BMS COLLEGE OF ENGINEERING, BENGALURU-19
Autonomous Institute, Affiliated to VTU

INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	**Environmental Pollution and Control**	**Course Code**	**17CY7IEEPC**
Credits	**03**	**L-T-P-S**	**3- 0 -0-0**
Contact hours	**38**	**Faculty Handling**	**Dr.Kirti Agarwl**

Course objective:

This course deals with the main sources of pollutants in three main environment constituents air, water and soil and their impact on the environmental ecosystem. It covers water and air pollution, its measurement, pollution abatement systems for wastewater, particulate matter and gaseous constituents. It also deals with the pollution remediation strategies for soil pollution and solid waste management. It will provide students the ability to analyse different industrial pollution control strategies and skills of remediation in combating pollution and providing solutions to societal problems.

Course outcomes:

After completion of course students will have:

CO 1	An ability to identify the components of environmental ecosystems and effect of water, air, soil pollutant on them
CO 2	An ability to apply pollution control measures on air, water and soil pollutants
CO 3	An ability to recognize and control environmental issues in various industries and comprehend engineering solutions.

Unit I

Introduction:

Biodiversity with an Introduction to Ecology & Environment. Environmental pollution an over view ambient air and water quality criteria, Standards and Acts – WHO, EPA &Indian. Effects and control of thermal, and radioactive pollution arising due to interaction of humans with environment. **6rs**

Unit II

Water Pollution:

Water a valuable resource, water quality standards, types of pollutant in water and their effect. Physical and chemical characteristics of Waste water, Biochemical oxygen demand (BOD), chemical oxygen demand (COD) and their determination. Methods of sampling, preservation of samples and analysis. Method for the treatment of liquid wastes to control pollution. Physical, chemical and biological methods with role of micro organism. Sludge treatment & Disposal. Numerical problems. Selection of equipment like hydro cyclone, settling tanks, filters, ion- exchange.

8hrs

Unit III

Air Pollution:

Pollutant Types – Natural and manmade air pollutants, classification into primary and secondary pollutants. **Primary**-particulate matter (both PM 2.5 and 10) Inorganic gases SO_2, nitric oxide, VOC, lead. **Secondary** pollutants- Peroxy acyl nitrate, ozone,SO_3, NO_2. Effect of air pollutants, air pollution laws and standard. Air sampling procedures, control of air pollutants. Sampling and measurement of gaseous and particulate pollutants in ambient air and industrial waste gases. Control of gaseous pollutants-VOCS SOx, NOx, H_2S, from auto exhaust. Remedial measures by using equipment's like, cyclones, electrostatic precipitators fabric bag filters and wet scrubbers. **8hrs**

Unit IV

SOIL POLLUTION AND SOLID WASTE MANAGEMENT:

Soil contamination by chemical pollutants: sources and fate. Remediation by plants, biomagnifications and bioremediation by microorganisms; contamination by inorganic (including heavy metals) and organic pollutants.

Solid waste-Definition, characteristics and perspectives, Problems of collection and handling, Types of solid wastes, Sources of solid waste, Properties of solid waste –solid waste management such as compaction ,incineration, composting, landfills and biological processing. Material flow in society, reduction in raw material usage, solid waste generation, and reuse with materials, energy recovery. 8 **hrs**

Unit V

INDUSTRIAL POLLUTION CONTROL:

Pollution control in important chemical industries like Tannery, Pulp and Paper,fertiliser, food processing, Pharmaceuticals, Sugar, Distillery , petrochemicals and electroplating.

8 **hrs**

T**ext Books:**

1. Rao C.S Environmental Pollution Control Engineering ,Wiley Eastern Ltd. New Delhi 2015 .

2. MahajanS.P.,Pollution Control in Process Industries, ". Tata McGraw Hill

. **Reference Books:**

1. Howard S. Peavy, D. R. Rowe & C. TChobonoglous "Environmental Engineering", McGraw Hill (1984).
2. Werner Strauss, 'Air Pollution Control: Measuring and monitoring air pollutant' Wiley (1978).
3. Metcalf & Eddy, "Waste Water Engineering Treatment, Disposal & Reuse", Tata McGraw Hill (2003).

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INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	Nanomaterials - Synthesis, Characterization And Applications	Course Code	17CY7IENMA
Credits	03	L-T-P-S	3- 0 -0-0
Contact hours	36	Faculty Handling	Dr. M. S. DHARMAPRAKASH

Course Objectives: The basic objectives course is to make students aware of Nano scale materials and structures, their properties, size effects. To make students learn some methods of synthesis of Nano materials their characterization by XRD, SEM and TEM. Some important Industrial applications of Nano materials is also dealt with.

CO NO.	COURSE OUTCOMES: *AT THE END OF THE COURSE THE STUDENT WILL HAVE*
CO1	AN ABILITY TO UNDERSTAND AND EXPLAIN NANOSCALE MATERIALS AND PROPERTIES,VAROIUS METHODS OF SYNTHESIS,CHARACTERIZATION
CO2	AN ABILITY TO APPLY THE LEARNT KNOWLEDGE AND CHOOSE APPROPRIATE METHOD TO SYNTHESIZE AND CHARACTERIZE NANOMATERIALS.
CO3	AN ABILITY TO APPLICATION OF NANOMATERIALS

UNIT-I

INTRODUCTION: **6 Hrs**

Definition and Classification of Nanostructures -Nano Particles, Nano crystalline Materials, Nanocrystalline Ceramics, Semiconductor Nanoparticles, Metal Nanoparticles, Nanotubes and Nano - Scale Architectures.

Unit-II

SYNTHESIS: **8 Hrs**

Top down approaches and bottom up approaches.

Chemical methods: sol-gel synthesis, Co-precipitation, CVD, CVS, and combustion synthesis. Microwave Synthesis of Metallic nano Particles (Ag, Au, pt) and Nanoparticles of Metal Oxides (ZrO_2, ZnO,Al_2O_3 TiO_2). Carbon Nanotubes -Synthesis Multi-Walled Nanotubes Aligned Carbon Nanotube Bundles Single-Walled Carbon Nanotubes.

Physical methods: Vapor deposition and different types of epitaxial growth techniques-pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining.

Unit-III

PROPERTIES: **6 Hrs**

Effects of nanometer length scale on Physical and Chemical Properties of Materials. Size Effects – Fraction of Surface Atoms – specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States. Chemical properties- catalysis.

Unit-IV

CHARACTERIZATION: **8 Hrs**

XRD-X-ray powder diffraction – Bragg's law - Instrumentation. Determination of lattice parameters - particle size analysis using Scherer formula.

SEM-Working Principle of Specimen Preparation – Modes of operation– Backscattered electrons – secondary electrons- X-rays – typical forms of contrast– Resolution and contrast – enhancement –Analyses of SEM images.

TEM-Basic principles - Modes of operation – Specimen preparation – Diffraction in imperfect crystals and dislocations – Structure of Grain boundaries and interfaces- HRTEM.

Unit-V

APPLICATIONS **6 Hrs**

Renewable energy, solar energy, fuel cells. Materials manufacturing and automobile industry. Biomedical Science, Medicine, Diagnostics. Biotechnology. Computers, Electronics and communication. Chemical analysis, Pharmacy Environmental sciences, Sport sector, Printing, Optics. Agriculture, Food, Textile, Cosmetics. Defense, Aerospace and Marine Nanotechnology.

Text book:

1. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, *The Chemistry of Nanomaterials :Synthesis, Properties and Applications*, Volume 1, Wiley-VCH, Verlag GmbH, Germany (2004).

References:

1. G.A. Ozin and A.C. Arsenault, "Nanochemistry : A chemical approach to nanomaterials", Royal Society of Chemistry, 2005.
2. Charles P.Poole Jr. "*Introduction to Nanotechnology*", John Willey & Sons , 2003. T. Pradeep
3. "*NANO The Essential , understanding Nanoscience and Nanotechnology"*. Tata McGraw-Hill
4. Nano scale Science and Technology Robert Kelsall, Ian Hamley, and Mark Geoghegan (Editors) John-Wiley

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INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	ANALYTICAL TECHNIQUES	Course Code	17CY8IEATE
Credits	03	L-T-P-S	3- 0 -0-0
Contact hours	40	Faculty Handling	--

Prerequisites: The candidate is expected to have proficiency in fundamentals of Chemistry and an interet to expand the knowledge.

Course Objectives: The fundamental goals of the course is to:
(a) Provide basic principles governing chemical data analysis
(b) Impart knowledge of sampling and separation techniques
(c) Promote awareness in spectroscopic and modern chromatographic techniques
(d) Teach importance of automation and reinforce the principles of quality assurance

A	Course Outcomes: *At the end of the course the student will have*
CO1	An ability to **understand and explain** the concepts of handling the chemical data, sampling, given absorption, emission, chromatographic techniques and quality assurance
CO2	An ability to **apply** the learnt knowledge and **choose** appropriate choice of technique for a given analytical sample
CO3	An ability **solve** the given problem sets of analytical chemistry

Unit I

Statistical Evaluation of Analytical Data **8hrs**

Introduction: Flow diagram for analytical approach (a) Determination of errors - Accuracy and Precision, Sensitivity, selectivity, Robustness, Ruggedness, Scale of operation, developing the procedure - compensating for interferences, calibration and standardization. (b) Evaluation of data - Measures of central tendency-mean and median, Measures of spread - Range, standard deviation and variance, Propagation of errors-Relative and absolute variance, The confidence limit, Tests of significance, Rejection of a result The Q Test, Statistics for small data sets, Linear least squares, Correlation coefficient and coefficient of determination, Detection limits, Statistics of sampling, Power analysis, Use of spreadsheets in analytical chemistry, Problems

Unit-II

Equilibrium chemistry and Sampling **8hrs**

Ladder diagrams: Acid-base equilibria, complexation equilibria, oxidation-reduction (redox) equilibria. Preparation of samples-coning and quartering, separating analyte from interferants, Theory of separation efficiency, Classification of separation techniques: size, mass and density, complex formation, change in physical state, change in chemical state and partitioning, Separation techniques employed for each classification as above. Liquid-Liquid

extractions: partition coefficients and distribution ratios, types-no secondary reactions, acid-base equilibria, metal chelators, Problems

Unit III

Spectroscopic Methods of Analysis **8hrs**

Atomic absorption spectroscopy: Introduction, Principle (Beer-lamberts law), instrumentation and applications, Atomic Emission Spectroscopy: Principles, Limitations of Flame Emission spectroscopy, Instrumentation of Inductively coupled Plasma (ICP) and comparison of AFS, AAS and ICP-AES. Spectroscopy based on Scattering: origin of scattering, Turbidimetry and Nephelometry - Principle, Instrumentation and applications

Unit IV

Chromatographic Techniques of Analysis **8hrs**

Principles, classification, Fundamentals, Techniques and Dynamics of Chromatography, Van Deemter's equation, Introduction, instrumentation and applications of (a) High performance liquid chromatography (HPLC) (b) Size-Exclusion chromatography (c) Supercritical fluid chromatography (d) Capillary electrophoresis.

Unit V

Automation and Quality Assurance in Analysis **8hrs**

Classification of automated methods, Automated Analysis, Flow Injection Analysis: Theory and Applications. Developing a standard method - verifying and validating the methods. Quality control, Quality Assessment-Internal and external methods, Evaluating quality assurance data-prescriptive approach, performance approach, Problems

Text Books:

1. Basic Concepts of Analytical Chemistry by S M Khopkar, New Age International, 3rd Edition (Reprint), 2017, 604 pages
2. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch, 9th Edition, Cengage Learning, 2013, 1072 pages

Reference books:

1. Analytical Chemistry by Gary D. Christian, Purnendu H. Dasgupta and Hevin A. Schug, 7th Edition, Wiley publications, 2014, 826 pages
2. Undergraduate Instrumental Analysis by James W Robinson, Eileen S Kelly Frane, George M Frame III, CRC Press, 7th edition 2014, 1264 pages
3. Modern Analytical Chemistry by David T Harvey, Mc-Graw Hill Higher Education, 1999, 816 pages

E Book: Creative Commons Attribution
http://www.freebookcentre.net/chemistry-books-download/Analytical-Chemistry-2.0-by-David-Harvey.html

MOOCS:http://nptel.ac.in/syllabus/104104066/

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Course Name	Corrosion Science & Engineering	Course Code	17CY8IECSE
Credits	03	L-T-P-S	3- 0 -0-0
Contact hours	40	Faculty Handling	Dr.Kalyan Raj

Course Objectives

- Study of corrosion principles and their role in understanding different types of corrosion problems
- To gain the knowledge of types of corrosion in applying corrosive techniques to protect faster corrosion and monitoring of corrosion.
- Study of corrosion and different forms of corrosion to understand the failure of metal structures.
- Explore the different corrosion testing methods to measure the corrosion rate.
- To understand various techniques involved in design rules, coatings and other techniques in corrosion control.

CO. NO	**COURSE OUTCOMES** At the end of the course the student will have
CO 1	An ability to understand and Explain corrosion principles and various forms of corrosion and its monitoring and corrosion control
CO 2	An Ability to apply the learnt knowledge in testing, monitoring and control of various forms of corrosion
CO 3	An ability to develop methods of science and engineering in testing, monitoring and control of various forms of corrosion

SYLLABUS:

Unit – I

Corrosion Principles: Introduction, definition, environment. Corrosion damage. Classification, electrochemical reactions. Polarization passivity. Faradays laws of electrolysis, application, and problems. Thermodynamics: Free energy change. Electrode potentials, e.m.f Nernst equation. Environmental effects. Effect of O_2, oxidizer, velocity, temperature. Corrosion concentration, galvanic coupling. Metallurgical aspects. Numericals. **8hrs**

Unit – II

Types of corrosion-1: Uniform attack, galvanic corrosion, definition, Galvanic series, environmental effects, distance and area effect. Prevention, crevice corrosion, definition, environmental effects, mechanism. Filiform corrosion, mechanism, prevention, definition, environmental effects. Pitting corrosion, mechanism, prevention, definition, environmental effects. Solution composition, velocity, evaluation of damage, prevention. Inter granular corrosion, definition, austenite SS. Weld decay.

Control for austenite SS, knife line attack. Selective leaching. Dezincification. Type's mechanism, prevention. **8hrs**

Unit – III

Types of corrosion-2: Erosion corrosion: definition, effect of surface film Velocity of environment, impingement, galvanic effect control of erosion corrosion. Cavitation damage. Fretting corrosion. Wear-oxidation and oxidation – wear mechanisms. Corrosion fatigue, definition, environmental factors, mechanism. Hydrogen damage, prevention, classification. Bio and soil corrosion. **8hrs**

Unit – IV

Corrosion testing and monitoring: Introduction, classification. Purpose of corrosion testing, materials, specimen. Surface preparation, measuring and weighing. Types of testing, lab, pilot plant and field tests. Measurement of corrosion rate, weight loss method. Electrochemical methods, Tafel extrapolation. Linear polarization method, cleaning specimen after exposure. Effect of temperature, std. expression for corrosion rate. Application, numericals. **8hrs**

Unit – V

Corrosion control: Selection of materials, alteration of environment, temperature. Medium, velocity, removal of oxygen. Design, wall thickness, design rules. Cathodic protection, principles, procedure. Anodic protection, principle procedure, comparison. Metallic and other inorganic coatings, Cladding, vapour phase deposition, diffusion, chemical conversion coating. Surface modification, organic coating. Corrosion inhibitors. **8hrs**

Text Books:

1. M.G. Fontana, Corrosion Engineering, Tata McGraw-Hill Edition 2005
2.

Reference Books:

1. Engineering Chemistry by B.K.Sharma. Edition: 6th Edition, 2011. Publisher: Krishna Prakashana Media (p) Ltd.
2. Electrochemistry and corrosion science, Nestor Perez, Springer (India) pvt.Ltd. 2004
3. Principles and prevention of corrosion, D.A.Jones, Macmillan Publ.Co. (1996)
4. Corrosion Handbook, Electrochemical society series. John Wiley and sons. (2000)

MOOCs:

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