed regulators, Adjustable voltage regulators, Switching regulators.	12
III	FETs and Digital Circuits: FETs: JFET, V-I characteristics, MOSFET, low frequency CS and CD amplifiers. Digital Circuits: Digital (binary) operations of a system, OR gate, AND gate, NOT, EXCLUSIVE OR gate, De Morgan Laws, NAND and NOR DTL gates, modified DTL gates, HTL and TTL gates, output stages, RTL and DCTL, CMOS, Comparison of logic families	6
IV	Combinational Logic Circuits: Basic Theorems and Properties of Boolean Algebra, Canonical and Standard Forms, Digital Logic Gates, The Map Method, Product-of-Sums Simplification, Don't-Care Conditions, NAND and NOR Implementation, Exclusive-OR Function, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers.	7
V	Sequential Logic Circuits: Sequential Circuits, Storage Elements: Latches and flip flops, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Shift Registers, Ripple Counters, Synchronous Counters, Random-Access Memory, Read-Only Memory.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] Differential amplifier and its applications	
CO2	They will be able to **interpret**[2] applications of OPAMP	
CO3	They will be able to **understand**[2] the FETs and Digital Circuits.	
CO4	They will be able to **distinguish**[4] various types of combinational logic circuits.	
CO5	They will be able to **understand**[1] the sequential logic circuits..	
TextBooks:	● Integrated Electronics: Analog and Digital Circuits and Systems, 2/e, Jaccob Millman, Christos Halkias and Chethan D. Parikh, Tata McGraw-Hill Education, India, 2010. ● Digital Design, 5/e, Morris Mano and Michael D. Cilette, Pearson, 2011.	
ReferenceBooks:	● Electronic Devices and Circuits, Jimmy J Cathey, Schaum's outline series, 1988. ● Digital Principles, 3/e, Roger L. Tokheim, Schaum's outline series, 1994.	

Syllabus SEMESTER VIII

COURSE CODE	ELEMENTS OF CONDENSED MATTER PHYSICS	TotalLec. :45
SC23PH012		3-0-2
Learning Objectives:	After studying this paper the students will know– ● To study some of the basic properties of the condensed phase of matter especially solids. Condensed matter physics (CMP) is the fundamental science of solids and liquids. ● As the largest branch of physics, it has the greatest impact on our daily lives by providing foundations for technology developments.	
Pre-requisite:	Foundations of Physics & Mathematics	
UNIT	**CONTENT**	**HOURS**
I	Basic Structures; symmetry properties, packing fractions, directions and position orientation of planes in crystal, concept of reciprocal lattice, concept of brillouin zones, closed packed structure, and structures of some binary/ternary compounds. Elementary concepts of polycrystalline, Nano crystalline and amorphous materials. Elementary concepts of defects in solids. X-ray scattering from solids including Laue conditions and line intensities.	10
II	Energy bands: Electron in periodic potential, Bloch function, solution of wave equation of electron in periodic potential, reduced, periodic and extended zone schemes. Construction of Fermi surfaces in brillouin zones for two - dimensional lattices, Introduction to methods for calculations of energy bands and their features. Semiconductors: Direct and indirect band gap semiconductors effective mass, intrinsic carrier concentration, impurity conductivity thermal ionization Revision on p-n junction and rectification, metal- semiconductor contacts, schotky barrier.	12
III	Dielectric properties of Solids, electronic, ionic, orientational, polarzabilities, static dielectric constant for gases, internal field in solids, dielectric constant of solids, dielectric relaxation in alternating fields, dielectric losses, complex dielectric constant.	6
IV	Concept of Energy Band: Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, Bloch theorem and crystal momentum, Classification of metal, insulator and semiconductors.	7
V	Super conductivity: Basic concepts, Meissner effect, heat capacity, energy gap, London equation, coherence length Josephson effect (flux quantization), type I and II superconductors, BCS theory, Introduction to high Tc Superconductors.	10
Course Out comes as per Bloom's Taxonomy		
CO1	The students will be able to **define**[1] basic structure of crystals.	
CO2	They will be able to **interpret**[2] energy bands.	
CO3	They will be able to **understand**[2] the dielectric properties of solids..	
CO4	They will be able to **distinguish**[4] various types of energy band.	
CO5	They will be able to **understand**[1] the super conductivity.	
Text Books:	● Srivastava, J.P., Elements of Solid State Physics, Prentice Hall of India, (2008).	
Reference Books:	● Introduction to Solid State Physics 4 th Ed. C. Kittel, ● Solid State Physics by A .J. Dekker ● Solid State Physics by N. W. Ashoroff &N. D. Mermin ● Solid State Physics S.O. Pillai ● Solid state Physics by R. L. Singhal	

Practical

COURSE CODE	PHYSICSLAB-VIII	Practicals:
SC23PH012P		1
	● To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO. ● To test a Diode and Transistor using a Multimeter. ● To design a switch (NOT gate) using a transistor. ● To verify and design AND, OR, NOT and XOR gates using NAND gates. ● To design a combinational logic system for a specified Truth Table. ● To convert a Boolean expression into logic circuit and design it using logic gate ICs. ● To minimize a given logic circuit. 8. Half Adder, Full Adder and 4-bit binary Adder. ● Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C. ● To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates. ● To build JK Master-slave flip-flop using Flip-Flop ICs. ● To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram	