BP 206 T. ENVIRONMENTAL SCIENCES (Theory) 30 hours

Scope: Environmental Sciences is the scientific study of the environmental system and the status of its inherent or induced changes on organisms. It includes not only the study of physical and biological characters of the environment but also the social and cultural factors and the impact of man on environment.

Objectives: Upon completion of the course the student shall be able to**:**

1. Create the awareness about environmental problems among learners.
2. Impart basic knowledge about the environment and its allied problems.
3. Develop an attitude of concern for the environment.
4. Motivate learner to participate in environment protection and environment improvement.
5. Acquire skills to help the concerned individuals in identifying and solving environmental problems.
6. Strive to attain harmony with Nature.

COURSE CONTENT

Unit-I

The Multidisciplinary nature of environmental studies Natural Resources Renewable and non-renewable resources:

10hours

Natural resources and associated problems

a) Forest resources; b) Water resources; c) Mineral resources; d) Food resources; e) Energy resources; f) Land resources: Role of an individual in conservation of natural resources

Unit-II

Ecosystems

- Concept of an ecosystem.
- Structure and function of an ecosystem.

10hours

- Introduction, types, characteristic features, structure and function of the ecosystems: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit- III

10 hours

Environmental Pollution: Air pollution; Water pollution; Soil pollution

Recommended Books:

1. Y.K. Sing, Environmental Science, New Age International Pvt, Publishers, Bangalore
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
3. Bharucha Erach, The Biodiversity of India, Mapin Pu blishing Pvt. Ltd., Ahmedabad – 380 013, India,
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
5. Clark R.S., Marine Pollution, Clanderson Press Oxford
6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
8. Down of Earth, Centre for Science and Environment

7. Cooper and Gunn‟s: Tutorial Pharmacy, CBS Publisher and Distribution.
8. Peppler: Microbial Technology.
9. I.P., B.P., U.S.P.- latest editions.
10. Ananthnarayan : Text Book of Microbiology, Orient-Longman, Chennai
11. Edward: Fundamentals of Microbiology.
12. N.K.Jain: Pharmaceutical Microbiology, Vallabh Prakashan, Delhi
13. Bergeys manual of systematic bacteriology, Williams and Wilkins- A Waverly company
14. "Nutrition Probiotics and prebiotics" by Pamela Mason; The Pharmaceutical Journal Vol 266 No 7132 p118-121.
15. Alfonso R. Gennaro Remington. The Science and Practice of Pharmacy, Lippincott Williams, New Delhi.

BP 304 T. PHARMACEUTICAL ENGINEERING (Theory) **45 Hours**

Scope:

This course is designed to impart a fundamental knowledge on the art and science of various unit operations used in pharmaceutical industry.

Objectives:

Upon completion of the course student shall be able:

1. To know various unit operations used in Pharmaceutical industries.
2. To understand the material handling techniques.
3. To perform various processes involved in pharmaceutical manufacturing process.
4. To carry out various test to prevent environmental pollution.
5. To appreciate and comprehend significance of plant lay out design for optimum use of resources.
6. To appreciate the various preventive methods used for corrosion control in Pharmaceutical industries.

Course content:

UNIT-I **10 Hours**

- Flow of fluids: Types of manometers, Reynolds number and its significance, Bernoulli‟s theorem and its applications, Energy losses, Orifice meter, Venturimeter, Pitot tube and Rotometer.
- Size Reduction: Objectives, Mechanisms & Laws governing size reduction, factors affecting size reduction, principles, construction, working, uses, merits and demerits of Hammer mill, ball mill, fluid energy mill, Edge runner mill & end runner mill.
- Size Separation: Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation Principles, construction, working, uses, merits and demerits of Sieve shaker, cyclone separator, Air separator, Bag filter & elutriation tank.

UNIT-II **10 Hours**

- Heat Transfer: Objectives, applications & Heat transfer mechanisms. Fourier‟s law, Heat transfer by conduction, convection & radiation. Heat interchangers & heat exchangers.
- Evaporation: Objectives, applications and factors influencing evaporation, differences between evaporation and other heat process. principles, construction, working, uses, merits and demerits of Steam jacketed kettle, horizontal tube evaporator, climbing film evaporator, forced circulation evaporator, multiple effect evaporator& Economy of multiple effect evaporator.
- Distillation: Basic Principles and methodology of simple distillation,flash distillation, fractional distillation, distillation under reduced pressure, steam distillation & molecular distillation

UNIT- III **08 Hours**

- Drying: Objectives, applications & mechanism of drying process, measurements & applications of Equilibrium Moisture content, rate of drying curve. principles,

construction, working, uses, merits and demerits of Tray dryer, drum dryer spray dryer, fluidized bed dryer, vacuum dryer, freeze dryer.

- Mixing: Objectives, applications & factors affecting mixing, Difference between solid and liquid mixing, mechanism of solid mixing, liquids mixing and semisolids mixing. Principles, Construction, Working, uses, Merits and Demerits of Double cone blender, twin shell blender, ribbon blender, Sigma blade mixer, planetary mixers, Propellers, Turbines, Paddles & Silverson Emulsifier,

UNIT-IV **08 Hours**

- Filtration: Objectives, applications, Theories & Factors influencing filtration, filter aids, filter medias. Principle, Construction, Working, Uses, Merits and demerits of plate & frame filter, filter leaf, rotary drum filter, Meta filter & Cartridge filter, membrane filters and Seidtz filter.
- Centrifugation: Objectives, principle & applications of Centrifugation, principles, construction, working, uses, merits and demerits of Perforated basket centrifuge, Non-perforated basket centrifuge, semi continuous centrifuge & super centrifuge.

UNIT- V **07 Hours**

- Materials of pharmaceutical plant construction, Corrosion and its prevention: Factors affecting during materials selected for Pharmaceutical plant construction, Theories of corrosion, types of corrosion and there prevention. Ferrous and nonferrous metals, inorganic and organic non metals, basic of material handling systems.

Recommended Books:

1. Paradkar A. Introduction to Pharmaceutical Engineering. Eleventh Edition, Nirali Prakashan, Pune. 2007.
2. Badger WL, Banchero JT. Introduction to Chemical Engineering. International Edition, McGraw Hill Book Company. 1955.
3. Subrahmanyam CVS, Thimma Setty J, Sarasija Suresh, Kusum Devi V. Pharmaceutical Engineering Unit Operations-II. Second Edition, Vallabh Prakashan, Delhi. 2011.

BP807ET	COMPUTER AIDED DRUG DESIGN (Theory)	45 Hours

Scope:
This subject is designed to provide detailed knowledge of rational drug design process and various techniques used in rational drug design process.

Objectives:
Upon completion of the course, the student shall be able to understand

1. Understand the design and discovery of leadmolecules
2. Classify the role of drug design tools for drug discoveryprocess
3. Understand and analyse concepts of QSAR anddocking
4. Analyse and apply various strategies to develop new drug likemolecules.
5. Use various molecular modeling software to design new drugmolecule

Course Content

UNIT-I **Introduction to Drug Discovery and Development -** Stages of drug discovery and development, Lead discovery approaches - Rational approaches to lead discovery based on traditional medicine, Random screening, Non-random screening, serendipitous drug discovery, lead discovery based on drug metabolism, lead discovery based on clinical observation. **Introduction to Ligand based and Structure Based DD** **Analog Based Drug Design -** Bioisosterism, Bioisosteric replacement **Case studies -** Ligand based (Design of inhibitors of tubulin polymerization eg. Colchicine), Structure based (Design of HMG-CoA reductase inhibitors. eg. Statins) and Analog based DD (Design of H2 histamine antagonist eg. Cimetidine)	**14 Hours**
UNIT- II **Introduction to Computational tools Molecular Modeling -** Introduction to molecular mechanics and quantum mechanics. Energy Minimization methods and Conformational Analysis, global conformational minima determination. **Molecular docking -** Rigid docking, flexible docking, manual docking, Docking based screening.	**10 Hours**
UNIT- III **Quantitative Structure Activity Relationship (QSAR) and Pharmacophore modeling** **Introduction -** SAR versus QSAR, History and development of QSAR, Types of physicochemicalparameters **2D QSAR -** Experimental and theoretical approaches for the determination of physicochemical parameters such as Partition coefficient, Hammet's substituent constant and Tafts steric constant. Hansch's analysis, Free Wilson analysis **3D-QSAR approaches -** COMFA and COMSIA. **Pharmacophore modeling -** Drug likeness screening, Concept of Pharmacophore mapping and Pharmacophore based screening	**14 Hours**

UNIT- IV **Informatics & Methods in drug design** Introduction to Bioinformatics, chemo informatics **Databases -** Chemical database, Natural compound database, Drug like compound database , Drug bank	**07 Hours**
Recommended Books (Latest Editions) 1. Robert GCK, ed., "Drug Action at the Molecular Level" University PrakPress Baltimore. 2. Martin YC. "Quantitative Drug Design" Dekker,NewYork. 3. Delgado JN, Remers WA eds "Wilson &Gisvolds's Text Book of OrganicMedicinal & Pharmaceutical Chemistry" Lippincott,NewYork. 4. Foye WO "Principles of Medicinal chemistry 'Lea&Febiger. 5. Korolkovas A, BurckhalterJH. "Essentials of Medicinal Chemistry" Wiley Interscience. 6. WolfME,ed"TheBasisofMedicinalChemistry,Burger'sMedicinalChemistry" John Wiley & Sons,NewYork. 7. PatrickGraham,L.,AnIntroductiontoMedicinalChemistry,OxfordUniversityPress. 8. Smith HJ, Williams H, eds, "Introduction to the principles of Drug Design" WrightBoston. 9. Silverman R.B. "The organic Chemistry of Drug Design and Drug Action"Academic Press NewYork. 10. D. J. Triggle, John Bodenhan Taylor, Peter Kennewell, Comprehensive Medicinal Chemistry, Volume I-VIII : Germany: Elsevier Science.	

CHEMISTRY OF NATURAL PRODUCTS (MPC 104T)	60 Hrs
Scope The subject is designed to provide detail knowledge about chemistry of medicinal compounds from natural origin and general methods of structural elucidation of such compounds. It also emphasizes on isolation, purification and characterization of medicinal compounds from natural origin. **Objectives** At completion of this course it is expected that students will be able to understand – • Different types of natural compounds and their chemistry and medicinal importance • The importance of natural compounds as lead molecules for new drug discovery • The concept of rDNA technology tool for new drug discovery • General methods of structural elucidation of compounds of natural origin • Isolation, Purification and characterization of simple chemical constituents from natural source	
UNIT-I **Study of Natural products as leads for new pharmaceuticals for the following class of drugs** a) Drugs Affecting the Central Nervous System: Morphine Alkaloids b) Anticancer Drugs: Paclitaxel and Docetaxel, Etoposide, and Teniposide c) Cardiovascular Drugs: Lovastatin, Teprotide and Dicoumarol d) Neuromuscular Blocking Drugs: Curare alkaloids e) Anti-malarial drugs and Analogues f) Chemistry of macrolide antibiotics (Erythromycin, Azithromycin, Roxithromycin, and Clarithromycin) and β- Lactam antibiotics (Cephalosporins and Carbapenem)	**12 Hrs**
UNIT-II **a) Alkaloids**: General introduction, classification, isolation, purification, molecular modification and biological activity of alkaloids, general methods of structural determination of alkaloids, structural elucidation and stereochemistry of ephedrine, morphine, ergot, emetine and reserpine. **b) Flavonoids**: Introduction, isolation and purification of flavonoids, General methods of structural determination of flavonoids; Structural elucidation of quercetin. **c) Steroids**: General introduction, chemistry of sterols, sapogenin and cardiac glycosides. Stereochemistry and nomenclature of steroids, chemistry of contraceptive agents male & female sex hormones (Testosterone,Estradiol, Progesterone), adrenocorticoids (Cortisone), contraceptive agents and steroids (Vit - D).	**12 Hrs**
UNIT-III **a) Terpenoids**: Classification, isolation, isoprene rule and general methods of structural elucidation of Terpenoids; Structural elucidation of drugs belonging to mono (citral, menthol, camphor), di(retinol, Phytol, taxol) and tri terpenoids (Squalene,Ginsenoside) carotinoids (β carotene). **b) Vitamins** : Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin.	**12 Hrs**

UNIT-IV **a) Recombinant DNA technology and drug discovery** rDNA technology, hybridoma technology, New pharmaceuticals derived from biotechnology; Oligonucleotide therapy. Gene therapy: Introduction, Clinical application and recent advances in gene therapy, principles of RNA & DNA estimation **b) Active constituent of certain crude drugs used in Indigenous system** **Diabetic therapy**- *Gymnema sylvestre, Salacia reticulate, Pterocarpus marsupiam, Swertia chirata, Trigonella foenum graccum;* Liver dysfunction - *Phyllanthus niruri; Antitumor - Curcuma longa Linn.*	**12 Hrs**
UNIT-V **Structural Characterization of natural compounds** Structural characterization of natural compounds using IR, ^{1}H-NMR, ^{13}C-NMR and MS Spectroscopy of specific drugs e.g., Penicillin, Morphine, Camphor, Vit–D, Quercetin and Digitalis glycosides.	**12 Hrs**

REFERENCES

1. Modern Methods of Plant Analysis, Peech and M.V.Tracey, Springer - Verlag, Berlin, Heidelberg.
2. Phytochemistry Vol. I and II by Miller, Jan Nostrant Rein Hld.
3. Recent advances in Phytochemistry Vol. I to IV - Scikel Runeckles, Springer Science & Business Media.
4. Chemistry of natural products Vol I onwards IWPAC.
5. Natural Product Chemistry Nakanishi Gggolo, University Science Books, California.
6. Natural Product Chemistry "A laboratory guide" - Rapheal Khan.
7. The Alkaloid Chemistry and Physiology by RHF Manske, Academic Press.
8. Introduction to molecular Phytochemistry - CHJ Wells, Chapmannstall.
9. Organic Chemistry of Natural Products Vol I and II by Gurdeep and Chatwall, Himalaya Publishing House.
10. Organic Chemistry of Natural Products Vol I and II by O.P. Agarwal, Krishan Prakashan.
11. Organic Chemistry Vol I and II by I.L. Finar, Pearson education.
12. Elements of Biotechnology by P.K. Gupta, Rastogi Publishers.
13. Pharmaceutical Biotechnology by S.P.Vyas and V.K.Dixit, CBS Publishers.
14. Biotechnology by Purohit and Mathur, Agro–Bios, 13th edition.
15. Phytochemical methods of Harborne, Springer, Netherlands.
16. Burger's Medicinal Chemistry.

COMPUTER AIDED DRUG DESIGN (MPC 203T)	60 Hrs
Scope The subject is designed to impart knowledge on the current state of the art techniques involved in computer assisted drug design. **Objectives** At completion of this course it is expected that students will be able to understand • Role of CADD in drug discovery • Different CADD techniques and their applications • Various strategies to design and develop new drug like molecules. • Working with molecular modeling software's to design new drug molecules • The in silico virtual screening protocols	
UNIT-I **Molecular Properties and Drug Design** a) Prediction and analysis of ADMET properties of new molecules and its importance in drug design. b) De novo drug design: Receptor/enzyme–interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. c) Homology modeling and generation of 3D–structure of protein.	**12 Hrs**
UNIT-II • **Pharmacophore Mapping and Virtual Screening** Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; Conformational search used in pharmacophore mapping. • In Silico Drug Design and Virtual Screening Techniques Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols.	**12 Hrs**
UNIT-III **Molecular Modeling and Docking** **a)** Molecular and Quantum Mechanics in drug design. **b)** Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation **c)** Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra–precision docking. Agents acting on enzymes such as DHFR, HMG–CoA reductase and HIV protease, choline esterase (AchE & BchE)	**12 Hrs**
UNIT-IV • **Introduction to Computer Aided Drug Design (CADD)** History, different techniques and applications. • **Quantitative Structure Activity Relationships**: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi–substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters.	**12 Hrs**
UNIT-V • **Quantitative Structure Activity Relationships:**	**12 Hrs**

Applications: Hansch analysis, Free Wilson analysis and relationship between them, • **Advantages and disadvantages**; Deriving 2D-QSAR equations. • 3D–QSAR approaches and contour map analysis. • **Statistical methods** used in QSAR analysis and importance of statistical parameters.	

REFERENCES

1. Computational and structural approaches to drug discovery, Robert M Stroud and Janet. F Moore, RCS Publishers.
2. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor & Francis group.
3. Drug Design by Ariens Volume 1 to 10, Academic Press, 1975, Elsevier Publishers.
4. Principles of Drug Design by Smith and Williams, CRC Press, Taylor & Francis.
5. The Organic Chemistry of the Drug Design and Drug action by Richard B. Silverman, Elsevier Publishers.
6. Medicinal Chemistry by Burger, Wiley Publishing Co.
7. An Introduction to Medicinal Chemistry -Graham L. Patrick, Oxford University Press.
8. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ippincott Williams & Wilkins.
9. Comprehensive Medicinal Chemistry - Corwin and Hansch, Pergamon Publishers.
10. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore

PHARMACEUTICAL PROCESS CHEMISTRY (MPC 204T)	60 Hrs
Scope Process chemistry is often described as scale up reactions, taking them from small quantities created in the research lab to the larger quantities that are needed for further testing and then to even larger quantities required for commercial production. The goal of a process chemist is to develop synthetic routes that are safe, cost–effective, environmentally friendly, and efficient. The subject is designed to impart knowledge on the development and optimization of a synthetic route/s and the pilot plant procedure for the manufacture of Active Pharmaceutical Ingredients (APIs) and new chemical entities (NCEs) for the drug development phase. **Objectives** At completion of this course it is expected that students will be able to understand • The strategies of scale up process of apis and intermediates • The various unit operations and various reactions in process chemistry	
UNIT-I **Industrial Safety** **a)** MSDS (Material Safety Data Sheet), hazard labels of chemicals and Personal Protection Equipment (PPE) **b)** Fire hazards, types of fire & fire extinguishers Occupational Health & Safety Assessment Series 1800 (OHSAS–1800) and ISO–14001(Environmental Management System), Effluents and its management	**12 Hrs**
UNIT-II **Process chemistry** • Introduction, Synthetic strategy • **Stages of scale up process**: Bench, pilot and large scale process. In–process control and validation of large scale process. • Case studies of some scale up process of APIs. • Impurities in API, types and their sources including genotoxic impurities	**12 Hrs**
UNIT-III **Unit operations** **a. Extraction**: Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction. **b. Filtration**: Theory of filtration, pressure and vacuum filtration, centrifugal filtration, **c. Distillation**: azeotropic and steam distillation **d. Evaporation**: Types of evaporators, factors affecting evaporation. **e. Crystallization**: Crystallization from aqueous, non– aqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs.	**12 Hrs**
UNIT-IV **Unit Processes – I** a) **Nitration**: Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration, **b) Halogenation**: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation	**12 Hrs**

process. **c) Oxidation**: Introduction, types of oxidative reactions, Liquid phase oxidation with oxidizing agents. Nonmetallic Oxidizing agents such as H2O2, sodium hypochlorite, Oxygen gas, ozonolysis	
UNIT-V **Unit Processes – II** a) **Reduction**: Catalytic hydrogenation, Heterogeneous and omogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process. b) **Fermentation**: Aerobic and anaerobic fermentation. Production of - i. Antibiotics; Penicillin and Streptomycin, ii. Vitamins: B2 and B12 iii. Statins: Lovastatin, Simvastatin c) Reaction progress kinetic analysis i. Streamlining reaction steps, route selection, ii. Characteristics of expedient routes, characteristics of cost-effective routes, reagent selection, families of reagents useful for scale–up.	**12 Hrs**

REFERENCES

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever– Changing Climate-An Overview; K. Gadamasetti, CRC Press.
2. Pharmaceutical Manufacturing Encyclopedia, 3rd edition, Volume 2.
3. Medicinal Chemistry by Burger, 6th edition, Volume 1–8.
4. W.L. McCabe, J.C Smith, Peter Harriott. Unit operations of chemical engineering, 7th edition, McGraw Hill
5. Polymorphism in Pharmaceutical Solids .Dekker Series Volume 95 Ed: H G Brittain (1999)
6. Regina M. Murphy: Introduction to Chemical Processes: Principles, Analysis, Synthesis
7. Peter J. Harrington: Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale–Up
8. P.H.Groggins: Unit processes in organic synthesis (MGH)
9. F.A.Henglein: Chemical Technology (Pergamon)
10. M.Gopal: Dryden's Outlines of Chemical Tech., WEP East–West Press Clausen,Mattson: Principle of Industrial Chemistry, Wiley Publishing Co.,
11. Lowenheim & M.K. Moran: Industrial Chemicals
12. S.D. Shukla & G.N. Pandey: A text book of Chemical Technology Vol. II, Vikas Publishing House
13. J.K. Stille: Industrial Organic Chemistry (PH)
14. Shreve: Chemical Process, Mc Grawhill.

HAZARDS AND SAFETY MANAGEMENT (MQA 201T)	**60 Hrs**
Scope This course is designed to convey the knowledge necessary to understand issues related to different kinds of hazard and their management. Basic theoretical and practical discussions integrate the proficiency to handle the emergency situation in the pharmaceutical product development process and provides the principle based approach to solve the complex tribulations. **Objectives** At completion of this course it is expected that students will be able to • Understand about environmental problems among learners. • Impart basic knowledge about the environment and its allied problems. • Develop an attitude of concern for the industry environment. • Ensure safety standards in pharmaceutical industry • Provide comprehensive knowledge on the safety management • Empower an ideas to clear mechanism and management in different kinds of hazard management system • Teach the method of Hazard assessment, procedure, methodology for provide safe industrial atmosphere.	
UNIT-I • Multidisciplinary nature of environmental studies Natural Resources and associated problems, Renewable and non-renewable resources, a) Forest resources; b) Water resources; c) Mineral resources; d) Energy resources; e) Land resources • **Ecosystems**: Concept of an ecosystem, Structure and function of an ecosystem. Environmental hazards: Hazards based on Air, Water, Soil and Radioisotopes.	**12 Hrs**
UNIT-II • Air based hazards Sources, Types of Hazards, Air circulation, Air handling system, HVAC system, air maintenance in industry for sterile area and non sterile area.	**12 Hrs**
UNIT-III • **Chemical based hazards**: Sources of chemical hazards, Hazards of Organic synthesis, sulphonating hazard, Organic solvent hazard. Control measures for chemical hazards. Management of combustible gases, Toxic gases and Oxygen displacing gases management, Regulations for chemical hazard, MSDS, Labelling guidelines, Management of over-Exposure to chemicals and TLV concept, Disposal of hazardous material.	**12 Hrs**
UNIT-IV • **Fire and Explosion**: Introduction, Industrial processes and hazards potential, Mechanical, electrical, thermal and process hazards, mechanical and chemical explosion, multiphase reactions. Safety and hazards regulations • **Fire protection system**: Fire prevention, types of fire extinguishers and critical Hazard management system, Preventive and protective management from fires and explosion- electricity passivation, ventilation, and sprinkling, proofing, fire walls, bunds, relief systems - relief valves, flares, scrubbers.	**12 Hrs**

UNIT-V • **Hazard and risk management**: Self-protective measures against workplace hazards. Critical training for risk management, Process of hazard management, ICH guidelines on risk assessment and Risk management methods and Tools, Preliminary hazard analysis • Factory act and rules, fundamentals of accident prevention, elements of safety programme and safety management, Physicochemical measurements of effluents, BOD, COD, Determination of some contaminants, Effluent treatment procedure, Role of emergency services.	**12 Hrs**

REFERENCES

1. Y.K. Sing, Environmental Science, New Age International Pvt, Publishers, Bangalore
2. Quantitative Risk Assessment in Chemical Process Industries, American Institute of Chemical Industries, Centre for Chemical Process safety.
3. T.S.S. Dikshith, Hazardous Chemicals: Safety Management and Global Regulations, CRC press
4. M. N. Vyas, Safety and hazard management in chemical industries, Atlantic Publisher
5. Daniel A. Crowl, Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, 3rd Edition, Prentice Hall, 2011
6. H. H. Fawcett and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd E/d, John Wiley & Sons, New York 1982.
7. C.S.Rao, Environmental Pollution Control Engineering, New Age international publisher
8. Phillip Carson, Clive Mumford, Butterworth-Heinemann, Hazardous Chemicals Handbook, Second edition, An imprint of Elsevier Science.