



SAMRAT ASHOK TECHNOLOGICAL INSTITUTE

(Engineering College), VIDISHA M.P.

(An Autonomous Institute Affiliated to Barkatullah Vishvavidhyalaya, Bhopal)

DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 401 (Electice I)	Subject Name		Nano Science and Technology		
Marks Allotted				Duration of Theory Paper	Weekly Contact Hours	
Theory					L	T
Maximum Marks		Minimum Marks				
End Sem	Sessional	End Sem	Sessional	3 Hours	3	1
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description						Hrs.
UNIT I - Basic Concept of Nanoscience and Nanotechnology:						
Introduction to Nano-science and Nano-technology, Properties of nanomaterials (Size Effects, Quantum confinement, Electronic, Magnetic, Optical, Thermal, and Mechanical), Classification of nanomaterials, Nanoparticles: (Polymeric nanoparticles, Dendrimers, Micelles, Liposomes, Quantum dots), Nano-wires, Nanotubes: Carbon nanotubes (CNTs), fullerene, Graphene. nanocomposites, Classification of nanocomposites.						8
UNIT II- Synthesis of Nanomaterials:						
Top Down and Bottom up Approach, Physical Methods: Physical Vapour Deposition (PVD), Ion sputtering, Pulse Laser Deposition (PLD), Ball Milling, and Electro-deposition. Chemical Methods: Reduction method, Sol- gel method, Solvothermal synthesis, Photochemical synthesis, Thermolysis routes, Self-assembly, Lithography and E-beam Lithography.						8
UNIT III - Characterization Techniques of Nanomaterials:						
Principle, Instrumentation and working of following techniques: BET surface area analyser, particle size analyser, laser diffraction, Electron microscopy: SEM (E-SEM, FE-SEM), TEM, AFM. Thermal Gravimetric Analysis, Differential Scanning Calorimetry, X-ray Fluorescence (XRF), X-ray diffraction (XRD), X-ray photoelectron spectroscopy. Graphical interpretation of UV and FTIR.						8
UNIT IV-Smart materials:						
Introduction to Smart Materials, piezoelectrics, ferroelectrics, electrostrictive materials, shape memory materials, magnetostrictive materials, optical smart materials, Hydrogels, Electro-active Materials, Conducting Materials, Shape Memory Alloys and polymers.						8
UNIT V- Applications of Nanomaterials						
Applications in nanomaterials in various fields: Drug Delivery, Tissue engineering, Agriculture & Food science, Energy (fuel cell, Photocatalytic hydrogen generation), Sensors, Water remediation-Photocatalytic degradation of toxic dyes, Membrane based water purification.						8
Total Hours						40

TEXT BOOKS:

- G.B. Sergeev, K.J. Klabunde, Nanochemistry, Elsevier, 2013, ISBN: 978-0-444-59397-9
- Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.
- Nanosensors: Physical, Chemical, and Biological by Vinod Kumar Khanna, Publisher: CRC Press.
- Wiesner, M.R., and Bottero, J.Y. (Ed.) "Environmental Nanotechnology: Applications and Impacts of Nanomaterials" McGraw-Hill, New York. 2007
- Diallo, M., Duncan, J., Savage, N., Street, A., and Sustich, R. (Eds). "Nanotechnology Applications for Clean Water" William Andrew. 2008.

REFERENCE BOOKS:

- Springer Handbook of Nanotechnology - Bharat Bhusan
- C Brechignac, P Houdy, M Lahmani, Nanomaterials and Nanochemistry, 2011, Wiley, ISBN: 0444593977.
- Robert Kelsall, Ian W. Hamley, Mark Geoghegan, Nanoscale Science and Technology, Wiley | 2005-04-29 | ISBN: 0470850868.
- Encyclopedia of Nanotechnology- Hari Singh Nalwa
- Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A. Balandin, K. L.Wang.
- K. Otsuka and C. M. Wayman, Shape Memory Materials, Cambridge Press 1999.

List/Links of e-learning resource

- **Introduction to Nano: basics to nanoscience and nanotechnology** by Amretashis Sengupta (Editor); Chandan Kumar Sarkar (Editor)
- **Nanotechnology: Principles and Practices** by Sulabha K. Kulkarni
- **Nanotechnology and Human Health** by Malsch Ineke

Recommendation by Board of studies on	20.12.2023
Approval by Academic council on	6.1.2024
Subject handled by department	Applied Chemistry



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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 401 (Elective I)	Subject Name	Catalysis Chemistry			
Marks Allotted			Duration of Theory Paper	Weekly Contact Hours		
Theory				L	T	
Maximum Marks		Minimum Marks		3 Hours	3	1
End Sem	Sessional	End Sem	Sessional			
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description						Hrs.
<p>UNIT I – Introduction:</p> <p>Definition, role of catalysts, classification of catalysts. Homogeneous catalysts: Mechanism of homogeneous catalysis, acid-base catalysis, enzyme catalysis, micellar catalysis, and phase transfer catalysts, homogeneous catalysis in industry: ZieglerNatta catalysts, olefin and acetylene polymerization, isomerization, hydrogenation, carbonylation reactions, hydroformylation, oxidation of olefins, metallocene catalysts.</p>						8
<p>UNIT II – Heterogenous catalysis:</p> <p>Introduction, Mechanism of heterogeneous catalysis, heterogeneous catalysis in industry: catalytic hydrogenation, Haber-Bosch process, contact process, Ostwald process, : Catalytic processes in petroleum industry- reforming, Fischer-Tropsch process, Volcano principle, shape and size selectivity of catalysts, kinetics of heterogeneous catalytic reactions.</p>						8
<p>UNIT III – Characterization of catalysts and their surfaces:</p> <p>Methods of surface analysis, surface area, pore size, void fraction, particle size, mechanical strength, surface chemical composition, surface acidity and reactivity.</p>						8
<p>UNIT IV- Solid heterogeneous catalysts:</p> <p>Clays, zeolites, bimetallic, semiconductor and oxide catalysts, supported catalysts, polymer catalysts. Production and design of industrial catalysts: Materials and methods, precipitated catalysts, impregnated catalysts, skeletal catalysts, fused and molten catalysts, calcination, reduction, shape formation of catalyst particles, optimal shape and size of catalysts particle.</p>						8
<p>UNIT V- Reactors:</p> <p>Definition, classification, reactor design, choosing reactors in laboratory and plant. Catalyst promotion and deactivation: Promotion and promoters, causes and mechanism of deactivation poisoning, sintering, prevention of catalyst decay, regeneration of catalysts.</p>						8
Total Hours						40

TEXT BOOKS:

- Bartholomew, C. H., Furrauto, R. J. Fundamentals of Industrial Catalytic Processes, 2nd Edn., (Wiley Interscience, 2006).
- Chakrabarty, D. K., Viswanathan, B. Heterogeneous Catalysis (New Age Int., 2008).

REFERENCE BOOKS:

- Gates, B. C. Catalytic Chemistry, (John Wiley & Sons, 1992).
- Wijngaarden, R. J. Industrial Catalysis, (Wiley-VCH, 1998).
- Augustine, R.L. Heterogeneous Catalysts for Synthetic Chemists, (Marcel- Dekker, 1996).

List/Links of e-learning resource

- [https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Chemistry_-_The_Central_Science_\(Brown_et_al.\)/14%3A_Chemical_Kinetics/14.07%3A_Catalysis](https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Chemistry_-_The_Central_Science_(Brown_et_al.)/14%3A_Chemical_Kinetics/14.07%3A_Catalysis)

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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 401 (Elective I)	Subject Name	Coordination Chemistry			
Marks Allotted			Duration of Theory Paper	Weekly Contact Hours		
Theory				L	T	
Maximum Marks		Minimum Marks		3 Hours	3	1
End Sem	Sessional	End Sem	Sessional			
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description						Hrs.
<p>UNIT I - Coordination Compounds: Simple inorganic molecules and coordination complexes. Nomenclature – IUPAC rules, Brief review of Werner’s theory, Coordination number, coordination geometries of metal ions, type of ligands. Isomerism in coordination compounds: stereo isomerism – (a) geometrical isomerism in (i) square planar metal complexes (ii) Octahedral metal complexes.</p>						8
<p>UNIT II – Isomerism in coordination compounds: (b) Optical isomerism in (i) Tetrahedral complexes [MABCD], (ii) Octahedral complexes [M(AA)2B2], [M(AA)3] using suitable examples. Structural isomerism: ionization, linkage, coordination ligand isomerism using suitable examples. Sidgwick’s electronic interpretation and EAN rule and their limitations.</p>						8
<p>UNIT III – Valence bond theory (VBT): Postulates and application to (a) tetrahedral complexes $[\text{Ni}(\text{NH}_3)_4]^{2+}$, $[\text{NiCl}_4]^{2-}$ and $[\text{Ni}(\text{CO})_4]$ (b) square planar complexes $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{Cu}(\text{NH}_3)_4]^{2+}$, $[\text{PtCl}_4]^{2-}$ (c) octahedral complexes $[\text{Fe}(\text{CN})_6]^{4-}$, $[\text{Fe}(\text{CN})_6]^{3-}$, $[\text{FeF}_6]^{4-}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{CoF}_6]^{3-}$. Limitations of VBT. Chelate effect, polynuclear complexes.</p>						8
<p>UNIT IV- Thermodynamic and kinetic Stability of complexes, Crystal field theory (CFT), Spectral and magnetic properties of coordination complexes, Reaction mechanism of transition metal complexes: Ligand substitution reaction in octahedral and square planer complex.</p>						8
<p>UNIT V - Organometallic compounds: Definition, nomenclature and classification of organometallic compounds. Methods of preparation, properties and applications of alkyl and aryl compounds of metals. Preparation and properties of ferrocene. Metal carbonyls and related compounds, 18 valence electron rule, 16 valence electron rule, classification of metal carbonyls: $\text{Ni}(\text{CO})_4$, $\text{Fe}(\text{CO})_5$, $\text{Fe}_2(\text{CO})_9$, $\text{Fe}_3(\text{CO})_{12}$ and $\text{Cr}(\text{CO})_6$.</p>						8

Total Hours	40
TEXT BOOKS:	
<ul style="list-style-type: none"> • Basic organometallic Chemistry by B. D. Gupta, A. J. Elias, University Press (India) Pvt. Ltd., 2nd edn, Hyderabad, 2013 • Organometallic Chemistry by R. C. Mehrotra, A. Singh, New Age International Ltd., 1st edn, 2011, New Delhi • Organometallic Compounds by Indrajeet Kumar, 4th edn, 2013, Pragati Prakashan, Meerut. • Inorganic Chemistry by G. L. Miessler, D. A. Tarr, 3rd edn., 2004, Pearson Education, Inc. 	
REFERENCE BOOKS:	
<ul style="list-style-type: none"> • Organometallic Chemistry by Pauson • Modern Aspects of Inorganic Chemistry by Emelius and Sharpe • Principle of Organometallic Chemistry by Coutes, Green, Powell and Wade 	
List/Links of e-learning resource	
<ul style="list-style-type: none"> • https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_and_Websites_(Inorganic_Chemistry)/Coordination_Chemistry/Structure_and_Nomenclature_of_Coordination_Compounds/Introduction_to_Coordination_Chemistry 	
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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 401 (Elective I)	Subject Name	Industrial Pharmacy			
Marks Allotted			Duration of Theory Paper	Weekly Contact Hours		
Theory				L	T	
Maximum Marks		Minimum Marks		3 Hours	3	
End Sem	Sessional	End Sem	Sessional			1
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description					Hrs.	
<p>UNIT I – Preformulation Studies:</p> <p>Introduction to preformulation, goals and objectives, study of physicochemical characteristics of drug substances, BCS classification of drugs & its significant Application of preformulation considerations in the development of solid, liquid oral and parenteral dosage forms and its impact on stability of dosage forms.</p>					8	
<p>UNIT II – Tablets:</p> <p>Introduction, ideal characteristics of tablets, classification of tablets. Excipients, Formulation of tablets, granulation methods, compression and processing problems. Equipments and tablet tooling. Tablet coating: Types of coating, coating materials, formulation of coating composition, methods of coating, equipment employed and defects in coating.</p> <p>Quality control tests: In process and finished product tests Liquid orals: Formulation and manufacturing consideration of syrups and elixirs suspensions and emulsions; Filling and packaging; evaluation of liquid orals official in pharmacopoeia</p>					8	
<p>UNIT III – Capsules: Hard gelatin capsules:</p> <p>Introduction, Production of hard gelatin capsule shells, size of capsules, Filling, finishing and special techniques of formulation of hard gelatin capsules, manufacturing defects. Quality control tests for capsules. Soft gelatin capsules: Nature of shell and capsule content, size of capsules, importance of base adsorption and minim/gram factors, production, in process and final product quality control tests. Packing, storage and stability testing of soft gelatin capsules and their applications.</p> <p>Pellets: Introduction, formulation requirements, pelletization process, equipments for manufacture of pellets</p>					8	
<p>UNIT IV- Parenteral Products:</p> <p>Definition, types, advantages and limitations. Preformulation factors and essential requirements, vehicles, additives, importance of isotonicity, Production procedure, production facilities and controls, aseptic processing, Formulation of injections, sterile powders, large</p>					8	

<p>volume parenterals and lyophilized products. Containers and closures selection, filling and sealing of ampoules, vials and infusion fluids. Quality control tests of parenteral products.</p> <p>Ophthalmic Preparations: Introduction, formulation considerations; formulation of eye drops, eye ointments and eye lotions; methods of preparation; labeling, containers; evaluation of ophthalmic preparations</p>	
<p>UNIT V- Cosmetics: Formulation and preparation of the following cosmetic preparations: lipsticks, shampoos, cold cream and vanishing cream, tooth pastes, hair dyes and sunscreens.</p>	8
<p>Total Hours</p>	40
<p>TEXT BOOKS:</p> <ul style="list-style-type: none"> • Semalty A, Industrial Pharmacy-I, 2021, Pharma Med Press, Hyderabad, India • Semalty A, Quick Review on Industrial Pharmacy, 2021, Pharma Med Press, Hyderabad, India • Semalty et al. Essentials of Pharmaceutical Technology, II Edn 2018, reprint 2019, Pharma Med Press, Hyderabad. 	
<p>REFERENCE BOOKS:</p> <ul style="list-style-type: none"> • <u>Niazi SK, Handbook of Preformulation, II Edn.; CRC Press, 2019; http://tiny.cc/preformulation;</u> • <u>Aulton ME, Taylor K. (ED), Aulton's Pharmaceutics: The Design and Manufacture of Medicines, 4th edn, Churchill Livingstone, London, 2013; http://tiny.cc/Aulton.</u> 	
<p>List/Links of e-learning resource</p>	
<ul style="list-style-type: none"> • Lachman L/Lieberman HA, Kanig JL, The Theory And Practice Of Industrial Pharmacy,4E (2020); http://tiny.cc/lachman. • <u>Semalty et al. Essentials of Pharmaceutical Technology, II Edn 2018, reprint 2019, Pharma Med Press, Hyderabad</u> 	
<p>Recommendation by Board of studies on</p>	20.12.2023
<p>Approval by Academic council on</p>	6.1.2024
<p>Subject handled by department</p>	Applied Chemistry



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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 402 (Elective II)	Subject Name	Regulatory Guidelines for Pharma Industry			
Marks Allotted			Duration of Theory Paper	Weekly Contact Hours		
Theory				L	T	
Maximum Marks		Minimum Marks		3 Hours	3	
End Sem	Sessional	End Sem	Sessional			1
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description					Hrs.	
<p>UNIT I – ICH Guidelines I: purpose, participants, process of harmonization, Brief overview of QSEM, with special emphasis on Q-series guidelines, ICH guidelines for stability testing of drug substance and drug products [Q1 A to Q1 F], ICH guidelines for Analytical methods development validation, Brief introduction about Q-3, Q-4, Q-5 and Q-6 guidelines.</p>					8	
<p>UNIT II – ICH Guidelines II: Scopes of Quality assurance and Quality control, Study of ICH Q-7 Good Manufacturing Practices and Good laboratory Practices: Principles, documentation of laboratory work, preparation of Standard operating procedures (SOPs), Validation of Methods, reporting and documentation of results. Organization and personnel Facilities, Premises, Equipments and Raw materials.</p>					8	
<p>UNIT III – ICH Guidelines III: Study of ICH Q-8 (Quality by design (QbD) in pharmaceutical development): Definition, overview, elements of QbD program, tools and process development report.</p> <p>Study of ICH Q-9 (Quality Risk Management): Introduction, Risk assessment, risk control, risk review, risk management tools. Introduction of ICH guideline Q-10 (Pharmaceutical Quality System). General Introduction of ICH guideline Q-11 and Q-12.</p>					8	
<p>UNIT IV- Regulatory Affairs:</p> <p>Indian Regulatory Rights: Introduction, Historical overview of Regulatory Affairs, Regulatory authorities, Role of Regulatory affairs department, Responsibility of Regulatory Affairs Professionals.</p> <p>Regulatory requirements for drug approval: Drug Development Teams, Non-Clinical Drug Development, Pharmacology, Drug Metabolism and Toxicology, General considerations of Investigational New Drug (IND) Application, Investigator’s Brochure (IB) and New Drug Application (NDA), Clinical Research Protocols, Biostatistics in Pharmaceutical Product Development, Data Presentation for FDA Submissions, Management of Clinical Studies.</p>					8	
<p>UNIT V- Intellectual Property Rights:</p>					8	

Introduction, Types of Intellectual Property Rights (Patents, Trademarks, Copyrights, Geographical Indications Industrial Designs and Trade secrets), Patentable Subject Matter (Novelty, Non- Obviousness, Utility, Enablement and Best mode), ISO 9000 & ISO14000: Overview, Benefits, Elements, steps for registration, NABL accreditation: Principles and procedures.	
Total Hours	40
<p>TEXT BOOKS:</p> <ul style="list-style-type: none"> • B.P. Nagori, Ajay Gaur, Renu Solanki & Vipin Mathur, Pharmaceutical quality assurance • K. P. R. Chowdary, A Textbook of Pharmaceutical Quality Assurance • Y. Anjaneyulu, Quality Assurance And Quality Management • Good Laboratory Practice Regulations, 2nd Edition, Sandy Weinberg Vol. 69. • Quality Assurance of Pharmaceuticals- A compendium of Guidelines and Related Materials Vol I WHO Publications. • ICH guidelines, ISO 9000 and 14000 guidelines. • Protection of Industrial Property rights by P. Das and Gokul Das • Law and Drugs, Law Publications by S.N. Katju 	
<p>REFERENCE BOOKS:</p> <ul style="list-style-type: none"> • Prof. Dr. R. Sundhararajan Dr.M.V.Kumudhavalli Dr. (Mrs). Minal T. Harde, Quality Assurance • Graham P. Bunn, Good Manufacturing Practices for Pharmaceuticals, CRC Press, Taylor & Francis Group, 2019 • Waghulkar, K K Tapar , & Shrikhande, Quality Assurance Techniques in Pharmaceuticals • Mrs G. Sai Sri Lakshmi, Dr. T. Vinay Kumar, Dr K Shanta kumara, Mrs S Padmavathi, Concepts of Pharmaceutical Quality Assurance and Quality Management • A guide to Total Quality Management- Kushik Maitra and Sedhan K Ghosh.. • The International Pharmacopoeia – Vol I, II, III, IV- General Methods of Analysis and Quality specification for Pharmaceutical Substances, Excipients and Dosage forms. • Good laboratory Practices – Marcel Deckker Series. • Pharmaceutical Regulatory affairs –selected topics. CVS subhramanyam and J Thimma settee. Delhi, Vallabh Prakashan, 2012 	
List/Links of e-learning resource	
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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 402 (Elective II)	Subject Name	Electrochemical Energy Conversion and Storage			
Marks Allotted				Duration of Theory Paper	Weekly Contact Hours	
Theory					L	T
Maximum Marks		Minimum Marks		3 Hours	3	1
End Sem	Sessional	End Sem	Sessional			
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description						Hrs.
<p>UNIT I – Introduction to Elementary Electrochemistry, The Laws of Electrochemistry and Electrolysis, Applications of Faraday's Laws of Electrolysis. Electrolytic Conduction: Arrhenius Theory of Electrolytic Dissociation, Electrochemical/Galvanic Cell: Construction and Cell Reactions, Electrode potential, Measurement of EMF of a cell, Nernst equation, Applications of Nernst Equation, Numerical Problems: Faraday's Laws of Electrolysis, Nernst Equation, EMF of Half Cell Reactions, Types of Electrodes (Glass, SHE, Calomel) in Electrochemistry.</p>						8
<p>UNIT II – Electrochemical Cells: Liquid Junction Potential, Electrolytic Solutions: Determination of Activity Coefficient, Experimental Methods to Determine Transport Number, Electrolytic Solutions, Electrolytes: Roles and requirements, organic electrolyte, ionic liquid electrolyte, Variation of Conductance with Concentration, Ionic mobilities in terms of ion Conductivities</p>						8
<p>UNIT III – Conventional sources of energy, limitations, Importance of storage, Batteries: Electrodes, Cell, battery, characteristics of battery, Operational principles, main characteristics and applications of: Primary batteries, secondary batteries: Lead Acid Batteries: Ni- Cd and Ni- MeH Batteries.</p>						8
<p>UNIT IV- Lithium batteries: categories of lithium batteries, Working principle, cell reactions and cell performances of Lithium and Lithium ion batteries. Recycling of lithium and other battery constituents from used battery, Fuel cells: Classification, H₂-O₂ fuel cell, advantages, disadvantages.</p>						8
<p>UNIT V- Introduction about Na ion rechargeable battery, Semiconductor electrodes and Solar energy system. Introduction to bioelectrochemistry, electrochemical communication in biological organisms.</p>						8
Total Hours						40
TEXT BOOKS:						
<ul style="list-style-type: none"> • Atkins, P. and Paula, J. de. Atkins' Physical Chemistry, 10th Edn., (Oxford University Press, New Delhi, 2014). • 2. Engel, T. and Reid, P. Thermodynamics, Statistical Thermodynamics and Kinetics, 2nd 						

Edn., (Pearson, New Delhi, 2011).	
REFERENCE BOOKS:	
<ul style="list-style-type: none"> • Laidler, K. J. Chemical Kinetics, 4th Edn., (McGraw Hill, New Delhi, 2007). • Bokris, J. O. M. and Reddy, A. K. N. Modern Electrochemistry, Vol. I & II, (Plenum, 2001). • A. J. and Faulkner, L. R. Electrochemical Methods: Fundamentals and applications, 2nd Edn., (Wiley, 2000). 	
List/Links of e-learning resource	
<ul style="list-style-type: none"> • https://onlinecourses.nptel.ac.in/noc21_mm34/preview • https://archive.nptel.ac.in/courses/113/105/113105102/ • https://www.digimat.in/nptel/courses/video/113105102/L58.html 	
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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 402 (Elective II)	Subject Name	Water & Waste water treatment			
Marks Allotted			Duration of Theory Paper	Weekly Contact Hours		
Theory				L	T	
Maximum Marks		Minimum Marks		3 Hours	3	1
End Sem	Sessional	End Sem	Sessional			
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description					Hrs.	
UNIT I–Water Treatment Methods: Definition, sources and nature of water pollutants. Physical (Colour, Taste, Odour, Turbidity, Total Solids), Chemical (pH, Acidity, Alkalinity, Hardness, Dissolved Gases, BOD, COD, Dissolved Minerals, Inorganic metal ions) and Biological characteristics (Microbiological agents such as Bacteria, Virus, Pathogens, etc.) of waste water.					8	
UNIT II– Primary Waste Water Treatment Introduction, Treatment of Domestic waste water Waste water treatment, Preliminary waste water Treatment: screening Gritting, sedimentation, Primary Treatment Methods: oil separation, coagulation, flocculation, sedimentation, filtration.					8	
UNIT III – Secondary Waste Water Treatment Aerobic processes: Aerated lagoons, Trickling filter process, Activated Sludge Process, Stabilization ponds (Oxidation Pond), Oxidation Ditch process, Secondary Sedimentation sludge treatment and disposal. Anaerobic processes: Flow through systems and contact systems. UASB reactors and modifications. Sludge types, treatment and disposal. Processing of sludge - conditioning, thickening, dewatering, drying, incineration and disposal.					8	
UNIT IV- Tertiary Waste Water Treatment Equalisation, Neutralization, Physical, Chemical (lime soda, zeolite and demineralization processes, Dechlorination, Reverse Osmosis, Electrodialysis) and Biological Treatment.					8	
UNIT V- Advanced Treatment Methods- Introduction, Treatment process: Ultra Filtration method, Microstaining method, Nanofiltration, Zero Discharge, Water Oxidation.					8	

Total Hours	40
TEXT BOOKS:	
<ul style="list-style-type: none"> • “Manual on Water Supply and Treatment”, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2009. • “Manual on Sewerage and Sewage Treatment”, CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2009. • METCALF & EDDY, INC. “Wastewater Engineering, Treatment and Reuse”, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2012. • Arceivala, S.J., “Wastewater treatment for pollution control”, TMH, New Delhi, 2001. • Qasim, S.R, “Wastewater Treatment Plant, Planning, Design & Operation”, Technomic Publications, New York, 2004. 	
REFERENCE BOOKS:	
<ul style="list-style-type: none"> • Eckenfelder, W.W., "<i>Industrial Water Pollution Control</i>", McGraw-Hill, 2001. • Arceivala, S.J., "<i>Wastewater Treatment for Pollution Control</i>", Tata McGraw-Hill, 2008. • Frank Woodard, "<i>Industrial waste treatment Handbook</i>", ButterworthHeinemann, New Delhi, 2001. • Lee, CC and Shun dar Lin, "<i>Handbook of Environmental Engineering Calculations</i>", McGraw-Hill, New York, 2009. 	
List/Links of e-learning resource	
•	
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DEPARTMENT OF APPLIED CHEMISTRY

Subject Code	AC 402 (Elective II)	Subject Name	Solid Waste Management			
Marks Allotted				Duration of Theory Paper	Weekly Contact Hours	
Theory					L	T
Maximum Marks		Minimum Marks		3 Hours	3	1
End Sem	Sessional	End Sem	Sessional			
80	20	21*	12			
Total Minimum in Theory* 40% = 128						
Syllabus Description						Hrs.
<p>UNIT I - Solid Waste Management Definition, sources, generation, classification and composition of solid waste. Types and Sources of solid wastes. Solid waste management methods- sanitary land filling, recycling, composting, vermi composting, Incineration and energy recovery from organic waste. Need for solid waste management. Modern techniques in managing solid waste - Case studies.</p>						8
<p>Unit II - Hazardous waste management: Sources, types and characterization and categories of hazardous wastes. Analytical approach for waste characterization, proximate analysis and survey analysis. Hazardous waste control & treatment methods- physical, chemical and thermal and advanced treatments. HW reduction, recycling, reuse and control. Regulatory aspects of HWM.</p>						8
<p>UNIT III – Radioactive & Biomedical waste management: Definition, types, sources, Classification, low level & high level radioactive wastes and their management. Radiation standard by ICRP & AERB. Health and safety aspects Control and management of radioactive wastes. Biomedical Waste: Definition, Sources of generation, classification, categories and colour coding system for segregation, transportation specifications and treatment methods- Incineration, Microwave, Plasma Pyrolysis, Hydroclave etc.</p>						8
<p>UNIT IV- E-Waste and Plastic management: Introduction of WEEE (waste electrical and electronic equipments), Sources of generation, categories, segregation, transportation, treatment methods, recycling and disposal methods of e-wastes. Disadvantages of E-wastes for the environment and society. Plastic waste: sources, production, Global & Indian context of plastic wastes.</p>						8

Recycling, energy production and green synthetic approaches for the preparation of environmental friendly polymers. Treatment and disposal of Plastic wastes. Recycling of polymer wastes by advanced techniques.	
UNIT V- Toxic wastes Removal of Heavy toxic metals: Sources of heavy metals, accumulation of heavy metals in Abiotic environment and Biotic components. Toxic effects of Lead, Mercury, Arsenic and Cadmium. Analytical methods of determination of small amounts of metal pollutants and their treatments to remove heavy metals and their recovery techniques.	8
Total Hours	40
TEXT BOOKS:	
<ul style="list-style-type: none"> • George Tchobanoglous et.al., <i>“Integrated Solid Waste Management”</i>, McGraw-Hill Publishers, 2003. • B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, <i>“Waste Management”</i>, Springer, 2004. • <i>“Manual on Municipal Solid Waste Management”</i>, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2010. • R.E.Landreth and P.A.Rebers, <i>“Municipal Solid Wastes – problems and Solutions”</i>, Lewis Publishers, 2002. • Bhide A.D. and Sundaresan, B.B., <i>“Solid Waste Management in Developing Countries”</i>, INSDOC, 2003. 	
REFERENCE BOOKS:	
<ul style="list-style-type: none"> • CPHEEO, <i>“Manual on Municipal Solid waste management”</i>, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000. • Micheael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and <i>“Environmental Resources Management”</i>, Hazardous waste Management, McGraw-Hill International edition, New York,2001. • Vesilind P.A., Worrell W and Reinhart, <i>“Solid waste Engineering”</i>, Thomson Learning Inc., Singapore, 2002 	
List/Links of e-learning resource	
<ul style="list-style-type: none"> • 	
Recommendation by Board of studies on	20.12.2023
Approval by Academic council on	6.1.2024
Subject handled by department	Applied Chemistry