NOTIFICATION

No. 138 /2021 Date : 02/12/2021

Subject : Implementation of the new Syllabi of Semester V & VI of B.Text.E., B.Tech. (Chem.Engg.) and B.Tech. (Chem. Tech.) (FPOPC) as per A.I.C.T.E. model curriculum from the session 2020-21 & onwards..

It is notified for general information of all concerned that the authorities of the University have accepted to implement the new syllabi **of Semester V & VI** of B.Text.E., B.Tech.(Chem.Engg.) and B.Tech. (Chem. Tech.) (Food, Pulp & Paper, Oil and Paint and Petrochemical Technology) (C.B.C.S.) as per A.I.C.T.E. Model Curriculum to be mplemented from the academic session 2021-2022 & onwards in phase wise manner as per **Appendix – A**.

Sd/-
(Dr.T.R.Deshmukh)
Registrar
Sant Gadge Baba Amravati University

SYLLABUS OF B.TEXT.ENGG. SEM. V VI [C.B.C.S.]

SEMESTER V

5TX 01 FABRIC STRUCTURE AND DESIGN

Course Objectives:

1) To recognize about basic fabrics weave structures
2) To create derivatives of basic fabric weave structures
3) To demonstrate the advance fabric weaves structures

Course Outcomes:

After the completion of Fabric Structure and Design course, students will able to

1) Construct of plain, twill, and satin sateen weaves
2) Construct of honeycomb, mockleno and velt structures
3) Illustrate the colour and weave effects
4) Develop the backed, Bedford and double cloth structures
5) Develop the leno and weft pile structures
6) Develop the terry pile and tapestry structures

SECTION-A

UNIT-I: Methods of fabric representation; repeat of weave; drafts; lifting plan; construction of weave from a given draft and lifting plan; construction of draft from a given lifting plan and weave. Plain weave; twill weaves; satin and sateen & their derivatives.

UNIT-II: Diamonds designs and diaper designs; honeycomb (ordinary & Brighton), huck-a-back; mock leno; Stripe and check weave combination:Welts and piques: Ordinary, wadded, fast back welts; piques; idea of loose back, half fast back and fast back fabrics.

Unit- III : Light & pigment theory of colour, Elements of colour; simple colour and weave effects; construction of line effects;Houndôs tooth pattern; Birdôs eye & spot effects; Hairline effects; step pattern; idea of compound color and weave effects.

SECTION- B

UNIT- IV : Bed ford cords- plain face, wadded, twill face Bedford cords. Backed cloth: Warp backed cloth; weft backed cloth; backed cloth with wadding threads; warp and weft wadded cloths; reversible backed cloths. Classifications of double cloth construction; concept of self stitched; stitched by thread interchange; stitch by cloth interchange; centre stitched.

UNIT -V : Leno structure: Principles of leno structures; methods of producing leno and idea of simple constructions, Weft-pile introduction; concept of simple constructions; Jacquard design- Introduction, Card cutting.

UNIT-VI: Terry pile introduction; formation of pile; simple terry weaves; idea of a terry pile forming mechanism. Tapestry structures: Introduction; idea of simple weft faced structures; carpet structures, Different types of selvedges and their applications, Introduction to Autotex CAD software.

Reference Books :

1) Grammar of Textile Design:Nisbet
2) Fabric Design:Blinov
3) Textile Design and Colour: Watson
4) Advanced Textile Design &colour:Watson
5) NCUTE- Wovenfabric

5TX02 ADVANCE YARN MANUFACTURING TECHNOLOGY

Course Objectives:

1) To gain basic knowledge about various new spinning systems viz rotor, air jet, air vortex, friction, wrap and siro spinning.
2) To gain the knowledge about modern aspects of various new spinning systems.
3) To explain various parameters influencing performance of new spinning systems.

Course Outcomes:

After completion of Advance Yarn Manufacturing course the students will be able to

1) Explain rotor spinning and description regarding rotor spinning machines.
2) Discuss friction spinning and description regarding friction spinning machines.
3) Summarize air jet and air vortex spinning and description regarding air jet and air vortex spinning machines.
4) Describe siro and wrap spinning and description regarding siro and wrap spinning machines.
5) Memorize self-twist and twist-less spinning and description regarding self-twist and twist-less spinning machines.
6) Recall core, electro-static, woollen and worsted spinning and description regarding core, electro-static, woollen and worsted spinning machines.

SECTION- A

UNIT-I: Rotor spinning: Introduction, open end spinning principle, sequence of operations, advantages and limitation of ring and rotor spinning, concept of break spinning, construction details of rotor spinning machines, different types groove and naval, profiles of opening rollers, process parameters influencing yarn quality, properties of rotor yarn, details of yarn structure, applications of rotor yarn, comparison of properties of rotor and ring yarn, recent developments in rotor spinning.

UNIT-II: Friction spinning: Introduction, principle of friction spinning, sequence of operation in fiction spinning, construction details of different friction spinning machines-dref-I, dref-II, dref-III, dref-2000 and dref-3000. Advantages and limitations of friction spinning, process parameters influencing yarn quality, details of yarn structure, properties of friction yarn, applications of friction yarn, recent developments in friction spinning.

UNIT-III: Air jet spinning: Introduction, principle of air jet spinning, idealized structure of fasciated yarn, construction details of air jet spinning machines, sequence of operation in air jet spinning, details of yarn structure, properties and applications of air jet yarn, recent developments in air jet spinning.
Air vortex spinning: Introduction, principle of air vortex spinning, sequence of operation in air vortex spinning, construction details of air vortex spinning machine, details of yarn structure, properties and application of air vortex yarn.

SECTION- B

UNIT-IV: Siro Spinning: Introduction, principle and importance of siro spinning, working and construction details of siro spinning machine, details of yarn structure and properties of siro yarn, applications of siro yarns, advantages and limitations of siro spinning. Concept of compact siro spinning. Wrap spinning: Introduction, principle of wrap spinning, construction details of wrap spinning machine, details of yarn structure, properties and applications of wrap yarn. Recent developments in wrap spinning.

UNIT-V: Self-twist spinning: Introduction, principle of self-twist spinning and yarn formation mechanism, concept and importance of phase shifting, structure, properties and applications of self twist yarn.Twistless spinning-Introduction, principle of twistless spinning, different techniques of twistless spinning. Process parameters, yarn quality and structure, properties and applications of twistless yarn, limitations of twistless spinning.

UNIT-VI: Core spinning: Introduction, concept of core yarn spinning, different techniques of core yarn manufacturing, process parameters, yarn quality and structure of core spun yarn, properties and application of core spun yarn. Electrostatics spinning: Introduction, principle of electrostatic spinning, yarn formation mechanism, yarn structure, properties and application of electro-static yarn.Woollen and worsted spinning: Introduction, construction details and working principle of woollen and worsted spinning machines, yarn structure, properties and applications.

Reference Books:

1. The Textile Institute Manual of Textile Technology ï Short staple spinning Series, Vol.V ï New Spinning System by W. Klein.
2. New Spinning System by R.V.Gowda
3. Hand Book of Yarn Production by P. R. Lord
4. Spun Yarn Technology by Carl A. Lawrence
5. Spun Yarn Technology by Eric Oxtoby
6. Textile Yarns by Martindale and Goswami.
7. Research papers, pamphlets, brochures, manuals of above machines
8. The Economics of Science and Technology of yarn production ï Vol.-I and II
9. Air jet spinning ï Textile Progress, Textile Institute Publication.

5 TX 03 CHEMICAL PROCESSING –I

Course Objectives:

1) To remember the textile wet processing sequence
2) To discuss various dyeing machineries
3) To explain the different class of dyes and its applications

Course outcomes:

After completion of Chemical Processing-I course the students will be able to understand the,

1) Recall the textile wet processing sequence
2) Discuss preparatory processes required for dyeing
3) Explain different dye class
4) Review various dyeing machineries
5) Memorize dyes applied on various cellulosic fibre
6) Memorize dyes applied on various synthetic and protein fibre

SECTION A

UNIT-I: Sequence of wet processing for cotton material: Grey inspection, shearing, cropping, singeing and different singeing methods. Desizing- Object, chemistry and technology of different desizing process (Acid, enzymatic, oxidative, novel methods), batch and continuous methods of desizing.

UNIT-II: **Scouring:** object, chemistry of scouring(saponification, emulsification, detergency, surface tension), technology of scouring (caustic boiling, soap soda ash process for colour goods), bio-scouring batch and continuous scouring process. Introduction to Silk degumming, Wool scouring.Bleaching- Objective, Chemistry and technology of Hypochlorite, peroxide &chlorite bleaching. Preparation process for synthetic and blended fabric in brief, batch and continuous process.

UNIT-III: **Mercerization:** Chemistry and technology (Chainless, Padless, Pad chain), Physical chemical effect of mercerization. Evaluation of Desizing, scouring (Copper number method, methylene blue absorption method) bleaching and mercerization performance (test methods).

SECTION B

UNIT-IV: **Dyeing :** Define dye, classification of dyes based on method of application, chemical constitution and different term used in dyeing. Dyeing machines ï Principal and working of different dyeing machines for fibre, yarn and fabrics. Latest Technological features of different dyeing machines.

UNIT-V: **Dyeing of cellulosic fibres:** Direct dye, Reactive dye, Vat dye, Azoic dye and Sulphur dye. Effect of Process parameters on dyeing performance.Various dyeing faults their causes and remedies.

UNIT-VI: **Dyeing of Protein and synthetic fibres:** Acid, Basic, Mordant and Disperse dyes. Dyeing of blend like polyester-cotton, polyester-viscose and polyester-wool. Effect of process and material parameter on dye performances, various dyeing faults their causes and remedies

Reference Books:

1) Textile Scouring and Bleaching by E.R. Trotman
2) Technology of Bleaching and Mercerising by V.A. Shenai,
3) Mercerization by J.T. Marsh
4) Technology of Textile processing, Vol. II, by V.A. Shenai
5) Chemistry of Dyes and Principles of Dyeing by V.A. Shenai,
6) Technology of Dyeing by V.A. Shenai,
7) Dyeing and Chemical Technology of Textile Fibres by E.R. Trotman,
8) Chemical Processing of Synthetic Fibres and Blends by K.V. Datye and A. A. Vaidya.
9) Textile Preparation and Dyeing by Asim Kumar Roychowdhury.

5TX04 PROF. ELECT. - I (i) ADVANCE GARMENT MANUFACTURING TECHNOLOGY

Course Objective:

1) To recognize the technological advancements in the industrial manufacturing processes of garment.
2) To learn the use of lean tools and time-motion analysis for industrial garment manufacturing process.
3) To learn the use of various computational tools in the industrial manufacturing processes of garment.

Course Outcomes:

After completion of Advance Garment Manufacturing Technology course students will be able to,

1) Discuss technological advancement taken placed in the spreading and cutting operations of garment manufacturing.
2) Discuss technological advancement taken placed in sewing and material handling operations ofgarment manufacturing.
3) Explain technological advancement taken placed in garment finishing and printing operations.
4) Use of lean tools and time-motion studies involved in garment manufacturing industry**.**
5) Application of varioussoftwares in garment manufacturing industry.
6) Use of CAD, 3D Simulation and 3D Scanning technologies in the garment industry.

SECTION-A

UNIT-I: Technological advancement in spreading and cutting: Salient features, advantages, and functional details about automatic spreading machine with data capturing, Plasma Cutting, water jet cutting, Laser cutting machine**,** CAM based automatic cutting machines and automatic single ply cutting machine.Use of fabric cut planning software for fabric utilization and saving during cutting, material cut planning.

UNIT-II: Technological advancement in sewing: Salient features, advantages, and functional details about computerized sewing machine. Selection of stitch type, stitch number and auto stop motion.General Sewing Data (GSD), Digital measurement óDigital Tapeô and thread consumption estimating software, application of robotics in sewing operation, Profile stitching/ Automatic workstation.Automated and flexible material handling system ETON:Salient features, technical details, and advantages of ETON system.

UNIT-III: Technological advancement in garment finishing: Salient features, advantages and functional details about Automatic vapor or steam press, use of a buck press machine for automatic pressing, Automatic folding machine.Advancement in garment printing and embroidery: Digital garment printing, Direct to Garment Printing (DTG), 3D garment printing and computerized embroidery and quilting machine,

SECTION-B

UNIT-IV: Lean tools for garment industry: Concepts and applications of single piece flow, quick change-over (SMED), total productive maintenance (TPM), Heijunka, cellular production system, visual controls (And-on), poka-yoke, supermarket concept, Kanban etc. Standard Time: Rating factor, allowances, SAM, SMV and SAM in garment manufacturing process.

UNIT-V: Work measurement in garment manufacturing process: Definition, need, importance, objective, techniques of time motion studies, steps in time study, breaking the job into elements, stopwatch procedure, predetermined motion time study.Application of various computer based software for garment manufacturing activities: PMTS based software for SAM estimation, time and motion study and real-time production tracking system. PLM software for Product lifecycle management (PLM),use of apparel Enterprise Resource Planning solution.

UNIT-VI: Application of CAD, Simulation and 3D scanning in garment Manufacturing: Salient features, advantages and functional details about the use of computer aided design (CAD) technology in pattern making , various CAD tools, digitization of paper pattern (manual pattern) pattern grading, nesting, marker making and fabric consumption analysis. Application of 3D simulation: Salient features, advantages, and functional details about development of 3D garment on the digital platform and pattern fitting. Application of 3D body scanning: Salient features, advantages, and functional details about full body measurement of the human body by 3D scanning. Use of virtual fitting room in sample approving process.

Reference Books:

1) Introduction to Clothing Manufacture by Cooklin Gerry Blackwell Science Ltd., 1995.
2) Lean Manufacturing Implementation: A Complete Execution Manual for any Size Manufacturer by Hobbs Dennis P, Cengage Learning India Private Ltd, NewDelhi, 2009
3) Industrial Engineering by Khan M.I, New Age International, 2004. 09.12.2019 Regulations-2015R Regulations-2014
4) Design and Analysis of Lean Production Systems by Goldberg Jeffrey B, Askin Ronald G; John Wiley & Sons Inc, 2003.

5 TX 04 PROF. ELECT. - I (ii) HIGH PERFORMANCE FIBRES

Course Objectives:

1) To memorize the high performance fibres
2) To describe the high function fibres
3) To discuss the specialty applications of fibre

Course outcomes:

After completion of High Performance Fibres course students will be able to,

1) Explain high performance fibres
2) Discuss high-tech fibres.
3) Recall carbon and glass fibres
4) Explain high function fibres
5) Describe specialty applications of fibre
6) Discuss thermally resistant fibres.

SECTION-A

UNIT-I: Introduction to high performance fibres: High-tech fibres, natural versus synthetic fibre, artificialfibre by bio-mimetics, fibrecharacteristics and shapes in the field of high performance fibres and textiles and their applications.

UNIT-II: Aramid Fibres: Introduction, polymer preparation, spinning of aramids, structure and properties of aramid fibres, applications of aramid fibres; Gel-spun high-performance polyethylene fibres- Introduction, manufacturing of Gel-spun high-performance polyethylene fibres, its properties and applications.

UNIT-III: Carbon Fibres: Introduction, PAN-based and pitch-based carbon fibre, properties and applications of carbon fibres. Glass fibres- Introduction, raw material, manufacturing, fibre finishes, properties and applications.

SECTION-B

UNIT-IV: High functionfibres: Introduction, sportswear using the high function fibre, Fibres in ocean, biomimetic and intelligent fibres, introduction to chlorinated and fluorinated fibres. Superfibres.

UNIT-V: Specialtyfibres: Introduction, fibres for health, Dietary fibre ï in health and disease Fibres produced by bacteria, Fibres for space, Perfumed fibres, Electronics and fibres.

UNIT-VI: Thermally resistant fibres- Introduction, thermosets, aromatic polyamides and poly-aramids, Polybenzimidazole(PBI), Polybenzoxazoles (PBO).

Reference Books:

1) High PerforamanceFibres, Woodhead Publishing Ltd., Edited By J. W. S. Hearl
2) New millennium fibers, Woodhead Publishing in Textiles, by Tatsuya Hongu, Glyn O. Phillips and MachikoTakigami
3) New Fibres, by Tatsuya Hongu, Glyn O. Phillips
4) Handbook of Textile Fibre Structure, Volume 1: Fundamentals and Manufactured Polymer Fibres, by S Eichhorn, J. W. S. Hearle, M Jaffe and T Kikutani
5) Handbook of Textile Fibre Structure, Volume 2: Natural, Regenerated, Inorganic and Specialist Fibres, by S Eichhorn, J. W. S. Hearle, M Jaffe and T Kikutani.

5 TX 05 OPEN ELECTIVE-I (I) FASHION TECHNOLOGY

Course Objectives:

1) To express the different terms and categories of fashion
2) To analyze different aspects of fashion forecasting and marketing
3) To analyzethe fashion resources and buying behaviour

Course Outcomes:

After completion of Fashion Technology the students will be able to,

1) Define different terms of fashion
2) Identify different categories of fashion and its adoption
3) Investigate fashion research and its analysis
4) Review concept and promotion of fashion
5) Explain different aspects of fashion marketing
6) Analyzethe fashion resources and buying behaviour

SECTION-A

UNIT-I: Fashion Styling: Concept and scope of styling, difference between fashion designing and fashion styling,types of styling. Elements of Style- Accessing styles and trends, elements of style, Achieve Visual balance, making trends and trend setting.

UNIT-II: Fashion Forecasting: Meaning, Short-term and long-term forecasting, Colour forecasting, Textile forecasting, style forecasting and sales forecasting.

UNIT-III: Fashion Illustration and photography: Figure proportions, Real vs Fashion figures, Technical drawing of garments ï Flats and specs. Focus techniques: full shot, medium shot, knee shot, waist shot, close-up, extreme close-up and detail shot.

SECTION-B

UNIT-IV: Fashion Promotion: Fashion Promotion, factors influencing fashion promotion, Publicity, fashion show, Personal selling and communication process, visual merchandising

UNIT-V: Fashion Marketing: Marketing concepts, fashion marketing, role of fashion marketer, market segmentation, Fashion marketing planning, Mass marketing, Marketing management, Franchising and goal of merchandiser and pricing policies.

UNIT-VI: Fashion Buying: Interpreting customer demand, Developing fashion images, Analyzing and selection of resources. Buying in domestic & foreign market.Consumer Behavior: Psychological, Social, Economical, Practical, Family Background and other.

Reference Books:

1) Concept of Consumer by Stephen Fringes, Fairchild Publication.
2) Fashion Merchandising by Stephen Fringes, Stone and samples publisher.
3) Creative fashion presentation by Polly Guerin, Stone and samples publisher.
4) Fashion Marketing byEasey, Stone and samples publisher.
5) Fashion Advertising and Promotionby Winter&Standlay Goodman, Stone and samples publisher.
6) Fashion from concept to consumer byGini Stephens Frings.

5TX05 OPEN ELECTIVE-I (ii) COMPUTER AIDED TEXTILE DESIGNING

Course objectives:

1) To gain basic knowledge about various textile fibers and Yarns
2) To gain the knowledge about fabric design & parameters
3) To use various computers aided textile design softwareôs.

Course Outcomes:

After the completion of Computer Aided Textile Designing course, students will able to demonstrate the knowledge about,

1) Define terms and parameters of textile fibers & yarns
2) Explain basic fabric properties
3) Recall basic fashion fundamentals
4) Use of software application for fashion creation
5) Demonstrate various module used for creating Computer Aided Textile design
6) Create fabric simulation and report generation

SECTION- A

UNIT-I: Introduction to textiles: Fibers; Natural and synthetic, Parameters, uses. Yarn: Types of yarns, numbering system, Quality parameter of yarns and uses. Fabric: Types of fabric,

UNIT-II: Fabric weaves, concept of fashion: Basic fabric properties, fabric design, Basic weave, comforts properties of fabric and uses, Comparison of various fabrics Fashion: Introduction to fashion and apparel design, Origin of fashion, Fashion Theories: Fashion of different eras, French and Greek revolutions, fashion promotion, style-fad trends.

UNIT-III: Fashion Design fundamentals: Fashion principle Elements of art, Definition of line shape, form, size, space, texture and colour. Display of fashion materials: definition and importance, source technique and window display, classic fashion shows. Important fashion centers of the world and India.

SECTION- B

UNIT-IV: Fashion software: Reach Fashion & Reach CAD, Configuration and Installation, commands, library, model E-fashion style, photo, and material studio**.**

UNIT-V: Computer aided designing-1: Fashion sketching, color matching and computer graphics. Autotex software Introduction, Configuration and Installation, Colour Library, Weave library, Checks & stripes, yarn library, Dobby, CAD in Dobby industry

UNIT-VI: Computer aided designing-II: fabric simulation, generation of Peg plan report, generation of report colour combination, Create design in weave library, Electronic jacquard, printing of weave, use of digital pen.

Reference Books:

1) Textile Science CBS Publishers & Distributors, by E.P.G Gohl, New Delhi,(India)
2) Textiles Fiber to Fabric by Bernard P. Corbman, McGraw-Hill International Editions, Singapore
3) Inside fashion design by Tate and Sharon Lee, Harper Publication Inc., UK (1976).
4) Individuality in Clothing ï Selection and Personal Appearance by Mary Kefgen, Mac Millan Publications, New York (1981). Page |41
5) Computer Aided Design and Manufacturing by Mikell P, Grover and E Mory, Prentice Hall of India
6) Garment Technology for Fashion Designer by Cooklin Gerry, OMBook Service, New Delhi (1997).
7) Product manuals of Auto tex and Reach tech softwares.

SYLLABUS OF B.TEXT.ENGG. SEM. VI

6TX01 PROCESS CONTROL IN TEXTILE MANUFACTURING

Course Objectives:

1) To remember the role of process control in textile industry with reference to productivity, quality and cost.
2) To investigate the influence of various key process parameters influencing the performance of spinning and weaving process.
3) To analyze the various process control techniques used for the control of spinning and weaving process.

Course Outcomes:

After the completion of Process Control in Textile Manufacturing course, students will able to,

1) Assess the process control techniques used for control of blow room and carding process.
2) Analyze the process control techniques used for control of combing preparatory, combing, drawing and speed frame process.
3) Analyze the process control techniques used for control of ring spinning process.
4) Analyze the process control techniques used for control of winding and warping process.
5) Analyze the process control techniques used for control sizing and weaving process.
6) Explain the concepts of maintenance management in textile industry for controlling productivity, quality and cost.

SECTION- A

UNIT-I: Introduction to process control: objectives and scope, importance of raw material cost and need of instrumental evaluation of fibre characteristics. Yarn realization: Importance, estimation process, factors influencing yarn realization, analysis of yarn realization in textile industry. Process control in blow room and carding: Blow room and carding, control of productivity, quality, waste, cleaning efficiency and neps, process parameters influencing performance of modern blowroom and carding.

UNIT-II: Process control in comber preparatory and combing: Importance of comber lap preparation, process parameters, influence of combing preparatory on combing performance. Importance of combing process, process parameters, factors influencing combing performance, control of productivity, quality, fractionating efficiency and comber noil. Process control in drawing: Importance, control of productivity, quality, waste, drafting irregularities, roller speed variation, roller vibration, influence of process parameters, role of auto levelers. Process control in speed frame: control of productivity, quality, waste, influence of process parameters and settings on roving quality, roving stretch and its control at speed frame.

UNIT-III: Process control in ring spinning: control of productivity, quality, waste, influence of various machine and process parameters on yarn quality, control of yarn count and strength variation, control of yarn evenness and imperfections, types of yarn irregularities- its causes and control, control of yarn hairiness and end breaks in ring spinning, control of yarn and package faults- causes & remedies.

SECTION- B

UNIT-IV: Process control in winding: control of productivity, quality, waste, control of splice quality, yarn clearing efficiency, assessment of clearing performance, control of unwinding and winding tension, control of package quality.

Process control in warping:control of productivity, quality, waste, characteristics of beam and monitoring of beam quality, control of end breaks, control of productivity & efficiency of warping machine and measures to improve the productivity.

UNIT-V: Process control in sizing: Selection of sizing ingredients, preparation of size paste, control of size pickup, size add-on, yarn stretch and moisture in sized yarn, characteristics of sized beam, optimization of weavability, control of productivity and waste. Process control in weaving: Control of productivity and fabric quality with reference to shuttle-less weaving technologies. Factors affecting loom speed, efficiency, loom stoppage and loom performance. Controlling efficiency losses, control of waste, fabric defects-causes and remedies.

UNIT-VI: Maintenance management: Objectives, basic concept of maintenance management, role of maintenance in textile industry, types of maintenance- planned and breakdown maintenance, mechanism of planned maintenance, maintenance activities from modern blow room to ring spinning, machine audit, introduction to ISO certifications.

Reference Books:

1. Process Control in Textile Manufacturingó by Abhijit Majumdar, Apurba Das , R. Alagirusamy, V. K. Kothari, Woodhead Publishing Series in Textiles, November 2012.
2. Process Management in Spinning by R. Senthil Kumar
3. Process Control in Weaving by M.C. Paliwal and P.D. Kimothi
4. Quality Control in Spinningó by Ratnam T.V. and Chellamani. K. P. - SITRA Coimbatore 1999.
5. Maintenance Management volumes 1 to 21, by IMME Delhi.
6. Maintenance Management, SITRA Publication
7. Process Control in Spinning by A. R. Garde& T. R. Subramaniam, ATIRA Publication.
8. Total Quality Management by John M. Kelly, Published by Aleycuder, Hamitton Institute Inc.
9. Process Control in Spinning by Dr. K. R. Salhotra, ATIRA Publications.
10. Weaving: Technology and Operations by Allan Ormerod.
11. Weaving Machine, Mechanisms, Management by Dr. Talukdar, Ajagaonkar, Sriramulu.
12. Loom shedó BTRA Publication, Mumbai, 1986.
13. Warping and Sizingó BTRA Publication, Mumbai, 1983.
14. Windingó BTRA Publication, Mumbai, 1986.

6TX02 ADVANCE FABRIC MANUFACTURING TECHNOLOGY

Course Objectives:

1) To describe the performance limitations of shuttle loom and the concept behind innovation of various shuttle-less weaving machines.
2) To analyze the various technological designs, working principle and their implications on the application scope of various shuttle-less weaving machines.
3) To explain introductorily about the various diversified fabrics used in textile field.

Course Outcomes:

After completion of Advance Fabric Manufacturing Technology course, students will able to,

1) Describe the theories of picking power, complexities and performance limitations of shuttle loom. Also will able to demonstrate the knowledge about various technical requirements of shuttle -less weaving technology.
2) Recall the technical features, design and working principle of projectile weaving machine.
3) Recall the technical features, design and working principle of rapier weaving machine.
4) Recall the fluid flow theories, technical features, design and working principle relating to air and water jet weaving machines.
5) Recall the technical features, design and working principle of multiphase weaving machines. Also will able to introduce the standard specifications and use of various important fabric types.
6) Remember the specifications, function, properties and production process flow of Multi-axial, Multi-dimensional, Denim and Narrow fabrics.

SECTION-A

UNIT-I: Limitations and complexities of shuttle loom: Theories of shuttle velocity loom speed and picking power. Theories of beat up forces, Introduction to shuttle-less weaving technologies- Classification of shuttle-less weaving machines, theories of weft velocities and acceleration, weft accumulator, weft measuring systems, cam beat up, selvedges formation on shuttle-less weaving machines, yarn quality requirements of shuttle-less weaving.

UNIT-II : Projectile weaving: Introduction, technical features, advantages, transfer of weft from projectile feeder to projectile, design of projectile, phases of weft insertion, projectile picking mechanism, timing cycle of projectile weaving, tuck in selvedge, weft tension variation, energy utilization, scope, limitations and modern developments in projectile weaving viz: Electromagnetic projection, Magnetic timing belt, FOR-Maglev etc.

UNIT-III : Rapier weaving: Classification of rapier weaving machines, rigid and flexible rapiers, methods of weft insertion viz. Dewas and Gabbler, rapier driving mechanism, design of rapier heads ,displacement and velocity of rapiers, weft control mechanism, weaving timings, scope, limitations and latest developments in rapier weft insertion, shedding, take up, selvedge formation and quick style change.

SECTION -B

UNIT-IV:Airjet weaving: Theories of fluid flow applicable to fluid based weft insertion, air stream, friction/ drag forces, working principle of air weaving, phases of weft insertion, air requirements, air jet nozzles, buckling of weft, traverse aids for maintaining air flow, confuser system, profile reed and relay nozzles, methods of air jet control, timings of air jet loom, scope and limitations of air jet weaving. Modern developments in air jet weaving. Water jet weaving -weft supply system, requirement of water, phages of weft insertion, hydraulic weft insertion system, timings of water jet weaving, quick style changing, weft yarn tension variation, modern developments, scope and limitations of water jet looms.

UNIT-V: Multiphase weaving: classification and warp way multiphase. Warp way principle of shedding, picking and beat up mechanism. Weft way multiphase principles of shedding, picking and beat up mechanism. Scope, limitation and advantages of multiphase weaving technology. Standard woven fabrics-Definition and quality particulars of important fabrics viz. Alpaca, bagging, belting, blankets, brocade, blazer cloth, calico, chenille, chiffon, corduroy, cashmere, cotton suiting and trousers , cheese cloth, crepe fabrics, chiffon, denim, damasks, dimity, dhotis, drills, duck/canvas, fiber glass, filter, flannel, foulard, fustian, gabardine, gauze, georgette, gingham, jean, khadi, khaki, lawn, laminated, leno, mousseline, muslin, narrow, organdy, poplin, quilts, saris, satin, sateen, sheeting, shirting, taffeta, tartan, velvet, voile.

Unit-VI: Multi-axial, Multi-dimensional fabric: Introduction, classification, functionality, properties and applications. Brief outline of major techniques used in production of multi-axial and multi-dimensional fabrics. Denim fabric- Types, specifications, functionality, properties, applications and process flow of various production techniques. Weaving machines used in denim production. Narrow fabric- Types, specifications, properties, applications and process flow and weaving machines used in their production.

Reference Books:

1) Weaving operations by AllenArmord
2) Handbook of Weaving by Sabit Adnur
3) Shuttle-less loom by J.J.Vincent
4) Weaving machine, mechanism management by D.B.Ajagaonkar , M.K.Talukdar
5) Principle of Weaving by R.Marks, A.T.C.Robinson
6) Watsonôs Advance Textile Design by Z.J Grosicki
7) Development of the Weaving Machine and 3D Woven Spacer Fabric Structures for Lightweight Composites Materials, Dissertation by Sobhey Badawi.

6 TX 03 CHEMICAL PROCESSING –II

Course objectives:

1) To remember the textile printing processes
2) To analyze the various functional finishes used in textile field
3) To remember the concept of computer colour matching

Course Outcomes:

After completion of Chemical Processing-II course the students will be able to,

1) Tell the fundamentals of textile printing
2) Describe the various textile printing methods.
3) Recall the printing recipes for different dyes
4) Remember the basic concept about functional finishes
5) Evaluation of various functional finishes and their various types.
6) Remember the concept of computer colour matching

SECTION A

UNIT-I: **Printing:** Definition of printing, difference between dyeing and printing , different steps Involved in printing viz, preparation of material ,Ingredients of printing paste, different thickener their chemical and theological behavior , drying of print , fixation of print (after treatments of printing).

UNIT-II: Styles of printing viz direct, resist, discharge and their comparison flock printing and batik printing. Different methods of printing viz block, roller, and screen (flat bed and rotary). Nonconventional methods like transfer printing, inkjet/Digital prints machines.

UNIT-III: **Printing recipe:** Standard recipes for printing with various types of dyes such as direct, reactive, azoic, vat, sulphur, disperse, acid dyes and pigment colour with relevant after treatments .Different faults of printing and their prevention. Evaluation of different fastness properties (wash, light, rubbing, perspiration, sublimation and other allied fastness properties).

SECTION B

UNIT-IV: Finishing: Object of finishing, classification of finishes, concept of anti crease, wash n wear and durable press finish. Concept of specialty finishes like anti-shrink, antistatic, soil release, water repellent, water proof, flame retardant, Parchmentisation, softening finish, etc.
Novel finishes ï Antimicrobial finish, cool finish, Aroma finish

UNIT-V: **Finishing Machineries:** Detail study of various finishing machine viz calendaring (types of calendars), sanforising, Stenter, drying machine. Testing of finishes - anti crease, anti-shrink, fire retardant, water proof and water repellent, antimicrobial.

UNIT-VI: **Computer Colour Matching**: Concept of colour and brief idea about the relation between colour and chemical constitution, factors governing transmission, tristimulus value, kubelkamunkôs equation, methods of colour estimation, -manual, their limitations, instrumental, pass-fail criteria, brief idea of computer colour matching and formulation.

Reference Books:

1) Textile printing by L. W. C.Miles
2) An introduction of Textile Printing by W. Clarke.
3) Technology of Printing by V.A. Shenai,
4) Textile finishing by A. J. Hall
5) Introduction to textile finishing by J. T. Marsh
6) Technology of Finishing by V.A. Shenai,
7) Instrumental colour measurements and computer aided colourmatchings for textiles by Shah and Gandhi
8) Modern concept of colour and appearance by Asim Kumar Roychowdhury.

6 TX 04 PROF. ELECTIVE-II (i) COMFORT AND CLOTHING SCIENCE

Course objectives:

1) To gain basic knowledge about clothing comfort
2) To gain the knowledge about general assessment of clothing comfort
3) To remember various aspects of thermal and moisture transmission.

Course Outcomes:

After the completion of Comfort and Clothing Science course, students will able to,
1) Memorize the basic element of clothing comfort
2) Recall the aspects and measurement of aesthetic comfort
3) Evaluate the subjective and objective assessment of fabric
4) Discuss the comfort in relation to heat and thermal transmission
5) Evaluate the moisture and vapour transmission in relation to clothing comfort
6) Evaluate the clothing comfort in relation with garments

SECTION A

UNIT-I: Clothing Comfort: Brief introduction to clothing comfort, Factors for clothing selection, basic element of clothing comfort. Scientific approaches Psychology and comfort: basic concepts, Psychological perceptions and sensorial perceptions,

UNIT-II: General aspects and measurement of aesthetic comfort: Aesthetic concept of clothing. Neurophysiological Processes of Comfort: Neurophysiologic basis of sensory perceptions, Perceptions of sensations related to mechanical, thermal and moisture stimuli.

UNIT-III: Human tactical responses: Tactical characteristics of clothing, Assessment of fabric handle characteristics: subjective assessment, objective assessment, Kawabata evaluation system of fabric assessment,Fabric assurance by simple testing (FAST)

SECTION B

UNIT-IV: Thermal transmission: Thermoregulatory mechanisms of human body, heat transfer theories, thermal conductivity of fibrous materials, and thermal comfort of clothing, transient heat flow and warm-cool feeling. Measurement of thermal transmission characteristics

UNIT-V: Moisture Transmission: transfer of liquid moisture and vapour transfer through fibrous materials. Dynamic Transmission of heat and moisture: Relationship of moisture and heat. Evaluations of moisture vapour transmission:

UNIT-VI: Fabric mechanical and tactile properties: pressure sensations like fabric prickliness, itchiness, stiffness, softness, smoothness, roughness and scratchiness, clothing comfort aspects in relations with garment size and fit, factors related to garment fit.

Reference Books :

1) Science in Clothing Comfort by Apurba Das and R. Alagirusamy.
2) Principles of Textile Testing by J.E. Booth
3) Physical Testing of Textiles byB.P.Saville
4) Textile Testing by Grover & Hamby.
5) Handbook of Technical Textiles byAnand&Harrocks.

6 TX 04 PROF. ELECTIVE-II (ii) SPECIALTY TEXTILE MATERIALS

Course Objectives:

1) To gain knowledge about speciality fibres
2) To gain knowledge about speciality yarns
3) To gain knowledge about speciality fabrics

Course outcomes:

After the completion of Speciality Textile Materials course, students will able to,

1) Describe speciality fibres
2) Discuss high-tech fibres and fibres for the next millennium.
3) Describe speciality yarns
4) High bulk and melange yarns
5) Describe speciality fabrics
6) Evaluate of special fabrics viz. spacer, polar, multi-functional fabrics.

SECTION A

UNIT-I: Speciality fibres: Introduction and classification of Specialty textile fibres, characteristics of specialty fibres and their applications, superfibers, Superfiber as a reinforcing material, superfiber applications, introduction to High polyketone fiber

UNIT-II: High Techfibres: Various categories of high-tech fibers, Design of specialist fibers, Biotechnology and fibers, Fibers for the next millennium : Dimensions and structurad control of fibers, High-tenacity and high-modulus fibers, Microdenier (ultra-fine) fibers and biomimetics, Super-biomimetic fiber materials, Super-natural materials.

UNIT-III: Speciality yarns: Design, manufacturing, characterization and applications of specialty yarns. Hybrid yarns. Core and cover yarns: - Principles of formation of yarn, constructional details of machine, process description, production of different types of core and cover yarns, yarn properties & end uses.

SECTION B

UNIT-IV: High bulk yarns: Electro-conductive yarns. Technical sewing threads.Coated yarns. Reflective yarns. Melange Yarn: - Concepts of producing mélange yarn. Process and sequence used for production of Melange yarn. Manufacture of some special purpose yarns like:ï Slub, double twist, Knop yarn, Chenille yarn, Diamond yarn, Eccentric yarn, Boucle yarn.

UNIT-V: Specialityfabrics-I: Introduction to structural design, properties-Performance and applications of specialty fabrics. Denim. Pile fabrics. Narrow fabrics.3D fabrics.

UNIT-VI: Speciality fabrics-II: Introduction to special textile fabrics viz. Spacer fabrics. Profiled fabrics. Contour fabrics. Polar fabrics. Spiral fabrics.Multi-functional fabrics.

References Books:

1) New fibres byT. Hongu, Ellis Horwood, New York 1990.
2) Carbon fibresby Donnet J. B. Bansol R .C , Marcel Dekkar, New York 1990.
3) High Performance Fibres byHearle J.W.S., , Textile Institute, Woodhead Publishing, 2001.
4) Fibre science and technology by S.P. Mishra.New Age International Publishers
5) High Performance Fibres by Edited by J. W. S. Hearle, Published by wood head publishing Ltd., England in association with Textile Institute Manchester.
6) New Fibres by Tatsuya Hongu, Glyn O. Phillips

6 TX 05 OPEN ELECTIVE-II (i) FASHION & CLOTHING SCIENCE

Course Objectives:

1) To remember the concept of fashion design process
2) To memorize elements and principles of fashion design
3) To evaluate parameters and properties of garment and its care

Course Outcomes:

After the completion of Fashion and Clothing Science course, students will able to,

1) Remember the concept of fashion
2) Discuss the different aspects of fashion design process
3) Memorize the elements and principles of fashion design
4) Describe the different mechanical and comfort properties of fabric
5) Evaluate the quality parameters and properties of garment
6) Describe the different methods, materials used for clothing care

SECTION-A

UNIT-I: Fashion concept: Meaning of fashion, fashion life cycle, fashion terminologies, Theories of fashion movement: Trickle up, Trickle down and Trickle across theories, Types of fashion dresses: Haute couture, Designerôs collection and Mass Fashion. Contemporary fashion dresses w.r.t. age, sex, nationality, etc.

UNIT-II: Fashion design process: Client brief, Innovational opportunities, Research Inspirations, Research direction, designing process, inspiration, themes, moodboard/storyboard/concept boards, illustrations, client profile, Prototyping and Collections, Portfolio development.

UNIT-III: Elements and principles of fashion design: Aspects of design: Structural, functional and decorative aspects. Elements: Line, shape, silhouette, form, size, colour, texture, pattern, typography. Principles: Balance, rhythm, proportion, emphasis, harmony and unity.

SECTION-B

UNIT-IV: Fabric properties: Fabric Properties for woven and knit clothing: concept, significance importance and evaluation of dimensional stability, serviceability, drape, pilling, abrasion, crease, thickness, surface property and texture, Low stress mechanical properties, Comfort and Handle propertie, Moisture transmission properties. Finishes used to improve these properties.

UNIT-V: Properties of garment: Comfort properties of garment, Permeability to Air, Moisture, and Light. Water Absorbency, wicking and retention properties. Quality parameters for assessing sew ability, seam strength, seam pucker, seam slippage Needle cutting and seam appearance. Tailor ability, Formability and factors affecting Tailor ability, Formability.

UNIT-VI: Clothing care detergents: Classification and function of soap and detergents. Composition of commercial detergents. Properties and application of various laundry agents like bleaching, optical, whitening agents, stiffeners, softeners, Stain removal: - Nature and classification of stains, principle and classification of stain removals, common stain and their removal.

Reference Books:

1) Concept of Consumerby Stephen Fringes, Fairchild Publication.
2) Fashion Merchandising byStephen Fringes, Stone and samples publisher.
3) Creative fashion presentation, by Polly Guerin, Stone and samples publisher.
4) Fashion Marketing by Easey, Stone and samples publisher.
5) Fashion Advertising and Promotion by Winter&Standlay Goodman, Stone and samples publisher.
6) Physical Testing of Textile bySaville

6 TX 05 OPEN ELECTIVE-II (ii)ENVIRONMENT SCIENCE & MANAGEMENT IN INDUSTRY

Course Objectives:

1) To analyze the impact of human beings upon the environment
2) To recall various pollutants.
3) To use waste and energy management

Course outcomes:

After completion of this course the students will be able to,

1) Remember concepts about the environmental pollution
2) Manage the waste management and its control
3) Manage the water pollution and its control
4) Manage the air pollution and its control
5) Manage the thermal and radiation Pollution and its control
6) Use of renewable energy.

SECTION-A

UNIT-I: Environmental Science definition: Scope & Importance- Environment- Its definition, the impact of human beings upon the environment The ñecological footprintò, how the natural world works, Different types of Industrial pollution: Water, air, soil, noise, thermal, radiation, etc.

UNIT-II: Waste management in textile industry: Types of textile wastes producedduring textiles manufacturing viz. spinning, weaving, etc, 3R concept-Reduce, Reuse & Recycle, viz extracting fibres from fabrics, manufacturing polyester fibres from PET bottles, etc. Development of standards & labels.

UNIT-III: Water pollution from textile industry: Sources of water pollution at various stages of process, preconditions & means for resolving the problem, various methods for the treatment of wastewater from textile plants- primary treatment, secondary, tertiary treatment- membrane technologies, waste minimization & clean technologiesEco-friendly processes, viz.- Supercritical dyeing technique, etc.

SECTION-B

UNIT-IV: Air pollution and humidification in textile industry: Air Pollution classification according to sources, Effect of pollutants on human beings, Pollution control at various stages of textile manufacturing. Humidification requirements in different sections viz. spinning, weaving etc., Localised humidification control, Maintenance of humidity

UNIT-V: Thermal and radiation pollution: Thermal pollution**:** Definition, sources and classification, its impact, and management. Radiation pollution: Definition, sources and its impact, and management.

UNIT-VI: Textile industry and renewable energy: Energy use in textile industry, Energy conservation management technologies, Energy Audit, Need of Renewable energy, Why solar for textile, subsidy, Advantages & Disadvantages for textile industry, Rooftop Solar Plants & its benefits for textile industry.

Reference Books:

1) Wastewater treatment- Third Edition by M.N.Rao, A.K.Dutta
2) Humidification & ventilation management in textile industry by B.Purushothama
3) The textile industry & environment by UNEP
4) Environmental impact of textiles, production, processes & protection. by Keith Slater- Woodhead publishing
5) Wastewater Engineering-treatment and reuse by Metcalf and Eddy
6) Environmental Pollution Control by C.S.Rao.

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SYLLABUS PRESCRIBED FOR FOUR YEAR DEGREE COURSE IN SEMESTER –V & VI OF BTECH. (CHEMICALENGINEERING) (C.B.C.S.)
SEMESTER - V
5CH01 HEAT TRANSFER

Course Objective :-
To introduce the concepts of heat transfer to enable the students to design components subjected to thermal loading.

SECTION A

UNITI: Importance of heat transfer in chemical process industries. Modes of heat transfer, steady state conduction in one dimension. Fourierôs law. Heat transfer through plane, cylindrical and spherical walls, compound resistance in series, thermal insulation, critical and economic thickness. Extended surface equipmentôs, types, their design and operation.**(7)**

UNITII: Heattransferbyconvection,filmconcept,individualandoverall coefficients and factors affecting them. Natural and forced convection. Dimensional analysis applied to heat transfer. Dittus-Boelter equation, Limitations andapplication. Theories of heat& Mass transfer & analogy between momentum & heat transfer. **(7)**

UNIT III: Heat transfer by parallel and counter current flow, concept of log mean temperature difference, rate of heat transfer. Heat transfer by film wise and drop wise condensation in horizontal &verticaltube.Process design of condenser **(7)**

SECTION-B

UNIT IV: Heat exchange equipmentôs and their design, double pipe, parallel, counter current, shell and tube heat exchangers, fouling factors, concepts of transfer units in heat exchangers, NTU concept for heat exchangers.Compact Exchangers, plate, plate fin,Spirals etc construction, features advantages, limitation & their process design aspects. **(8)**

UNIT V: Boiling and Evaporators: Theory of boiling. Classification, types and field applications of evaporators.Single and multiple effect evaporators. Heat transfer in agitated vessels, jackets, coils etc. **(8)**

UNIT VI: Heat transfer by radiation, concept of black body, Kirchhoffôs law, Stefanôs law, Black and gray body radiation, view factors luminous and non-luminous gases. Heat transfer in packed and fluidized beds.Recent developments and technological forecasting in heat transfer. **(8)**

Text Books :

1) Heat Transfer by Sukhatme.
2) Heat Trasnfer by McAdams
3) Process Heat Transfer By Kern D. Q.
4) Process Heat transfer By G He.

Reference Books:

1) Unit Operations of Chemical Engineering by McCab and Smith
2) Chemical Engineering by Coulson & Richardson, Vol. I
3) Heat Transfer byR.C.Sachdeva

5CH02 CHEMICALENGINEERINGPROCESS-I
(Inorganic Chemical Technology)

Chemical Engineers are trained primarily to work in chemical industries. Its basic purpose is to start from one ore or other chemical raw material and end up with a consumer product through series of chemical and physical changes, and here it differs from other manufacturing industries which are assembly industries not creative industries. It will be shown in the study of a number of types of chemical industrial process that the fundamentals chemistry, thermodynamics, kinetics, engineering and economics are always valid.

Objective:
After studying this subject the chemical engineering student will have a comprehensive picture of the chemical industry, particularly as to the reasons and the basis for many and diverse operations which are carried out in process.

SECTION A

UNIT-I : 1. Sugar and Starch Industries: Sugar, Starches and related products.
2. Soap and Detergents: Detergents, Soap and Glycerin. **(7)**

UNIT-II: 1. Pulp and Paper Industries: Types, raw materials, manufacture of pulp and paper.
2.Cement and Lime Industries: Portland Cement, types, raw materials, setting and hardening of cement, manufacturing processes of Portland cement; Manufacture, use of lime and gypsum. **(8)**

UNIT-III: 1. Industrial Gases: Manufacture and application of carbon dioxide, hydrogen, oxygen, nitrogen.
2. Fuel Gases: Manufacture and uses of producer gas, water gas, natural gas, synthesis gas. **(8)**

SECTION B

UNIT-IV: 1. Acids: Sulfuric acid, nitric acid, hydrochloric acid.
2. Fertilizer Industry: Manufacture of ammonia, urea, di-ammonium phosphate, super phosphates (SSPandTSP) (8)

UNIT-V: Principles of electro-chemical technological process; Electrolytic process in igneous and molten system; caustic soda, chlorine.(7)

UNIT-VI: Electro-thermal Industries: aluminum, lithium, titanium. Electro-chemical sources of energy and storage. **(7)**

Note: The students are expected to visit the various industries to have a thorough understanding of the subject.

Text Books:

1. Austin, G.T., ñShreveôs Chemical Process Industriesñ, Fifth Edition, McGraw-Hill International Book Co, Singapore,1984.
2. Dryden, C.E., ñOutlines of Chemical Technology ñ, Edited and Revised by Gopala Rao M.and M. Sittig, Third edition, Affiliated East-West press, 1997.

Reference Books:

1. Kent, J.A.,ñRiggelôs Hand Book of Industrial Chemistryñ,7th Edition, Van Nostrant Reinhold, 1974.
2. CHEMTECH 1-4, ñChemical Engineering Education Development Centreñ, I.I.T.,Madras1975-78.

5CH03 MATERIAL SCIENCE & ENGINEERING

Materials Science & Engineering is the study of mechanical, physical, and chemical properties of engineering materials, such as metals, ceramics, polymers, and composites.

Objectives: The objective of a Materials Engineeris to predict and control material properties through an understanding of atomic, molecular, crystalline, and microscopic structures of engineering materials.

SECTION A

UNIT I: Introduction to materials and their principle properties, Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hooks law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poissonôs ratio, Strain energy due to axial load and impact. Introduction to determination of mechanical properties of materials ASTM methods. **(7)**

UNITII: Basic principles in their selection for fabrication and erection of chemical plant. Testing of materials, destructive and non destructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes. **(7)**

UNIT III: Metals and their alloys: Iron ï carbon diagram, Ferrous and nonferrous alloys, mild steel, special steels, stainless steels, brasses, brasses, aluminum alloys and titanium alloys, high and low temperature material, insulation, refractories. Methods for fabrication, rolling, bending, central punching, revetting, welding. Nickel and its alloys: aluminum and its alloys. **(8)**

SECTION B

UNITIV: Corrosion and its control: Corrosion attack methods, Different types of corrosion : chemical, biochemical, and electrochemical; Internal and external factors affecting corrosion of chemical equipments, Methods to minimize corrosion, corrosion charts for process equipments.
Polyaniline and anti-corrossive surface coatings electrochemical corrosion prevention corrosion case studies from the chemical industry. **(8)**

UNIT V: Polymers, natural and synthetic: Selection of polymetric materials for equipment linings, fiber reinforced plastic, application of special polymers like Nylon 66, Teflon in engineering. Polymer Composites. **(7)**

UNIT VI: Ceramic and glasses: Definition of ceramics and glasses; interaction between structure, processing, and properties; Applications of ceramic and glass materials; Crystalline and noncrystalline ceramics, silicates, refractories, clays, cements, glass vitreous silica and boro silicate.**(7)**

Text Books:

1. James F. Shacketford, Introduction to Material Science, McMillan publishing company, New York ISBN1990
2. D.Z. Jestrazebaski, Properties of Engineering Materials, 3rd Ed. Toppers. Co.Ltd.

Reference Books:

1. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works1978
2. Designofmachineelements,SpottM.M.PrenticeHall
3. A text book of machine design, Khurmi R.S. and GuptaJ.K.
4. Material Science &Metallurgy for Engineers, Dr.V.D.Kodgire, Everest PublishingHouse.

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5CH04 PROF. ELECTIVE-I (1) AIR POLLUTION CONTROL

Objective:

This subject covers the sources, characteristics and effects of air pollution and the methods of controlling the same. The student is expected to know about source inventory and control mechanism.

SECTION A

UNIT I: Sources of air pollution: Classification of air pollutants ï Particulates and gaseous pollutants ï Sources of air pollution Source inventory. **(7)**

UNIT II: Effects of air pollution: Effects of air pollution on human beings, materials, vegetation, animals ï global warming-ozone layer depletion, Sampling and Analysis ï Basic Principles of Sampling ï Source and ambient sampling ï Analysis of pollutantsï Principles. **(8)**

UNIT III: Dispersion of pollutants: Elements of atmosphere ï Meteorological factors ï Wind roses ï Lapse rate ï Atmospheric stability and turbulenceï Plumeriseï Dispersion of pollutants ï Dispersion modelsï Applications. **(7)**

SECTION B

UNITIV: Air Pollution Control: Concepts of control ï Principles and design of control measures ï Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation ï Selection criteria for equipment - gaseous pollutant control by adsorption, absorption, condensation, combustionï Pollution control for specific major industries. **(8)**

UNITV: Air Quality Management: Air quality standards ï Air quality monitoring ï Preventive measures-Air pollution control efforts ï Zoning ï Town planning regulation of new industries ï Legislation and enforcement ï Environmental Impact Assessment andAirquality. **(8)**

UNITVI: Sampling and Analysis: Basic principle of sampling ï Statistical Techniques - Source and ambient sampling ï Analysis of Gaseous and Particulate pollutants - Standards. **(7)**

Text Books:

1. Anjaneyulu, D., ñAir Pollution and Control Technologiesò, Allied Publishers, Mumbai, 2002.
2. Rao,C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.

Reference Books:

1. Rao M.N., and Rao H.V.N., Air Pollution Control, Tata ï McGraw Hill, New Delhi, 1996.
2. W.L.Heumann, Industrial Air Pollution Control Systems, McGraw- Hill, New Yark, 1997.
3. Mahajan S.P., Pollution Control in Process Industries, Tata McGraw- Hill Publishing Company, New Delhi, 1991
4. Peavy S.W., Rowe D.R. and TchobanoglousG. Environmental Engineering,McGrawHill,NewDelhi,1985
5. Garg,S.K.,ñEnvironmentalEngineeringVol.IIò,KhannaPublishers, NewDelhi
6. Mahajan, S.P., ñPollution Control in Process Industriesò, Tata McGraw-Hill, New Delhi,1991

(2) ECONOMICS & MANAGEMENT

Engineers are trained primarily to work in industries, market as managers. They should have knowledge about the basic concepts of economics, latest developments in the field, foreign trades, banking, etc. As amanger they should have basic knowledge about management from production tomarketing.

Objective:
Afterstudyingthissubjecttheengineeringstudentwillhaveunderstanding of the happenings in the field of economics and preliminary idea about management.

SECTION A

UNIT-I: Nature and scope of economics, Demand and Supply, Demand: concepts, specification, types of demand. Demand Analysis: significance of demand analysis, law of diminishing utility, consumer surplus. Demand Forecasting: concept of forecasting, types of forecast, steps in demand forecasting, techniques ofdemandforecasting. **(8)**

UNIT-II: Market: Meaning, types of market ï Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition. Inflation: Causes, measurement, effects, controlling of inflation. **(7)**

UNIT-III: Nature and characteristics of Indian economy, Privatization ï meaning, merits and demerits. Globalisationof Indian economy ï merits and demerits. Concepts of VAT, WTO, GATT & TRIPS agreement, Banking, Foreign exchange. (8)

SECTION B

UNIT-IV: Basic concepts and functions of Management, Personal Management.ProductionManagement:Definition,Objectives, Functions and Scope, Production Planning and Control; its significance, stages in production planning and control. Concepts of material management, inventory control; itsimportance andvariousmethods. **(8)**

UNIT-V: Marketing Management: Definition of marketing, marketing concept, objectives and functions of marketing.
Marketing Research ï Meaning; Definition; objectives; Importance; Limitations; Process.
Advertising ï meaning of advertising, objectives, functions, criticism. **(7)**

UNIT-VI: Financial Management: Introduction, Objectives of Financial Management, Functions and Importance of Financial Management. Concept of capital structure and various sources offinance. **(7)**

Text Books:

1. Modern Economic Theory ï K.K. Dewett,S.Chand
2. PrinciplesandPracticeofManagement:R.S.Gupta,B.D.Sharma, N.S. Bhalla Kalyani Publishers.

Reference Books:

1. PrinciplesofEconomics:P.N.Chopra(KalyaniPublishers).
2. Micro Economic Theory ï H.L. Ahuja(S.Chand)
3. Indian Economy: RudarDutt&K.P.M.Sundhram
4. Principles&PracticesofManagementï L.M.Prasad(SultanChand&Sons)
5. Marketing Management ï S.A. Sherlikar (Himalaya Publishing House,Bombay).
6. FinancialManagementï I.M.Pandey(VikasPublishingHouse,NewDelhi)

5CH05 OPEN ELECTIVE-I (i) RISK AND SAFETY MANAGEMENT IN INDUSTRIES

Public awareness of hazards and risks has enhanced the importance of safety assessment andmanagement in todayôs increasingly litigious society. Worldwide the burden of responsibility for safety is shifting towards those who own, manage and work in industrial and commercial organizations. The management of safety and risk needs to be integrated into the overall
management of the organization. It should be appropriate and cost- effective without dampening the innovative entrepreneurial spirit of employees with inflexible bureaucratic rules and procedures. An organizationôs exposure to potential hazards needs to be managed so as to reduce the chance of loss and mitigate any effects. Risk and safety issues need to be evaluated in a structured and calculated manner but in the light of an overall organizationalstrategy.

SECTION - A

UNIT-I : Hazard identification methodologies, risk assessmentmethods-
PHA,HAZOP,MCA,ETA,FTA,consequenceanalysisprobit
analysis. **(8)**

UNIT II : Hazards in work places - nature and type of work places, types of hazards, hazards due to improper house-keeping, hazards due to fire in multi-floor industries and buildings, guidelines and safe methods in the abovesituations. **(7)**

UNIT-III: Workersôexposurestohazardouschemicals,TLVsofchemicals, physical and chemical properties of chemicals leading to accidentslikefireexplosions,ingestionandinhalation,pollution in work places due to dangerous dusts, fumes and vapours, guidelinesandsafemethodsinchemicalshandling,storageand entry intoconfinedspaces. **(8)**

SECTION B

UNIT-IV: Hazards peculiar to industries like fertilizer, heavy chemicals, petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries, guidelines for safeguarding personnel and safeguarding against water, land and air pollution in the above industries. **(8)**

UNIT- V: Safety education and training - safety management, fundamentals of safety tenets, measuring safety performance, motivating safety performance. **(7)**

UNIT VI: Legal aspects of industrial safety, safety audit. **(7)**

Text Books:

1. F. P. Lees, ñLoss prevention in process industriesò, 2nd, Butterworth-Heinemann,1996.
2. W. Handley, ñIndustrial safety handbookò, 2nd ed., McGraw-Hill, 1977.

Reference Books:

1. S.P.Levine,ñProtectingpersonnelathazardouswastesitesò,Martin- Butterworth,1971.
2. R. P. Blake, ñIndustrial safetyò, Prentice Hall,1953.
3. D. Patterson, ñTechniques of safety managementò, McGraw-Hill, 1978.

5CH06 HEAT TRANSFER -LAB

List of Experiments:

1. Heatconduction
2. Natural convection
3. Thermalradiation-determinationofemissivity
4. Double pipe heatexchanger
5. Shell and tube heatexchanger
6. Plate Heatexchanger
8. Heat transfer in agitatedvessels
9. Double effectevaporator
10. Open panevaporator
11. Heat pipedemonstrator
12. Fluidized bed heattransfer

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory.Additional experiments relevant to the syllabus may be added to the mainlist.

5CH07 MATERIAL SCIENCE & ENGINEERING-LAB

List of Experiments:

1. Microstructure observation and study of metals and alloys. (Minimum five) low carbon steel, medium carbon steel, high carbon Steel, tin, bronze, brass, phosphor bronze.
2. Study of properties of polymeric materials; impact test and polymericTests.
3. Corrosion testing (salt spray test for different samples such as plain carbon steel, chrome plate steel, galvanized steel.)
4. Different types of hardness test on metals, i.e. Rock well hardness test, Brinell hardness test, Shore scleroscope tests.
5. Izod and Charpy impact test on mild steel, copper, brass and aluminium.
6. Chemical analysis of metals and alloys (Any one element to be analysed e.g. molybdenum from stainless steel, carbon from steel, copper from brassetc.
7. Macrostructure observation: (flow lines observation in forging by macro etching sulphur printing of steel.)
8. Study experiments based in, i) Dyepenetration ii) Rubberlining, iii) Ultrasonic test, iv) Heat treatments.

Note: The students should perform minimum 8 experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the mainlist.

Note – An orientation programme/Mooc courses of 15 hr duration on **Indian Constitution** to be offered to the students during fifth semester

- **List of open Elective** offered by chemical engineering department
  A) Risk & Safety Management
- **List of Professional Elective**
  (a) Air Pollution Control
  (b) Economics &Managmen.

6CH01 CHEMICALENGINEERING OPERATION-II (MASS TRANSFER - I)

SECTION-A

UNITI: Importance of Mass Transfer Operation. Classification of mass transfer, operations based on gas liquid-solid contacts.Concepts of flux, resistance, driving force, equilibrium, direction of mass transfer, Dimensionless numbers in mass transfer. Diffusion, Fickôs law I and II, Dependence of diffusivity on physical properties, Schmidtôs no. calculation, Determination of diffusivity in liquid-liquid, gas-gas, gas-liquid diffusion. **(7)**

UNIT II: Interphase mass transfer, various coefficient of mass transfer and their determination, resistance concept, controlling phase concept, Mass transfer in turbulent flow, Analogies of mass transfer, Empirical equations. Theories of mass transfer, two film theory, Higbies penetration theory, Derivation of flux equation, surface renewal theory, Applications andproblems. (7)

UNIT III: Absorptions, stagewise absorption, material balance overall, stepwise minimum irrigation rate, Absorption and stripping factor calculation of number of stages, McCabe-Thiele graphical method, Kremsor-Brown-Sounderôs equation. Equipments of absorption, tray towers, packed towers. Continuous absorption, concept of HTU, NTU, HETP, comparison with stepwise columns, design concepts, determination of height and diameter of packed absorption column. **(8)**

SECTION-B

UNIT IV: Adsorption: Adsorption equilibria, types of adsorption, properties of adsorbents, single and multi-stage adsorption, adsorption isotherms, principles of adsorption, Break through curves, adsorption of liquids, basic equations, adsorber design, adsorption equipmentôs. Ion Exchange: Principles of ion exchange,techniquesandapplications,Ionexchangeequilibria, rate ofionexchange. **(7)**

UNIT V: Drying and humidification: Principles of drying, phase equilibrium, cross circulation drying, through circulation drying, drying of suspended particles, rate of drying curve, dryers for solids and pastes, dryers for solutions and slurries, i.e.various types of dryers, Humidification : Terms, definitions, wet bulb temp., dry bulb temperature and measurement of humidity, adiabatic saturation temperature, study of temperature humidity chart, Enthalpy-humidity charts, determination of humidity, and concept of dehumidification, equipments for humidification operations. **(8)**

UNIT VI: Crystallisation: Principles of crystallisation, equilibria, calculation of yield, heat effects, crystal growth, properties of crystals nucleation, fractional crystallisation, caking of crystals, Various types of crystalliseôs and their applications. Membrane separation process, Types of membrane, separation of gases, separation of liquids, Dialysis, Reverse Osmosis, pervaporisation, desalination. Recent developments in mass transferoperation. **(8)**

Text Books:

1) Unit Operation in Chemical Engineering : W .L. McCabe & J.C.Smith, Mc-Graw Hill.
2) Mass Transfer Operation: R.E.Treybal.

Reference Books:

1) Mass Transfer:T.K.Sherwood, R.I. Pigford, McGraw Hill.
2) Chemical Engineering : Coulson & Richardson

6CH02 CHEMICAL ENGINEERING PROCESS-II
(Organic Chemical Technology)

Chemical Engineers are trained primarily to work in chemical industries. Its basic purpose is to start from one ore or other chemical raw material and end up with a consumer product through series of chemical and physical changes, and here it differs from other manufacturing industries which are assembly industries not creative industries. It will be shown in the study of a number of types of chemical industrial process that the fundamentals chemistry, thermodynamics, kinetics, engineering and economics are always valid.

Objective:

After studying this subject the chemical engineering student will have a comprehensive picture of the chemical industry, particularly as to the reasons and the basis for many and diverse operations which are carried out in process.

SECTION A

UNITI: 1. Fermentation Industries: Industrial alcohol, absolute alcohol,wine.
2. Organic acid production: Acetic acid, lactic acid, citric acid. (7)

UNITII: 1. Polymerization Industries: Polyethylene, polypropylene, polyester synthetic fibers.
2. Rubber Industries: Natural rubber, synthetic rubber, SBR. (8)

UNIT III: 1. Petroleum Refinery: Refining of crude oil, products of refining.
2. Petrochemicals: Significant petrochemicals and their derivatives. **(8)**

SECTION B

UNIT IV: 1. Nitration: Nitration agents, kinetics, mechanism, industrial preparation of nitrobenzene, nitronaphthalene, chloro- nitronaphthalene, nitro-acetanilide.

2. ulphonation and Sulfation: agents, kinetics, mechanism, technical preparation of aliphatic sulphonates, sulphonation of lauryl alcohol, dimethyl ether. **(8)**

UNIT V: 1. Hydrogenation: Catalytic hydrogenation, kinetics, mechanism, hydrogenation of fatty oils, synthesis of methanol.

2. Hydrolysis: Hydrolysis of fat, carbohydrate, starch: Manufacture of ethanol from ethylene, manufacture of phenol. **(7)**

UNIT VI: 1. Halogenation: Technical preparation of halogen compounds- allyal chloride, DDT, BHC, chlorobenzene, vinyl chloride.

2. Oxidation: Liquid and vapour phase oxidation, technical oxidation of isopropyl benzene, naphthalene, benzene, ethyl benzene, naphthalene sulfonic acid. **(7)**

Note: The students are expected to visit the various industries to have a thorough understanding of thesubject.

Text Books:

1. P.H. Groggins, ñUnit Processes in Organic Synthesisò, McGraw Hill Book Co., Kogakusha (1984)
2. J.A.Kent,ñRiegelôs Hand book of Industrial Chemistryò,7th Edition, Van Nostrand Reinhold Co., New York (1974)

Reference Books:

1. Peter Wiseman, ñAn Introduction to Industrial Organic Chemistryò, 2nd Edition, Applied Science Publishers Ltd., London (1979)
2. CHEMTECH 1-4, ñChemical Engineering Education Development Centreñ, I.I.T.,Madras 1975-78

6CH03 COMPUTER PROGRAMMING & APPLICATIONS

Application of the following techniques is for problems of interest in chemical engineering, writing and testing of programs in C Language.

SECTION-A

UNIT I: Numerical solution of first order differential equations with initial condition, Eulerôs method, Runge-Kutta method. **(7)**

UNIT II: Systems of linear equations, solution by the method of determinants, matrix inversion for the solution of linear equations, Gausse limination method. **(7)**

UNIT III: Roots of algebraic and transcendental equation, iteration methods, Regula-Falsi method, Newton-Raphson method, roots of simultaneous and solution set of transcendental and algebraic equations. Development of equations for heat transfer, fluid mechanics and reaction engineering problems. **(8)**

SECTION-B

UNITIV: Regression analysis - Least Square, error approach, approximation by Chebychev orthogonal polynomial. **(7)**

UNIT V: Elements of optimization techniques, single variable function, optimization-direct search, with and without acceleration, method of regular intervals and fibonacci search method, gradientmethods. **(8)**

UNIT VI: Computer programming in modular form, use of subroutine libraries, Block diagrams of preliminary aids in programming, capacity optimization. **(8)**

Text Book: Digital Computation for Chemical Engineering by Leon Lapidas, McGraw Hill.

6CH04 PROF. ELECTIVE-II (1) PROCESS EQUIPMENT - DESIGN &DRAWING

SECTION -A

UNIT I: Material behaviour under stresses, theories of failures. **(7)**

UNIT II: Fabrication methods and their effects: Design method for atmospheric storage vessels, unfired pressure vessel subjected to internal and externalpressure. **(7)**

UNIT III: Vessels for high pressure operations, Agitated vessels. Tail columns, internals of the reactors. **(8)**

SECTION - B

UNIT IV: Design of process equipment accessories and support systems. (7)

UNIT V: Complete design and preparation of working drawing for typical process equipment, such as large storage vessels, thick wall pressure vessels. Self supportedtall columns, agitated pressurevessels with heat transfer requirements etc. **(8)**

UNIT VI: Design and layout of piping system and preparation of piping diagram for a typical process. Material selection andpipingcoding. **(8)**

Note: Drawings of minimum eight design problems are expected.

Text Books:

1) Process Design of Equipments: S.D.Dawande.
2) Process Equipment Design: M.V.Joshi, McMillan.

Reference Books:

1) Introduction to Chemical Engineering Design, Mechanical Aspects
2) I.S.Code for Unfired Pressure: ISNo.2825-1969 pressure vessel
3) Process Equipment Design: I.E.Brownell, E.H.Young, John Wiley.
4) International & Indian Standard codes for Piping.

(2) FUEL TECHNOLOGY

COURSE OUTLINE:

Fuels and combustion technology course is required at various Indian universities and IITsas a part of the degree courses. This course is also useful to post graduate students researchers, teachers and technical personnel. It may become a useful guide to industry The course introduces basic knowledge about solid, liquid and gaseous fuels, their origin classification, preparation procedure and characterization in terms of physico-chemical properties. In Solid fossil fuels coal is the main fuel which is focused here. Coal mining cleaning and its combustion processes are themainfeatureofdiscussioninthesectionof Solid fuel. In Liquid fuel section, petroleum is the liquid fuel which is elaborated in terms of exploration, evaluation, distillation and secondary processing. Different important gaseous fuels are included in Gaseous fuel section. Emphasis is given to combustion of various fuels in the light of thermodynamics and various combustion appliances are discussed in Combustion technology section. Requisite mathematical examples with their step-wise solutions areal so include d in the course. Whereever required, concepts are illustrated with schematic and block diagrams.

SECTION A

UNIT-I: History of Fuels, History of solid fuel, History of liquid fuels and Gaseous fuels, Production, present scenario and consumption, pattern of fuels, Fundamental definitions, properties and various measurements.

UNIT-II: Definitions and properties of solid fuels, Definitions and properties of liquid and gaseous fuels, Various measurement techniques.

UNIT-III: Coal classification, composition and basis, Coal mining, Coal preparation and washingCombustion of coal and coke making, Action of heat on different coal samples, Different types of coal combustion techniques, Coal tar distillation, Coal liquefaction, Direct liquefaction, Indirect liquefaction, Coal gasification,

SECTION -B

UNIT-IV: Exploration of crude petroleum,Evaluation of crude Distillation, Atmospheric distillation, Vacuum distillation Secondary processing, Cracking, Thermal cracking, Visbreaking, Coking,Catalytic cracking

UNIT-V: Reforming of naphtha Refineryequipmentôs, Natural gas and LPG,Producergas,Watergas,Hydrogen, Acetylene, Other fuel gases, Fundamentals of thermo chemistry,

UNIT-VI: Combustion air calculation, Calculation of calorific value of fuels, Adiabatic flame temperature calculation, Mechanism and kinetics of combustion, Flame properties, Combustion burners , Combustion furnaces,Internal combustion engines.

References:

1. Modern Petroleum Technology,Vol 1,Upstream, Ed.by Richard A.Dave, IP, 6th ed., John Wiley & Sons.Ltd.
2. Modern Petroleum Technology,Vol2,Downstream, Ed.by Alan G.Lucas,IP, 6th ed., John Wiley &Sons.Ltd.
3. Combustion, Irvin Glassman, 2nd ed., Academic Press.
4. Modern Petroleum Refining Processes, B.K. Bhaskar Rao,4th ed.,Oxford & IBH Publishing Co.Pvt. Ltd.
5. Report on the projectñCoal Combustion Studyò, sponsored by Tata Iron and Steel Company Ltd.,Jamshedpur.
6. Fuels Combustion and Furnaces, John Griswold, Mc-Graw Hill Book Company Inc.
7. Fuels and Combustion, Samir Sarkar, 3rd. ed Universities Press.
8. Petroleum Refinery Engineering, W.L. Nelson, 4th ed. Mc-Graw Hill Book Company.

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6CH05 OPEN ELECTIVE-II (1) RENEWABLE ENERGYSOURCES

Objectives:

- To explain concept of various forms of renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications.
- To analysis the environmental and cost economics of using renewable energy sources compared to fossil fuels.

Course-Outcome:

- At the end of the semester the student will have knowledge about various renewable energy sources and be able to choose the appropriate renewable energy as an alternate for conventional power in any application.

SECTION A

UNIT I : Solar-Energy : Solar radiation its measurements and prediction - solar thermal flat plate collectors concentrating collectors - applications - heating, cooling, desalination, power generation, drying, cooking etc - principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.(7)

UNITII: Wind-Energy : Atmospheric circulations - classification - factors influencing wind - wind shear - turbulence - wind speed monitoring - Betz limit - Aerodynamics of wind turbine rotor- site selection - wind resource assessment - wind energy conversion devices - classification, characteristics, and applications.Hybridsystems-safetyandenvironmentalaspects. (8)

UNIT III: Bio-Energy : Biomass resources and their classification - chemical constituents and physicochemical characteristics of biomass - Biomass conversion processes - Thermo chemical conversion: direct combustion, gasification, hydrolysis and liquefaction - biochemical conversion: anaerobic digestion, alcohol production from biomass - chemical conversion process: hydrolysis and hydrogenation. Biogas - generation - types of bio-gas Plants - applications.**(7)**

SECTION B

UNITIV: Hydrogen and Fuel Cells: Thermodynamics and electro-chemical principles - basic design, types, and applications, production methods, Bio photolysis: Hydrogen generation from algae biological pathways, Storage gaseous, cryogenic and metal hydride and transportation. Fuel cell: principle of working, various types, construction and applications. **(8)**

UNIT V: Other Types of Energy: Ocean energy resources, principles of ocean thermal energy conversion systems, ocean thermal power plants, principles of ocean wave energy conversion and tidal energy conversion, hydropower, site selection, construction, environmental issues, geothermal energy, types of geo-thermal energy sites, sites election, and geo-thermal power plants.**(8)**

UNIT VI: Analysis of the cost effectiveness of renewable energy sources, present status, comparison, forecast. **(7)**

Text Books:

1. Rai G. D., Non-conventional Energy Sources, Khanna Publishers, New Delhi,2007
2. John Twidell, Tony Wier, óRenewable Energy Sourcesô, Taylor & Francis Publishers, New York, 2005.

Reference Books:

1. Sukhatme, S.P., Solar Energy, Tata McGraw-Hill Publishing Company Limited, 2006.
2. Khandelwal K.C, Mahdi S.S., Biogas Technology - A Practical Hand book,Tata McGraw Hill, 1986
3. Thomas .b. Johansson, Henry Kelly, Amulya K.N.Reddy, Robert . H.Williams,óRenewable Energy Sources for Fuels and Electricityô, Island Press, Washington DC, 2009.
4. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, 1980.

(2) WATER TECHNOLOGY

Objectives: To make the students aware about the issues involved in water and water quality aspects and also to learn about physical, chemical and biological techniques available for managing water quality.

SECTION A

UNIT I: Conventional water and waste water treatment methods, their capabilities and limitations, Need for advanced treatment of water and waste water. **(7)**

UNIT II: Advanced water treatment ï Iron and manganese removal, colour and odour removal, activated carbon treatment, carbonate balance for corrosion control, ion exchange, electro-dialysis, reverse osmosis and modern methods and fluoride management. **(8)**

UNIT III: Advanced waste water treatment - Nutrient control in effluents, Nitrogen and phosphorus removal methodsincludingbiological methods, Methods for the removal of heavy metals, oil and refractoryorganics. **(7)**

SECTION B

UNIT IV: Microscreening, ultra-filtration, centrifugation and other advanced physical methods-aerobic digestion, anaerobic filtration, rotating biological contractor, novel methods of aerationetc. **(7)**

UNIT V : Combinedphysico-chemicalandbiologicalprocesses,Activated carbon treatment, chlorination of waste water, Pure oxygen systems. **(8)**

UNIT VI: Filtration for high quality effluents, multistage treatment systems, Land treatment and other resources recovery systems. **(8)**

Text Books:

1. Introduction to Environmental Engineering, By P.A.Veslind, PWS Publishing Company, Boston, 1997.
2. Activated Sludge Process: Theory and Practices, By N.F.Grey, Oxford University Press, 1990.

Reference Books:

1. Wastewater Treatment and disposal, By S.J. Arceivalla, Marcel Dekker,1981.
2. Waste waterTreatment Plant Planning, Designand Operation, By S.R. Quasim, Holt, Rinehart & Winston N.Y.

6CH06 CHEMICAL ENGINEERING OPERATION-II LAB (MASS TRANSFER - I)

List of Experiments:

1. To calculate the diffusivity of vapors of volatile liquid into air by Stefanôs tube. (WinkelmannôsExperiment)
2. To find coefficient of mass transfer of naphthalene ball in stagnant air.
3. To find yield of crystallization with and without seeding.
4. To establish Freundlich and Langmuirisotherm.
5. To determine liquid diffusion coefficient of solute diffusing in water.
6. To determine the critical moisture content of given material.
7. To measure humidity of air from humidifier.
8. To study unsteady state adsorption.
9. To compare the mass transfer instagnant infinite medium in laminar and turbulent flow.
10. To determine gas film mass transfer coefficient by wetted column for G/Lsystem.
11. Use of humidity or psychometric chart.
12. To compare the mass transfer coefficient for different liquids from free surface by evaporation.
13. Separation of NaNO3 by fractional crystallization.
14. To study the efficiency of traydrier.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list.

6CH07 COMPUTER PROGRAMMING & APPLICATIONS – LAB

List of Experiments:

1. Design analgorithm, draw a flow chart and write program to perform addition, subtraction, multiplication and division of two numbers by taking two values fromusers.
2. Algorithm quadratic equation (for root of).
3. Program for solving ordinary differential equation with initial value of Eulerôsmethod.
4. To find value of unknown of simultaneous by Gauss elimination method.
5. To find roots of equation using Bisection method.
6. Algorithm for Regula-Falsi method.
7. Find the roots of equation by Newton-Raphsons method.
8. Program for modified Newton ï Raphson method.
9. Design algorithm for regression.
10. Algorithm for print the grades of students using if-else-if statement.
11. Design algorithm and flow-chart for Runga-Kutta method.
12. Design algorithm and flow-chart to find greatest and smallest element.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the mainlist.

6CH08 MINOR PROJECT

The students in a group of not more than four members have to work on a topic which is experimental and analytical in the area of **Chemical Engineering**. Each project shall have a guide. On completion of the work, a project report should be prepared and submitted to the Department. The project work and the report will be evaluated by an internal assessment committee for 25 marks. The university examination for 25 marks will be a Viva-Voce examination conducted by a committee of one external examiner and one internal examiner / Guide appointed by the University.

NOTE-1. An orientation programme / Mooc courses of 15 hr duration on **Indian traditional knowledge** to be offered to the students during Sixth semester.

2. **List of open Elective-II** offered by chemical engineering department:

a. Renewable energy Sources
b. Water Technology

3. **List of Professional Elective-II:**
a.Process Equipment Design & Drawing
b.Fuel Technology

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SYLLABUS PRESCRIBED FOR BACHELOR OF TECHNOLOGY (CHEMICAL TECHNOLOGY) (FPOPC)

SEMESTER PATTERN (C.B.C.S.)

SEMESTER: FIFTH

5CT01 HEAT TRANSFER

Subject Code: 5CT01	Title: Heat Transfer	Credits = 5		
		L	T	P
Semester: V		3	1	2

Course Outcomes:

- Understand the concept & mechanism of heat transfer by conduction, convection & Radiation.
- Obtain the numerical solution of conduction convection and Radiation Problem.
- Design and analyze the heat exchange and evaporators
- Determine the heat transfer through submerged coil and jacketed vessel
- Understand the concept of boiling and evaporation.
- Understand the various fundamental laws of radiation

SECTION-A

UNIT-I: Importance of heat transfer in chemical process industries, modes of heat transfer, steady state and unsteady state conduction. Fourier's law, heat transfer through plane, cylindrical and spherical coordinate system, concepts of resistance to heat transfer and coefficient, thermal insulation, critical and economic thickness. Extended surface equipments, types, their design and operation.

UNIT-II: Heat transfer by convection, film concept, individual and overall coefficients and factors affecting them. Natural and forced convection; dimensional analysis; Thermal boundary layer. Dittus-Boelter equation, limitations and applications.

UNIT-III: Heat transfer by parallel and counter current flow, concept of log mean temperature difference(LMTD), rate of heat transfer, heat transfer by film and drop wise condensation in horizontal and vertical tube.

SECTION-B

UNIT-IV: Heat transfer equipments and their design-double pipe heat exchanger (DPHE), double pipe, parallel pipe, counter current, shell and tube heat exchangers, fouling factors, Concept of transfer unit in heat exchangers, NTU concept for heat exchangers. Compact exchangers, plate, spirals etc construction, features advantages, limitation and their process design aspects

UNIT-V: Boiling and evaporators: classification of types and field applications of evaporators single and multiple effect evaporators. Heat transfer through submerged coils, jacketed vessels.

UNIT-VI: Heat transfer by radiation, concept of black body, Kirchhoffôs law, Planckôs law, Stefanôs law, Black and grey body radiation, view factors, Luminous and non luminous gases. Heat transfer in packed and fluidized beds. Design aspects of furnaces
Introduction to Radiative heat transfer.

5CT06- HEAT TRANSFER- LAB.

PRACTICALS: Based on above syllabus.

- To study the thermal conductivity of given metal rod.
- To study the heat transfer in vertical hollow cylinder (Natural convection)
- To study the heat transfer in Forced Convection
- To study the Condensation in Drop and Film forms
- To study the heat transfer in horizontal condenser
- To verify the Stefan Boltzmann constant.
- To study the emissivity of given test plate
- To study the heat transfer in calandaria evaporator
- To study the heat transfer in parallel flow shell and tube heat exchanger
- To study the heat transfer in counter current flow shell and tube heat exchanger
- To study the heat transfer in Plate type heat exchanger.

BOOKS RECOMMENDED

- Process of Heat Transfer: D. Q. Kern, TATA McGraw Hill(1997).
- Basic Heat Transfer : Necati Orisik, McGraw Hill Co., Kogakusha.
- Heat Transfer : J. P. Holman, S. Bhattacharya, 10th Ed. TATA McGraw Hill(2011).
- Unit Operations of Chemical Engineering: W. J. McCab, J. Smith, P. Harriot 6th Ed. McGraw Hill (2005)
- Introduction to Chemical Engineering : Bedger and Banchero.
- Chemical Engineering : Coulson & Richardson, Vol. I (ELBS, Pergamon Press, Latest Edition)
- Heat Transfer : Gebhart, McGraw Hill, 2nd edition, Latest Edition
- Fundamentals of Engg. : R. C. Sachdeva, Wiley Eastern.
- Heat Transfer : R. C. Sachdeva.
- Heat & Mass Transfer : S. D. Dawande, Central Techno Pub., Nagpur
- Fundamental of Heat and Mass Transfer : M. Thirumaleshwar, Pearson
- Computational Heat Transfer and Fluid Flow : Murlidhar & Sunder Rajan, Narosa
- Thermal Engineering : M.L. Mathur & F.S. Mehta, Jain Publications
- A Course in Heat & Mass Transfer : V.M. Domkundwar, Dhanpat Rai & Co.
- Process Heat Transfer & Chemical Equipment Design: D.C.Sikdar, Khanna Publishing House
- Heat Transfer Principles and Applications : B.K. Dutta, PHI

References Books

- Bejan, A., A. D. Kraus, Heat Transfer Handbook, John Wiley (2003).

5CT02 MECHANICAL OPERATION

Subject Code: 5CT02	Title: Mechanical Operation	Credits = 4		
		L	T	P
Semester: V		3	0	2

Course Outcomes:

- Perform the size reduction and screening operation in industry
- Understand the principle, construction and working of various classifier and thickenersôused for solid separation.
- Select the suitable transportation system for different types of solids.
- Understand the principle construction and working of various filtration equipments for solid separation form liquid.
- Understand the principle of centrifuges and cyclones.
- Understand the adsorption mechanism and application of adsorption.

SECTION-A

Unit I: Relevance of mechanical operations in industry.

1. Size reduction, stages of reduction, Equipments operatingvariables, laws of energies, energy requirements.
2. Screening: Screen analysis, Particle Size distribution
3. Unit operation design, basis concepts.

Unit II: 1. Classification: Equal falling particles, equipments, jigging,tabling.
2. Gravity settling, drag force, terminal settling velocity.
3. Sedimentation: Continuous thickeners.

Unit III: 1. Storage and handling of solids, transportation
2. Mixing, Mixers, agitation, types of equipments, 3D design of equipments

SECTION-B

Unit IV: 1. Filtration: Theory, operation, types, Flotation agents,flotation cells.
2. Filter Calculations, filtration equation for compressibleand non-compressible cakes, specific cake resistance.
3. Filtration - Constant pressure and constant rate and theirequipments.

Unit V: 1. Centrifuges: Theory, Equipments, types and calculations.
2. Cyclones: Hydrocyclones, liquid scrubbers and electrostatic precipitators.

Unit VI: 1. Adsorption, theory, type and application, nature of adsorbents, industrial adsorbents.
2. Adsorption in fixed bed, fluidized beds. Adsorption equilibria calculations for vapor, gas & liquid adsorption. Adsorption, operation such as single stage, multi stage, cross current & multistage counter current operation &equipments.
3. Recent developments in mechanical operation equipments, animation.

5CT02 Prof. Elect. I (Mech. Operation)
PRACTICALS: Based on above syllabus.

BOOKS RECOMMENDED:

- Momentum Transfer Operation : S .K. Gupta, TMC, Latest edition.
- Unit Operations of Chemical Engineering : McCabe and Smith, TMC
- Chemical Engineering Vol. I : Coulson & Richardson, Pergamon, Latest edition.
- Principles of Unit Operations : A. S. Foust, *et al.*
- Unit Operations : C. G. Brown.
- Introduction to Chemical Engg. : Beder & Bachero.
- Mass Transfer Operations : R.E. Treybal
- Mechanical Operations Vol-I : R. S. Hiremath & A. P .Kulkarni.

5CT03 CHEMICAL ENGINEERING THERMODYNAMICS

Subject Code: 5CT03	Title: Chemical Engineering Thermodynamics	Credits = 4		
		L	T	P
Semester: V	Total contact hours:	3	0	2

Course Outcomes:

- Understanding of concept of thermodynamics, thermodynamic laws calculation of work done, free energy and heat changes
- Understanding vapor liquid equilibrium for binary, ternary systems and its applications in chemical reactions
- Understanding chemical equilibrium, feasibility of reactions for manufacture of chemical products

SECTION-A

Unit I: Scope of thermodynamics and its importanceôs to chemical Engineers, Basic concepts, extensive & intensive properties, state function & chemical systems. Interrelation, concepts of Entropy, Enthalpy & internal energy. Equations of state, critical properties, Virial expansions, Redlich-Kwong equation, Beattie-Bridgeman equation.

Unit II: First law applied to thermodynamic processes & calculation of Work done, free energy & heat changes. Maxwell relation equation, Laws of thermodynamics. Thermodynamics relations based on second law. Relation between Cp & Cv, compressibility factor & coefficient of thermal expansion, concept of residual entropy & entropy of equilibrium.

Unit III: Partial molar and apparent molar properties, Chemical potential, effect of temperature and pressure excess thermodynamic properties and thermodynamic properties of mixing. Gibbs-Duhem-Morgules equation, Konovalov laws. Colligative properties. Ebulliometric constant. Determination of molecular weightof unknown chemical substances. Solubility law.

SECTION-B

Unit IV: Vapor liquid equilibrium, T-X-Y diagrams & X-Y diagram for ideal & non ideal system. Raoultôs law and Henryôs law. Deviations from Raoultôs law. Comparision of ideal & non- ideal systems. Phase equilibria in non reaching multi-components, Binary, ternary systems. Graphical representation of L/L, L/S & G/S systems. Right angled triangular diagrams. Equilateral triangular diagrams, Janecke diagram, Effect of temperature & pressure on ternary equilibrium, Phenol-water system. Aniline-water-chlorobenzene system.

Unit V: Statistical thermodynamics, thermodynamics probability, its relation with Entropy, partition function and its relation with thermodynamics functions, the Boltzmann distribution law, Distribution law for chemically reactive system. Thermodynamics charts & their uses. Searching of thermodynamics data.

Unit VI: Chemical Equilibrium, feasibility of chemical reaction, free energy change, Reaction co-ordinate, equilibrium constant, Effect of temperature & pressure, Relation between Kp, Kc & Kv, Le-Chatelierôs principle, Endo-Exothermic relations, Heterogeneous equilibria, various methods of calculating free energy charge. Equilibrium conversions, case study of feasibility report for manufacture of industrial chemicals. Introduction to refrigeration and air conditioning.

5CT08 : C.E.T. - Lab

Practical's: Based on above syllabus.

BOOKS RECOMMONDED:

- An Introduction to Chemical : R. P. Rastogi, R. R. Misra.Thermodynamics
- Chemical Engineering Process : Houghen-Watson.
- Introduction to Chemical Engg. : J. M. Smith, H. C. VauhessThermodynamics
- Thermodynamics for : H. C. Weber, J. P. MeissnerChemical Engineering
- Engineering Thermodynamics : P. K. Nag.
- Chemical Thermodynamic : M. R. Awode, Dattson, Nagpur.

5FT04 SPECIAL TECH (II) FOOD TECHNOLOGY

Subject Code: 5FT04	Title: Sp. Tech (II) Food Technology	Credits = 4		
		L	T	P
Semester: V	Total contact hours:	3	0	2

Course Outcomes:

- Student will be well versed with isolation of enzymes, photosynthesis, digestion and metabolism of carbohydrates
- They will be well acquainted about assay of vitamin, minerals and will be able to understand energy requirement of individual, loss of nutrients during processing, enrichment and fortification of food, toxic compounds
- Students will have knowledge about techniques of biochemical analysis using modern instruments

Organization cell and cellular constituents. Introduction and classification of enzymes, specificity, enzymes Kinetics, activators and inhabitors. Assay techniques, Isolation ofenzymes from sources and their applications.

Bio-energetics, Digestion and metabolism of carbohydrates, proteins and fats. Photosynthesis, Nucleic acids and their functions.

Vitamins: Classification, sources, Chemistry, functions anddeficiency symptoms. Assay of vitamins.

Minerals: Macro and micro-minerals, sources, functions andefficiency symptoms.

Nutrition: Functions of foods Energy, value of foods. BMR and its measurement, Energy requirement of individuals. Recommended dietary allowances of proteins, fats, carbohydrates, vitamins and minerals. Nutritional evaluation of proteins, Factors influencing nutritive value of foods, Loss of nutrients during processing. Enrichment and fortificationof foods, Formulation of diets and foods for specific needs, Food allergy.

Antinutritional Factors of Foods; Toxic compounds, enzyme inhabitors, alkaloids etc.

Techniques of biochemical analysis like spectrophotometry, Mass spectroscopy, Chromatography, HPLC, GC, GC-MS, electro-phoresis Light and electromicroscopy.

Histochemical techniques, isotopic methods. Food preservation; thermal and non thermal, HPP, Cold Plasma. Recent Advances in the field.

5FT09 : Fluid Technology Lab :

Practicals: A. BIOCHEMISTRY

1. Estimation of carbohydrates and proteins by various methods.
2. Estimation of minerals, Phosphorus, Iron, Calcium.
3. Estimation of vitamin C and effect of heat.
4. Qualitative demonstration of enzyme with salivary amylase.
5. Study of rate of enzyme reaction, effect of environmental factors onrate of enzyme action.
6. Detection of trypsin inhibitor.
7. Chromatographic separation of carbohydrates and amino acids.
8. Simple histological studies on plant tissue.

B.MICROBIOLOGY

1. Preparation and sterilization of nutrient media.
2 Cultivation and morphological study of common species of bacteriayeasts and moulds.
3. Isolation of pure culture from natural sources.
4. Enumeration of bacteria Haemoeytometer, standard plate count MBRTtests for milk.
5. Bacteriological analysis of water.
6. Microbial spoilage of various foods and effect of extrinsic andintrinsic factors on food spillage.

BOOKS RECOMMENDED:

- Outlines of Biochemistry : E. E. Conn & P. K .Stump, Wiley EasternPvt. Ltd., New Delhi.
- Biochemistry of Foods : N.A. Eskin, H. M. Handerson, H.M. & R.J.TownEnd, Academic Press, NY.
- Cell Physiology : A. C. Giese, Sanders & Company, Toppan, Japan.
- Integrated Biology : L. Hill, D. Bellamy, I Chester, Jones Chapman& Hall Ltd., London, EC4.
- Principles of Enzymology for the Food Science: J. R. Whitaker,Marcel Dekker, INC, NY.
- Applied Nutrition : R. Rajalaxmi, Oxford & IBH Publishing Co., NY.
- Heinz Handbook of Nutrition : Benzamin T. Burton, McGraw Hill.Book Company, NY.
- Nutrition-An Integrated Approach: R.C.Pyke & M.L. Brown,Wiley Eastern Pvt. Ltd., New Delhi.
- Hawkôs Physiological Chemistry: Edited by Bernard L. Oser, TataMcGraw Hill Publishing Co. Ltd., New Delhi.
- Biochemistry : A.White,P. Handler, E. L. Smit., McGraw Hill, Tokyo.
- Text Book of Biochemistry : H. R. Mahler & E. H. Chordes, Harper &Row Publisher, NY.
- Microbiological Methods : C.H. Collinse, P. M. Lyme, Butterworth Co. Ltd. London
- Microbes if Action-A Laboratory manual of microbiology: H.W. Seelay (JR), P. J. Von. Denmark-Taraporewala I., W. Pvt. Ltd. Bombay
- Introduction to Practical Biochemistry: D.T. Plummer, Tata McGraw Hill Co. New Delhi

5PT04 SPECIAL TECH (II) PULP & PAPER TECHENOLOGY

Subject Code: 5PT04	Title: Pulp & Paper Tech.	Credits = 4		
		L	T	P
Semester: V	Total contact hours:	3	0	2

Course Outcomes:

- Detail knowledge of pulping processes such as mechanical pulping, semi chemical pulping and semi mechanical pulping
- Understanding comparative pulping methods such as sulphite pulping, alkaline pulping

Collection grading and storage of various raw materials, wood preparation for pulping, units for measuring wood handlingwood barking chipping, Screening, chip, handling and storage,relationship between wood and quality.

Introduction to pulping, Fiber separation commercial processes, types of pulping processes. advances and trends in pulping.Manufacture of mechanical pulp: Types, grades and uses of mechanical pulp stone ground wood process, types of grinders. theory of grinders, theory of grinding. Variable in ground wood process, characteristics of ground wood pulp, pulp mill operations control, practice and testing methods, whole wood fiber manufacture. ground wood from pretreated wood, refiner mechanical pulping scheme, thermomechanical pulping.Semichemical pulping and Semimechanical pulping: Neutral sulfite semichemical pulping, bisulfite semichemical pulping, craft semichemical pulping. cold soda semichemical pulping, hot sulfite chemomechanical semichemical pulp.Sulfite pulping: Description of various sulfite processes, sulfite liquor preparation. variables in sulfite pulping. mechanics and kinetics of sulfite pulping. delignification, digestion in sulfite process. characteristics of sulfite pulp,Alkaline pulping: General description of alkaline pulping process. alkaline digestion, chemical reactions during alkaline digestion. Variables in alkaline pulping process, digesteroperation, material and heat balance bamboo, reeds, hemp, jute, etc.

Recent advances in the field.

SPECIAL TECHNOLOGY-II (PRACTICAL) PULP & PAPER TECHNOLOGY

Analysis of fibrous materials; Pulp analysis: Determination of moisture ash content, permanganate number, copper number, kappa number of pulps 2, B, V, cellulose, solubilityof pulp in alkali.

Analysis of non-fibrous materials: Analysis of black, green and white liquors, bleaching powder, soda ash, caustic soda, lime stone etc.

BOOKS RECOMMENDED:

- Pulping processes : Rydholm. Interscience Pub., John Wiley &Sons Inc., NY.
- Pulp & Paper: Chemistry & Chemical Technology, 3rd Ed., Vol I :James P. Casey, John Wiley & Sons, NY
- Pulp and Paper Manufacture, 2nd Ed., Vol I : Ronald G. McDonald.
- Pulp and Paper Science Technology. Vol. I : C. E. Libby. McGrawHill Co.
- Hand book of Pulp & Paper Technology 2nd Ed.: Bitt VanNostrad. Reinhold Co. NY.
- Technology of Textile Properties : M. A. Taylor,
- Identification of Textile Materials, 7th Ed., Textile Inc., Manchester,7.
- Analytical methods for a Textile Lab., 2nd Ed., AATCC Monog No.3 Research Triangle Park. North Carolina, Printed in USA
- ISI Standards for Textile Testing
- Textile Testing : Sinkale.

5OT04 SPECIAL TECH (II) OIL & PAINT TECHNOLOGY

Subject Code: 5OT04	Title: Oil & Paint Tech	Credits = 4		
		L	T	P
Semester: V		3	0	2

Course Outcomes:

- Awareness about chemistry and biochemistry of oils and fats and there effects on metabolism of human being

Techniques of separation of fats and fatty acids: Low temperature crystallization, esterification, urea adducts, counter distribution, chromatographic methods of separation with special reference to thin-layer chromatography and gas-liquid chromatography.

Methods for quantitative investigation on the component, fatty acids of natural fats and processed fats. Lipase hydrolysis, X-ray diffraction (XRD) and polymorphism of glycerides and other fatty acids and their derivatives. Dilatimetric measurements and their significance.

Infrared (IR), Ultraviolet (UV), Nuclear Magnetic Resonance (NMR) and mass spectroscopy (MS) for the analysis of fatty materials.

Reichert-Missel and Polanske and Krischner values. Advanced method of analysis of fats, fatty acids and glycerides. .

Chemical reactions pertaining to the manufacture of fatty acid derivatives including metal salts other than alkali metals. Quantitative investigation of component triglycerides of Natural fats. Theories of fatty acid distribution in natural fats. Effect of fatty acid distribution on the physical properties. Polymorphism of fats and fatty acids. Biosynthesis of fatty acids, phosphlipids and triglycerides in plants and animals. Elongation and desaturation of acyl chains. Biological utilization of fats. Fat assimilation; Essential fatty acids.

Recent advances in the field.

5OT09 : Lab

SPECIAL TECHNOLOGY-II (PRACTICAL) OIL & PAINT TECHNOLOGY

Analysis of nickel catalyst and acids oils, Preparation of mixed fatty acids and determination of composition.

Analysis of commercial fatty acids. Preparation of pure fatty acids.Determination of mono, di and tri-glycerides.

Analysis of soaps and detergents. Detection of Adulteration. Analysis of Oils by thin layer and column chromatography.

BOOKS RECOMMENDED:

- Industrial Oil and Fat Products : A. E. Bailey : Interscience Publishers,NY, Latest Ed.
- Fatty Acids : K.S. Markley (5 Volumes), Interscience Publishers, NY.
- Structure and Utilization of Oil Seeds : J. G. Vaughon.
- Melting and Solidification of Fats : A. E. Bailey, IntersciencePublishers, NY, Latest Ed..
- The Analysis of Fats and Oils : V. C. Mehlenbacher : The GarrardPress Champing, Ed., Latest Ed.
- Progress on the Chemistry of Fats and other Lipids: T. T. Homan,
- W.O. Lundberg and T. Malkia, Pergamon Press, NY, LatestEdition (7 Vols.)
- The Chemical Constitution Natural Fats: Wiley Books Publishers,NY, Latest Edition..
- Vegetable Fats and Oils : G.S.Jamiesan, Renehold Publishers, NY, Latest Edition..
- Vegetable Fats and Oils : E. W.Eckey : Renehold Publishers, NY, Latest Edition..
- Gas-Liquid Chromatography-Theory & Practice: S. Dal Nagoreand R. S. Juvent: Interscience Publishers, NY, Latest Ed.
- Lipid Chromatographic Analysis : C. V. Marinelt.
- Fatty Acid Synthesis and Application: N. E. Bednareyk &W. L. Erickson.
- The Lipids : H. D. Dauel: Interscience Publishers, NY, LatestEdition.
- Analysis and Characterization of Oil, Fats Products:H. A. Bookenoogen.
- Thin-layer Chromatography : Babbit.

5PT04 SPECIAL TECH (II) PETRO CHEMICAL TECHOLOGY

Subject Code: 5PC04	Title: Petro Chem. Tech.	Credits = 4		
		L	T	P
Semester: V		3	0	2

Course Outcomes:

- Students will have knowledge about petroleum refining industry in India, industrial practice of various conversion process such as catalytic cracking, coking, solvent extraction, petroleum specialty products
- They will be well acquainted with various safety aspects of refinery and will develop skill for testing methods

Introduction to petroleum refining. Basic refinery processes-operations. Product pattern. Classification of refining processes. Important properties of crude oil: Specific gravity, Sulfur content, TAN number. Improving distillate yields and production of high value products. Classifying Refineries by Configuration and Complexity, Nelson's complexity and its determination. Integrated Refinery.Refinery Classes and Characteristic Yield Patterns. Descriptive account of atmospheric and vacuum distillations.Features of Primary Conversion Processes. Features of Primary Upgrading Processes. Treating (Hydrotreating) Processes. Separation Processes, Utilities and Support Operations, Product Blending. Petroleum refining industry in India, Vision of refining industries in India. Worldwide trends & challenges before Indian refineries.

Introduction to Quality Control of Petroleum Products. Commercial petroleum products, quality requirements, Indian specifications, purpose of these standards, vehicle emission standards. Fuel requirements, composition, tests, testing methods and their significance. Composition, properties and specifications of Compressed Natural Gas (CNG), LPG, ATF, Kerosene, Transformer oil, Bitumen, Waxes, Greases etc. Solvents, functions and properties of solvents. The basic function of lubricants, Physical properties, Chemical properties, factors considered while manufacturing/formulating the lubricating oils, essential properties of lubricants used in IC engines, essential properties of lubricants used in gear oils, essential properties of transformer oils, factors affecting oil consumption, up gradation of lubricants, lubricant composition, role of base oil and additives in finished lubricants, Chemically inert additives, chemically active additives.

Treatment techniques (process description, process variables, typical operating conditions). Types of impurities, Sulphur, nitrogen and oxygen in petroleum, purposes for desulfurization, order of difficulty of sulfur removal. Dehydration of natural gas, Dehydration and desalting processes for crude oil, conditioning of crude oil. Caustic processes, Liquid solvents for H_2S removal from sour gases, Solid adsorbents for H_2S. Cascade system of gas cooling, Turbo Expander natural gas liquefaction process, Production of LPG based on the principle of separation. Diethanolamine treatment of LPG fraction, Copper chloride process, Merox process, Caustic methanol process, Doctor treatment, Hot potassium carbonate process, Sulfuric acid treatment, Hydrodesulfurization. Treatment of kerosene: Liquid Sulfur dioxide, DMF and DMSO extraction process.

Production of lube base stocks, Lube oil processing (process description, process variables, typical operating conditions).Propane deasphalting process. Solvent extraction of lube oil fractions: purpose of solvent extraction,comparison of solvents. Phenol-Furfural-NMP extraction processes, Duo-Sol (Selecto) Extraction Process. Dewaxing processes: Chilling and pressing process. Solvent dewaxing processes, selection of solvents, ketone dewaxing processes, propane dewaxing process.Modern catalytic dewaxing process.Hydrofinishing process.Asphalt technology.

Thermal and Catalytic cracking processes (process description, process variables, reactions involved, typical operating conditions). Mechanism of thermal cracking, most probable thermal reactions for various types of hydrocarbon compounds. Thermal cracking processes: Visbreaking,Coil visbreaker, Soaker visbreaker Dubs two coil cracking. Types of coking process: Delayed coker, Hot oven coking, Fluid coking, Contact coking, CDE, CCR. Mechanism of catalytic cracking, catalytic cracking processes: fixed bed catalytic cracking, moving bed catalytic cracking, fluidized bed catalytic cracking processes. Hydrocracking process, Advantages of hydrocracking.

Catalytic reforming processes: Continuous catalyst regeneration (CCR Platforming) process, semi-regenerative process. Isomerization processes, Alkylation processes, Polymerization processes (process description, process variables, reactions involved, typical operating conditions). Refinery utilities, Environmental pollution control in petroleum refineries. Corrosion control in refining processes. Conservation of petroleum products.

5PC09 : Lab.

SPECIAL TECHNOLOGY-II (PRACTICAL) PETROCHEMICAL TECHNOLOGY-II

Analysis and testing of petroleum and petroleum products.
ASTM distillation of motor gasoline, Kerosene and high speed diesel, viscosity index. Demulsification number and forming charcterstics of lubricating oils; existant gum in motor gasoliene; oxidation tests for lubricating oils, oxidation stability of gasoline, water washout characteristics and roll stability of grease. Ductility of bitumen; Electric strength-transfer oil, PONA analysis by FIA method, aniline point method liquid vapor pressure, Heat of combustion of liquid hydrocarbon fuels, calorific value ofô gases, mercaptan sulphur content, salt content, Sulphur by lamp and bomb methods, P, Ca and Cl lubricating oils, study of Vapor-Liquid equilibrium for binary systems using Othmer still study of ternary equilibrium systems and representation triangular diagrams.

BOOKS RECOMMENDED:

- Petroleum Refinery Engineering. : W.L. Nelson : Mc Graw Hill Kogakusha, 4th Ed., Latest Ed.
- Modem Petroleum Technology, Applied Science. : G. D. Hobson and W. Pol Publisher 4th Ed., Latest Ed.
- Petroleum Processing, Principles and Applications : R. J. Hengatabes, McGraw Hill, Latest Ed.
- Petroleum Refiing, Technology and Economics : J. H. Gary & G.E., Hand-work, Merceidekker, NY, Latest Ed.
- Petroleum Processing Handbook : W. E. Bland & P. L. Daviason. McGraw Hill, Latest Ed.
- Petroleum Refinery Manual : M. M. Noel, Rinebold, New York, 1959.
- Petroleum Products Handbook : V. B. Guthrie, McGraw Hill, 1960.

5CT05 ECONOMICS AND MANAGEMENT

Subject Code: 5PT04	Title: Economics & Management	Credits = 3		
		L	T	P
Semester: V		3	0	0

Course Outcomes:

- Understanding types of demand and its analysis for forecasting
- Knowledge about calculation of economic viability of projects
- Understanding markets assessment and survey
- Awareness about business and finances of chemical industry

SECTION-A

Unit I: Nature and scope of Economic, Concept, Scope, Techniques of Managerial Economics, Demand Analysis, Demand Function, Elasticity of Demand and Demand Fore casting.
Unit II: Production Concept, Production Planning and Control: Objective, Function. Essential factors for the success of production planning and control.
Unit III: The concept of management, Principles of Management, Delegation of Authority oganizational Conflict Management.

SECTION-B

Unit IV: Instruments of long term and short term financing, cost of different sources of raising capital.
Unit V :Business Environment , External and Internal Environment, controllable and Uncontrollable Environment, Socio-cultural environment, Healthhazards of chemical industries, Business in post LPG, WTO.
Unit VI : Entrepreneur and Entrepreneurship , Entrepreneurial competencies, institutional interface for SSE opportunity scanning and identification, market assessment for SSE. Main features of Indian factories act & minimum wage act. Brief idea of Taxation in India.

BOOKS RECOMMENDED:

1. Managerial Economics : K. K. Seo, Richard D. Irwin Inc.
2. Engineering Economics : J. L. Riggs, McGraw Hill, New York, Latest Edition.
3. Managerial Economics : Adhikary M., Khosla Pub. House, New Delhi.
4. Small Business Management Fundamentals: Dan Strenhoff and J.F. Burgess, McGraw Hill Book Company.
5. Effective Small Business Management: Richard M. Hodgills, Academic Press Incorporated, Harcourt, Brace Jovanovich.
6. Marketing Management for Small Units: Jain Vijay K., Management Publishing Co., Latest Edition.
7. Marketing Management : Analysis, Planning, Implementation and Control: Kotler, Phillip, Prentice Hall of India Pvt. Ltd., Latest Edition.
8. International Economy, Liberalization Process : V.K. Bhalla Anmol, New Delhi
9. Marketing Management for Small Units : Jain Vijay K., Management Publishing Co., Latest Edition.
10. Management : Koonts H and Wechrich H, Mc Graw Hill.
11. Production and Operations Management : Cherry S.N., Tata Mc Graw Hill.

6CT01PE-II: PROCESS EQUIPMENT DESIGN & DRAWING

Subject Code: 6CT01	Title: Process Equipment Design & Drawing	Credits = 4		
		L	T	P
Semester: VI		3	0	2

Course Outcomes:

- Understand the material behavior under stresses and theories of failures.
- Design and fabricates atmospheric and pressure vessel
- Design high pressure vessel, agitated vessel, tall column etc.
- Select support system for various process equipments.
- Prepare the working drawing for various equipments
- Design and understand the layout of piping system.

SECTION-A

Unit I : Material behavior under stresses, theories of failures. Materials of Constructions

Unit II : Fabrication methods and their effects : Design method for atmospheric storage vessels, unfired pressure vessel subjected to internal and external pressure.

Unit III: Vessels for high pressure operations, Agitated vessels, Tall columns, internals of the reactors.

SECTION-B

Unit IV: Design of process equipment accessories and support systems.

Unit V: Complete design and preparation of working drawing for typical process equipment, such as large storage vessels, thick wall pressure vessels. Self supported tall columns, agitated pressure vessels with heat transfer requirements etc.

Unit VI : Design and layout of piping system and preparation of piping diagram for a typical process. Material selection and pipingcoding. Introduction to computer aided design of equipments.

6CT06 : Lab.

PRACTICALS: Based on the above syllabus.

BOOKSRECOMMENDED:

- Process Equipment Design : I.E.Brownell, E.H.Young, John Wiley,Latest Edition.
- Process Equipment Design : M.V.Joshi, McMillan, Latest Edition.
- Introduction to Chemical Engg. Design, Mechanical Aspects
- I.S.Code for Unfired Pressure : IS No. 2825 - 1969 pressure vessel.
- Process Equipment Design & Drawing : S.D.Dawande.
- International & Indian Standard codes for Piping.
- Process Design of Equipments : S.D. Dawande, Vol I & II,3rd Ed, Central Techno Pub., Nagpur

6CT02: COMPUTER PROGRAMMING AND APPLICATION

Subject Code: 6CT02	Title: computer programming & application	Credits = 4		
		L	T	P
Semester: VI		3	0	2

Course Outcomes:

- Application of numerical solution with differential/ linear equation for various chemical operation such as heat transfer, fluid mechanics, reaction engineering
- Understanding optimization techniques
- Writing & testing of programs in óCô language for problems in chemical engineering
- Solve chemical Engineering problems using computers

Note: Application of the following techniques for problems of interest in chemical engineering, writing and testing of programs written in C Language.

SECTION-A

Unit I: Numerical solution of first order differential equations with initial condition, Eulerôs method, Runge-Kutta method.

Unit II: Systems of linear equations, solution by the method of determinants, matrix inversion for the solution of linear equations, Gauss elimination method

Unit III: Roots of algebraic and transcendental equation, iteration methods, Regula-Falsi method, Newton-Raphson method, rootsof simultaneous and solution set of transcendental and algebraic equations.

Computer programming in modular form, use of subroutine libraries, Block diagrams of preliminary aids in programming,capacity optimization.

SECTION-B

Unit IV: Regression analysis-Least Square, error approach, approximation by Chebychev orthogonal polynomial. Recent trends in Chemical Software; Hysis-Aspin, DW Sim.

Unit V: Elements of optimization techniques, single variable function, optimization-direct search, with and without acceleration, method of regular intervals and fibonacci search method, gradient methods.

Unit VI: Reaction engineering: Concentration profiles of series/ parallel reaction, PFR design, estimation of rate constants for catalytic reactions.

Development of equations for heat transfer, fluid mechanics and reaction engineering problems. Introduction to Python and SCILAB programming.

6CT07 : Lab.

PRACTICALS: Based on above theory.

BOOK RECOMMENDED:

Introductory Methods of Numerical Analysis : S.S. Sastry , Fifth Edition
Digital Computation for Chemical Engineering: Leon Lapidas, McGraw Hill, Latest Edition.
VBA and Macros : Microsoft Excel 2010
www.scilab.in (Free Books for Chemical Engineering)

6CT03: INSTRUMENTATION AND CONTROL

Subject Code: 6CT03	Title: Instrumentation & Control	Credits = 4		
		L	T	P
Semester: VI		3	0	2

Course Outcomes:

- Understand importance of instrumentation & control in chemical process industries.
- Understand the static and dynamic characteristics of measuring instruments
- Understand the principle construction and working of Temperature, Pressure, Flow, Level and pH measuring instruments
- Understand an instruments use for composition analysis.
- Understand the characteristics and application of control valves.
- Understand dynamic behavior of various process
- Design of controllers
- Determine the stability of control system

SECTION-A

Unit I: Measuring Instruments: Qualities of measurement, elements of instrument, static & dynamic characteristics, measurementsof temperature and levels.

Unit II: Measurement of pressure, vacuum, humidity & pH in process industry.

Unit III: Methods for composition analysis, Principle and techniques of instruments for composition analysis and working principles in process industry; chromatography, spectroscopy, refractometry etc.

SECTION-B

Unit IV: Flow measuring instruments: Flow measuring devices for incompressible and compressible fluids. Electro-hydraulic valves, hydraulic servomotors, electro-pneumatic valves, Pneumatic actuators.

Unit V: Introduction to Simple system analysis: Laplace transformation, Block diagrams, linearization, first and higher ordersystem.

Unit VI: Frequency response, distributed parameter system, dead time, Feedback control, servo and regulator control. Time domainclosed loop responses, closed loop frequency response.

6CT08 : INSTRUMENTATION AND CONTROL LAB.

Practicals:

- Level measurement by Air Purge method
- To study the response of first order system.
- To study the response of mercury thermometer.
- To study the response of two tank interacting system.
- To study the response of two tank non interacting system
- To study the response of U-tube manometer.
- To study the modes of controller
- To study tuning of controllers
- To study closed loop response
- To study open loop response
- To study the response of system
- To study stability of system bode plots

BOOKSRECOMMENDED:

- Industrial Instrumentation : Eckman, Wiley Eastern
- Instrumental Methods of Chemical Analysis : Erwing, McGraw Hill.
- Instrumentation & Process Measurements : W. Bottom, Orient Longman.
- Industrial Control & Instrumentation : W. Bottom, Orient Longman.
- Outlines of Chemical Instrumentation & Process Control: A.Suryanarayan, Khanna Pub., New Delhi.
- Process Systems Analysis and Control : Donald R. Cougha Nowr,McGraw Hill Pub., NY.
- Process Control and Instrumentation : R. P. Vyas, Central Techno Pub.,Nagpur.
- Principles of Industrial Instrumentation : Patranabis D, 2nd Ed., McGraw Hill Pub. Co., New Delhi.
- Principles of Process Control : Patranabis D, McGraw Hill Pub. Co., New Delhi.
- Process Dynamics & Control : Gaikwad R.W., Misal S.A., CentralTechno Pub., Nagpur.
- Chemical Process Control & Introduction toTheory & Practice: Stephanopoulos G., PHI, Latest Ed.
- Process Instrumentation & Control Handbook: Considine D.N.,McGraw Hill.

6FT04: SPECIAL TECH (III) FOOD TECHNOLOGY

Subject Code: 6FT04	Title: Sp. Tech (III) Food Technology	Credits = 4		
		L	T	Minor
Semester: VI		3	0	2

Course Outcomes:

- Student will have knowledge about food preservation, control of microorganism, sterilization techniques, immunological methods
- They will have knowledge about freeze drying, dehydration, and safety of food products such as breads, cheese, yogurt, etc.

Brief historical background, classification and terminology of micro-organisms. Study of morphology and physiology of bacteria, yeasts moulds and actinomicetes, introduction to viruses and bacteria. Methods of isolation, cultivation and enumeration of micro-organisms, Nutrition, reproduction and metabolism. Synchronised and balanced growth and continuous cultivation of microorganisms.

Control of microorganisms by physical and chemical methods, Sterilisation and disinfection, inadiation antibiotics, evaluation of antimicrobial agents, Microbiology of air, water and sewage. Immunological methods, Bacteriological analysis of foods, Role of microorganisms in food spoilage.

Principles of food preservation, Preservation of food by means of low temperature, Freeze-drying thermal processing irradiation, dehydration chemicals antibiotics and C. A. Storage. Sources and prevention of contamination. Food Production, properties of materials and Microbial toxins, Principles of a amitation in food technology and safety of foods. Fermented food like bread, cheese, yogurt, vinegar, alcohol, pickles, thermal processing, refrigeration, psychrometrics, food laws, regulations and standards. Single Cell protein and Probiotics.

Recent advances in the field.

BOOKSRECOMMENDED:

- Food Microbiology : W. C. Frazier, Tata McGraw Hill Pub., Co.,Bombay.
- Microbiology : M. J. Pelkzar, Ried R.D., E. C. S. Chan, Tata McGraw Pub., Co. Ltd., New Delhi.
- Fundamentals of Microbiology: M. Frobisher, W. B. Saunders Co.,Philadelphia.
- Microbiology : P. L. Carpenter, W. B. Saunders Co., Philadelphia.
- Microbiological Methods : C. H. Collins & P. M. Lyne, Butterworth andCo., London.
- Food Processing Operations : M. A. Goslyn & J. Hold, The AVI Pub.Co., INC, Westport.
- Principles of Food Science, Vol. II : G. Borgestrom, MacMilIan Co.Ltd., London.
- Technology of Food Preservation: Destosier, Norman W., AVI Pub.Co., INC, London.
- Practical Food Microbiology and Technology: H.H. Weiser, The AVIPub. Co., Westport (Coun.)

6PT04: SPECIAL TECH (III) PULP AND PAPER TECHNOLOGY

Subject Code: 6PT04	Title: Sp. Tech (III) Pulp & Paper Technology	Credits = 4		
		L	T	Minor
Semester: VI		3	0	2

Course Outcomes:

- Knowledge on pulp washing, bleaching and recovery of spent chemical used in pulping process
- Understand the importance of recovery of chemicals in different pulping process
- Comprehensive knowledge on multistage bleaching and environmental aspects of bleaching chemicals

Pulp Washing, Bleaching and Recovery of Spent Chemicals

Washing of Pulp: Delibration of sulphate pulp, brown stock washing, screening and clearing of sulphate pulp, washing of sulphite pulp, screening and clearing of sulphite pulp, screening and clearing of other pulps.

Recovery of spent chemical: Liquor recovery in alkaline pulping, evaporation of kraft liquors, recovery furnace, recausticizing treatment to digester and evaporator condensates, recovery of alkalining sulphate, turpentine, tall oil and other alkaline pulping by products.

Recovery process in sulfite pulping, Calcium, Magnesium, Amonia and Sodium bases recovery, other sulfitex recovery methods, recovery of by-products from sulfite process, whole spent liquor and ligoo sulfonates. Vaniline and alcohol fromsulfite spent liquor, fermentation of sulfite spent liquor to produce proteins.

Bleaching: History of Bleaching, bleaching of mechanical pulps, semichemical pulps, chemi-mechanical and chemical pulps, multistage bleaching, control procedures in bleaching process, colour reversion of bleaching pulps, environmentalaspects of Bleaching chemicals.

Recent advances in the field.

BOOKS RECOMMENDED:

- Pulping Processes : S.A.Rydholm.
- Pulp & Paper Chemistry and Chemical Technology:James P.Casay, 3rd Ed., Vol. I.
- Pulp & Paper Manufacture : R.P.Mc Donald,, 2nd Ed., Vol.-I.
- Hand Book of Pulp & Paper Technology : K. W. Britt, , 2nd Ed.

6OT04: SPECIAL TECH (III) OIL AND PAINT TECHNOLOGY

Subject Code: 6OT04	Title: Sp. Tech (III) Oil & Paint Tech.	Credits = 4		
		L	T	Minor
Semester: VI		3	0	2

Course Outcomes:

- Comprehensive picture of the oil industry, particularly to the reasons and basis for many diverse operations which are carried out in processes

Domestic and World production of oil seeds and oils, storage, sampling, Grading of oil seeds and oils. Pre-Extraction treatments of oil seeds.

Mechanical expression, solvent extraction and other methods of recovery of oils and fats. Economic aspects of these processes, processes and plants employed for refining, bleaching, deororisation and hydrogenation of oils and fats.

Manufacture of butter, Ghee, margarine, vanaspati and confectionary fats. Transesterified oils, fats, winterization ofoils.

Manufacture and evaluation of ancillary materials such as activated earths, activated carbons, Nickel catalyst for hydrogenation. Cooking and salad oils, plastic shortening agents.

Environmental aspects in Oils seeds and oil processing units.Effective control according to Indian Standard specification.

Non Glyceride Constituents, general method of upgrading and utilization of oils and fats, oil-cakes and other products. Synthetic fatty acids and glycerides.

Recent advances in the field.

BOOKS RECOMMENDED:

- Cottonseed and Cottonseed Products : A. B. Bailey, Interscience Publishers, NY.
- Industrial Oil and Fat Products : A. B. Bailey, Interscience Publishers,NY.
- Soyabeans and Soyabean Products : K. B. NarkIev, IntersciencePublishers, NY.
- Hydrogenation of Fatty Oilseeds : Waterman, Lquosevier Publishers,NY.
- Fatty Acids : K. S. Markely (5 Vols.), Interscience Publishers, NY.
- Continuous Processing of Fats : M. K. Schwitzer, Latest Edition.
- Refining of Oils and Fats for Edible Purposes : A.J.C. Anderson,Academic Press, New York.
- Vanaspati Industry : G. S. Hattangadi
- Practical Treaties on Vegetable Ghee Manufacture: Varma & Jaidev.
- Solvent extraction of Vegetable Oils : H. Y. Parkb.
- Refining and Technology of Oils & Fats : T. N. Mahatte, SmallBusiness Publication, New Delhi.
- Food Oils and their Uses : T. J. Weiss, Latest Edition.

- Bleaching Earths : M. K. H. Siddiqui, Latest Edition.
- Progress in the Chemistry of Fats & other Liquids: R. T. Holman, M. O. Luadberg & T. Malkin, Pergamon Press, NY (7Vols.)
- Vegatable Fats and Oils : E. W. Eckay, Rinehold Publishers, NY.
- The Chemistry, Flavouring and Manufacture in Chocolate, Confectionary and Cocoa: H. P. Jenson, Blackiston Publishers, Philadelphia, Latest Edition.
- The Butter Industry : O. F. Huzoker, Latest Edition.
- Margarine: : A. J. C. Anderson, Academic Press, NY

6PC04: SPECIAL TECH (III) PETROCHEMICAL TECHNOLOGY

Subject Code: 6PC04	Title: Sp. Tech (III) Petrochemical Technology	Credits = 4		
		L	T	Minor
Semester: VI		3	0	2

Course Outcomes:

- Students will have skill of calculation in process like distillation, computation of properties of petroleum fraction, flash equilibrium calculation in petroleum refinery
- They will have knowledge of energy balance azeotropic and extractive distillation along with numerical method for designing heat exchanger and fluid dynamics

Vaporization and Condensation, Effect of partial vaporization and condensation at the boiling point, Mechanism of vaporization, Differential or batch vaporization, Equilibrium or flash vaporization, Phase behaviour of multicomponent hydrocarbon systems. Commercial vaporization, Distillation curves- The equilibrium flash vaporization (EFV) curve, ASTM distillation curve, TBP distillation curve. Equilibrium condensation, Equilibrium relations between liquids and vapors, Partial pressures of vapor components (Dalton's law), partial vapor pressures of liquid components (Rault's law), Equilibrium compositionfor an ideal binary gas system and multicomponent systems: derivations-problems. K-values and their estimates for complex mixtures, K-value correlations. Calculations of bubble and dew Points for complex mixtures.

Evaluation of crude oil: Crude Oil Assay Analysis, Crude oil properties-sulfur, nitrogen, and metals content, properties appropriate for certain boiling point ranges, additive and non-additive properties. Objective of Crude Oil Characterization. Typical distillation range of fractions in petroleum assays. Types of assays, TBP-ASTM-EFV distillation apparatus. Comparison of ASTM-TBP-EFV distillation and distillation curves.Factors affecting the efficiency of TBP apparatus. Use of gravity mid percent curves, specific gravity mid percent curve, yield curves. Cut point, End point and Mid boiling point of petroleum fraction. Mid percent curves. Mid-boiling point components. Mid-volume percentage point components. Calculation procedure for characterizing crude oils. Average boiling points. Calculation of characterization factor (K) for whole crude oil.Thermo physical properties of petroleum fractions.

ASTM-TBP-EFV distillation curves. Computation of the ASTM-TBP-EFV distillation Curves by Edmister and Nelson's method. Construction of Successive flash vaporization curves for complex mixtures. Pressure effect on EFV curves, Phase diagram construction for petroleum fractions. Pressure-Temperature-Percent vaporized relationships of petroleum fractions.

Distillation: Arrangement of towers- Top Tray Reflux, Pump back reflux, Pump around Reflux. Important variables in the design of crude columns. Degree of separation, Degree of difficulty of separation, Separation capability (F), degree of fractionation, ASTM gap, TBP overlap. Significance of flash zone, flash zone conditions, concept of overflash. ASTM gaps followed in practice in petroleum refineries. Steam stripping.The typical usual dimensions and operating data for an atmospheric distillation column. Vacuum distillation unit (VDU), Vacuum column operating data. Fundamentals of multidrum tower.Factors affecting efficiencies of plates. Brief overview of the design steps involved in the design of a crude distillation tower. Number of traysin various sections of the tower.Column overhead temperature, bottom stripping. Material and energy balance in topping tower. Cold reflux, hot reflux, circulating reflux, side draw temperature.

Tube still heaters: types of tube still heaters, Features of tube still heaters, ideal still, limiting factor in the designing of tube still heaters. Design of tube still heater.Wilson-Lobo-Hottel equation.Lobo-Evans method of tube still heater design. Design of radiant and convection section.Calculation of radiant absorption rates.Steps involved in Designing of tube still heaters.Analysis and evaluation of heat transfer, Stefan-Boltzmann Law, Heat transfer in the radiant and convection section.

Combustion: heating value, net heating value, grossheating value, excess air. Oil-burner troubles analyzed by Robert Reed, stack draft, effects of altitude on the height and diameter of a stack .Combustion reactions, combustion characteristics of gaseous fuels, combustion characteristics of liquid fuels. Use of combustion charts. Calculation of theoretical combustion air, excess air calculation,calculation of composition of flue gas, Calculation of net heating value, Use of sensible heat chart for gases, Analysis of flue gas from fuel analysis, Heat balance of furnace.

(The subject has to be covered entirely by Numerical)

BOOKS RECOMMENDED:

- Petroleum Refinery Engineering : W. L. Nelson, McGraw Hill,Kogakusha, 4th Ed.
- Petroleum Refinery Distillation : R.N. Watkins, Gulf Pub. Co., Texas,Latest Edition.
- Data Book on Hydrocarbons : J. B. Maxwall, K.E.Kriegar Pub. Co.,NY, Latest Edition.
- Distillation : M. Van Winkle, McGraw Hill, Latest Edition.
- Handbook of Natural Gas Engineering : D. L. Katz & Others, McGrawHill, Latest Edition.
- Applied Hydrocarbon Thermodynamics : W. C. Edmister, Gulf Pub.Co., Latest Edition, Vol. I & II.
- Surface Operations in Petroleum Production: G. Y. Chilingar & C. M .Beeson, Elsevier, NY.
- Petroleum Processing Handbook : W. F. Bland & R. L. Davidson,McGraw Hill, Latest Ed.
- Chemical Engg. : J. M. Coulson & J. F. Richardson, Pergamon Press3rd Ed., Vols. I & II, Latest Edition.
- Equipment Design Handbook for Refineries & Chemical Plants:Frank L. Evans, Jr., Gulf Pub. Co., Houston, Texas, Latest Edition.

6CT05 OE-II: CHEMICAL TECHNOLOGY

Subject Code: 6CT05	Title: Chemical Technology	Credits = 3		
		L	T	P
Semester: VI		3	0	0

Course Outcomes:

- Detailed understanding of kinetics and mechanism of various chemical processes used in manufacturing chemicals such as nitration, sulfonation and sulfation, hydrogenation, halogenations, oxidation etc
- Techniques of waste water treatment
- Study of manufacturing processes for industrial gases, acid, marine chemicals, fertilizers and electrochemical

SECTION A

UNIT I: Nitration: Nitrating agents, kinetics and mechanism of aromatic nitration. Thermodynamics of nitrations. Equipments for nitration. Mixed acids for nitration and typical industrial nitration processes e.g. preparation of Nitrobenzene and Chloronitronapthalene.

Sulphonation and Sulfation: Sulphonation and sulphonating agents, kinetics, mechanism and thermodynamics. Industrial equipments and techniques. Technical preparation of sulphonates and sulphates. Sulphation of lauryl alcohol, dimethyl ether etc.

UNIT II: Hydrogenation: Catalytic Hydrogenation, kinetics and thermodynamics of hydrogenation reactions. Apparatus and material of construction, hydrogenation of fatty oils. Synthesis of methanol. Hydroforming of naptha, Hydrogenation of heavy oils.

Halogenation: Thermodynamics and Kinetics of halogen. Photohalogenation. Equipment and design for halogenations.Technical preparation or halogen compounds e.g. allyl chloride, Chlorobenzene, dichlorodiflurometh ane, vinyl chloride etc.

UNIT III: Oxidation: Liquid and Vapor phase oxidation, kinetics and thermo chemistry, apparatus for oxidation. Technical oxidation of acetaldchyde, Cyclohexane,Iso-propylbenzene. napthaleum refinery, electro-plating, tanning, coat mining and radioactive waste.

Electrolytic and Electro-chemical Industries: Chlorates, per chlorates, Primary and Secondary cells, artificial abrasives, Calcium carbide, Refractory carbides, borides, silicates and nitrides.

SECTION B

UNIT IV: Water: Impurities in water, Requirements of waterby different industries. Treatment of water for industrial and domestic purpose, boiler feed water treatment, recycle of water, water conservation.

Wastewater Treatment: Classification of wastewater, Methods of treatment aerobic and anaerobic, sludge treatment and disposal, treatment of effluent waterfrom textiles rayon, pulp, dairy, distillery Petroleum refinery, electro-plating, tanning, coal mining and radioactive waste.

Marine Chemicals: Salt from sea water, by product of salt industry viz. Bromine and Iodine.

UNIT V: Industrial gases: CO, CO_2, H_2, O_2, N_2, SO_2, C_2, H_2 synthesis gas, nitrous oxides, rare gases: Helium, Argon, Neon etc.

Industrial Acids: Sulphuric acid, Nitric acid and hydrochloric acid.

UNIT VI: Fertilizers: Ammonia nitrogenous fertilizers, Phosphate fertilizers, Potassium fertilizers. Compound and complex fertilizers, Miscellaneous fertilizers,

BOOKS RECOMMENDED:

- Unit Processes in Organic Synthesis : P. H. Groggins, V^{th} Ed. McGraw Hill Co.
- Chemical Technology : D. Venkateswarlu, Chemical Engg. Education Development Centre. IIT Madras, Latest Ed., Vol. I, II, III.
- Chemical Process Industries : R. N. Sherve & J. A. Brink. McGraw Hill, Co., Latest Edition.
- Chemical Technology in two parts. Edited : I. P. Mukhlyanov, Mir Publishers Moscow, Latest Edition.