Dr. Babasaheb Ambedkar Technological University, Lonere

(Established as a University of Technology in the State of Maharashtra)

(Under Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra

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Curriculum for Second year
Undergraduate Degree Programme
B. Tech. in Chemical Engineering

With effect from AY 2021-22

	Semester III									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				
			L	T	P	CA	MSE	ESE	Total	Credit
BSC	BTBS301	Engineering Mathematics – III	3	1	-	20	20	60	100	4
PCC	BTCHC302	Fluid Flow Operations	3	1	-	20	20	60	100	4
PCC	BTCHC303	Process Calculations	3	1	-	20	20	60	100	4
PCC	BTCHC304	Mechanical Operations	3	-	-	20	20	60	100	3
PEC	BTCHE305	Professional Elective I	3	-	-	20	20	60	100	3
LC	BTCHL306	Fluid Flow Operations + Mechanical Operations Lab	-	-	3	60	-	40	100	2
Seminar	BTCHS307	Seminar I	-	-	4	60	-	40	100	2
Internship	BTCHI308	Internship – 1 (Evaluation)	-	-	-	-	-	-	-	Audit
		Total	**15**	**3**	**7**	**220**	**100**	**380**	**700**	**22**
	Semester IV									
PCC	BTCHC401	Chemical Engineering Thermodynamics	4	1	-	20	20	60	100	5
PCC	BTCHC402	Heat Transfer Operations	3	1	-	20	20	60	100	4
HSSMC	BTHM403	Basic human rights	3	-	-	20	20	60	100	3
OEC	BTCHO404	Open Elective I	3	-	-	20	20	60	100	3
PEC	BTCHE405	Professional Elective – II	3	1	-	20	20	60	100	4
LC	BTCHL406	Heat Transfer Operations Lab	-	-	3	60	-	40	100	2
Seminar	BTCHS407	Seminar II	-	-	4	60	-	40	100	2
Internship		Field Training / Internship 2/Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time).	**-**	**-**	**-**	-	-	-	-	Credits To be evaluate d in V Sem.
		Total	**16**	**3**	**7**	**220**	**100**	**380**	**700**	**23**

**** As per the recent directives from the University, online courses on Artificial Intelligence(credit course) and Constitution of India are added in third semester as mandatory courses over and above the courses mentioned in course structure.**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course ,PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Course

List of Electives

1) Professional Elective I
   A. Green Technology
   B. Nanotechnology
   C. Energy Technology and Conversion
   D. Renewable Energy Sources
   E. Materials for Engineering applications
2) Professional Elective II
   A. Numerical methods
   B. Introduction to Bioprocess Engineering
   C. Strength of Materials
   D. Introduction to Polymer Science and Engineering
   E. Advanced Engineering Chemistry
3) Open Elective I
   A. NSS I
   B. Development Engineering

Semester: III[rd]

BTBS301 Engineering Mathematics – III 4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
BSC	BTBS 301	Engineering Mathematics-III	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Laplace and inverse Laplace transforms and their derivatives for elementary functions
2. properties of Laplace and inverse Laplace transforms to solve simultaneous linear and linear differential equations with constant coefficients
3. definitions and properties of Fourier transforms
4. solutions of partial differential equations governing real-world problems

Course Outcomes:

At the end of the course, the student will be able to:

1. comprehend the fundamental knowledge of the Laplace and inverse Laplace transforms and their derivatives for elementary functions
2. apply the properties of Laplace and inverse Laplace transforms to solve simultaneous linear and linear differential equations with constant coefficients
3. conceptualize the definitions and properties of Fourier transforms, to solve boundary value problems using Fourier transforms
4. find the solutions of partial differential equations governing real-world problems
5. conceptualize limit, continuity, derivative and integration of complex functions, complex integrals useful in real-world problems

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	✓	-	-	✓		✓	-	-	-	-	-	-
CO2	✓	-	-	✓		✓	-	-	-	-	-	-
CO3	✓	-	-	✓		✓	-	-	-	-	-	-
CO4	✓	-	-	✓		✓	-	-	-	-	-	-
CO5	✓			✓		✓						

Detailed syllabus

Unit 1: Laplace Transform

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

Unit 2: Inverse Laplace Transform

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit 3: Fourier Transform

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

Unit 4: Partial Differential Equations and Their Applications

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\left(\text{i.e } \frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}\right)$, and one dimensional wave equation (i.e.$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$).

Unit 5: Functions of Complex Variables

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. RajnishVerma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.

4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York.

BTCHC302 Fluid Flow Operations 4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 302	Fluid Flow Operations	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Knowledge of dimensionless groups by dimensional analysis.
2. Manometers and decanters using the principles of fluid statics.
3. Pipe size / flow rate / power requirements under laminar / turbulent conditions
4. Motion of fluid, fluid – solid operations in packed and fluidized beds
5. Machinery for fluid transportation.

Course Outcomes: At the end of the course, the student will be able to:

1. Derive dimensionless groups by dimensional analysis.
2. Solve problems related to manometers and decanters using the principles of fluid statics.
3. Deter mine pipe size / flow rate / power requirements under laminar / turbulent conditions
4. Understand and solve Motion of fluid, fluid – solid operations in packed and fluidized beds
5. Select Machinery for fluid transportation.
6. Determine the flow rate of fluid passing through closed channels.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-
CO5	✓	✓	✓	✓	✓							
CO6	✓	✓	✓	✓	✓							

Detailed syllabus

Unit I:

Continuity equation for compressible and incompressible fluids. Bernoulli equation, Euler equation.Equation of motion. Types of flow, steady and unsteady, laminar and turbulent flows, relationship between shear stress and pressure gradient, Hagen Poiseuille equation.

Unit II:

Prandtl mixing length theory and eddy diffusivity, losses in pipes and fittings. Darcy-Weisbach equation for frictional head loss, friction factor, Moody diagram. Velocity profile and boundary layer calculations for turbulent flow.

Unit III:

Flow through packed and fluidized beds. Introduction to non-Newtonian flow and two phase flow.

Unit IV:

Pumps and compressors for handling different fluids, valves, pipe fittings and their standards, power requirement for flow. Piping layout and economical pipe diameter. Vacuum producing devices.

Unit V:

Flow measuring devices: Orificemeter, Venturimeter, rotameter, Pitot tube, anemometer etc. Flow through constrictions such as notches, weirs, nozzles. Mixing and agitation, calculation of power numbers and mixing indices.Liquid-liquid and liquid solid mixing.

Texts / References:

1. W. L. McCabe and J. C. Smith, P. Harriot, Unit Operations of Chemical Engineering 4th ed. McGraw Hill 1985.
2. S. K. Gupta, Moment Transfer Operations, Tata McGraw Hill, 1979.
3. J. M. Coulson and J. F. Richardson, Chemical Engineering Vol. I.Pergamon Press, 1970.
4. S. Foust, L. A. Wenzel, C. W. Clump, L. B. Andersen. Principles of Unit Operations, 2nd ed. John Wiley, New York, 1980.

BTCHC303 Process Calculations 4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 303	Process Calculations	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Material and energy balances of chemical processes.
2. Material and energy balances on chemical processes/equipment
3. Chemical Engineering problems involving recycle, purge and bypass
4. Ideal and real behavior of gases, vapors and liquids.

Course Outcomes: At the end of the course, student will be able to:

1. Understand the material and energy balances of chemical processes.
2. Perform material and energy balances on chemical processes/equipment
3. Draw the flow diagram and solve the problems involving recycle, purge and bypass
4. Understand the ideal and real behavior of gases, vapors and liquids.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-

Detailed syllabus

Unit I:
Introduction to Chemical Engineering: Historical evolution of Chemical Engineering and Chemical Process Industries, Chemistry to Chemical Engineering, Revision of Units and Dimensions., Mathematical techniques, Introduction to use of calculators.Mole concept, composition relationships and stoichiometry.

Unit II:
Material Balances: Basic Material Balance Principles, Material balance problems without and with chemical reactions, Recycle, Bypass and Purge.

Unit III:

Gases, Vapours and Liquids: Ideal Gas Law, Real Gas relationships, Vapour pressure, Vapor-Liquid Equilibrium calculations, Partial saturation & Humidity, Humidity chart, Material balances involving condensation and vaporization.

Unit IV:

Energy Balances: Heat Capacity, Calculation of enthalpy changes, Energy balances without chemical reactions, Enthalpy changes of phase changes, Heat of solution and mixing, Energy balances accounting for chemical reactions - Standard heat of reaction, formation and combustion, Hess Law, Effect of temperature, Adiabatic flame temperature.

Unit V:

Un-steady state mass balances, with and without reactions.

Texts / References:

1. D.M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 6th Edition, Prentice Hall of India, 1997.
2. B. I. Bhat and S. M. Vora, “Stoichiometry” Tata McGraw-Hill, New Delhi
3. V. Venkataramani, N. Anantharaman and K.M. MeeraSheriffa Begum, “Process Calculations” 2nd edition, Prentice Hall of India, 2015.

BTCHC304 Mechanical Operations 3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 304	Mechanical Operations	3	-	-	20	20	60	100	3

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Mechanical operations and their role in chemical engineering
2. Nature of solids, their characterization, handling, and the processes involving solids.
3. Performance of size reduction equipment and calculate the power requirements.
4. Solid-fluid separation equipment.

Course Outcomes: At the end of the course, the student will be able to:

1. Understand mechanical operations and their role in chemical engineering
2. Understand nature of solids, their characterization, handling, and the processes involving solids.
3. Analyze the performance of size reduction equipment and calculate the power requirements.
4. Design solid-fluid separation equipment.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-

Detailed syllabus

Unit I:

Introduction: Unit operations and their role in chemical industries; Types of mechanical operations.Properties and handling of particulate solids: Characterization of solid particles, Properties of masses of particles, mixing of solids, Size reduction, ultrafine grinders.

Unit II:

Screening: Screening equipment, Screen capacity.

Unit III:

Cake filters: Centrifugal filters, Filter media, Principles of cake filtration, Washing filter cakes. Clarifying filters: Liquid clarification, Gas cleaning, Principles of clarification.

Unit IV:

Cross flow filtration: Types of membranes, Permeate flux for ultrafiltration, Concentration polarization, Applications of ultrafiltration, Dia-filtration, Microfiltration.

Unit V:

Sedimentation: Gravity sedimentation processes, Centrifugal sedimentation processes.

Text / Reference:

1. McCabe W. L., Jullian Smith C. and Peter Harriott - Unit operations of Chemical Engineering, 7th Edition, McGraw-Hill international edition, 2005.
2. Coulson J.M., Richardson J.F, Chemical Engineering, Vol. II, 4th Edition, Elsevier India, 2006.

BTCHE305 Professional Elective – I

3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	BTCHE305	Professional Elective I	3	-	-	20	20	60	100	3

A. Green Technology

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Principles and concepts of green chemistry
2. Manufacturing processes to reduce wastage and energy consumption
3. Technologies to reduce the level of emissions from buildings and core infrastructure
4. Effects of pollutants on the environment

Course Outcomes: At the end of the course, the student will be able to:

1. Understand principles and concepts of green chemistry
2. Develop manufacturing processes to reduce wastage and energy consumption
3. Design the technologies to reduce the level of emissions from buildings and core infrastructure
4. Analyze the effects of pollutants on the environment

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	

CO1	✓	✓	-	-	-	-	✓	-	-	
CO2	✓	✓	✓	-	-	-	✓	-	-	
CO3	✓	✓	✓	✓	✓	-	✓	-	-	
CO4	✓	✓	-	✓	-	✓	✓	-	-	

Detailed Syllabus

Unit 1: Principles and concepts of Green Chemistry: Introduction, Sustainable Development and Green Chemistry, Atom Economy, Atom Economic Reactions, Rearrangement Reactions, Addition Reactions, Atom Un-economic Reactions, Substitution Reactions, Elimination Reactions, Wittig Reactions, Reducing Toxicity, Measuring Toxicity.

Unit 2: Waste- Production, Problems and Prevention: Introduction, Some Problems Caused by Waste, Sources of Waste from the Chemical Industry, The Cost of Waste, Waste Minimization Techniques, The Team Approach to Waste Minimization, Process Design for Waste Minimization, Minimizing Waste from Existing Processes, On-site Waste Treatment, Physical Treatment, Chemical Treatment, Biotreatment Plants, Design for Degradation, Degradation and Surfactants, DDT, Polymers, Some Rules for Degradation, Polymer Recycling, Separation and Sorting, Incineration, Mechanical Recycling, Chemical Recycling to Monomers. Measuring and controlling environmental performance: The Importance of Measurement, Lactic Acid Production, Safer Gasoline, Introduction to Life Cycle Assessment, Green Process Metrics, Environmental Management Systems, The European Eco-management and Audit Scheme, Eco-labels, Legislation, Integrated Pollution Prevention and Control. Catalysis and green chemistry.

Unit 3: Organic solvents, Environmentally benign solutions: Organic Solvents and Volatile Organic Compounds, Solvent-free Systems, Supercritical Fluids, Supercritical Carbon Dioxide, Supercritical Water, Water as a Reaction Solvent, Water-based Coatings, Ionic Liquids, Ionic Liquids as Catalysts, Ionic Liquids as Solvents, Fluorous Biphase Solvents. Renewable resources: Biomass as a Renewable Resource, Energy, Fossil Fuels, Energy from Biomass, Solar Power, Other Forms of Renewable Energy, Fuel Cells, Chemicals from Renewable Feed stocks, Chemicals from Fatty Acids, Polymers from Renewable Resources, Some Other Chemicals from Natural Resources, Alternative Economies, The Syngas Economy, The Bio-refinery, Chemicals from renewable feed stocks.

Unit 4: Emerging Greener technologies and Alternative energy solutions: Design for Energy Efficiency, Photochemical Reactions, Advantages of and Challenges Faced

by Photochemical, Processes, Examples of Photochemical Reactions, Chemistry Using Microwaves, Microwave Heating, Microwave-assisted Reactions, Sono-chemistry, Sono-chemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical Synthesis. Designing greener processes: Conventional Reactors, Batch Reactors, Continuous Reactors, Inherently Safer Design, Minimization, Simplification, Substitution, Moderation, Limitation, Process Intensification, Some PI Equipment, Examples of Intensified Processes, In-process Monitoring, Near-infrared Spectroscopy.

Unit 5: Industrial case studies: A Brighter Shade of Green, Greening of Acetic Acid Manufacture, EPDM Rubbers, Vitamin C, Leather Manufacture, Tanning, Fatliquoring, Dyeing to be Green, Some Manufacturing and Products Improvements, Dye Application, Polyethene, Radical Process, Ziegler–Natta Catalysis, Metallocene Catalysis, Eco-friendly Pesticides, Insecticides. An integrated approach to a greener chemical industry: Society and Sustainability, Barriers and Drivers, The Role of Legislation, EU White Paper on Chemicals Policy, Green Chemical Supply Strategies.

Text / Reference:

1. Mike Lancaster, Green Chemistry, Royal Society of Chemistry, 2010.
2. Paul T. Anastas John C. Warner, Green Chemistry: Theory and Practice, Oxford University Press, 2000.
3. Jay Warmke, Annie Warmke, Green Technology, Educational Technologies Group, 2009.

B. Nanotechnology

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Properties of nano-materials and their applications
2. Chemical engineering principles to nano-particles production and scale-up
3. Quantum confinement equations
4. Characterization of nano-materials.
5. Applications of nanotechnology in electronics and chemical industries.

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the properties of nano-materials and their applications
2. Apply chemical engineering principles to nano-particles production and scale-up
3. Solve the quantum confinement equations
4. Characterize nano-materials.
5. State the applications of nanotechnology in electronics and chemical industries.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				-	-	-	-	-	-	-	-	-
CO2								-	-	-	-	-
CO3		-	-	-	-	-		-	-	-	-	-
CO4					-		-	-	-	-	-	-
CO5										✓	✓	-

Detailed Syllabus:

Unit I: Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano sizes and properties comparison with the bulk materials, different shapes and sizes and morphology.

Unit II: Fabrication of Nanomaterials: Top Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapor Depositions.

Unit III: Kinetics at Nano-scale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH. Carbon Nanomaterials: Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metal lofullerenes solid C60, bucky onions nano-tubes, nano-cones Difference between Chemical Engineering processes and nano-synthesis processes.

Unit IV: Characteristics of quantum dots, Synthesis of quantum dots, Semiconductor quantum dots, Introduction – Nano-clay Synthesis method, Applications of nano-clay. Nanomaterials characterization: Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential

Microscopy's SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

Unit V: Applications in Chemical Engineering: Self-assembly and molecular manufacturing : Surfactant based system Colloidal system applications, ZnO,TiO2, Silver Nanoparticles Functional materials Applications, Production Techniques of Nano-tubes, Carbon arc, bulk synthesis, commercial processes of synthesis of nano-materials, Nano-clay, Commercial case study of nano synthesis - applications in chemical engineering, Nano inroganic materials - CaCO3 synthesis, Hybrid wastewater treatment systems, Electronic Nano-devices, sensor applications.

Text / Reference:

1. Kulkarni Sulabha K., Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, JoydeepDutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Davies, J. H. 'The Physics of Low Dimensional Semiconductors: An Introduction'

C. Energy Technology and Conservation

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Energy conversion processes for solid fuels.
2. Energy utilization systems for heat recovery.
3. Properties of fuel samples
4. Energy audit.

Course Outcomes: At the end of the course, the student will be able to:

1. Understand energy conversion processes for solid fuels.
2. Design energy utilization systems for heat recovery.
3. Estimate the properties of fuel samples

4. Perform energy audit.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	✓	-	-	-	-	-

Detailed syllabus

Unit I: Energy scenario: Introduction and classification of energy, renewable and non-renewable energy, Indian energy scenario, energy pricing in India, energy and environment. Solid fuels: Introduction, Biomass, Peat, Light and brown coal, Black Lignite, Bituminous coal, Semi anthracite , Anthracite, Natural coke/SLV fuel, Origin of coal, composition of coal, classification of coal, Sampling and analysis of solid fuels, oxidation of coal, Hydrogenation of coal, storage of coal.

Unit II: Carbonization and gasification processes: Introduction, carbonization of coal, the gasification of solid fuels, the gasification of oil and hydrocarbon gas reforming, carbureted water gas. Energy conversion with combustion: Introduction, Combustion, Burner design, Combustion plant, direct conversion of energy.

Unit III: Fuel testing: Introduction, Calorific value, tests on liquid fuels, Fuel and flue gas analysis. Energy auditing: Introduction, Energy conservation schemes Industrial energy use, energy conversion, energy index, energy costs. Energy sources: Energy consumption, world energy reserves, energy prices, fuel production and processing, energy policies, choice of fuels, cycle efficiency.

Unit IV: Heat transfer media: Water, Steam, Thermal fluids, Air-water vapor mixtures, Heat transfer equipment: Heat exchangers, Combustion and thermal efficiency, Steam plant, pressure hot water and thermal fluids plant, thermal fluids plant.

Unit V: Energy utilization and conversion systems: Furnaces, Hydraulic power systems, Compressed air, steam turbines, combined power and heating systems, Energy conversion, District heating, Heat recovery: Sources of waste heat and its applications, Heat recovery systems, Incinerators, Regenerators and recuperators, waste heat boilers.

Text / Reference:

1. Samir Sarkar, Fuels and Combustion, Universities Press, 2009.
2. Murphy W.R and Mckay G., Energy Management, Elsevier, 2007.
3. HarkerJ.H. and J.R. Backhurst, Fuel and Energy, Academic Press, London, 1981.

D. Renewable Energy Sources

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Challenges and problems associated with the use of energy sources.
2. Renewable energy resources and technologies
3. Conversion technologies for solar, wind, biomass and hydrogen energies
4. Performance of energy conversion technologies

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the challenges and problems associated with the use of energy sources.
2. List renewable energy resources and technologies
3. Design conversion technologies for solar, wind, biomass and hydrogen energies
4. Evaluate the performance of energy conversion technologies

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO2	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	✓	-	-	-	-	-

Detailed syllabus

Unit I: Sources of energy: Energy sources and their availability, renewable energy sources. Energy from

Unit II: Solar Energy: Sun and solar energy, solar radiation and its measurement, solar energy collectors, solar energy storage, Photovoltaic systems, Application of solar energy.

Unit III: Wind Energy: Wind as an Energy source, Basic principles of wind energy conversion, Types of Wind machines, Components of wind energy conversion system, Performance of wind machines, application of wind energy.

Unit IV: Energy from the Oceans: Introduction, Ocean Thermal Electric Conversion (OTEC), Energy from Tides, Ocean Waves

Unit V: Hydrogen energy: Introduction, Hydrogen production, Hydrogen storage, Hydrogen transportation. Chemical Energy Sources: Introduction, Fuel cells, Batteries.

Text / Reference:

1. Rai, G.D, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2010.
2. Rajesh Kumar Prasad, T.P. Ojha, Non-Conventional Energy Sources, Jain Brothers, 2012.
3. Sukhatme S.P and J. Nayak, Solar energy – Thermal Collection and storage, 3rd Edition, Tata McGraw Hill Education Pvt Ltd., 2008.
4. MM. EI – Wakil, Power Plant Technology, Tata McGraw Hill, NewYork, 1999.

E. Materials for Engineering Applications

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Processing, microstructure and properties of materials.
2. Behavior of materials under various conditions.
3. Modes of failure of engineering materials and design new materials with better properties and cost effective processes.
4. Suitable materials for engineering applications.

Course Outcomes: At the end of the course, the student will be able to:

1. Correlate processing, microstructure and properties of materials.
2. Understand behavior of materials under various conditions.
3. Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.

4. Identify suitable materials for engineering applications.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	✓	-	-	✓	-	✓		✓	-	-	-
CO2	-	✓	-	-	✓	-	✓		✓	-	-	-
CO3	-	✓	-	-	✓	-	✓		✓	-	-	-
CO4	-	✓	-	-	✓	-	✓		✓	-	-	-

Detailed Syllabus:

Unit I: Materials Science and Engineering Materials,Classification of Materials and Properties: Mechanical, Dielectric, Magnetic and Thermal.

Unit II: Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of micro structural features.

Unit III: Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications; Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers.

Unit IV: Materials for Electrical Applications: Conductors, Dielectrics, insulators; Materials for Civil Engineering Applications.

Unit V: Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products.

Text / Reference:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

BTCHL306 Fluid Flow Operations and Mechanical Operations Lab

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
LC	BTCHL 306	Fluid Flow Operations and Mechanical Operations Lab	-	-	3	60	-	40	100	2

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Viscosity determination using Fenske or other viscometer
2. Laminar and turbulent flows.
3. Selection of manometric fluid for experiment.
4. Characteristics of packed & fluidized beds and centrifugal pumps
5. Ball, gate, globe, check valves, elbow, bend and T-joint
6. Screen effectiveness
7. Dry and wet screen analysis
8. Cyclone separator and froth flotation

Course Outcomes: At the end of the course, the student will be able to:

1. Determine viscosity using Fenske or other viscometer and terminal velocity
2. Distinguish laminar and turbulent flows.
3. Select manometric fluid for experiment.
4. Determine the characteristics of packed & fluidized beds and centrifugal pumps
5. Identify ball, gate, globe, check valves, elbow, bend and T-joint
6. Understand screen effectiveness
7. Understand dry screen analysis
8. Understand wet screen analysis
9. Understand cyclone separator and froth flotation

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	✓							

CO6	✓	✓	✓	✓	✓							
CO7	✓	✓	✓	✓	✓							
CO8	✓	✓	✓	✓	✓							
CO9	✓	✓	✓	✓	✓							

(Perform minimum 9 and maximum 11 of the experiments from the two sets, *viz.* Fluid Flow and mechanical Operations with at least 4 experiments from each set. This list is indicative. Colleges and departments can choose additional experiments as per availability subject to adherence with the syllabus.)

List of Experiments (Fluid Flow Operations):

1. Determination of flow regimes -Reynolds' apparatus
2. Verification of Bernoulli's equation
3. Determination of Fanning friction factor for smooth and rough pipes
4. Determination of equivalent length of pipe fittings
5. Determination of viscosity with capillary tube viscometer.
6. Determination of friction factor for flow through packed bed.
7. Determination of discharge coefficient for venturi meter
8. Centrifugal pump characteristics
9. Study of Rota meter

List of Experiments (Mechanical Operations):

1. Determination of screen effectiveness
2. Dry screen analysis
3. Wet screen analysis
4. Study of sedimentation
5. Study of air elutriation
6. Study of cyclone separator
7. Study of froth flotation

BTCHS307 Seminar I

2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Seminar	**BTCHS307**	**Seminar - I**	**-**	**-**	**4**	**60**	**-**	**40**	**100**	**2**

Course Outcomes: At the end of the course, the student will be able to:

1. Acquire knowledge on topics outside the scope of curriculum.
2. Communicate with group of people on different topic
3. Collect and consolidate required information on a topic
4. Prepare a seminar report

Each student is expected to collect information on recent advances in Chemical Engineering by regularly referring to national and international journals and reference books. At the end of the semester he/she is required prepare a report as per the guide lines prescribed by the Department. Each student will be assigned a guide for this seminar course. Every student shall give a power point presentation on his Seminar topic before a panel of examiners.

BTCHI308 Internship - 1 (Evaluation)

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Internship	**BTCHI308**	**Internship - 1 (Evaluation)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Audit**

BTCH308 Internship – I (Industrial Training)

Course Outcomes: At the end of the course, the student will be able to:

1. Acquire knowledge on topics outside the scope of curriculum on summer training.
2. Communicate with group of people on different topics of summer training.
3. Collect and consolidate required information on a topic of summer training.
4. Prepare a seminar report on summer training

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of IIndsemester (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc.

The student shall submit the report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.

Semester IVth

BTCHC401 Chemical Engineering Thermodynamics 5 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC401	Chemical Engineering Thermodynamics	4	1	-	20	20	60	100	5

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. First and second laws of thermodynamics to chemical processes and the properties of ideal and real mixtures.
2. Behavior of flow and non-flow processes using mass and energy balances
3. Heat and work requirements for industrial processes.
4. Efficiency of processes involving heat into work, refrigeration and liquefaction
5. Heat effects involved in industrial chemical processes
6. Thermodynamic properties of gaseous mixtures / solutions
7. Bubble-P & T, Dew-P & T for binary and multi-component systems
8. Vapor-liquid equilibrium (VLE) composition for ideal and non-ideal systems
9. Equilibrium constant and composition of product mixture at given temperature and pressure.

Course Outcomes: At the end of the course, the student will be able to:

1. Apply the first and second laws of thermodynamics to chemical processes. Compute the properties of ideal and real mixtures.
2. Analyze the behavior of flow and non-flow processes using mass and energy balances
3. Estimate heat and work requirements for industrial processes.
4. Determine the efficiency of processes involving heat into work, refrigeration and liquefaction
5. Calculate heat effects involved in industrial chemical processes
6. Determine thermodynamic properties of gaseous mixtures / solutions
7. Calculate Bubble-P & T, Dew-P & T for binary and multi-component systems
8. Calculate vapor-liquid equilibrium (VLE) composition for ideal and non-ideal systems
9. Determine equilibrium constant and composition of product mixture at given temperature and pressure.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	✓	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	✓	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO6	✓	✓	✓	✓			✓					
CO7	✓	✓	✓	✓			✓					
CO8	✓	✓	✓	✓			✓					
CO9	✓	✓	✓	✓			✓					

Detailed Syllabus :

Unit 1 : INTRODUCTION : The Scope of thermodynamics; Dimensions and units; Measures of Amount or size; Force; Temperature; Pressure; Work; Energy; Heat. **THE FIRST LAW OF THERMODYNAMICS:** Joule's Experiments; Internal Energy; The First Law of Thermodynamics; Energy balance for closed systems; Thermodynamic state and state functions; Equilibrium; The phase rule; The reversible process; Constant V and constant P processes; Enthalpy; Heat capacity; Mass and energy balances for open systems. **VOLUMETRIC PROPERTIES OF PURE FLUIDS :** PVT Behaviour of pure substances; the Virial Equation; The Ideal Gas; Application of the Virial Equation; Cubic Equations of State; Generalised Correlation's for gases; Generalised correlation's for Liquids**. HEAT EFFECTS:** Sensible Heat Effects, Heat Effects Accompanying Phase Changes of Pure Substances,The Standard Heat of Reaction, The Standard Heat of Formation, The Standard Heat of Combustion, Effect of Temperature on the standard Heat of Reaction**.**

Unit II: THE SECOND LAW OF THERMODYNAMICS : Statement of the Second law : The Heat Engine; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the Second Law; Entropy balance for open systems; Calculation of ideal work; Lost work; The Third Law of Thermodynamics; Entropy from the Microscopic view point. **THERMODYNAMIC PROPERTIES OF FLUIDS:** Property Relations for Homogeneous phase; Residual Properties; Residual properties by equations of state; Two phase systems, Thermodynamic diagrams; Tables of Thermodynamic properties; Generalised property correlations for gases.

Unit III: APPLICATIONS OF THERMODYNAMICS TO FLOW PROCESSES: Duct flow of compressible fluids; Turbines (expanders); Compression processes. **REFRIGERATION AND LIQUEFACTION :** The Carnot Refrigerator; the vapour-compression cycle; The Choice of refrigerant; Absorption Refrigeration; The heat pump; Liquefaction Processes. **Vapour/Liquid Equilibrium Introduction**: The nature of equilibrium, the Phase Rule, Duhem's Theorem, VLE: Qualitative behaviour, Simple models for vapour/liquid equilibrium, VLE by modified Raoult's Law, VLE from K- value correlations.

Unit IV: Solution Thermodynamics: Theory: Fundamental property relation, The chemical potential and phase equilibria, Partial properties, Ideal gas mixtures, Fugacity and fugacity coefficient. Fugacity and fugacity coefficient: Species in the solution, Generalized correlations for the fugacity coefficient, The ideal solution, Excess properties.
Solution Thermodynamics: Applications: Liquid-phase properties from VLE data, Models for the excess Gibbs energy, Property changes of mixing, Heat Effects of mixing processes.

Unit V: Chemical Reaction Equilibria: The reaction coordinate, Application of equilibrium criteria to chemical reactions, The standard Gibbs energy change and equilibrium constant, Effect of temperature on the equilibrium constants. Relation of equilibrium constants to composition, Equilibrium conversions for single reactions, Phase rule and Duhem's theorem for reacting systems, Multi reaction equilibria, Fuel cells.

Text/Reference books:

1. J. M. Smith, H.C. Van Ness, and M.M. Abbott, Chemical Engineering Thermodynamics, 6thed, Tata McGraw Hill edition, 2003.
2. Y. V. C. Rao, "Chemical Engineering Thermodynamics", University Press 1997
3. S. I. Sandler. "Chemical Engineering Thermodynamics", Wiley, New York, 1999.

BTCHC402 Heat Transfer Operations **4 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC402	Heat Transfer Operations	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Different modes of heat transfer.
2. Heat transfer coefficients for forced and natural convection.
3. Heat transfer involving phase change.
4. Heat exchanger performance for co-current and counter-current flows.
5. Double pipe and shell & tube heat exchangers

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the modes of heat transfer.
2. Determine heat transfer coefficients for forced and natural convection.
3. Understand heat transfer involving phase change.

4. Analyze the heat exchanger performance for co-current and counter-current flows.
5. Design double pipe and shell & tube heat exchangers

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	-	✓	✓	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed syllabus

Unit I: **Conduction** through a single homogeneous solid, thermal conductivity of solids, liquids and gases. Conduction through several bodies in series. Contact resistances. Unsteady state heat conduction, lumped heat capacity system, transient heat flow in a semi-infinite solid. Concept of critical insulation thickness.

Unit II: **Heat transfer by Convection**: Forced convection, Laminar heat transfer on a flat plate Laminar and turbulent flow heat transfer inside and outside tubes. Film and overall heat transfer coefficients. Resistance concept, Coefficients for scale deposits, L.M.T.D. in heat exchangers with co and counter current flow. Heat exchanger design, Effectiveness – N T U method in finned tube heat exchangers. **Natural convection**: Heat transfer from plates and cylinders in verticals and horizontal configuration, natural convection to spheres. **Combined natural and forced convection:** Fluid flow and heat transfer across cylinders and spheres. Combined natural and forced convection heat transfer in horizontal circular conduits.

Unit III: **Heat transfer with phase change,** heat transfer in condensing vapour, types of condensation. Nusselt Theory. Heat transfer to Boiling liquid. Pool boiling. Evaporation , Single and multiple effect evaporators. Types of evaporators. Performance of evaporator. Calculations of single and multiple effect evaporator.

Unit IV: **Heat Transfer by Radiation:** Black and gray body radiations, emissivity, laws of radiation, view factor, luminous and non-luminous gases. Radiation between surfaces, Combined heat transfer, i.e. conduction, convection and radiation together. .

Unit V: **Introductory Concepts of Heat exchanger design:** Design of single and multi pass shell and tube type exchangers using LMTD and effectiveness – NTU methods. Spiral coil and plate type heat exchangers. Single and multi phase condenser. Design of

Reboilers, vapourisers, Kettle type and Thermosiphon reboilers, forced circulation vaporizers. Heat transfer in agitated vessels both, jacketed and with coil, Determination of overall heat transfer coefficient, transient heating or cooling. Heat transfer in packed and fluidized beds. Heat transfer in extended surfaces such as fins, conduction convection heat transfer, forced convection heat transfer in circular conduits with longitudinal fins. Heat transfer in non Newtonian fluids.

Texts / References:

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergamon press, 1970

2. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon press, 1970

3. W. L. McCabe J. C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 4th ed. McGraw Hill 1985.

4. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 1950.

BTHM403 Basic human rights 3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
HSSMC	BTHM403	Basic human rights	3	-	-	20	20	60	100	3

Course Objectives:

1) To train the young minds facing the challenges of the pluralistic society and the rising conflicts and tensions in the name of particularistic loyalties to caste, religion, region and culture.
2) To give knowledge of the major "signposts" in the historical development of human rights, the range of contemporary declarations, conventions, and covenants.
3) To enable them to understand the basic concepts of human rights (including also discrimination, equality, etc.), the relationship between individual, group, and national rights.
4) To develop sympathy in their minds for those who are denied rights.
5) To make the students aware of their rights as well as duties to the nation.

Course Outcomes:

1. Students will be able to understand the history of human rights.
2. Students will learn to respect others caste, religion, region and culture.
3. Students will be aware of their rights as Indian citizen.
4. Students will be able to understand the importance of groups and communities in the society.
5. Students will be able to realize the philosophical and cultural basis and historical perspectives of human rights.

Detailed Syllabus

UNIT I:
The Basic Concepts: - Individual, group, civil society, state, equality, justice.
Human Values, Human rights and Human Duties: - Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

UNIT II
Fundamental rights and economic programme.
Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior, Social Structure and Social Problems: - Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labor.

UNIT III
Migrant workers and human rights violations, human rights of mentally and physically challenged.
State, Individual liberty, Freedom and democracy.
NGOs and human rights in India: - Land, Water, Forest issues.

UNIT IV
Human rights in Indian constitution and law:-
i) The constitution of India: Preamble
ii) Fundamental rights.
iii) Directive principles of state policy.
iv) Fundamental duties.
v) Some other provisions.

UNIT V
Universal declaration of human rights and provisions of India. Constitution and law.
National human rights commission and state human rights commission.

Reference books:

Shastry, T. S. N., *India and Human rights: Reflections*, Concept Publishing Company India (P Ltd.), 2005
Nirmal, C.J., *Human Rights in India: Historical, Social and Political Perspectives(Law in India)*, Oxford India

BTCHO404 Open Elective I

3 Credits

Category	Code	Subject Name	L	T	I	CA	MSE	ESE	Total	Credit
OEC	BTCHO404	Open Elective I	3	-	-	20	20	60	100	3

A. NSS-I

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Features of Indian constitution, fundamental rights and duties of citizens
2. Importance of Health, Hygiene & Sanitation
3. Yoga as a tool for healthy lifestyle
4. Environmental issues and organize its management
5. Disasters and youth role in its management

Course Outcomes: At the end of the course, students will be able to:

1. Understand features of Indian constitution, fundamental rights and duties of citizens
2. Explain importance of Health, Hygiene & Sanitation
3. Summarize yoga a tool for healthy lifestyle
4. Conclude environmental issues and organize its management
5. Classify the disasters and youth role in its management

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1										
CO2										
CO3										
CO4										
CO5										

Detailed Syllabus

Unit I: Introduction and Basic Concepts of NSS: History, Philosophy, Aims & objectives of NSS Organizational structure, Concept of regular activities, Special camping, Day Camps. Basis of adoption village/slums, Methodology of conducting Survey

Unit II: Youth and Community Mobilization: Definition, Profile of youth, Categories of youth, Issues, Challenges and opportunities for youth, Youth as an agent of social change, Youth-adult partnership, Mapping of community stakeholders, Identifying methods of mobilization, Needs & importance of volunteerism

Unit III: Importance and Role of Youth Leadership: Meaning and types of leadership, Qualities of good leaders; Traits of leadership, Importance and role of youth leadership

Unit IV: Life Competencies and Skill; Definition and importance of life competencies, Communication, Inter Personal, Problem solving and decision making, Positive thinking, Self-confidence and self-esteem, Life goals, Stress and time management

Unit V: Social Harmony and National Integration: Indian history and culture, Role of youth in peace-building and conflict resolution, Role of youth in Nation building **Youth Development Programs in India:** National Youth Policy, Youth development programs at the National Level, State Level and voluntary sector, Youth-focused and Youth-led organizations.

B. Development Engineering

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Importance of development
2. Different tools used in development
3. Methods and modalities of development engineering

Course Outcomes: At the end of the course, the student will be able to:

1. Understand importance of development
2. Use different tools used in development
3. Understand the methods and modalities of development engineering

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1							✓			
CO2							✓			
CO3							✓			

Detailed Syllabus

Unit I: **Introduction to Development Engineering:** Introduction to development engineering; need of development engineering; core disciplines and concept; major issues in development, urban development; rural development; socioeconomic development; scientific social research, formulation of research problem, field work and data collection, report drafting.

Unit II: **Design of Sustainable Communities:** Concept and development of sustainable communities; Sustainable design principles, building regulations, codes and standards – ANSI,ASTM,ASHRAE, approval process; green buildings – green building techniques-energy solutions, site solutions, site solutions, exterior and interior solutions, Certification – BREEAM, GRIHA, NAHB, LEED,IGBC.

Unit III: **Town / City Planning:** Town Planning, history of town planning in India, characteristics of city/town, town planning at national, regional and local levels, planning standards, master plan, site layout and development, zoning and density control, green belt, slum redevelopment; Smart city planning introduction to city planning, infrastructure elements of smart city planning, d imensions of smart cities global standards and performance benchmark; smart solutions e -governance, waste management, water management, energy management, urban mobility, citizen services, other services such as tele-medication and education, trade facilitation, skill development; GIS for Planning.

Unit IV: **Planning and Development of Rural Areas**: District administration, District Planning, introduction to various sectors of rural areas such as drinking water, Waste water treatment, electricity, public transport, irrigation, sanitation and cooking energy; issues and challenges associated with these sectors; People's participation and role in development of rural areas; various schemes and policies floated by state and central government - phases in the schemes; life cycle costing of these schemes.

Unit V: **Development aspects: Urban and Rural:** Planning and designing of a model town / city and using Auto-CAD and / or GIS, Visit to a village or small town – The project will be carried out in groups. Problem faced by the villagers pertaining to various sectors or existing schemes; define the need, method, tools and techniques for development; deliver technology based solution.

Text Books:

1. Chand M. and Purr U.K. (1983), 'Regional Planning in India', Allied Publisher, New Delhi.
2. Kaiser E.J., et. al., 'Urbun Landuse Planning', 4th edition Urbana, University of Illinois Press.
3. Sundaram K.V., 'Geography Planning', Concept Publishing Co., New Delhi.

4. Ayyar C.P.V., 'Town Planning in Early South India', Mittal Publications, Delhi.
5. Reeder, Hoboken, 'Guideto green building rating systems', John Wiley& sons, Inc.
6. Longley, et.al, 'Geographic Information Systems and Science', John Wiley & Sons, New York.
7. Desai V., 'Rural Development of India', Himalaya Publishing house, Mumbai.
8. Rau S.K., 'Global Search for Rural Development', NIRD, Hyderabad.

Reference Books:

1. Institute of Town Planners, India, Ministry of Urban Affairs & Employment, Government of India, New Delhi, UDPFI Guidelines, 1996.
2. Miles R. Simon, 1970, 'Metropolitan Problems', Methuen Publications, Canada.
3. B.I.S., 1980, "National Building Code of India', ISI, New Delhi.
4. ANSI/ASHRAE/USGBC/IES Standard 189.1, Standard for the Design of High-Performance Green Buildings except Low-Rise Residential Buildings.
5. **ASHRAE Standard 90.1, Energy Standard for Buildings except Low-Rise Residential Buildings.**

BTCHE405 Professional Elective – II

4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	BTCHE405	Professional Elective - II	3	1	-	20	20	60	100	4

A. Numerical Methods

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Common numerical methods and how they are used to obtain approximate solutions.
2. Numerical methods to obtain approximate solutions to mathematical problems
3. Numerical methods for various mathematical operations like interpolation, differentiation etc.
4. Accuracy of common numerical methods.

Course Outcomes: At the end of the course, the student will be able to:

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions.
2. Apply numerical methods to obtain approximate solutions to mathematical problems
3. Derive numerical methods for various mathematical operations like interpolation, differentiation etc.
4. Analyse and evaluate the accuracy of common numerical methods.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1	✓	-	-	✓	-	✓	-	-	-	
CO2	✓	-	-	✓	-	✓	-	-	-	
CO3	✓	-	-	✓	-	✓	-	-	-	
CO4	✓	-	-	✓	-	✓	-	-	-	

Detailed syllabus

Unit I: **Solutions of Linear Algebraic Equations -** Gauss elimination and LU decomposition, Gauss-Jordan Elimination, Guass-Seidel and relaxation methods.

Eigen values and Eigen Vectors of Matrices –Faddeev-Leverrier method, Power method, Householder's and Given's method

Unit II: **Nonlinear Algebraic Equations -** Fixed point method, Multivariable successive substitutions, Single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

Unit III: **Function Evaluation -** Least-squares curve fit, Newton's Interpolation formulae, Newton's divided difference interpolation polynomial, Langrangian interpolation, Pade approximations, Cubic spline approximations

Unit IV: **Ordinary Differential Equations (Initial value problems) –** RungeKutta Methods, Semi-implicit RungeKutta Techniques, Step size control and estimates of error **Ordinary Differential Equations (Boundary value problems) -** Finite difference technique, Orthogonal collocation technique, Orthogonal collocation on finite elements

Unit V: **Partial Differential Equations –** Introduction to finite difference technique

Texts / References:

S.K. Gupta, "Numerical Methods for Engineers", Wiley Eastern, 1995.
M.E. Davis, "Numerical Methods & Modeling for Chemical Engineers", Wiley, 1984.

B. Introduction to Bio-process Engineering

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Cell and enzyme kinetics
2. Basics of biology, structure of cells
3. Material and energy balances in bioprocesses
4. Kinetics and manufacture and application of enzyme-catalyzed reactions,
5. Design of bioreactors

Course Outcomes: At the end of the course, the student will be able to:

1. Understand cell and enzyme kinetics
2. Understand basics of biology, structure
3. Understand material and energy balances in bioprocesses
4. Understand kinetics and manufacture and application of enzyme-catalyzed reactions,
5. Study design of bioreactor

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					-	-	-	-	-	-	-	-
CO2					-	-	-	-	-	-	-	-
CO3					-	-	-	-	-	-	-	-
CO4					-		-	-	-	-	-	-
CO5					-	-	-	-	-	-	-	-

Detailed Syllabus:

Unit I: Bioprocess engineering and related fields, basics of biology, structure and function of microbial, plant and animal cells, introduction to chemicals of life such as lipids, carbohydrates, nucleic acids and proteins. Metabolism and central metabolic pathways, central dogma, transcription and translation processes, material and energy balances in bioprocesses with examples.

Unit II: Unstructured and structured growth models of bioprocesses, growth kinetics, estimation of process parameters, logistic equation, effect of substrate and product inhibition.

Unit III: Enzymes, kinetics of enzyme-catalyzed reactions, inhibited enzyme kinetics, immobilized enzymes, manufacture and application of enzymes.

Unit IV: Design of biological reactors, continuous, batch and fedbatch processes and their comparison, multistage chemostat systems, introduction to transport phenomena in bioprocesses.Non-ideal effects. Scale-up and scale-down criteria.

Unit V: Recovery and purification of bioprocesses, recent advances and applications of bioprocess engineering, genetic engineering and recombinant DNA technology, mixed cultures, application to biological wastewater treatment. Introduction to control strategies in bioprocesses.

References:

1. Shuler and Kargi, "Bioprocess Engineering : Basic Concepts" Prentice Hall of India,2002
2. J.E. Bailey & D.F. Ollis (eds) : `Biochemical Engineering Fundamentals', McGraw Hill Inc., 1986.
3.

C. Strength of Materials

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain
2. Materials in design considering engineering properties, sustainability, cost and weight.
3. Engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

Course Outcomes: At the end of the course, the student will be able to:

1. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain
2. Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.

3. Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	✓	-	-	-	-	-	-	-
CO2	✓	✓	-	-	✓	-	-	-	-	-	-	-
CO3	✓	✓	-	-	✓	-	✓	-	-	-	-	-

Detailed syllabus

Unit I:
Stress and Strain:
Load and its effect, Types of stresses, Types of strain, Support and free body diagram, Types of structures, Equilibrium considerations, Thermal stresses and strains

Unit II:

Trusses: Stability of trusses on application of load, redundancy, Unstable trusses

Use of different methods for analysis of trusses, Condition for perfect trusses

Unit III:
Shear Force and Bending Moment: S. F. and B. M. diagram, Cantilever, Simply Supported Beams, Concentrated and Uniformly Distributed Loads **Torsion**: Concept of torsion, Basic Torsion equation, Slope and Deflection of Beams, Cantilevers etc.Macaulay's Method.

Unit IV:
Short and Long Columns (Struts): Basic Theory, Crippling loads and conditions thereof, Euler's and Rankine's Approach for the same.

Unit V:
Thick and Thin Cylinders: Radial and Longitudinal Stresses, Behavior of thin Cylinders, Problems on thin cylinders and Spherical shells, Behavior of thick cylinders

Texts and References:

1. Timoshenko & Young, "Strength of Materials."
2. V.N. Vazirani&Ratwani, "Analysis of Structures", Vol.I Khanna Publishers.
3. R.L. Bansal, "Strength of Materials", Luxmi Publishers.

4. Popov, “Strength of Materials”, Prentice Hall of India.

5. Ramamrutham, Strength of materials

D. Introduction to Polymer Science and Engineering

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Thermodynamics of polymer structures
2. Polymerization reactor for a polymer product.
3. Characterization of polymers.
4. Polymer additives, blends and composites.
5. Polymer Rheology

Course Outcomes: At the end of the course, the student will be able to:

1. Understand thermodynamics of polymer structures
2. Select polymerization reactor for a polymer product.
3. Characterize polymers.
4. State polymer additives, blends and composites.
5. Understand Polymer Rheology

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					-			-	-	-	-	-
CO2								-	-	-	-	-
CO3					-	-	-	-	-	-	-	-
CO4						-		-	-	-	-	-
CO5						-		-	-	-	-	-

Detailed Syllabus:

Unit I: **Introduction:** Basic concepts of Polymer Science, Various molecular forces in polymer, Various Molecular weights and their distribution.

Unit II: **Polymerization:** (i) Step growth: Mechanism, Kinetics, Polyfunctional Step growth polymerization. (ii) Radical polymerization: Mechanism, Kinetics, Effects of

temperature, pressure. (iii) Ionic and Coordination Polymerization: Kinetics of Cationic and Anionic polymerization.

Unit III: Polymerization Conditions: Bulk, Solution, Suspension and Emulsion polymerization.

Unit IV: Measurement of Molecular Weight: End group analysis, Colligative property measurement, Gel Permeation Chromatography.

Unit V: Polymer Processing: Plastic technology: Molding, Extrusion, Additives and Compounding; **Fiber Technology:**Textile and Fabric properties, Spinning, Elastomer technology: Vulcanization, Reinforcement.

Text/References:

1. Text book of Polymer Science: Fred W. Billmeyer, Jr., Second Edition, 1994, John Wiley and Sons, Inc., Singapore.
2. Principals of Polymerization, George Odian, Third Edition, 2002, John Wiley and Sons, Inc., Singapore.
3. Fundamentals of Polymers, Anil Kumar and Gupta, R. K., McGraw Hill, 1998.

E. Advanced Engineering Chemistry

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Basic concepts in electrochemistry and corrosion science
2. Basic concepts in molecular interactions
3. Synthesis and analysis of modern materials
4. Concepts of organic chemistry for synthesis
5. Synthesis and applications of polymer science
6. Structure of organic molecules using photo chemistry and chemical spectroscopy

Course Outcomes: At the end of the course, the student will be able to:

1. Understand and apply the concepts in electrochemistry and corrosion science
2. Understand the concepts in molecular interactions
3. Understand the synthesis and analysis of modern materials
4. Apply the concepts of organic chemistry for synthesis
5. Understand the synthesis and applications of polymer science

6. Identify the structure of organic molecules using photo chemistry and chemical spectroscopy

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-
CO2	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-
CO3	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-
CO4	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-
CO5	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-
CO6	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-

Detailed syllabus

Unit I: Corrosion and its Control: Introduction, Fundamental reason, Electrochemical Corrosion, Direct Chemical Corrosion, Factors affecting the rate of corrosion, types of corrosion-Galvanic, Pitting Corrosion, Microbiological corrosion, Stress corrosion, methods to minimize the corrosion- Proper design, Cathodic and Anodic protection. Study of Composite materials.

Unit II: Spectroscopy: Brief introduction to spectroscopy, UV – Visible Spectroscopy: Laws of absorption, types of transitions, instrumentation and application. FT-IR spectroscopy: introduction, theory, instrumentation and application. Brief discussion on NMR Spectroscopy and its Applications. Brief introduction of AAS (Atomic Absorption Spectroscopy)

Unit III: Instrumental Methods of Chemical Analysis: Introduction to Chromatography, Types of Chromatography (Adsorption and partition chromatography), Paper and Thin Layer Chromatography, Gas Chromatography – introduction, theory, instrumentation. Brief discussion of Thermo gravimetric analysis (TGA), Differential Scanning Colorimetry .

Unit IV: Organic reaction Mechanisms: Introduction, Electronic displacement effects in organic molecule, reactive intermediates (carbocation, carbanion and carbine), Brief introduction of Addition and Substitution and Elimination reaction with suitable examples. **Rearrangement:** introduction, Pinacole – Pinacolone rearrangement.

Unit V: Drugs and Dyes:

Drugs: Introduction, Study of the following drugs with reference to structure, occurrence, medicinal uses and side effects: Antipyretic:Paracetamol (synthesis), Anti Inflammatory drug: Ibuprofen, Antibiotic drugs, Anti-malarial drug: Quinine(Synthesis), Anti- Cancer drugs, Anti- hypertensive drugs.

Dyes: Introduction, Synthesis and uses of Synthetic dyes: Congo- red, Eriochrome black – T

Text books:

1. Bhal and Bhal Advance Organic Chemistry, S. Chand & Company, New Delhi, 1995.
2. Jain P.C & Jain Monica, Engineering Chemistry, DhanpatRai& Sons, Delhi, 1992.
3. Bhal&Tuli, Text book of Physical Chemistry (1995), S. Chand & Company, New Delhi.
4. Handbook of Drugs and Dyes, Himalaya Publications.

Reference books:

1. Finar I.L., Organic Chemistry (Vol. I & II), Longman Gr. Ltd & English Language Book Society, London.
2. Barrow G.M., Physical Chemistry, McGraw-Hill Publication, New Delhi.
3. ShikhaAgarwal, Engineering Chemistry- Fundamentals and applications, Cambridge Publishers - 2015.
4. O. G. Palanna , Engineering Chemistry, Tata McGraw-Hill Publication, New Delhi.
5. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.

Books on Drugs and Dyes, McGraw-Hill Publication, New Delhi

BTCHL406 Heat Transfer Operations Lab 2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
LC	BTCHL406	Heat Transfer Operations Lab	-	-	3	60	-	40	100	2

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Electrical analogy in relation to heat conduction
2. Emissivity of a given body.
3. Heat flow for resistances in series

4. Heat losses from cylindrical furnace
5. Temperature profiles in rod-double pipe heat exchanger, helical coil, heat pipe demonstration experiment
6. Boiling Phenomena in liquids

Course Outcomes: At the end of the course, students will be able to:

1. Understand the Electrical analogy in relation to heat conduction
2. Determine Emissivity of a given body.
3. Determine heat flow for resistances in series

4. Determine heat losses from cylindrical furnace
5. Determine temperature profiles in rod-double pipe heat exchanger, helical coil, heat pipe demonstration experiment
6. Understand boiling Phenomena in liquids

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1	✓	✓	✓	✓	-	-	-	-	-	
CO2	✓	✓	✓	✓	-	-	-	-	-	
CO3	✓	✓	✓	✓	✓	-	-	-	-	
CO4	✓	✓	✓	✓	✓	-	-	-	-	
CO5	✓	✓	✓	✓	✓					
CO6	✓	✓	✓	✓	✓					

List of Experiments

1. To determine thermal conductivity of given metal rod
2. Study of Double Pipe Heat Exchanger
3. Study of Shell and Tube Heat Exchanger
4. Study of Study of emissivity of circular discs with and without black coating.
5. Study of Stefan-Boltzman's constant
6. To determine the surface heat transfer coefficient for a vertical tube losing heat by natural convection.

BTCHS407 Seminar II

2 Credits

Category	Code	Subject Name		T	I	CA	MSE	ESE	Total	Credit

Seminar	BTCHS 407	Seminar - II		-	4	**60**	-	**40**	**100**	**2**

Course Outcomes: At the end of the course, the student will be able to:

1. Prepare a seminar report on summer training
2. Communicate with group of people on different topic
3. Collect and consolidate required information on a topic
4. Prepare a seminar report

Each student is expected to collect information on recent advances in Chemical Engineering by regularly referring to national and international journals and reference books. At the end of the semester he/she is required prepare a report as per the guide lines prescribed by the Department. Each student will be assigned a guide for this seminar course.

Every student shall give a power point presentation on his Seminar topic before a panel of examiners.

BTCHI508 Internship - 2 **Audit**

Category	**Code**	**Subject Name**	**L**	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**Credit**
Internship	**BTCHI508**	**Internship - 2**							**-**	**Audit**

Field Training / Internship 2 / Industrial Training (minimum of 4 weeks, which can be completed partially in third semester and fourth semester or at one time). Credits To be evaluated in V Sem.

Internship- II (Industrial Training)

Course Outcomes: At the end of the course, the student will be able to:

1. Acquire knowledge on topics outside the scope of curriculum on summer training.
2. Communicate with group of people on different topics of summer training.

3. Collect and consolidate required information on a topic of summer training.
4. Prepare a seminar report on summer training

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of IV^{rth} semester (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc. Student shall submit report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.