**DEPARTMENT OF CHEMICAL ENGINEERING**
**B.M.S. COLLEGE OF ENGINEERING, BENGALURU**
**Autonomous Institute, Affiliated to VTU**

# B.M.S. COLLEGE OF ENGINEERING BENGALURU
# Autonomous Institute, Affiliate to VTU

| VISION | MISSION |
|---|---|
| PROMOTING PROSPERITY OF MANKIND BY AUGMENTING HUMAN RESOURCE CAPITAL THROUGH QUALITY TECHNICAL EDUCATION & TRAINING | ACCOMPLISH EXCELLENCE IN THE FIELD OF TECHNICAL EDUCATION THROUGH EDUCATION, RESEARCH AND SERVICE NEEDS OF SOCIETY |

## DEPARTMENT OF CHEMICAL ENGINEERING
## Program Accredited by NBA in Tier-1 format for 6 years

# Scheme and Syllabus Book
# (3rd to 4th Semester)
# Batch 2022-2026

## DEPARTMENT VISION

Be a Globally Recognized Chemical Engineering Department

## DEPARTMENT MISSION

**M1:** Imparting Quality education and exposure to the budding chemical engineers.
**M2:** Foster and encourage the pursuit of excellence in chemical science and engineering with research potential.
**M3:** Chemical engineering graduates to acquire coveted positions in industries and society.

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

**PEO1:** Graduates secure profession in chemical & allied engineering.
**PEO2:** Graduates pursue higher education & research in world class organization.
**PEO3:** Graduates work in diversified fields towards sustainable society.

## PROGRAM SPECIFIC OUTCOMES (PSOs)

**PSO1:** Graduates will apply the knowledge of natural sciences and chemical engineering for techno feasible synthesis, separation, and purification of products.
**PSO2:** Graduates will ensure intrinsic process safety and sustainability by automation and control of processes.
**PSO3:** Graduates will optimize and design process equipment for engineering applications.

# PROGRAM OUTCOMES (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

# NOTATIONS

| | |
|---|---|
| AY | Academic Year |
| AAT | Alternative Assessment Tools |
| BOE | Board of Examination |
| BOS | Board of Studies |
| CBCS | Choice Based Credit System |
| CGPA | Cumulative Grade Point Averages |
| CIE | Continuous Internal Evaluation |
| CO | Course Outcomes |
| PC | Programme Core Course |
| GC | Group Core |
| HSS | Humanity and Social Science courses |
| IC | Institutional Core |
| OE | Open Elective |
| IL | Institutional Lab |
| LTP | Lecture-Tutorial-Practical |
| NFTE | Not Fit for Technical Education |
| IPCC | Integrated Programme Core Course |
| PSO | Programme Specific Outcomes |
| PO | Programme Outcomes |
| PEC | Programme Elective Courses |
| SEE | Semester End Examination |
| SGPA | Semester Grade Point Average |
| ST | Studio |

# DEPARTMENT OF CHEMICAL ENGINEERING
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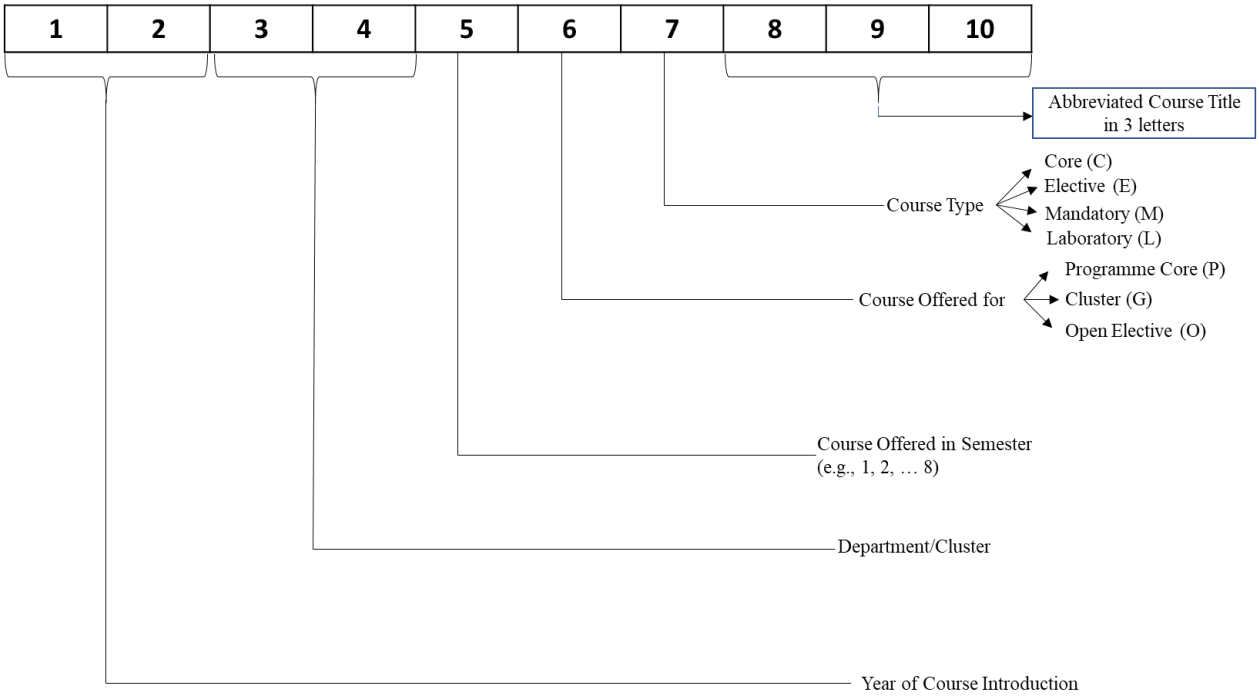
## NOMENCLATURE FOR THE COURSE CODE



## SCHEME OF INSTRUCTION FOR THIRD SEMESTER

| Course Type | Code | Course Title | Credits | | | Total | Contact Hours/ week |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| BS | 23MA3BSTFN | Transform Calculus, Fourier Series and Numerical Techniques | 2 | 1 | 0 | 3 | 4 |
| ES | 23CY3ESMCA | Material Chemistry and Applications | 3 | 0 | 0 | 3 | 3 |
| PC | 23CH3PCPPC | Process Principles and Calculations | 2 | 1 | 0 | 3 | 4 |
| PC | 23CH3PCMOP | Mechanical Operations | 3 | 0 | 1 | 4 | 5 |
| PC/IPCC | 23CH3PCFME | Fluid Mechanics | 3 | 0 | 1 | 4 | 5 |
| PC/IPCC | 23CH3PCTD1 | Process Engineering Thermodynamics- I | 2 | 0 | 0 | 2 | 2 |
| BS | 23CH3BSBFE | Biology for Engineers | 2 | 0 | 0 | 2 | 2 |
| AE/SDC | 23CH3AEAWE | Advanced MS Word & Excel for Engineers | 0 | 0 | 1 | 1 | 2 |
| NCMC | | NSS | 0 | 0 | 0 | 0 | 1 |
| | | YOGA | | | | | |
| | | Physical Education (Sports and Athletics) | | | | | |
| TOTAL | | | 17 | 2 | 3 | 22 | 28 |

## SCHEME OF INSTRUCTION FOR FOURTH SEMESTER

| Course Type | Code | Course Title | Credits | | | Total | Contact Hours/ week |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| BS | 23MA4BSSAP | Statistics and Probability | 2 | 1 | 0 | 3 | 4 |
| ES | 23CH4ESANI | Analytical Instruments | 3 | 0 | 1 | 4 | 5 |
| PC | 23CH4PCTD2 | Process Engineering Thermodynamics - II | 3 | 0 | 0 | 3 | 3 |
| PC | 23CH4PCMT1 | Mass Transfer-I | 3 | 0 | 0 | 3 | 3 |
| PC/IPCC | 23CH4PCHTR | Process Heat Transfer | 3 | 0 | 1 | 4 | 5 |
| PC/IPCC | 23CH4PCPCM | Pollution Control and Management | 3 | 0 | 0 | 3 | 3 |
| UHV | 23MA4AEUHV | Universal Human Values | 0 | 1 | 0 | 1 | 2 |
| AE | 23CH4AESIM | Simulation Laboratory | 0 | 0 | 1 | 1 | 2 |
| NCMC | | NSS/Lecture Series on Advances in Technology | 0 | 0 | 0 | 0 | 1 |
| | | YOGA | | | | | |
| | | Physical Education (Sports and Athletics) | | | | | |
| TOTAL | | | 17 | 2 | 3 | 22 | 28 |

## THIRD SEMESTER

| Course Title | Transform Calculus, Fourier Series and Numerical Techniques | | | | |
|---|---|---|---|---|---|
| Course Code | 23MA3BSTFN | Credits | 03 | L – T – P | 2 – 1 – 0 |
| CIE | 100 marks (50% Weightage) | SEE | 100 marks (50% weightage) | | |

PREREQUISITES: Calculus and Differential Equations and Advanced Calculus and Numerical Methods

**COURSE OBJECTIVES:** The purpose of the course is to facilitate the learners to:

- Appreciate the importance of Series, Transform and Numerical Techniques in Engineering Problems.
- Acquire the knowledge of Series, Transform and Numerical Techniques to apply them in their core domain.
- Improve their Mathematical thinking and acquire skills required for sustained lifelong learning.

**TEACHING-LEARNING PROCESS (General Instructions):**

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Encourage the students for group learning to improve their creative and analytical skills.

**SYLLABUS:**

**UNIT-I**

**LAPLACE TRANSFORMS**

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of derivatives and integrals. Laplace Transform of periodic functions (statement only) and unit-step function – problems. Inverse Laplace transforms definition and problems. solution of differential equations.

**08 Hrs**

**UNIT-II**

**FOURIER SERIES:**

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period and arbitrary period. Complex Fourier series. Practical harmonic analysis.

**08 Hrs**

**UNIT-III**

**INFINITE FOURIER TRANSFORMS**

Definition, Fourier sine and cosine transforms –Problems.
Inverse Infinite Fourier transforms, Inverse Fourier cosine and sine transforms - Problems. Convolution theorem (only statement) – problems.

**08 Hrs**

**UNIT-IV**

**NUMERICAL SOLUTIONS OF PDE**

Classifications of second-order partial differential equations, finite difference approximations to derivatives. Solution of one-dimensional heat equation by Schmidt explicit formula and Crank- Nicholson method. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme.

**08 Hrs**

**UNIT-V**

**CALCULUS OF VARIATIONS**

Definition, Variation of a functional, Euler's equation, variational problems. Applications: Hanging cable problem, Brachistochrone problem.

**Z-TRANSFORMS**

Definition, Standard z-transforms, damping rule, Shifting rule, Initial value and final value theorems-problems. Inverse z-transform and applications to solve difference equations.

**08 Hrs**

**Course Outcomes**

After successfully completing the course, the student will be able to understand the topics:

| COURSE OUTCOMES | | PO | Strength |
|---|---|---|---|
| **CO 1** | Apply the concepts of Transform Techniques, optimization and Finite Difference Methods to solve engineering problems. | 1 | 3 |
| **CO 2** | Analyze the solution of differential equations using Transform Techniques, optimization and Finite Difference Methods | 1 | 1 |
| **CO 3** | Demonstrate the importance of Transform Techniques, optimization and Finite Difference Methods in engineering using programing tools. | 5, 9, 10 | 1 |

**Assessment:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| Theory Component | Three Internals (Best of Two) | 80% | Course Instructor |
| | AAT | 20% | Course Instructor |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**Assessment Pattern:**

| Component | Theory (100%) | | | Total Marks |
|---|---|---|---|---|
| | Test 1 | Test 2 | AAT | |
| Max. Marks | 40 | 40 | 20 | 100 |
| Reduced CIE | 20 | 20 | 10 | 50 |

**Two best scores out of the three tests will be considered for CIE.**

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester End Examination Question Paper Pattern:**

1. Overall question paper pattern to have seven questions from five units
2. Five full questions to be answered.
3. One question from each unit.
4. One question each from Unit II, III, and IV and two questions each from Unit I and V.

**SUGGESTED LEARNING RESOURCES:**

**TEXT BOOKS:**

1. B. S. Grewal, "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018
2. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

**REFERENCE BOOKS:**

1. B.V. Ramana, "Higher Engineering Mathematics", McGraw-Hill Education, 11th edition.
2. Srimanta Pal & Subodh C. Bhunia, "Engineering Mathematics ", Oxford University Press, 3rd Reprint, 2016.
3. N.P Bali and Manish Goyal, "A textbook of Engineering Mathematics", Laxmi Publications.

4. C. Ray Wylie, Louis C. Barrett, "Advanced Engineering Mathematics", McGraw – Hill Book Co. Newyork, Latest edition
5. Gupta C.B, Sing S.R and Mukesh Kumar, "Engineering Mathematics for Semester I and II", Mc-Graw Hill Education (India) Pvt. Ltd 2015.
6. H.K. Dass and Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand Publication, 2014.
7. James Stewart: "Calculus", Cengage publications, 7th edition, 4th Reprint 2019.

**WEB LINKS AND VIDEO LECTURES (E-RESOURCES):**

1. http://www.class-central.com/subject/math(MOOCs)
2. http://academicearth.org/
3. http://www.bookstreet.in.
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

| Course Title | Materials Chemistry and Applications | | | | |
|---|---|---|---|---|---|
| Course Code | 23CY3ESMCA | Credits | 03 | L – T – P | 3 – 0 – 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**COURSE OBJECTIVES**:

1. To provide students with knowledge of engineering materials for building technical competence in industries.
2. To impart the knowledge of fundamentals in material science and engineering principles involved in catalytic materials, smart materials, ceramics, glass and lubricants

**PREREQUISITES:** Engineering Physics and Engineering Chemistry

## UNIT-I

**Structure and Bonding:**

**Types of bonds: Ionic bond -** Lattice energy, Born-Haber Cycle, calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds.

**Covalent bond -** Molecular orbital theory (stability, bond order, and magnetic properties). Metallic bond - Band theory, electrical properties of metals, semiconductors and insulators, band gaps, effect of doping.

**Secondary bonding -**Dipole-dipole, dipole – induced dipole, London dispersion/Van derWaals, Hydrogen bond (Intra molecular and Inter molecular types). Effect of secondary bonding on properties of materials.

**8 Hrs**

## UNIT-II

**Structure of Solids:**

**Types of solids:** General features and classification. Crystal systems and unit cells, Symmetry, Bravais lattices, Lattice planes and Miller indices, X-ray diffraction - Bragg's equation - numerical. PXRD – Indexing of data, Calculation of particle size - Debye Scherrer equation, Neutron diffraction – principle and applications.

**Defects:** Point, line, surface, bulk defects, relevance of defects in materials science. Intercalation compounds.

**Electron diffraction** – The principle and construction, working and applications of Scanning electron microscopy, Transmission electron microscopy.

**8 Hrs**

## UNIT-III

**Materials for catalysis:**

Introduction, significance to industry. General features of homogeneous and heterogeneous catalysis, catalytic promoters and poisons, catalyst support.

Mechanism of catalysis by taking an example. Acid and base catalysis, metal ions, organo-metallic complexes- meaning, significance, two examples in each case with mechanism, phase transfer catalysis.

Shape selective catalysis - zeolites as catalysts - composition and structure, Preparation, properties and applications. Catalysts used in steam reforming and cracking. Environmental catalysis - catalysts used in catalytic converters.

**8 Hrs**

**UNIT-IV**

**Phase Equilibria:**

**Azeotropes:** Miscible liquids - ethanol-water system. Partially miscible liquids - phenol-water system. Critical solution temperature (CST), immiscible liquids and steam distillation. Nernst distribution law. Calculation of the partition coefficient. Applications of distribution law.

**Phase diagram and phase transformations:** Phase rule, single component system for Iron, binary phase diagrams - lever rule, phase diagrams for Lead-Tin, and Iron - Iron-Carbide systems. Isothermal transformation (TTT) curves for eutectoid steel.

**Phase diagram and phase transformations:** Phase rule, Single component system for Iron, Binary phase diagrams for Lead-Tin, Copper-Zinc and Iron- Iron-Carbide systems. Isothermal transformation (TTT) Curves for eutectoid steel.

**Typical engineering materials:** Metals and non-metals, General properties of ferrous metals, non-ferrous metals and alloys, Copper and its alloys, lead and its alloys, Nickel and its alloys, Alloys for high temperature service. **8 Hrs**

**UNIT-V**

**Industrial Materials:**

**Typical engineering materials** - Metals and non-metals, General properties of ferrous metals, non-ferrous metals and alloys, Copper and its alloys, Lead and its alloys, Nickel and its alloys, Alloys for high temperature applications.

**Glass** - properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

**Lubricants** - General Introduction - Types of Lubricants with examples (Solid, liquid, Greases, emulsion, and Gaseous lubricants). Properties - Viscosity index (VI) - determination, numerical, mechanism of action of lubricants.

**7 Hrs**

**TEXT BOOKS:**

1. Shikha Agarwal, “Engineering Chemistry - Fundamentals and Applications,” Cambridge university press, 2016
2. P. C. Jain and Monica Jain, Dhanpat Rai, Engineering Chemistry, Publishing Company (P) Ltd. 16th edition.
3. V. Raghavan, Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited; 6th revised edition.

**REFERENCE BOOKS:**

1. Solid state chemistry and its applications - A.R. West, 2nd edition, John Wiley & Sons, Inc.
2. Callister's Materials Science and Engineering, R. Balasubramaniam, 2nd edition, John Wiley & Sons, Inc.

3. S. O. Pillai, Solid State Physics, New Age International, 2006, 8th edition.
4. Julio de Paula, Atkins' Physical Chemistry, Peter Atkins, Oxford University Press, 11th edition.
5. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Inorganic Chemistry; Principles of Structure and Reactivity, Pearson Education India, 4th edition.

**MOOCs**

1. https://nptel.ac.in/noc/individual_course.php?id=noc18-cy01
2. https://nptel.ac.in/courses/104104101/
3. https://nptel.ac.in/courses/104103019/

**QUESTION PAPER PATTERN:**

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, II, V and two questions each from Unit III and IV.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES |
|---|---|---|
| **CO 1** | Understand the basic principles of structure and bonding, catalysis, phase equilibria and Industrial Materials | PO1 |
| **CO 2** | Based on the acquired knowledge, analyse the structure, topology, composition, catalytic properties and applications of materials. | PO2 |
| **CO 3** | Apply the principles of materials chemistry in addressing societal problems. | PO6 |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100 (Weightage 50%) |
|---|---|---|
| **Theory Component** | **Three Internals Test (Best of Two)** | **80%** |
| | **Quiz (Two Quizzes or AAT)** | **20%** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** |

**Assessment Pattern:**

| Component | Test 1 | Test 2 | Quiz 1/AAT | Quiz 2 /AAT | Total Marks |
|---|---|---|---|---|---|
| **Max. Marks** | **40** | **40** | **10** | **10** | **100** |
| **Reduced CIE** | **20** | **20** | **5** | **5** | **50** |

| Course Title | Process Principles and Calculations | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH3PCPPC | Credits | 03 | L – T – P | 2 – 1– 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Mathematics and Engineering Chemistry

**SYLLABUS:**

**UNIT- I**

**Units and Dimensions:** Fundamental and derived units, conversion of units, dimensional consistency of equations, dimensionless groups and constants, conversion of equations. Basic Chemical Calculations: Concept of mole, mole fraction, compositions of mixtures of solids, liquids and gases. Concept of normality, molarity, molality, parts per million, Ideal gas law, Amagat's law and Dalton's law and related problems. **[3L+4T=7Hrs]**

**UNIT -II**

**Material Balance without reaction:** General material balance equation for steady and unsteady state operations. Typical steady state material balances in distillation, absorption, extraction, crystallization.

**Material balances involving bypass, recycle and purging:** drying, mixing and evaporation. **[3L+7T=10Hrs]**

**UNIT- III**

**Steady State Material Balance with Reaction:** Principles of stoichiometry, concept of limiting and excess reactants and inert, fractional and percentage conversion, fractional yield and percentage yield, selectivity and related problems.

**[3L+4T=7Hrs]**

**UNIT-IV**

**Calculations related fuels and combustion:** Ultimate and proximate analysis of fuels, calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations.

**[2L+7T=9Hrs]**

**UNIT- V**

**Energy balance:** General steady state energy balance equation, heat capacity, enthalpy, heat of formation, heat of reaction, heat of combustion, and heat of mixing, determination of heat of formation at standard and elevated temperatures, theoretical flame temperature and adiabatic flame temperature.

**[2L+4T=6Hrs]**

**TEXT BOOKS**

1. K. V. Narayanan and B. Lakshmikutty Stoichiometry and Process Calculations, 2nd edition, 2009, PHI Learning private Ltd. New Delhi.

2. Bhatt B. L. and Vora S. M. Stoichiometry, 3rd edition, 1996, Tata McGraw Hill Publishing Ltd., New Delhi.

**REFERENCE BOOKS:**

1. Hougen O. A., Waston K. M. and Ragatz R.A., Chemical Process Principles Part -I' Material and Energy Balances, 2nd edition, CBS publishers and distributors, New Delhi, 1995.
2. Himmelblau D.M., Basic Principles and Calculations in Chemical Engineering, 6th edition, Prentice Hall of India, New Delhi 1997. Charts: Psychrometric chart, steam tables

**E-BOOKS**

1. K. V. Narayanan, B. Lakshmikutty, "Stoichiometry and process calculations", https://books.google.co.in/books?id=52tqCFSC0ZgC&printsec
2. Gavhane, K. A, "Introduction to Process Calculations Stoichiometry", https://books.google.co.in/books?id=80v3hRHoEv0C&printsec

**MOOC's and ONLINE COURSES:**

1. http://www.nptel.ac.in/syllabus/103102017/
2. http://elearning.vtu.ac.in/10BT46.html

**SEE QUESTION PAPER PATTERN:**

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, III, V and two questions each from Unit II and IV.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES | Level |
|---|---|---|---|
| **CO1** | Apply basic to convert units from one set to another and to check equations' dimensional consistency. | PO1 | 2 |
| **CO2** | Understand mole concept, conversion, selectivity and related terms, as well as their applicability in various processes. | PO1 | 3 |
| **CO3** | Formulate material balance problems of various unit operation and unit processes. | PO2 | 2 |
| **CO4** | Solve material balance problems various unit operation and unit processes. | PO2 | 3 |
| **CO5** | Analyse and interpret complex problems involving air-fuel ratios calculations and provide viable solutions using fundamental principles. | PO3 | 2 |
| **CO6** | Formulate and solve energy balance problems of various unit processes. | PO2 | **2** |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| Theory Component | Three Internals (Best of Two) | 80% | Course Instructor |
| | AAT | 20% | Course Instructor |
| Semester End Examination (Written Examination for Three Hours) | | Marks 100 (Weightage 50%) | |

**Assessment Pattern:**

| Component | Theory (100%) | | | Total Marks |
|---|---|---|---|---|
| | Test 1 | Test 2 | AAT | |
| Max. Marks | 40 | 40 | 20 | 100 |
| Reduced CIE | 20 | 20 | 10 | 50 |

| Course Title | Mechanical Operations | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH3PCMOP | Credits | 04 | L – T – P | 3 – 0 – 1 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Mechanics and Engineering Mathematics

**SYLLABUS:**

**UNIT- I**

**Particle Technology**: Ideal and actual screen, differential and cumulative size analysis, particle size analysis, specific surface area, screen effectiveness and related problems. Standard screen series, motion of screens, gyratory screen shaker, vibrating screen shaker, trammels and sub-sieve analysis.

**7 Hrs**

**UNIT- II**

**SIZE REDUCTION**: Forces used, characteristics of products, laws of size reduction, work index, verification of laws, problems. Open circuit grinding, closed circuit grinding, wet & dry grinding, equipment: Jaw crusher, Gyratory crusher, Ball mill, Fluid energy mill & Hammer mill, numerical on critical speed of ball mill.

**6 Hrs**

**UNIT- III**

**FLOW OF FLUID PAST IMMERSED BODIES**: Drag, drag coefficient, particle Reynolds number. Ergun equation and its modifications, particle size determination by Kozeny-Carmen equation, types of fluidization and applications, numerical on applications of these equations. Conveying of solids-belt conveyors Chain conveyors.

**FILTRATION**: Classification, modification of Kozeny-Carman equation for filtration, principles of cake filtration, numerical on determination of cake and filter medium resistance. Industrial filters: Leaf filter, rotary drum filter, bag filter, suspended batch centrifuge, filter aids.

**10 Hrs**

**UNIT- IV**

**MOTION OF PARTICLES THROUGH FLUIDS**: Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, terminal settling velocity, motion of spherical particle in different regions, criterion for settling, hindered settling, numerical on settling of particles. Cyclones, hydro-cyclones, and heavy media separation.

**SEDIMENTATION**: Batch settling test, theories, application of batch settling test to design a continuous thickener and related numerical.

**10 Hrs**

**UNIT- V**

**AGITATION AND MIXING**: Types of impellers. flow patterns in agitated vessels, prevention of swirling, power correlation and calculation. Mixers: Muller mixer, ribbon blender, and internal screw mixer. Separations: electrostatic separation, jigging, froth floatation.

**6 Hrs**

**LABORATORY COMPONENT:**

1. Air elutriation
2. Air permeability
3. Batch sedimentation
4. Beaker decantation
5. Drop weight crusher
6. ICI sedimentation
7. Jaw crusher
8. Leaf filter
9. Plate and frame filter press
10. Screen effectiveness

**TEXTBOOKS:**

1. McCabe, Warren, L., Smith, Julian, C. and Harriott, Peter, Unit operations of chemical engineering, 5th edition, McGraw-Hill, Singapore, 2000.
2. Kiran D Patil, Mechanical Operations Fundamental Principles and Applications, 2nd Edition Nirali Prakashan, India, 2012

**REFERENCE BOOKS:**

1. Badger, Walter, L. and Banchero, Julius, T. Introduction to Chemical Engineering, 3rd edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.
2. Richardson, J.F., Harker, J. H., and Backhurst, J. R.Particle Technology and Separation Processes, 2nd volume, 5th edition, Replika Books Pvt. Ltd., New Delhi, 2003

**E BOOKS**

1. Mechanical Operations Fundamental Principles and Applications: https://books.google.co.in/books/about/Mechanical_Operations_Fundamental_Princi.html?id=O0DPOKxC0YEC&hl=en
2. Ebook Library chemical engineering mechanical Operations: http://csfbook.sourceforge.net/pdf/chemical-engineering-mechanical-operations.pdf

**MOOC's &ONLINE COURSES:**

1. http://nptel.ac.in/courses.php
2. http://www.msubbu.in/sp/mo/

**QUESTION PAPER PATTERN:**

Overall question paper pattern to have seven questions from five units

1. Five questions to be answered.
2. One question from each unit.
3. One question each from Unit I, II, V and two questions each from Unit III and IV.

**COURSE OUTCOMES:**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES |
|---|---|---|
| **CO1** | **Apply basic principles of mechanical operations** | **PO1** |
| **CO2** | **Develop solutions by applying mass and force balance for unit operations.** | **PO2** |
| **CO3** | **Analyse the working of equipment with an understanding of the requirements of professional engineering practice.** | **PO3** |
| **CO4** | **Apply the knowledge of solid-solid and gas-solid separation techniques for various applications including coal, mineral beneficiation, environmental pollution control etc.** | **PO4** |
| **CO5** | **Conduct experiments and evaluate in team for different mechanical operations to derive valid conclusion.** | **PO9** |
| **CO6** | **Present the experimental observations in the form of a lab report.** | **PO2** |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| **Theory Component** | **Three Internals (Best of Two)** | **40%** | **Course Instructor** |
| | **Quiz (One Quiz or AAT)** | **10%** | **Course Instructor** |
| **Laboratory Component** | **Laboratory Component** | **50%** | **Course Instructor** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**ASSESSMENT PATTERN:**

| Component | Theory (50%) | | | Practical (50%) | | Total Marks |
|---|---|---|---|---|---|---|
| | Test 1 | Test 2 | Quiz/AAT | Records & Performances | Lab Test | |
| **Max. Marks** | **20** | **20** | **10** | **30** | **20** | **100** |
| **Reduced CIE** | **10** | **10** | **5** | **15** | **10** | **50** |

| Course Title | Fluid Mechanics | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH3PCFME | Credits | 04 | L – T – P | 3 – 0 – 1 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Physics and Engineering Maths

**SYLLABUS:**

**UNIT-I**

**Fluid statics and its applications:** Introduction, fluid properties, Pressure concept- Pascal's Law, Hydrostatic law, Pressure at a point in compressible fluid (Barometric Equation), Measurement of fluid Pressure-U-tube manometers, Inverted U-Tube manometer and Differential manometers.

**Fluid flow phenomena:** Types of fluids - shear stress and velocity gradient relation, Newtonian and non - Newtonian fluids, Types of fluid flow, Reynold's stress, Reynolds number, Eddy viscosity, Flow in boundary layers, Boundary layer separation and wake formation.

**10 Hrs**

**UNIT-II**

**Kinetics of Flow:** Basic equations of fluid flow- Continuity equation, mass velocity, momentum equation, Bernoulli's equation, modified equations for real fluids with correction factors.
**Flow of incompressible fluids in pipes**: Shear-stress distribution in a cylindrical pipe, friction factor, laminar flow in pipes, turbulent flow, friction factor chart and related numerical. Energy loss due to friction (Minor and Major losses).

**10 Hrs**

**UNIT-III**

**Flow of compressible fluids:** Introduction**,** Basic equations of Compressible flow (Continuity, Bernoulli's or Energy equations, Velocity of sound or Pressure wave in a fluid, Stagnation properties, Concept of Mach number, Area–velocity relationship for compressible flow, Mass flow rate of compressible fluid through Venturimeter, Pitot static tube. **7 Hrs**

**UNIT - IV**

**Transportation of fluids**: Applications of Bernoulli's Equation- Venturi meter, Orifice meter, Pitot tube, Rotameter and related numerical. Pumps & Classification, construction and working of centrifugal pump, Heads and efficiency, pump work, Introduction to Priming and Cavitation, Characteristic curves of centrifugal pump, Net positive suction head and suction height.

**7 Hrs**

**UNIT- V**

**Dimensional analysis**: Introduction, Primary and derived quantities, Dimensional homogeneity, Methods of dimensional analysis (Rayleigh's and Buckingham's II – method). Significance of different dimensionless numbers. **5 Hrs**

**LABORATORY COMPONENT**

1. Determination of Friction factor in circular pipes
2. Determination of Friction factor in non-circular pipes.
3. Friction in helical spiral coils.
4. Flow rate measurement using Orifice meters (incompressible fluid)
5. Measurement of pressure drop in Packed bed
6. Measurement of pressure drop in Fluidized bed
7. Study and development of characteristics for centrifugal pump
8. Study of various pipe fittings and their equivalent lengths
9. Fluid flow measurement using Venturi and Orifice meters (incompressible fluid)
10. Demonstration of fluid flow phenomena using Reynold's apparatus

**TEXT BOOK:**

1. McCabe. W. L. f et. al. "Unit Operations of Chemical Engineering", 5th edition., McGraw Hill New York 1993.
2. Bansal R.K, A Textbook of Fluid Mechanics (VTU), Edition 2005, Laxmi Publications.

**REFERENCE BOOKS**:

1. R. K Rajput, "A Text Book on Fluid Mechanics", 2nd Edition 2002, S Chand and company Ltd.

2. Coulson J. and Richardson. J.F.., 'Chemical Engineering' Vol.II L., 5th edn., Asian Books (p) Ltd., New Delhi, 1998.

**E BOOKS**

1. Multimedia Engineering Fluid Mechanics: https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=fl
2. Elementary Fluid Mechanics: http://www.worldscientific.com/worldscibooks/10.1142/5895

**MOOC's &ONLINE COURSES:**

1. http://www.learnerstv.com/video/Free-video-Lecture-2626-Engineering.htm#
2. http://www.myopencourses.com/subject/fluid-mechanics-2#downloads

**QUESTION PAPER PATTERN:**

1. Overall question paper pattern to have seven questions from five units

2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit III, IV, V and two questions each from Unit I and II.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES |
|---|---|---|
| **CO1** | **Apply basic principles of pressure & conservation laws to solve fluid flow problems** | **PO1** |
| **CO2** | **Possess familiarity with the construction and working of fluid flow equipment with an understanding of the requirements of professional engineering practice** | **PO3** |
| **CO3** | **Develop correlations / solutions for flow processes that meet specific needs** | **PO3** |
| **CO4** | **Estimate energy requirements and losses in transportation and metering of fluids.** | **PO2** |
| **CO5** | **Conduct fluid flow experiments in team and derive valid conclusions.** | **PO9** |
| **CO6** | **Present the experimental observations in the form of a lab report.** | **PO2** |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| **Theory Component** | **Three Internals (Best of Two)** | **40%** | **Course Instructor** |
| | **Quiz (One Quiz or AAT)** | **10%** | **Course Instructor** |
| **Laboratory Component** | **Laboratory Component** | **50%** | **Course Instructor** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**ASSESSMENT PATTERN:**

| Component | Theory (50%) | | | Practical (50%) | | Total Marks |
|---|---|---|---|---|---|---|
| | Test 1 | Test 2 | Quiz/AAT | Records & Performances | Lab Test | |
| **Max. Marks** | **20** | **20** | **10** | **30** | **20** | **100** |
| **Reduced CIE** | **10** | **10** | **5** | **15** | **10** | **50** |

**DEPARTMENT OF CHEMICAL ENGINEERING**
**B.M.S. COLLEGE OF ENGINEERING, BENGALURU**
**Autonomous Institute, Affiliated to VTU**

| Course Title | Process Engineering Thermodynamics-I | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH3PCTD1 | Credits | 02 | L – T – P | 2 – 0 – 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Chemistry and Engineering mathematics

**SYLLABUS:**

**UNIT- I**

**INTRODUCTION:** The scope of thermodynamics, different approaches, heat and work, state and its forms, intensive and extensive properties, system and types of system, energy and its evaluation for various types of system, equilibrium concept, processes and types, concept of stability, zeroth law of thermodynamics, phase rule, temperature scale

**4 Hrs**

**UNIT- II**

**FIRST LAW OF THERMODYNAMICS:** Joule's paddle wheel experiment, internal energy, first law of thermodynamics, reversible and irreversible processes with examples, first law application to closed, open and steady state flow systems and numerical.

**EVALUATION OF VARIOUS FORMS OF ENERGY**: Enthalpy and its evaluation, principle and working of flow calorimeter, numerical on enthalpy calculations.

**6 Hrs**

**UNIT- III**

**VOLUMETRIC PROPERTIES OF PURE FLUIDS**: P-V-T behavior of pure fluids, equations of state and ideal gas law, equations of state for real gases: Virial equation and its applications, ideal gas temperatures and universal gas constant; cubic equations of state- van der Waals equation and determination of parameters, theorem of corresponding states; acentric factor, Pitzer correlations and compressibility charts.

**5 Hrs**

**UNIT-IV**

**PROCESSES INVOLVING IDEAL GAS LAW**: Implied property relations for an ideal gas law, equations for process calculations-constant volume, constant pressure, constant temperature, adiabatic and polytrophic processes, numerical to evaluate energy interactions of various processes.

**6 Hrs**

**UNIT- V**

**SECOND LAW OF THERMODYNAMICS:** Limitations of first law of thermodynamics, general statements of the second law, entropy, Carnot theorem and equations, Clausius inequality, concept of entropy increase-mathematical statement of the second law, calculation of entropy changes. Ideal work and lost work, and third law of thermodynamics.

**5 Hrs**

**TEXT BOOKS:**

1. Smith J. M. and Van Ness H.C, "Introduction to Chemical Engineering Thermodynamics", 5th edition, McGraw Hill, New York, 1996.

2. Narayanan, K. V. "Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

**REFERENCE BOOKS:**

1. Rao, Y.V.C Chemical Engineering Thermodynamics, New Age International Publication, Nagpur, 2000.
2. Halder, Gopinath, "Introduction to chemical engineering thermodynamics", PHI Learning Pvt. Ltd., New Delhi, 2009.

**E BOOKS**

1. Kevin Dahm, "Fundamentals of Chemical Engineering Thermodynamics": https://books.google.co.in/books
2. DimitriosTassios, "Applied Chemical Engineering Thermodynamics": https://books.google.co.in/books

**MOOC's and ONLINE COURSES:**

1. http://elearning.vtu.ac.in/06ME33.html
2. MOOC's Course on Thermodynamics: https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about

**QUESTION PAPER PATTERN:**

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, III, V and two questions each from Unit II and IV.

**COURSE OUTCOMES (Cos):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES | Level |
|---|---|---|---|
| **CO1** | Apply the fundamental concepts of thermodynamics for various systems | PO1 | 1 |
| **CO2** | Formulate equations for energy functions | PO2 | 2 |
| **CO3** | Ability to apply various thermodynamics laws to real and ideal systems | PO2 | 3 |
| **CO4** | Comprehend the relations between fundamental properties of pure fluids with governing equations. | PO2 | 2 |
| **CO5** | Evaluate the various energy properties of pure fluids for different processes | PO3 | 3 |
| **CO6** | Interpret the directional change by applying the thermodynamic concepts for steady state process | PO3 | 2 |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| Theory Component | Three Internals (Best of Two) | 80% | Course Instructor |
| | AAT | 20% | Course Instructor |
| Semester End Examination (Written Examination for Three Hours) | | Marks 100 (Weightage 50%) | |

**Assessment Pattern:**

| Component | Theory (100%) | | | Total Marks |
|---|---|---|---|---|
| | Test 1 | Test 2 | AAT | |
| Max. Marks | 40 | 40 | 20 | 100 |
| Reduced CIE | 20 | 20 | 10 | 50 |

| Course Title | Biology for Engineers | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH3BSBFE | Credits | 02 | L – T – P | 2 – 0 – 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**Prerequisites: Natural Sciences**

**SYLLABUS:**

**UNIT-I**

**MICROBIOLOGY:** Definition, characteristics, importance, classification of microorganisms, reproduction cycle, growth kinetics curve, sources of nutrients to formulate the growth medium, types of sterilization of microorganisms, applications of microorganisms.

**06 Hrs**

**UNIT-II**

**BIOMOLECULES:** Introduction to biomolecules, General classification, important functions and structure of carbohydrates, lipids, vitamins, and proteins.

**05 Hrs**

**UNIT-III**

**ENZYMES & GENETICS:** Enzymes: Introduction, Enzyme commission's nomenclature, enzyme substrate, mechanism of enzyme action; Genetics: Introduction to genetics, genetic engineering, and its application; structure, functions & importance of DNA, RNA, genes & chromosomes.

**06 Hrs**

**UNIT-IV**

**TISSUE CULTURE:** Animal & plant tissue culture, Harvesting and isolating cells, Preparation of growth media, Cell culture techniques and Applications.

**05 Hrs**

**UNIT-V**

**IMMUNOLOGICAL SCIENCE & BIO-NANO SCIENCE:** Immune system and its types; Functional properties of antibodies; Helper T cells and T cell activation; Nano

Biomolecules and its various types; Principles and Application of Biosensor.

**05 Hrs**

**TEXTBOOKS:**

1. Dr. Sohini Singh and Dr. Tanu Allen, "Biology for Engineers", Vayu Education of India, New Delhi, 2014.
2. Molecular Biology of the cell. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Garland Science; 5th edition.

**REFERENCE BOOKS:**

1. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox, 7th Edition, W. H. Freeman and Company, New York.

**E-BOOKS**

1. www.bio12.com/ch3/RaycroftNotes.pdf
2. www.engineering.uiowa.edu/bme050/cvb-solids.pdf
3. www.biologyjunction.com/mendelian_genetics.html

**MOOC's & ONLINE COURSES:**

1. Biology for engineers and other non-biologists: https://onlinecourses.nptel.ac.in/noc19_ge31/preview
2. Biology & Life Sciences: https://www.edx.org/course/subject/biology-life-sciences

**QUESTION PAPER PATTERN:**

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit II, III, V and two questions each from Unit II and IV.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | Programme Outcomes |
|---|---|---|
| **CO1** | **Understand the biological living organisms' concepts from an engineering perspective.** | **PO1** |
| **CO2** | **Appreciate the importance of microbiology and immunological science.** | **PO1** |
| **CO3** | **Integrate biological principles for developing next generation technologies for development of artificial systems AND mimicking human action.** | **PO2** |
| **CO4** | **Comprehend the cellular and make up structural functions of biomolecules.** | **PO1** |
| **CO5** | **Apprehend the applications of tissue cultures for different applications.** | **PO1** |
| **CO6** | **Apply the knowledge of biological science related to the multidisciplinary areas.** | **PO2** |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100 (Weightage 50%) | Assessment |
|---|---|---|---|
| **Theory Component** | **Three Internals (Best of Two)** | **80%** | **Course instructor** |
| | **Quiz (Two Quizzes or AAT)** | **20%** | **Course instructor** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**ASSESSMENT PATTERN:**

| Component | Test 1 | Test 2 | Quiz 1/AAT | Quiz 2 /AAT | Total Marks |
|---|---|---|---|---|---|
| **Max. Marks** | **40** | **40** | **10** | **10** | **100** |
| **Reduced CIE** | **20** | **20** | **5** | **5** | **50** |

| Course Title | ADVANCED MS WORD & EXCEL FOR ENGINEERS | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH3AEAWE | Credits | 01 | L – T – P | 0-0-1 |
| CIE | 50 marks | SEE | 50 marks | | |

**PREREQUISITES:** Nil

**SYLLABUS:**

- **Introduction to MS Word:** Tabs, Ribbon, Group, Quick Access toolbar, and customization.
- **Figures:** Adding multiple figures and different shapes of figures, formatting, and numbering.
- **Tables:** Modification of tables as per the requirement, formatting, basic calculations, and numbering.
- **Equations:** Use of MathType
- **Table of contents:** Automatic creation of contents and formatting.
- **Introduction to MS Excel:** Built-in-functions, operations with columns and rows, error bars, solver, sort & filter, mathematical functions, trigonometric functions.
- **Plotting graphs:** Scatter, 2D line, 3D line, Column charts, Pie charts, Histogram.

**TEXTBOOK:**

1. Wallace Wang, Microsoft Office 2019 for Dummies, 2nd edition, John Wiley & Sons, Inc., 2016.
2. Mariano Martin Martin, Introduction to Software for Chemical Engineers, CRC Press, Taylor & Francis group.

**MOOCs and ONLINE COURSE:**

1. https://elearn.nptel.ac.in/shop/nptel/digital-skilling/

**ASSESSMENT:**

| Continuous Internal Assessments | Marks 50 (Weightage 50%) | Assessment |
|---|---|---|
| Quiz either as MCQ or fill in the blanks | 100 % (20% for each lecture session) | Course Instructor |
| Passing criteria | MCQs | |

| Yoga | |
|---|---|
| **Course objectives:**<br>• Promoting positive health, prevention of stress related health problems and rehabilitation through Yoga.<br>• Integral approach of Yoga Therapy to common ailments.<br>• Imparting skills in them to introduce Yoga for health to general public and Yoga for total personality development of students in Colleges and Universities.<br>• Invoke scientific attitude and team spirit to channelize their energies in to creative and constructive endeavors.<br>• To enable them to establish Yoga Therapy centers in the service of common man. | |
| **Teaching-Learning Process (General Instructions)**<br>These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.<br>• Teachers shall adopt suitable pedagogy for effective teaching - learning process. The pedagogy shall involve the combination of different methodologies which suit modern technological tools and software's to meet the present requirements of the Global employment market.<br>(i) Direct instructional method (Low /Old Technology),<br>(ii) Flipped classrooms (High/advanced Technological tools),<br>(iii) Blended learning (combination of both),<br>(iv) Enquiry and evaluation-based learning,<br>(v) Personalized learning,<br>(vi) Problems based learning through discussion,<br>(vii) Following the method of expeditionary learning Tools and techniques,<br>Apart from conventional lecture methods, various types of innovative teaching techniques through videos, animation films may be adapted so that the delivered lesson can progress the students in theoretical applied and practical skills in teaching of the concepts of Health and Wellness in general. | |
| **Module-1** | |
| **Introduction and Trends of Yoga**<br>• Meaning, Definition, and Importance of Yoga<br>• History and Philosophical Aspects of Yoga<br>• Need for and Importance of Yoga in Modern World | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

| | |
|---|---|
| **Module-2** | |
| **Means of Yogic Practices**<br>• Introduction to Prayer and Its Importance<br>• Concept of Asana, Types and Benefits of Asana<br>• Concept of Pranayama, types, and benefits of Pranayama<br>• Concept and types of Mudras and Bandha<br>• Concept of Meditation and its benefits | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |
| **Module-3** | |
| **Meaning, techniques, precautions & effects of the following**<br>• Classification of Asanas - Meditative Asanas – Relaxative Asanas – Cultural Asanas. - safety measure and precautions while performing asanas.<br>• Pranayama – different phases in Pranayama practices: Puraka (Inhalation), Kumbhaka (Retention) and Recaka (Exhalation), - safety measures and precautions while performing pranayama.<br>• Meditation - Its techniques & benefits.<br>• Practicing methods and benefits of Kriyas, Bandha and Mudra. | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments & Practical sessions. |
| **Module-4** | |
| **Application of Yoga**<br>• Yoga for Health and Wellness<br>• Yoga for Aged Population<br>• Yoga for Otherly able population<br>• Yoga for Elite Sports Persons | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |
| **Module-5** | |
| **Yoga and Stress Management:**<br>• Concept of Stress according to Yoga<br>• Stress Management and Relaxation Techniques<br>• Postural deformities and corrective measures<br>• Yoga and development of Social qualities of personality - Co-operation - Simplicity - | |

| | |
|---|---|
| | Tolerance - Social adjustments - Yoga and personal efficiency. Improvement of personal efficiency through yoga |
| Teaching Learning process | Chalk and talk method, Demonstration and assessment method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

**Course outcome (Course Skill Set)**

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

1. Demonstrate an understanding of anatomy and physiology as it applies to the intentional integration of breath, postures, and movement within the practice of yoga
2. Identify asana specific to their desired health benefits and create a yoga practice
3. Apply their understanding of yogic text and principles to their daily lives and yoga practice

**Suggested Learning Resources:**

**Books:**

1. Yoga – A Healthy Way of Living" by NCERT
2. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers.
3. Nagendra, H.R., and Nagarathana, R., (2004). Yoga perspective in stress management. Bangalore: Swami Vivekananda Yoga Prakashana.

**Activity based Learning (suggested Activities in Class)/ Practical Based learning.**

- Asanas practice session, Contents related activities (Activity-based discussions)
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions and Health issues-based activities.
- Quizzes and Discussions
- Seminars and assignments

| Course Title | Physical Activity | | | | |
|---|---|---|---|---|---|
| Course Code | 23PE3NCPYA | Credits | 00 | L – T – P | 0 – 0 – 0 |
| Non-Credit Mandatory Course | | SEE | | P/NP | |

**Physical Education (Sports and Athletics)**

**Course objectives:**

- To impart the students with basic concepts of Physical Education and Sports Science for health and wellness.
- To familiarize the students with health-related Exercises, Sports for Overall growth & development
- To create a foundation for the professionals in Physical Education, Sports.
- To impart the basic knowledge and skills to teach Physical Education, Sports activities.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies; which teacher can use to accelerate the attainment of the various course outcomes.

- Teachers shall adopt suitable pedagogy for effective teaching - learning process. The pedagogy shall involve the combination of different methodologies which suit modern technological tools and software's to meet the present requirements of the Global employment market.
  (i) Direct instructional method (Low /Old Technology),

  (ii) Flipped classrooms (High/advanced Technological tools),

  (iii) Blended learning (combination of both),

  (iv) Enquiry and evaluation-based learning,

  (v) Personalized learning,

  (vi) Problems based learning through discussion,

  (vii) Following the method of expeditionary learning Tools and techniques,

- Apart from conventional lecture methods, various types of innovative teaching techniques through videos, animation films may be adapted so that the delivered lesson can progress the students in theoretical applied and practical skills in teaching of the concepts of Health and Wellness in general.

**Module-1**

**Engineering Technology in Sports:**

Introduction to Sports Technology, Technological innovations in sports, Use of technology in performance enhancement and analysis, Computer applications in sports

Teaching Learning process: Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments.

**Module-2**

**Fitness and Healthy Lifestyle:**

- Health and Safety in Daily Life at Work- Balance diet
- Yogic practice
- Aerobic Dance/Zumba

Teaching Learning process: Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments.

**Module-3**

**Sports Training**

- Meaning, definition, aim and objectives of sports training.
- Principles, Characteristics of sports training.
- Basic skills and techniques of the Sports/Game. (Each student shall involve in minimum 02 games).

Teaching Learning process: Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments.

**Module-4**

**Ethics in Sports:**

Ethics in Sports - Nature, Characteristics and Needs, Ethical practices in the field of Sports, Code of Conduct, Ethical Value System - Distributive Justice, Individual freedom of Choice, Professional Codes. Their application in the field of sports, Sports as a Profession - Conflict between organization demand, Individual needs and professional ideal, Conflicts the Sports Managers encounter, Social and Ethical - responsibilities of different Sports Association, Clubs, Manager, Coach and Sports Persons, Morale of Sportsmen- Role of Organizations I Association and Sports Manager in the area.

Teaching Learning: Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving

process activities & assignments.

**Module-5**

**Fundamental Exercise**

Head, Neck and Facial Exercises, Shoulder and Chest Exercises, Abdominal, Hip and Trunk Exercises, Upper arm, lower Arm, Wrist and Finger Exercises, Thigh, Knee, Calf, Ankle and Finger Exercises

Teaching Learning process: Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in practical session. Giving activities & assignments.

**Course outcome (Course Skill Set)**

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

1. Understand fundamental concepts of physical education and sports.
2. Apply in advanced sports technology with personal accountability, integrity and social responsibility for outcome and through dynamic work-teams that uses resources efficiently.
3. Acquire fundamental theory, training methods and sports pedagogy.
4. Create a wider base of personnel to pursue various sport related careers.

**Suggested Learning Resources:**

1. Managing Sporting Events- Jerry Solomon (Human kinetics)
2. Managing Sports Organizations- Ruben Acosta Hernandez
3. Contemporary Sports management- Janet. B. Parks & Jerome Quarter man

(Publishers Human Kinetics)

4. Bompa T. (1999). Periodization- Theory and Methodology of Training (4th ed). Champaign,

Illinois: Human Kinetics.

5. Singh H (1999). Science of Sports Training. New Delhi. DVS Publication.
6. Uppal AK (1999). Sports Training. New Delhi. Friends Publication
7. Franz K. F. et. al., Editor, Routledge Handbook of Sports Technology and Engineering (Routledge, 2013)

8. Steve Hake, Editor, The Engineering of Sport (CRC Press, 1996)

9. Dixon, Sharon. The science and engineering of sport surfaces. Routledge, 2015.

10. Franz K. F. et. al., Editor the Impact of Technology on Sports II (CRC Press, 2007)

11. John Mongilo, (2001), "Nano Technology 101 "New York: Green wood publishing group.

12. Magdalinski, Tara. Sport, technology, and the body: The nature of performance. Routledge, 2009.

**Activity based Learning (suggested Activities in Class)/ Practical Based learning**

- Contents and Practical related activities (Activity-based Skills practice/discussions)
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions and Health issues-based activities
- Quizzes and discussions
- Seminars and assignments

# FOURTH SEMESTER

| Course Title | Statistics and Probability | | | | | |
|---|---|---|---|---|---|---|
| Course Code | 23MA4BSSAP | Credits | 03 | L – T – P | 2 – 1 – 0 | |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | | |

**Prerequisites:** Basic concepts of Statistics and Probability, addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial distribution. Basic concepts of statistics. Matrices.

**Course Objectives:**

- To get acquainted with the procedure of collecting, designing, analysing and drawing inference about the data
- To have insight into Statistical methods, Correlation and regression analysis.
- To develop probability distribution of discrete and continuous random variables, Joint probability distribution occurs in design engineering.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
- State the need for Mathematics with Engineering Studies and Provide real-life examples.
- Support and guide the students for self–study.
- You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
- Encourage the students for group learning to improve their creative and analytical skills.

## UNIT-I

### STATISTICS & PROBABILITY

**Curve fitting** – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of the exponential curve of the $y = ab^x$. Correlation and Regression

**Probability distributions:** Discrete distribution - Poisson distribution. Continuous distribution-Normal distribution. [08 Hrs]

## UNIT-II

### JOINT PROBABILTY AND MARKOV CHAIN

**Joint Probability Distributions:** Discrete random variables, Mathematical expectations, Covariance and Correlation.
**Markov Chain:** Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain. **[08Hrs]**

## UNIT-III

### STATISTICAL INFERENCE – I

Introduction, estimation – point, interval; procedure for testing of hypothesis, level of significance, construction of confidence interval. [Large sample] Test of significance for single mean, difference between two means, single proportion, difference between two proportions, and difference of two Standard deviations. **[08Hrs]**

## UNIT-IV

### STATISTICAL INFERENCE – II

[Small sample] Test of significance for single mean, difference between two means, paired t-test, ratio of variances (F- distribution), Chi -Square distribution-goodness of fit, independence of attributes. Analysis of variance (one-way and two-way classifications).
**[08 Hrs]**

## UNIT-V

### DESIGN OF EXPERIMENTS

Principles of experimental design – Randomization, Replication, Local Control. Randomized block design, Completely Randomized block design, Latin Square Design–Problems.

**[08 Hrs]**

**Text Books:**

1. Fundamentals of Biostatistics, Khirfan A. Khan, Atiya Khanum, 3rd edition, 2012, UkaazPublications.
2. An Introduction to Biostatistics, P. S. S. Sundar Rao and J. Richard, 4th edition, 2006,Prentice Hall of India.

**Reference Books:**

1. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th edition, Wiley.
2. Biostatistics, P. N. Arora, P. K. Malhan, 2nd edition, 2013, Himalaya Publishing House.

On Completion of the course, student will have the ability to:

| CO # | COURSE OUTCOME (CO) | PO | Strength |
|---|---|---|---|
| CO 1 | Apply the basic principles of statistics and probability, Markov chain and design of experiments to the problems in Engineering. | 1 | 3 |
| CO 2 | Apply the concepts of Sampling distributions to Analyze and interpret the data from real world examples. | 1 | 3 |
| CO 3 | Demonstrate an understanding of sampling distributions and principles of experimental design. | 1,6,9,10 | 3,1,1,1 |

**E books and online course materials:**

1. https://www.coursera.org/learn/basic-statistics
2. https://www.coursera.org/learn/probability-intro
3. https://www.classcentral.com/course/udacity-intro-to-statistics-361
4. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook

**Online Courses and Video Lectures:**

1. http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring- 2014/
2. http://nptel.ac.in/courses/*111105041/1* NPTEL >> Mathematics >> Probability and Statistics
3. https:// www.khanacademy.org/Math
4. https:// www.class-central.com/subject/math (MOOCS)

**Question Paper Pattern:**

1. Five full questions to be answered.
2. To set one question from Units 2, 3, 4 and two questions from Unit 1 and Unit 5.

| Course Title | Analytical Instruments | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH4PCANI | Credits | 04 | L – T – P | 3 – 0– 1 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Physics, Engineering Chemistry and Technical Chemistry

**SYLLABUS:**

**UNIT – I**

**INTRODUCTION:** Introduction to classical qualitative and quantitative analysis, classification of instrumental methods, Errors, precision and accuracy of instruments, Types of calibration curves for data handling and interpretation.

**6Hrs**

**UNIT – II**

**SPECTROSCOPY:** UV spectral region, Origin of light absorptions in UV and IR, Electronic transitions of organic compounds, Modes of vibrations in IR spectra, Beer's Law, deviation of Beer's Law.

**INSTRUMENTATION OF UV AND IR SPECTROSCOPY:** Monochromatic Source, grating systems and types of detectors, different sampling techniques and application of UV & IR Spectroscopy.

**10Hrs**

**UNIT – III**

**GRAVIMETRIC ANALYSIS:** Principle of Thermogravimetric analyser (TGA), construction of TGA, principle of bomb Calorimeter (BC), principle of Differential scanning calorimeter (DSC), Instrumentation of TGA and BC, Application of TGA and BC instruments.

**7Hrs**

**UNIT – IV**

**GAS CHROMATOGRAPHY:** Introduction, Principle, carrier gas, stationary phase, instrumentation, principles of column detectors: TCD, FID, ECD and PID, qualitative and quantitative analysis.

**10Hrs**

**UNIT – V**

**HIGH PERFORMANCE LIQUID CHROMATOGRAPHY:** Principle, instrumentation, types of columns, sample injection, detectors used like (absorbance, refractive index, and electrochemical measurements), criteria for mobile phase selection and application of HPLC.

**6Hrs**

**LABORATORY COMPONENT**

1. Determination of Pka value of a component using UV-spectroscopy
2. Qualitative Analysis of UV-spectroscopy of $KMnO_4$.
3. Effect of temperature on viscosity of oils using red wood viscometer
4. Determination of concentration of alkali metal by Flame photometer
5. Determination of moisture content in a liquid and solid sample using KF titration
6. Qualitative Analysis using Turbidometer
7. Thin layer Chromatography
8. Bomb calorimeter for analysis of calorific value of given sample.
9. Electro analytical instrument like conductivity cell and its measurements

**TEXT BOOK:**

1. Instrumental Methods of Chemical Analysis; Gurudeep R. Chatwal and Sham K. Anand, Himalaya Publishing House
2. Douglas A. Skoog, F. James Holler, Stanley R. Crouch., "Principles of Instrumental Analysis", 6th Edition, published by Thomson Brooks/Cole, 2007.

**REFERENCE BOOKS:**

1. Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan., "Introduction to Modern Liquid Chromatography"., 3rd Edition, Wiley-Blackwell, scholarly publishing.
2. H.H. Willard, L.L. Merritt, J.N. Dean and F.A. Settle, "Instrumental methods of analysis"., I.B.H. Publishing House, New Delhi

**E-BOOKS**

1. Gregory S. Patience, "Experimental Methods and Instrumentation for Chemical Engineers": https://books.google.co.in/books?id
2. Sharma, B. K, "Instrumental Methods of Chemical Analysis":https://books.google.co.in/books?id

**MOOC's and ONLINE COURSES:**

1. http://www.myopencourses.com/subject/modern-instrumental-methods-of-analysis
2. http://nptel.ac.in/courses/103108100/module1/module1.pdf

**Question Paper Pattern:**

1. Overall question paper pattern to have seven questions from five units

2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, III, V and two questions each from Unit II and IV.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES |
|---|---|---|
| **CO1** | **Understand the theoretical concepts behind the functioning of analytical instruments** | **PO1** |
| **CO2** | **Understand the impact, complexity, strength and limitations of each instrument** | **PO2** |
| **CO3** | **Select suitable instruments based on their applicability** | **PO2** |
| **CO4** | **Conduct experiments in teams using various instruments for physical and chemical analysis** | **PO9** |
| **CO5** | **Present the experimental observations in the form of a lab report.** | **PO2** |
| **CO6** | **Ability to engage in life-long learning in context of technological change in instrumentations.** | **PO12** |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| **Theory Component** | **Three Internals (Best of Two)** | **40%** | **Course Instructor** |
| | **Quiz (One Quiz/AAT)** | **10%** | **Course Instructor** |
| **Laboratory Component** | **Laboratory Component** | **50%** | **Course Instructor** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**ASSESSMENT PATTERN:**

| Component | Theory (50%) | | | Practical (50%) | | Total Marks |
|---|---|---|---|---|---|---|
| | Test 1 | Test 2 | Quiz/ AAT | Records & Performances | Lab Test | |
| **Max. Marks** | **20** | **20** | **10** | **30** | **20** | **100** |
| **Reduced CIE** | **10** | **10** | **5** | **15** | **10** | **50** |

# DEPARTMENT OF CHEMICAL ENGINEERING
# B.M.S. COLLEGE OF ENGINEERING, BENGALURU
**Autonomous Institute, Affiliated to VTU**

| Course Title | Process Engineering Thermodynamics-II | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH4PCTD2 | Credits | 03 | L–T–P | 3–0–0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Chemistry, Engineering mathematics and Process Engineering Thermodynamics -I

**SYLLABUS:**

**UNIT - I**

**THERMODYNAMIC PROPERTIES OF PURE FLUIDS**: Thermodynamic properties, Relationships among thermodynamic properties, Heat capacity, Entropy and other forms of energy relations, two phase systems-Clapeyron and Clausius-Clapeyron equations, Temperature dependence of vapor pressure of liquids, Alternative equations for liquids, Joule-Thomson coefficient, Gibbs-Helmholtz equation, Thermodynamic diagrams.

**[9L+3T=12Hrs]**

**UNIT - II**

**RESIDUAL PROPERTIES:** Residual properties, Fugacity, Fugacity coefficient, Fugacity in solutions, Henry's law and dilute solutions, Activity, Activity in solutions, Activity coefficients, Property changes of mixing.

**SOLUTION THERMODYNAMICS:** Partial molar properties and Gibbs- Duhem equations, Numerical on estimation of partial molar properties.

**[9L+3T=12Hrs]**

**UNIT- III**

**PHASE EQUILIBRIA:** Criteria of phase equilibrium, Chemical potential, Criterion of stability, Duhem's theorem, Vapour-Liquid Equilibrium, Phase diagrams for binary solutions, VLE in ideal solutions, Simple models for vapor liquid equilibrium, VLE-Qualitative behaviour, Raoult’s law, Henry’s law and Modified Raoult’s laws, Numerical on Dew and bubble point temperature and pressure, VLE from K value correlations, Flash calculations.

**[8L+2T=10Hrs]**

**UNIT - IV**

**NON-IDEAL SOLUTIONS**: Excess properties, Azeotropes, Activity coefficient equations: Van Laar equation, Margules and Willson equations; Consistency test for VLE data: Slope method, Midpoint method, Redlich-Kister method and Partial pressure data.

**[8L+2T= 10Hrs]**

## UNIT - V

**CHEMICAL REACTION EQUILIBRIUM**: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Feasibility of chemical reaction; Equilibrium constant: Effect of temperature, Evaluation, Effect of pressure; Equilibrium conversion: Effect of pressure, inert materials, excess of reactants, products, Phase rule for reacting system.

**[6L+2T=08Hrs]**

### TEXTBOOKS:

1. Smith J. M. and Van Ness H.C, "Introduction to Chemical Engineering Thermodynamics", 5th edition, McGraw Hill, New York, 1996.
2. Narayanan, K. V. “Chemical Engineering Thermodynamics”, Prentice Hall of India Private Limited, New Delhi, 2001.

### REFERENCE BOOKS:

1. Rao, Y.V.C Chemical Engineering Thermodynamics, New Age International Publication, Nagpur, 2000.
2. Halder, Gopinath, “Introduction to chemical engineering thermodynamics”, PHI Learning Pvt. Ltd., New Delhi, 2009

### E BOOKS

1. Kevin Dahm, “Fundamentals of Chemical Engineering Thermodynamics”: https://books.google.co.in/books
2. DimitriosTassios, “Applied Chemical Engineering Thermodynamics”: https://books.google.co.in/books

### MOOC’s and ONLINE COURSES:

1. http://elearning.vtu.ac.in/06ME33.html
2. MOOC’s Course on Thermodynamics: https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about

### QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit III, IV, V and two questions each from Unit I and II.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES | Level |
|---|---|---|---|
| **CO1** | Apply the knowledge of classical thermodynamics to predict the thermodynamic properties of ideal and real gases | PO1 | 1 |
| **CO2** | Derive thermodynamic relations between thermodynamic properties | PO2 | 3 |
| **CO3** | Estimate properties of ideal and real gases from the thermodynamic relations. | PO2 | 2 |
| **CO4** | Apply equations of state for describing the phase behaviour of various fluids. | PO3 | 3 |
| **CO5** | Evaluate the equilibrium conversion in a reversible reaction using the Gibbs phase rule criteria | PO3 | 2 |
| **CO6** | Assessment of the phase behaviour and equilibrium data of both pure and multicomponent systems by using phase equilibrium criteria. | PO3 | 2 |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| **Theory Component** | **Three Internals (Best of Two)** | **80%** | **Course Instructor** |
| | **AAT** | **20%** | **Course Instructor** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**Assessment Pattern:**

| Component | Theory (100%) | | | Total Marks |
|---|---|---|---|---|
| | Test 1 | Test 2 | AAT | |
| **Max. Marks** | **40** | **40** | **20** | **100** |
| **Reduced CIE** | **20** | **20** | **10** | **50** |

| Course Title | Mass Transfer-I | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH4PCMT1 | Credits | 03 | L – T – P | 3 – 0 – 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Chemistry, Engineering Maths and Technical Chemistry

**SYLLABUS:**

**UNIT–I**

**INTRODUCTION:** Diffusion in fluids, Wilke-Lee and Wilke and Chang equations for determination of Diffusivities, diffusion in solids, and calculations of diffusivities.
Eddy diffusion, individual and overall mass transfer coefficients and their correlations, theories of mass transfer, interphase mass transfer. **10 Hrs**

**UNIT-II**

**HUMIDIFICATION OPERATIONS**: Vapour pressure curve, enthalpy of pure substance, humidity and related terminologies, Psychometric chart and evaluation of absolute humidity, molal humidity, relative humidity, and others. Adiabatic-Saturation curves, wet bulb temperature, Lewis relation and gas-liquid contact operations, dehumidification. Equipment: water cooling towers and spray chamber.

**10 Hrs**

**UNIT-III**

**DRYING:** Introduction to drying operation, equilibrium, drying rate curves, time of drying, and mechanism of drying. Equipment: classification, direct, and indirect batch driers, and rotary, spray and drum continuous driers.

**06 Hrs**

**UNIT – IV**

**ADSORPTION AND ION EXCHANGE**: Theories of adsorption, industrial adsorbents. Material balance for co-current, cross current, and counter-current operations. Fixed bed adsorption, adsorption of liquids.

**07 Hrs**

**UNIT- V**

**CRYSTALLIZATION:** Factors governing nucleation and crystal growth rates, methods of obtaining super-saturation, Mier's super-saturation theory. Crystallizer equipment: vacuum, Swenson-walker, and draft tube- baffle crystallizers.

**06 Hrs**

**TEXTBOOK:**

1. Robert E. Treybal, "Mass transfer operations", 3rd edition, McGraw Hill publications, 1980.

2. McCabe & Smith, "Unit operations in chemical engineering", 6th edition, McGraw Hill publications, 2001.

**REFERENCE BOOKS**:

1. Coulson and Richardson, "Chemical Engineering", Vol I, II, IV & V, 4th edition, Pergamon Press.
2. Badger, W.L. and Banchero J.T.,"Introduction to Chemical Engineering", 3rd edition, McGraw Hill International Edition., 1999.

**EBOOKS**

**1.** Mass Transfer in Chemical Engineering Processes, by Jozef Markoš http://www.e-booksdirectory.com/details.php?ebook=6659

2.Transport Processes and Unit Operations by Geankoplis http://chembookneed.blogspot.in/2010/08/transport-processes-and-unit-operations.html

**MOOC's:**

1. Mass Transfer operations 1 https://www.coursebuffet.com/sub/chemical-engineering/480/mass-transfer-operations-i
2. Mechanical heat and mass transfer https://www.springboard.com/udemy/mechanical-heat-and-mass-transfer/

**Question Paper Pattern:**

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit III, IV, V and two questions each from Unit I and II.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES | Levels |
|---|---|---|---|
| **CO1** | Comprehend the basic principles of diffusion, humidification, drying, adsorption and crystallization. | PO1 | 1 |
| **CO2** | Formulate equations to estimate diffusivities and mass transfer flux in fluids and solids using first principles of engineering sciences. | PO2 | 3 |
| **CO3** | Apply the principles of mass transfer to solve the problems related to diffusion, humidification, adsorption, drying, and crystallization | PO2 | 3 |
| **CO4** | Analyze the psychrometric chart to calculate the various parameters of the air-water vapour mixture. | PO2 | 2 |
| **CO5** | Select the appropriate humidifier, dryer, and crystallizer based on the requirement. | PO5 | 2 |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| Theory Component | Three Internals (Best of Two) | 80% | Course Instructor |
| | AAT | 20% | Course Instructor |
| Semester End Examination (Written Examination for Three Hours) | | Marks 100 (Weightage 50%) | |

**Assessment Pattern:**

| Component | Theory (100%) | | | Total Marks |
|---|---|---|---|---|
| | Test 1 | Test 2 | AAT | |
| Max. Marks | 40 | 40 | 20 | 100 |
| Reduced CIE | 20 | 20 | 10 | 50 |

# DEPARTMENT OF CHEMICAL ENGINEERING
# B.M.S. COLLEGE OF ENGINEERING, BENGALURU
**Autonomous Institute, Affiliated to VTU**

| Course Title | Process Heat Transfer | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH4PCHTR | Credits | 04 | L – T – P | 3 – 0 – 1 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Mathematics and Engineering Physics

**SYLLABUS:**

**UNIT -I**

**INTRODUCTION:** Various modes of heat transfer Viz. Conduction, Convection and Radiation.
**Conduction:** Fourier's law, Steady state unidirectional heat flow through single and multiple layer slabs, spheres and cylindrical surfaces for constant and variable thermal conductivity.

**7Hrs**

**UNIT-II**

**INSULATION:** Properties of insulation materials, Types of insulation, Critical and Optimum thickness of insulation.
**FIN:** Types of fins, Heat dissipation from a fin loosing heat at tip, Heat flow through infinitely long rectangular fin, heat dissipation from fin insulated at tip. Fin efficiency and fin effectiveness-derivation and problems. Elementary treatment of unsteady state heat conduction.

**10Hrs**

**UNIT -III**

**CONVECTION**: Individual and over all heat transfer coefficient, LMTD, LMTD correction factor, Heat Transfer with Phase Change: Boiling phenomena, Nucleate and film boiling.
**CONDENSATION:** Film and Drop wise condensation, Nusselt's equations.

**10Hrs**

**UNIT -IV**

**EVAPORATION:** Methods of Feeding multi effect evaporator, working of single effect natural Circulation evaporator. Enthalpy Balance for single effect evaporator and calculations, BPE, Durhring's Chart, Economy and capacity of Evaporators.

**6Hrs**

**UNIT-V**

**RADIATION:** Definitions for absorptivity, reflectivity, emissive power and intensity of radiation, black body radiation, grey body radiation Stefan-Boltzman's Law, Wien's displacement Law, Kirchoff'sLaw, view factors. Radiation between surfaces-different shapes, radiation involving gases and vapors, radiation shields.

**6Hrs**

**LABORATORY COMPONENT**

1. Shell and Tube Heat Exchanger
2. Double Pipe Heat Exchanger
3. Vertical condenser
4. Emissivity
5. Helical coil Heat Exchanger
6. Transient Heat Conduction (constant temperature)
7. Bare Tube Heat Exchanger
8. Fin Tube Heat Exchanger
9. Packed Bed Heat Exchanger
10. Transient Heat Conduction (constant flux)

**TEXTBOOKS:**

1. Kern D. Q.,"Process Heat Transfer" McGraw-Hill, NewYork,1965
2. McCabe, Warren, L., Smith, Julian, C. and Harriott, Peter, “Unit operations of chemical engineering”, 5th edition, McGraw-Hill, Singapore, 2000.

**REFERENCE BOOKS**:

1. Coulson J. M. and Richardson J. F. "Unit Operations of Chemical Engineering, 5th edition, Chemical Engineering Pergamon and ELBS, McGraw Hill, New York 2000.
2. P. K. Nag, Heat and Mass Transfer, 2nd edition, Tata McGraw hill publications.

**E-BOOKS**

1. Rao Y. V. C, Heat Transfer, 1st edition, Universities Press (India) Ltd., New Delhi, 2000.
2. Dutta, B. K, Heat Transfer: Principles and Applications, PHI Learning Pvt. Ltd., New Delhi,2006

**MOOC’s and ONLINE COURSES:**

1. http://textofvideo.nptel.iitm.ac.in/103103031/lec1.pdf
2. https://www.mooc-list.com/course/heat-transfer-saylororg%3Fstatic%3Dtrue+&cd=7&hl=en&ct=clnk&gl=in

**QUESTION PAPER PATTERN:**

1. Overall question paper pattern to have seven questions from five units

2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, IV, V and two questions each from Unit II and III.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | PROGRAMME OUTCOMES |
|---|---|---|
| CO1 | Understand the principles of heat transfers and perform heat flux calculations for constant & variable area elements | PO2 |
| CO2 | Estimation of optimum insulation thickness and select different shapes of extended surfaces to enhance overall heat transferee co-efficient. | PO2 |
| CO3 | Perform preliminary design of heat transfer equipment using data with and without phase change | PO3 |
| CO4 | Comprehend and apply the laws governing radiation mode | PO2 |
| CO5 | Conduct experiments in teams and estimate the heat transfer co-efficient for fluids with and without phase change | PO9 |
| CO6 | Present the experimental observations in the form of a lab report. | PO2 |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| Theory Component | Three Internals (Best of Two) | 40% | Course Instructor |
| | Quiz (One Quiz or AAT) | 10% | Course Instructor |
| Laboratory Component | Laboratory Component | 50% | Course Instructor |
| Semester End Examination (Written Examination for Three Hours) | | Marks 100 (Weightage 50%) | |

**ASSESSMENT PATTERN:**

| Component | Theory (50%) | | | Practical (50%) | | Total Marks |
|---|---|---|---|---|---|---|
| | Test 1 | Test 2 | Quiz/AAT | Records & Performances | Lab Test | |
| Max. Marks | 20 | 20 | 10 | 30 | 20 | 100 |
| Reduced CIE | 10 | 10 | 5 | 15 | 10 | 50 |

# DEPARTMENT OF CHEMICAL ENGINEERING
# B.M.S. COLLEGE OF ENGINEERING, BENGALURU
**Autonomous Institute, Affiliated to VTU**

| Course Title | Pollution Control and Management | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH4PCPCM | Credits | 03 | L – T – P | 3– 0 – 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES:** Engineering Chemistry and Engineering Physics

**SYLLABUS:**

**Unit - I**

**WATER POLLUTION**: Water as resource, drinking water quality-IS10500, water consumption standards as per National building codes (NBC), Types of Water Pollutants and sources, State and central wastewater quality and prevailing discharge standards. Wastewater Sampling and Characteristics - Physical, Chemical and Biological characteristics of wastewater: Solving numerical on the sampling and analysis **6Hrs**

**UNIT - II**

**WASTEWATER TREATMENT**: Preliminary/Primary/physical unit operations, Chemical unit processes, Secondary/Biological treatment process, aerobic/anaerobic attached and suspended growth process. Activated sludge process: Process analysis: Completely mix with recycle, Sequential Batch Reactor (SBR), Rotating biological contactor/disc (RBC), Trickling filter, UASB digester, aerated lagoon, stabilization ponds.– Standard type and modifications. Aerators/diffusers and Sludge treatment & Disposal. With applicable numerical **10Hrs**

**UNIT – III**

**TERTIARY/ADVANCED WASTEWATER TREATMENT:** Ultrafiltration, Filtration, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis.

**BIOLOGICAL NUTRIENT REMOVAL**: Introduction, Biological nitrogen removal-, Nitrification–denitrification. Physicochemical process for nitrogen removal - Air stripping **6Hrs**

**UNIT- IV**

**AIR POLLUTION & CONTROL:** Definition, Sources, Classification, Properties of air pollutants, and Effects of air pollution on health, vegetation, and materials. Ambient sampling and Stack sampling & Analysis of air pollutants, Control methods - Equipments for particulates and gaseous pollutants.

**NOISE POLLUTION**: Definition, Sources, Effects of Noise, Equipment for Noise Measurement, Approaches for Noise Control. **7Hrs**

**UNIT –V**

**SOLID WASTE MANAGEMENT:** Definitions, Characteristics, Types, Sources and Properties of solid waste with numericals.

**E-WASTE MANAGEMENT** What is E-Waste, Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of e-waste, Possible hazardous substances present in e-waste, Environmental and Health implications.

The hazardous waste (Management and Handling) rules 2003, E-waste management rules 2015, Regulatory compliance including roles and responsibility of different stakeholders – producer, manufacturer, consumer, Proposed reduction in the use of hazardous substances (RoHS), Extended producer responsibility (EPR). **10 Hrs**

**TEXT BOOKS:**

1. Environmental Engineering by Howard S. Peavey, Donald R. Rowe, George Techobanolous, McGraw-Hill International Editions.
2. Wastewater Engineering – Treatment, Disposal and Reuse, METCALF AND EDDY, INC. 3rd Edition Tata McGraw-Hill Publishing Company Limited.
3. M N. Rao, Air Pollution, Tata McGraw-Hill Publishing Company Limited

**REFERENCE BOOKS:**

1. S P Mahajan, Pollution Control in Process Industries McGraw Hill Education 2017
2. C S Rao, Environmental Pollution Control Engineering, New Age International Publisher, 2011.
3. Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi.
4. Rumana Riffat, Taqsim Husnain, Fundamentals of Wastewater Treatment and Engineering, CRC Press, 2022

**E BOOKS**

1. Air Pollution by M N Rao and HVN Rao: http://www.avlib.in/ebook/title/air-pollution-mn-rao-and-hvn-rao-.html
2. https://www.free-ebooks.net/ebook/introduction-to-wastewater-treatment

**MOOC's & ONLINE COURSES:**

1. https://www.basel.int/Implementation/TechnicalAssistance/MOOC/tabid/4966/Default.aspx
2. https://www.class-central.com/subject/civil-environmental-engineering
3. https://www.class-central.com/subject/environmental-science

**Question Paper Pattern:**

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, III, IV and two questions each from Unit II and V.

**COURSE OUTCOMES (COs):**

| COURSE OUTCOMES | | Programme Outcomes | Levels |
|---|---|---|---|
| **CO1** | understand quality standards, sources pollution and pollutant types, and discharge regulations in accordance with national standards, with proficiency in sampling and analysis techniques**.** | PO6 | 1 |
| **CO2** | Demonstrate comprehensive knowledge of treatment methods and evaluate characteristics. | PO2 | 2 |
| **CO3** | Display expertise in advanced wastewater treatment technologies to enhance water quality. | PO6 | 3 |
| **CO4** | Explain biological nutrient removal and apply techniques. | PO7 | 2 |
| **CO5** | Identify, evaluate, and propose solutions for air, noise, solid, and e-waste management | PO12 | 2 |

**ASSESSMENT:**

| Continuous Internal Assessments | | Marks 100% (Weightage 50%) | Assessment |
|---|---|---|---|
| **Theory Component** | **Three Internals (Best of Two)** | **80%** | **Course Instructor** |
| | **AAT** | **20%** | **Course Instructor** |
| **Semester End Examination (Written Examination for Three Hours)** | | **Marks 100 (Weightage 50%)** | |

**Assessment Pattern:**

| Component | Theory (100%) | | | Total Marks |
|---|---|---|---|---|
| | Test 1 | Test 2 | AAT | |
| **Max. Marks** | **40** | **40** | **20** | **100** |
| **Reduced CIE** | **20** | **20** | **10** | **50** |

| Course Title | Universal Human Values | | | | |
|---|---|---|---|---|---|
| Course Code | 23MA4AEUHV | Credits | 01 | L – T – P | 0– 1 – 0 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**Course Objectives:** To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.

## UNIT – I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

## UNIT – II

Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I am being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

## UNIT –III

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

## UNIT – IV

Understanding harmony in the nature and existence - whole existence as coexistence

1. Understanding the harmony in the nature
2. Holistic perception of harmony at all levels of existence.

## UNIT – V

Implications of the above holistic understanding of harmony on professional ethics

1. Natural acceptance of human values
2. Definitiveness of ethical human conduct

Includes practice of exercises, case studies in practice (tutorial) sessions.

Example: Discuss the conduct as an engineer or scientist etc.

At the end of the course, the student will have the ability to

| | |
|---|---|
| CO1 | Conduct self-exploration and distinguish between the values and skills, happiness and accumulation of physical facilities, the self and the body, intension and competence of an individual. |
| CO2 | Analyze the value of harmonious relationship based on trust and respect in personal and professional life . |
| CO3 | Examine the role of a human being in ensuring harmony in society and nature. |
| CO4 | Apply the understanding of ethics in life and profession. |

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

REFERENCE MATERIAL:

1. Ek Parichaya, A Nagaraj, Jeevan Vidy, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
3. Annie Leonard, The Story of Stuff, 2010.
4. Mohandas Karamchand Gandhi, The Story of My Experiments with Truth
5. E. F Schumacher, Small is beautiful
6. Cecile Andrews, Slow is beautiful
7. J C Kumarappa, Economy of Permanence, 2017
8. Dharampal, Rediscovering India, 1963
9. Mohandas K. Gandhi, Hind Swaraj or Indian Home Rule
10. Maulana Abdul Kalam Azad, India Wins Freedom
11. Vivekananda- Romain Rolland (English)

**Assessment pattern:**

**CIE and SEE for Universal Human Values Course with 1 credit:**

**CIE Component:**

- Only one CIE shall be conducted after CIE2 and before CIE 3.
- CIE shall be conducted at department level and by the respective faculty handling the course.
- Marks for CIE is 50.

The Marks distribution among various components of CIE is given hereunder:

| | |
|---|---|
| **Multiple-Choice Question: (MCQs)** | 10 marks |
| **Attendance:**<br>Attendance >95%<br>Attendance 85% - 95%<br>Attendance 75%-85% | <br>05 marks<br>03 marks<br>NO marks |
| **Report Submission:**<br>i. Each student shall submit a report on his/her experiences about the course contents.<br>ii. The report shall be a maximum of 2 pages and a minimum of 1 page.<br>Marks for submission of report within the timelines and as per the format (as specified by the faculty) | <br><br><br>05 marks |
| AAT component – Assessment shall be done using rubrics as specified by the faculty. | 30 marks |

SEE Component:

- Marks for SEE is 50.
- SEE shall have a maximum of 25 MCQs and a duration of 1 hour.
- The conduction of SEE shall be done in online mode with MCQs by the respective course instructor and marks shall be submitted to the COE office.
- The award of marks for SEE shall be completed well before the commencement of regular SEE.
- Awarding grades will be based on CIE and SEE marks.
- The course addresses Program Outcomes, PO8, PO9, PO10 and PO12

| Course Title | Simulation Laboratory | | | | |
|---|---|---|---|---|---|
| Course Code | 23CH4AESIM | Credits | 01 | L – T – P | 0– 0 – 1 |
| CIE | 100 marks (50% weightage) | SEE | 100 marks (50% weightage) | | |

**PREREQUISITES: Fluid mechanics, Mechanical operations, Process Heat Transfer and Chemical Engineering Thermodynamics**

**List of Experiments**

1. Bubble point and Dew point calculation for a two-component mixture
2. Pressure drop in a pipe for Newtonian Fluid
3. Computation of energy efficiency in a crusher
4. Design and optimization of shell and tube heat exchanger
5. Simulation of flash separator
6. Simulation of continuous filtration operation
7. Simulation of refrigeration cycle
8. Simulation of flow in Static Mixer
9. Simulation of Heat transfer in a heating coil
10. Data Analysis using Artificial Intelligence and Machine Learning (AI&ML)

**ASSESSMENT PATTERN:**

**SCHEME OF CONTINUOUS INTERNAL EVALUATION (CIE):**

| Criteria | Lab conduction (30 M) | | | Lab Test (20 M) | Total Marks (50 M) |
|---|---|---|---|---|---|
| Marks | Conduction of experiment and reporting | Record writing | Viva-voce | | |
| | 15 | 10 | 5 | 20 | 50 |

**LAB TEST:**

One experiment will be allotted for each student Details of marks for each experiment.

1. Write-up 05
2. Conduction of experiment 05
3. Interpretation of observations and calculations 05
4. Viva-voce 05

**Total : 20**

**ELIGIBILITY FOR SEMESTER END EXAMINATION**

Submission and certification of lab manual and record is compulsory to attend SEE. Minimum marks required in CIE to attend semester end examination is 35% of maximum 50 marks: Lab conduction (35% of 30 Marks) and Lab Test (35% of 20 Marks).

**SEMESTER END EXAMINATION:**

All 10 experiments are included for the practical examination.

| **Scheme of Semester End Examination (SEE):** | | | |
|---|---|---|---|
| 1 | ● Exam will be conducted for 50 marks in 3 hrs duration<br>● One experiment will be allotted for each student | | |
| 2 | Minimum marks required in SEE to pass: 20 out of 50 marks | | |
| 3 | Write-up | 10 marks | 50 marks |
| 4 | Conduction of experiment | 15 marks | |
| 5 | Calculation and inferences | 15 marks | |
| 6 | Viva- voce | 10 marks | |

| Yoga |
|---|
| **Course objectives:**<br>• Promoting positive health, prevention of stress related health problems and rehabilitation through Yoga.<br>• Integral approach of Yoga Therapy to common ailments.<br>• Imparting skills in them to introduce Yoga for health to general public and Yoga for total personality development of students in Colleges and Universities.<br>• Invoke scientific attitude and team spirit to channelize their energies in to creative and constructive endeavors.<br>• To enable them to establish Yoga Therapy centers in the service of common man. |
| **Teaching-Learning Process (General Instructions)**<br>These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.<br>• Teachers shall adopt suitable pedagogy for effective teaching - learning process. The pedagogy shall involve the combination of different methodologies which suit modern technological tools and software's to meet the present requirements of the Global employment market.<br>(i) Direct instructional method (Low /Old Technology),<br>(ii) Flipped classrooms (High/advanced Technological tools),<br>(iii) Blended learning (combination of both),<br>(iv) Enquiry and evaluation-based learning,<br>(v) Personalized learning,<br>(vi) Problems based learning through discussion,<br>(vii) Following the method of expeditionary learning Tools and techniques,<br>Apart from conventional lecture methods, various types of innovative teaching techniques through videos, animation films may be adapted so that the delivered lesson can progress the students in theoretical applied and practical skills in teaching of the concepts of Health and Wellness in general. |
| **Module-1** |
| **Introduction and Trends of Yoga**<br>• Meaning, Definition, and Importance of Yoga<br>• History and Philosophical Aspects of Yoga<br>• Need for and Importance of Yoga in Modern World |

| | |
|---|---|
| Teaching | Chalk and talk method, Power Point presentation and YouTube videos, Animation |

| | |
|---|---|
| Learning process | videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |
| **Module-2** | |
| **Means of Yogic Practices**<br>• Introduction to Prayer and Its Importance<br>• Concept of Asana, Types and Benefits of Asana<br>• Concept of Pranayama, types, and benefits of Pranayama<br>• Concept and types of Mudras and Bandha<br>• Concept of Meditation and its benefits | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |
| **Module-3** | |
| **Meaning, techniques, precautions & effects of the following**<br>• Classification of Asanas - Meditative Asanas – Relaxative Asanas – Cultural Asanas. - safety measure and precautions while performing asanas.<br>• Pranayama – different phases in Pranayama practices: Puraka (Inhalation), Kumbhaka (Retention) and Recaka (Exhalation), - safety measures and precautions while performing pranayama.<br>• Meditation - Its techniques & benefits.<br>• Practicing methods and benefits of Kriyas, Bandha and Mudra. | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments & Practical sessions. |
| **Module-4** | |
| **Application of Yoga**<br>• Yoga for Health and Wellness<br>• Yoga for Aged Population<br>• Yoga for Otherly able population<br>• Yoga for Elite Sports Persons | |
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |
| **Module-5** | |
| **Yoga and Stress Management:** | |

- Concept of Stress according to Yoga
- Stress Management and Relaxation Techniques
- Postural deformities and corrective measures
- Yoga and development of Social qualities of personality - Co-operation - Simplicity - Tolerance - Social adjustments - Yoga and personal efficiency. Improvement of personal efficiency through yoga

| | |
|---|---|
| Teaching Learning process | Chalk and talk method, Demonstration and assessment method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

**Course outcome (Course Skill Set)**

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

1. Demonstrate an understanding of anatomy and physiology as it applies to the intentional integration of breath, postures, and movement within the practice of yoga
2. Identify asana specific to their desired health benefits and create a yoga practice
3. Apply their understanding of yogic text and principles to their daily lives and yoga practice

**Suggested Learning Resources:**

**Books:**

4. Yoga – A Healthy Way of Living" by NCERT
5. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers.
6. Nagendra, H.R., and Nagarathana, R., (2004). Yoga perspective in stress management. Bangalore: Swami Vivekananda Yoga Prakashana.

**Activity based Learning (suggested Activities in Class)/ Practical Based learning.**

- Asanas practice session, Contents related activities (Activity-based discussions)
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions and Health issues-based activities.
- Quizzes and Discussions
- Seminars and assignments

| Course Title | Physical Activity | | | | |
|---|---|---|---|---|---|
| Course Code | 23PE3NCPYA | Credits | 00 | L – T – P | 0 – 0 – 0 |
| Non-Credit Mandatory Course | | SEE | | P/NP | |

## Physical Education (Sports and Athletics)

**Course objectives:**

- To impart the students with basic concepts of Physical Education and Sports Science for health and wellness.
- To familiarize the students with health-related Exercises, Sports for Overall growth & development
- To create a foundation for the professionals in Physical Education, Sports.
- To impart the basic knowledge and skills to teach Physical Education, Sports activities.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies; which teacher can use to accelerate the attainment of the various course outcomes.

- Teachers shall adopt suitable pedagogy for effective teaching - learning process. The pedagogy shall involve the combination of different methodologies which suit modern technological tools and software's to meet the present requirements of the Global employment market.

  (i) Direct instructional method (Low /Old Technology),

  (ii) Flipped classrooms (High/advanced Technological tools),

  (iii) Blended learning (combination of both),

  (iv) Enquiry and evaluation-based learning,

  (v) Personalized learning,

  (vi) Problems based learning through discussion,

  (vii) Following the method of expeditionary learning Tools and techniques,

- Apart from conventional lecture methods, various types of innovative teaching techniques through videos, animation films may be adapted so that the delivered lesson can progress the students in theoretical applied and practical skills in teaching of the concepts of Health and Wellness in general.

**Module-1**

**Engineering Technology in Sports:**

Introduction to Sports Technology, Technological innovations in sports, Use of technology in

performance enhancement and analysis, Computer applications in sports

| | |
|---|---|
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

**Module-2**

**Fitness and Healthy Lifestyle:**

- Health and Safety in Daily Life at Work- Balance diet
- Yogic practice
- Aerobic Dance/Zumba

| | |
|---|---|
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

**Module-3**

**Sports Training**

- Meaning, definition, aim and objectives of sports training.
- Principles, Characteristics of sports training.
- Basic skills and techniques of the Sports/Game. (Each student shall involve in minimum 02 games).

| | |
|---|---|
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

**Module-4**

**Ethics in Sports:**

Ethics in Sports - Nature, Characteristics and Needs, Ethical practices in the field of Sports, Code of Conduct, Ethical Value System - Distributive Justice, Individual freedom of Choice, Professional Codes. Their application in the field of sports, Sports as a Profession - Conflict between organization demand, Individual needs and professional ideal, Conflicts the Sports Managers encounter, Social and Ethical - responsibilities of different Sports Association, Clubs, Manager, Coach and Sports Persons, Morale of Sportsmen- Role of Organizations I Association and Sports Manager in the area.

| | |
|---|---|
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in classroom discussions. Giving activities & assignments. |

**Module-5**

**Fundamental Exercise**

Head, Neck and Facial Exercises, Shoulder and Chest Exercises, Abdominal, Hip and Trunk Exercises, Upper arm, lower Arm, Wrist and Finger Exercises, Thigh, Knee, Calf, Ankle and Finger Exercises

| | |
|---|---|
| Teaching Learning process | Chalk and talk method, Power Point presentation and YouTube videos, Animation videos methods. Creating real time stations in practical session. Giving activities & assignments. |

**Course outcome (Course Skill Set)**

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

1. Understand fundamental concepts of physical education and sports.
2. Apply in advanced sports technology with personal accountability, integrity and social responsibility for outcome and through dynamic work-teams that uses resources efficiently.
3. Acquire fundamental theory, training methods and sports pedagogy.
4. Create a wider base of personnel to pursue various sport related careers.

**Suggested Learning Resources:**

1. Managing Sporting Events- Jerry Solomon (Human kinetics)
2. Managing Sports Organizations- Ruben Acosta Hernandez
3. Contemporary Sports management- Janet. B. Parks & Jerome Quarter man

(Publishers Human Kinetics)

4. Bompa T. (1999). Periodization- Theory and Methodology of Training (4th ed). Champaign,

Illinois: Human Kinetics.

5. Singh H (1999). Science of Sports Training. New Delhi. DVS Publication.
6. Uppal AK (1999). Sports Training. New Delhi. Friends Publication
7. Franz K. F. et. al., Editor, Routledge Handbook of Sports Technology and Engineering (Routledge, 2013)
8. Steve Hake, Editor, The Engineering of Sport (CRC Press, 1996)
9. Dixon, Sharon. The science and engineering of sport surfaces. Routledge, 2015.
10. Franz K. F. et. al., Editor the Impact of Technology on Sports II (CRC Press, 2007)
11. John Mongilo, (2001), “Nano Technology 101 “New York: Green wood publishing group.
12. Magdalinski, Tara. Sport, technology, and the body: The nature of performance. Routledge,

2009.

**Activity based Learning (suggested Activities in Class)/ Practical Based learning**

- Contents and Practical related activities (Activity-based Skills practice/discussions)
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions and Health issues-based activities
- Quizzes and discussions
- Seminars and assignments