

**PANDIT DEENDAYAL PETROLEUM UNIVERSITY**  
**SCHOOL OF TECHNOLOGY**  
**COURSE STRUCTURE FOR B. TECH. CHEMICAL ENGINEERING**

SEMESTER VIII			B.TECH. CHEMICAL ENGINEERING										
Sr No	Course Code	Course Name	Teaching Scheme					Examination Scheme					
			L	T	P	C	Hrs/wk	Theory			Practical		Total marks
								MS	ES	IA*	LW	LE/Viva	
1	CH 406T	Environmental Engineering and Pollution Control	3	--	0	6	3	30	60	10	--	--	100
	CH 406P		--	--	2	1	2	--	--	--	25	25	50
2	CH 407	Process Plant Safety, Health and Hygiene	3	--	--	6	3	30	60	10	--	--	100
3	CH-02XT	Department Elective II	3	--	--	6	3	30	60	10	--	--	100
4	CH-03XT	Department Elective III	3	--	--	6	3	30	60	10	--	--	100
5	CH 408	B. Tech. Project	--	--	12	6	12				50	50	100
6	CH 409	Project Management	3	--	--	6	3	30	60	10	--	--	100
		Total	<b>15</b>	<b>0</b>	<b>14</b>	<b>37</b>	<b>29</b>						750

**MS** = Mid Semester, **ES** = End Semester;

\* **IA** = Internal assessment (like quiz, assignments etc)

**LW** = Laboratory work; **LE** = Laboratory Exam

**Dept Elective II:** Biochemical Engineering; Environmental Issues and Control in Chemical Industry; Disaster Management in Chemical Industry; Chemical Industry Practices

**Dept Elective III:** Newer Separation Processes; Nuclear Chemical Engineering; Chem Informatics; Dyes and Intermediates

CH 406 T Environmental Engineering and Pollution Control										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100
<b>UNIT I</b>										
Environmental regulations in India, Environmental Standards, Classification of pollutants, Cleaner production practices, GPCB & CPCB norms										
Air Pollution Control - Various pollutants (like SO <sub>x</sub> , NO <sub>x</sub> , CO, organic vapors and particulate matter) and their permissible limits										
Air pollution control processes – settling chamber, Cyclone separators, dust collector, fabric filters, venturi scrubbers, Electrostatic precipitators, wet scrubber, adsorption, absorption, Catalytic reduction eg. SCR.										
<b>UNIT II</b>										
Sources of water, Impurities in water, Indian & WHO standards for drinking water, Water borne diseases and their control, Physical, chemical and biological characteristics of water and waste water, Sources of waste water and industrial effluents from fertilizer, petrochemical, pulp and paper, caustic soda, tanning and sugar industries										
Effluent Treatment methodologies Primary treatment processes -Sedimentation, Coagulation and flocculation, filtration										
Secondary treatment processes(Biological treatment) - Design procedures for HRT, CRT, SVI, MLSS, Activated Sludge Process, trickling filters, Drying of sludge & use of sludge for designated & approved landfill sites and possibility of using as fertilizer.										
<b>UNIT III</b>										
Tertiary Treatment Processes: Membrane processes, Adsorption and ion exchange, chlorination, ozonation, Aeration, Softening, fluoridation, Recarbonation, Lime soda softening, Desalination, Demineralization.										
Solid Waste Management: Quantity, Composition and characteristics of solid waste, Methods of solid waste treatment and disposal (Open dumping, Land filling, incineration, composting and recycling)										
Treatment of plastic and e-waste, recovery of valuable intermediates from plastic waste and e-waste.										
<b>UNIT IV</b>										
Noise Pollution: Definition, characteristics of sound and its measurement, Definition of noise frequency, noise pressure, noise intensity, and noise threshold limit value, equivalent noise level Sources, Effects and control of noise pollution, Noise level and its standards, Noise pollution control										
Alternate routes of manufacture and/or sequencing of operations as means pollution control and recovery of chemicals. Alternate use of byproducts waste as means of pollution abatement.										
Texts and References										
1. C. S. Rao, "Environmental Pollution Control Engineering										
2. H. S. Peavy, "Environmental Engineering", McGraw-Hill, International Ed., New York -1985.										
3. Metcalf & Eddy, "Waste Water Engineering: Treatment, Disposal, Reuse", 2nd Ed., McGraw-Hill, New York - 1979.										
4. S. P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, New Delhi - 1996.										
5. N.M. Rao & H. V. Rao, " Air Pollution", PMH, New Delhi - 1992										

**CH 406 P Environmental Engineering and Pollution Control**

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100
<ol style="list-style-type: none"><li>1. Determination of pH and conductivity for water and waste water</li><li>2. Determination of Turbidity and Hardness</li><li>3. Determination of Acidity and Alkalinity</li><li>4. Determination of fluoride and sulphate</li><li>5. Measurement of residual chlorine</li><li>6. Determination of coagulant dose by jar test apparatus</li><li>7. Determination of DO and BOD</li><li>8. Determination of rate kinetics constant of aerobic reactions</li><li>9. Determination of COD and Solids</li><li>10. Presumptive test for coliform bacteria</li><li>11. Ambient air quality measurement using High Volume sampler</li><li>12. Exhaust gas analysis for air pollutants</li><li>13. Measurement of noise at different sources using sound meter</li></ol>										

CH 407 Process Plant Safety, Health and Hygiene										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100
<b>UNIT I</b>										
Introduction: Engineering ethics, Accident and loss statistics, Nature of accident process, Inherent safety in process, Indore air quality management, personal safety aspects										
Fire and Explosion Hazards: Fire triangle, Flammability characteristics of fluids, Flammability diagram, Explosions, DOW F& I Index										
Prevention of Fire and Explosion: Inserting, Static electricity, Ventillation, Sprinkler systems, Explosion proof instruments and equipments and control rooms, Miscellaneous concepts for preventing fire and explosions, use of fire retardant cables, means of emergency escape										
<b>UNIT II</b>										
Industrial Hygiene: Government Regulations, Material safety data sheet (MSDS) and their significance, Evaluation of industrial hygiene, Control of industrial hygiene, quality management										
Source models: Different source models, Dispersion and parameters affecting dispersion, Study about various dispersion models										
<b>UNIT III</b>										
Hazard Identification: Hazard & Operability Study, Hazard Analysis, Hazard surveys										
Risk Assessment: Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Review of Probability theory, Quantitative Risk Analysis, LOPA concept										
National and International standards for health and safety, Acts and legislation (OSHA, ISO standards), REACH regulations										
<b>UNIT IV</b>										
Seven Major Disaster in Chemical Process Industry, Introduction to relief and sizing of reliefs systems & API codes, Location of Flare system and Knockout pots, Personal protective equipments used in laboratory and chemical industry.										
<b>Texts and References</b>										
<ol style="list-style-type: none"> <li>1. F. P. Lees, Loss Prevention in the Process Industries, Vol. 1, 2 and 3, Second Edition, Butterworth (1996).</li> <li>2. O. P. Kharbanda and E. A. Stallworthy, Management of Disasters and How to Prevent Them, Gower, 1986.</li> <li>3. Daniel A. Crowl and Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall (1990)</li> <li>4. Sanjoy Banerjee, Industrial Hazards and Plant Safety, Taylor &amp; Francis (2003).</li> <li>5. R. W. King and J Magid, Industrial Hazards and Safety Handbook, Butterworth, 1982</li> <li>6. A M Flynn and L Theodore, Health, safety, and accident management in the Chemical Process Industries, Marcel Dekker, 2002</li> <li>7. Nicholas P Cheremisinoff, Practical Guide to Industrial Safety, Marcel Dekker, 2001</li> </ol>										

CH 408 B Tech Project										
Teaching Scheme					Examination Scheme					Total marks
L	T	P	C	Hrs/Week	Theory			Practical		
					MS	ES	IA	LW	LE/Viva	
--	--	12	6	12	--	--	--	50	50	100
1.										

CH 409 Project Management										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	6	3	30	60	10	--	--	100
<b>UNIT I</b>										
<p><b>Introduction to Project Management:</b> concept of basic engg/ detail engg, LSTK approach, EPC Approach, Justifying Project Management, Projects – Definitions, The Project Management Triangle – Scope, Time and Cost, What is Project Management, Projects &amp; Operations, The Project Life Cycle, Project Stakeholders, Project Management Process Groups, Project Management Knowledge Areas, Introduction to PRIMA software</p> <p><b>Specification of a Project:</b> The Project Charter, The Project Scope Document, Work Breakdown Structures, Project Contracts – Scope, Delivery, Costs and Risks. Preparation of DPR.</p>										
<b>UNIT II</b>										
<p><b>Project Planning and Scheduling:</b> Project procurement, Project evaluation and assessment of project profitability. Organization of project Engineering, Project Network Representations, Activity Parameter Estimation – Time, Cost and Resources, Project Time Schedule, Gantt Charts, CPM and PERT, Activity and Project Crashing, Resources Scheduling, IRR, Concept of various project completion like mechanical completion, trials, commissioning.</p>										
<b>UNIT III</b>										
<p><b>Project Execution Management:</b> Quality Specifications, Quality Control Tools, Resources Procurement and Allocation, Systems and Processes, Communications and Documentation, Managing Teams, Resources Demobilization, Project Simulation and Risk Assessment, Use of IT tools, Project development and commercialization. Licensing and contract, Plant location and layout, Piping Engineering. Project Engineering management. Selection of alternatives. Selection of plant capacity. Plant expansion/modernization v/s totally new plant.</p>										
<b>UNIT IV</b>										
<p><b>Project Monitoring and Control:</b> Project Work Measurement, Performance Measurement, Earned Value Management, Estimate Revision, control of overrunning of project from time and cost.</p> <p><b>Project Closure and Review:</b> Performance Evaluation – Scope, Time and Cost, Performance of Teams, Lessons Learnt, Project Closure Report.</p>										
<b>Integrated Examples/Cases</b>										
<b>Texts and References</b>										
<ol style="list-style-type: none"> <li>1. <i>PMBOK® Guide</i>, 4<sup>th</sup> Edition</li> <li>2. Mantel Jr., Samuel J., Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton with M. R. Gopalan (2006) <i>Project Management Core Text Book</i>, First Indian Edition, Wiley, New Delhi.</li> <li>3. Meredith, Jack R., and Samuel J. Mantel, Jr. (2010) <i>Project Management: A Managerial Approach</i>, 7/e, Wiley, New Delhi.</li> <li>4. Maylor, Harvey (2003) <i>Project Management</i>, 3/e, Pearson, New Delhi.</li> <li>5. Pinto, Jeffrey K. (2009) <i>Project Management: Achieving Competitive Advantage and MS</i></li> </ol>										

*Project*, 1/e, Pearson, New Delhi.

6. Gray, Clifford and Erik Larson (2005) *Project Management: The Managerial Process*, 3/e, Tata McGraw-Hill, New Delhi.
7. Nicholas, John M. (2008) *Project Management for Business, Engineering and Technology: Principles and Practice*, 3/e, Elsevier, New Delhi.

CH-021 Biochemical Engineering										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<b>UNIT I</b>										
Scope and possibilities, Microbiology fundamentals, characteristics and classification of biological matter and their properties, OCN cycle										
Kinetics of microbial growth, balance equations for batch and continuous cultures, kinetics of enzyme catalysed reactions, analysis of mixed microbial populations.										
<b>UNIT II</b>										
Design and analysis of biological reactors: growth mechanism, types and comparison of reactors, design of fermenter, scale up studies										
Production kinetics and kinetic models, Isolation and utilization of enzymes.										
<b>UNIT III</b>										
Study of Major Metabolic Pathways: Bioenergetics, Glucose Metabolism, Biosynthesis.										
Transport phenomena in biological systems.gas liquid transfer, rate determination, mass transfer of free bodies and bioseparation										
<b>UNIT IV</b>										
Introduction to biochemical process industries- production of industrial alcohols, single cell proteins, vitamins, alkaloids, enzymes, lactic acid. etc										
Environmental biotechnology - biological waste water treatment, activated sludge process, Anaerobic digestion, denitrification, biodegradation, bioleaching, biogas production, biomethane and biohydrogen.										
<b>Texts and References</b>										
1. J. E. Baley, D. F. Ollis , Biochemical Engineering Fundamentals, 2 <sup>nd</sup> ed. McGraw Hill, 1986										
2. B. Atkinson, Biochemical Reactor , Pion Ltd, London, 1974										
3. Coulson and Richardson's Chemical Engineering- Vol-3, Chemical and Biochemical Reactors and process control, Asian Book Pvt. Ltd.										



CH-022 Environmental Issues and Control in Chemical Industries

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

**UNIT I**

Environmental Regulations in India, Environmental Standards, Cleaner Production Practices, Role of material and energy balance in waste minimization, Environmental Impact Assessment, Environmental Audit, Pollution problems from industries and other sources: Air, Water and solid waste issues – municipal as well as industrial, Health hazards in chemical industries, Effects on the environment of the chemicals industry and its products

**UNIT II**

Water pollution and control, Characteristics of effluent from different sectors, Effluent treatment methodologies – primary, secondary and tertiary treatment, Water recycling – zero discharge system, Advanced treatments for effluent, Destruction of specific pollutants like Cyanide, Evaporation, multiple effect evaporation etc

**UNIT III**

Air pollution control, Various air pollutants and their permissible limits, Air pollution control systems – cyclones, dust collectors, bag filters, ESP, venturi scrubber, packed bed scrubber etc, Emission monitoring – stack monitoring and ambient air monitoring as well as stack design, volatile organic content (VOC) control, Noise pollution control

**UNIT IV**

Solid and hazardous waste management, Municipal solid waste management, Industrial waste management, Secured landfill, Incineration, Co-processing, Recycle and reuse

Case Studies: Fertilizer industries, Petroleum refineries, Distilleries, Pulp and Paper, Textiles, Tanneries, pollution abatement for oil spillage in sea, for mishaps during transportation of chemicals by rail/road etc.

**Texts and References**

1. S. P. Mahajan, Pollution Control In Process Industries, McGraw Hill, 2004
2. Abbas Ghasse, Handbook of Pollution Control and waste minimization, Marcel Dekker, 2002
3. Nelson L. Nemerow, Franklin J. Agardy, ' Strategies of Industrial and Hazardous Waste Management' International Thomson Publishing Co., 1997
4. Peavy H.S., Rose D.R.& Tchobanoglous G., Environmental Engineering, McGraw Hill,
5. Metcalf & Eddy, "Waste Water Engineering: Treatment, Disposal, Reuse", 2<sup>nd</sup> Ed., McGraw-Hill, New York – 1979
6. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991

CH-023 Disaster Management in Chemical Industry										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<b>UNIT I</b>										
Sources of Chemical Disasters, Initiators of Chemical Accidents, Impact of chemical disaster and analysis, definition of stake holders. Statutory Regulatory Framework and Codes, institutional Framework and Compliance, emergency preparedness & mock drills, technical activities, chemical disaster global and national scenario, central and state board of disaster management: role and responsibility of stake holder										
<b>UNIT II</b>										
Gap identification, management of chemical accident, regulations, education and awareness, preparedness, research and development, response and rehabilitation, liability and compensation. Management of chemical disaster, codes and frameworks, tools and techniques in disaster management, training and education, research and development, onsite and offsite preparation plan: formulation, BIS standards on HAZCHEM,										
<b>UNIT III</b>										
Guidelines and codes for the chemical industries, OSD (oil safety directorate) regulations, SMPV rules, factory act, PESO Regulations (Earstwhile CCE Regulations), safety management, engineering safety, accident reporting, storage, transportation and handling, preparation of documentation, investigation, risk reduction strategies and emergency management planning- onsite & offsite emergency planning, hazard identification and risk assessment in chemical installations and pipelines										
<b>UNIT IV</b>										
Implementation of action plan, financial resource management and implication, capacity development Hazardous Waste Management & Engineering Landfill Site. Case studies and lesson to learn: Bhopal, Chernobyl, Mexico city, Flixborough Disaster, Fire & Explosion in butadiene plant, fertilizer plants, etc.										
<b>Texts and References</b>										
<ol style="list-style-type: none"> <li>1. <a href="http://nidm.gov.in/books.asp">http://nidm.gov.in/books.asp</a></li> <li>2. Sam Mannan, Lees' Loss Prevention in the Process Industries Hazard Identification, assessment and control, Elsevier, third edition, volume 1, 2005</li> <li>3. A Gupta and S Nair, Chemical Industrial Disaster Management, NIDM report</li> <li>4. Gujarat state disaster management plan, GSDMA, 2013 report</li> <li>5. Trevor Kletz, "What went wrong?: case history of process plant disaster", 3<sup>rd</sup> edition, Gulf Professional Publication, 1999</li> </ol>										

CH-024 Chemical Industry Practices										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<b>Syllabus is to be prepared</b>										
<b>Texts and References</b>										
<b>1</b>										

CH-031 Newer Separation Processes										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<b>UNIT I</b>										
Fundamentals of separation processes, Separation factor, various separation processes and identification of novel separation process										
Supercritical Fluid Extraction – Introduction, Physiochemical principles, thermodynamics modeling Process synthesis and energy analysis, case studies										
<b>UNIT II</b>										
Membrane Processes - Brief review, module design and module characteristics, plant design and operation, Reverse osmosis, ultrafiltration and microfiltration, pervaporation, case studies										
<b>UNIT III</b>										
Surfactant based Separation - Fundamentals of surfactants at surfaces and in solution, liquid membrane permeation, Foam separations, micellar separations										
<b>UNIT IV</b>										
Chromatographic separation and ion exchange techniques, Centrifugal separation processes and their calculations, Electrophoretic separation processes										
<b>Texts and References</b>										
<ol style="list-style-type: none"> <li>1. R. Rautenbach, and R. Albercht, "Membrane Processes", John Wiley &amp; Sons,(1994)</li> <li>2. R W Rousseau 'Handbook of Separation Process Technology', John Wiley &amp; Sons</li> <li>3. M. A. McHugh, and V. J. Krukoni, "Supercritical Extraction", Butterworths, (1985).</li> <li>4. R. G. Gutman, "Membrane Filtration", Adam Hilger, Bristol, (1987).</li> <li>5. J. F. Scamehorn, and J. H. Harwell, "Surfactant Based Separation Processes", Surfactant Science Series, Vol. 33, Marcel – Dekkar Inc., New York, (1989).</li> </ol>										

CH-032 Nuclear Chemical Engineering										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<p><b>UNIT I</b> Role of Chemical Engineering in the nuclear industry an overview of the various separations used in the nuclear industry (liquid liquid extraction, ion exchange etc).</p> <p>Nuclear Energy Fundamentals: Atomic structure and radio isotopes, radio activity, nuclear fission, nuclear fission reactors,</p> <p><b>UNIT II</b> Radiation Chemistry: Basic principles, dosimetry and experimental methods, chemistry of nuclear fuel cycle</p> <p>Uranium ore processing, Uranium refining, uranium hydrometallurgy</p> <p>Electrochemical technology in nuclear industry</p> <p><b>UNIT III</b> Production of UF and fluorine, choice and problems.</p> <p>Isotope separation</p> <p><b>UNIT IV</b> Fuel reprocessing Nuclear waste management, storages for primary and secondary solid wastes, Ultimate disposal.</p> <p><b>Texts and References</b></p> <ol style="list-style-type: none"> <li>1. AR Foster and RL Wright "Basic Nuclear Engineering", Owen and Bacon Inc. 7th Edition, 1975</li> <li>2. M Benedict and T H Pigford, Nuclear Chemical Engineering, 2<sup>nd</sup> ed. McGraw Hill</li> <li>3. K Sriram, Basic Nuclear Engineering, Wiley Eastern Ltd., 1990</li> </ol>										

CH-033 Cheminformatics										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<b>UNIT I</b>										
Introduction to cheminformatics, account and advancement, prospects and application, role of current information for molecular modeling and structure interpretation										
Classification of notation, structure representation and coding and constitution, matrix types and formation, input and output of chemical structure; processing the constitutional information, chemical reaction representation										
<b>UNIT II</b>										
Database concepts, design of chemical databases and data models; classification of databases, Instances & Schemes; Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts; Metadatabases; Indexing and Hashing; Basic concepts; Text Databases; Introduction to Distributed Database Processing, Data Security. Interfacing programs with databases										
Structure databases; Reaction Databases; Literature Databases; Medline; GenBank; PIR; CAS Registry; National Cancer Institute (NCI) Database										
<b>UNIT III</b>										
Database search methods: chemical indexing, proximity searching, 2D and 3D structure and substructure searching Full structure search; sub structure search; basic ideas; similarity search; Three dimensional search methods; Basics of Computation of Physical and Chemical Data and structure descriptors; Data visualization and Non-linear Mapping										
<b>UNIT IV</b>										
Properties Prediction of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Model Building; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design										
<b>Texts and References</b>										
<ol style="list-style-type: none"> <li>1. Andrew R. Leach, Valerie J. Gillet, Cluwer , Introduction to Cheminformatics, Springer, Netherlands, 2003</li> <li>2. Johann Gasteiger and Thomas Engel 'Chemoinformatics: A Textbook', Wiley-VCH, 2003</li> </ol>										

CH-034 Dye and Intermediates										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100
<b>UNIT I</b>										
<p>Definition, Classification of dyes, Nomenclature and color indexing, color theories, spectral properties of colorants, Jablonski diagram, Classification and chemical constitution dyes, types of dyes (Azo , azoic colours, acid , mono azo ; diasazo, nitro, diphenylamine and anthraquinone; acid mordant , metal complex dyes, etc),</p> <p>Basic dyes: Diphenylmethane and triphenylmethane dyes and heterocyclic analogues dyes, Characteristic properties, synthesis &amp; application of Ionic &amp; non-ionic dyes like Direct, Vat, Acid, Disperse, Azoic, etc., Synthesis, properties &amp; application of Nitro dyes, Acridine &amp; Azo dyes etc.</p>										
<b>UNIT II</b>										
<p>Synthesis of dyes from intermediate compounds, Introduction to classes of pigments, Reactive dyes: types and properties, Mineral colours and oxidation colours, Synthesis and properties of dyes for food, leather, paper, hair application</p> <p>Unit processes in dye manufacturing: Sulphonation, Nitration, Halogenation, Oxidation, Reduction, Alkali fusion, Reagents, Bucherer reaction, Alkylation, Friedel crafts reaction, Diazotization etc.</p>										
<b>UNIT III</b>										
<p>Basic Operation in dyeing process - Preparation of the fibers, Preparation of the dye bath, Application of the dye, Finishing , Methods of Dyeing - Direct dyeing , Vat dyeing, Mordant dyeing, Disperse dyeing, Formation of dye on fibers, Dyeing of the wool with acid dyes, Dyeing with reactive dyes.</p>										
<b>UNIT IV</b>										
<p>Processes and equipments for textile dyeing: earlier developments, recent developments in machinery and dyeing techniques, functions of dyeing aids and properties and application</p>										
<b>Texts and References</b>										
<ol style="list-style-type: none"> <li>1. Shenai, V. A. , Chemistry of dyes &amp; principles of dyeing, VOL. I, Sevak Publication, Bombay, 2nd edition, 1994.</li> <li>2. G. R. Chatwal, Synthetic dyes,</li> <li>3. K.M.Shah, Handbook of Synthetic Dyes and Pigments, Multi tech Publishing Company, Bombay, 2nd edition, 1998.</li> <li>4. Shenai V.A , Technology of Dyeing,., Vol. 6, Sevak Publication, Bombay, 2nd edition, 1994.</li> <li>5. Panda, H., Modern technology of textile dyes and pigments,</li> </ol>										