MANONMANIAM SUNDARANAR UNIVERISTY,
TIRUNELVELI-12

SYLLABUS

PG - COURSES – AFFILIATED COLLEGES

Course Structure for M. Sc. Physics

(Choice Based Credit System)

(with effect from the academic year 2024-2025 onwards)

Semester-III				
Part	**Subject Status**	**Subject Title**	**Subject Code**	**Credit**
III	CORE VII	QUANTUM MECHANICS-II	VPHC31	5
III	CORE VIII	CONDENSED MATTER PHYSICS	VPHC32	5
III	CORE IX	NUMERICAL METHODS AND PROGRAMMING IN C++	VPHC33	5
III	CORE X	PRACTICAL – III: ADVANCED PHYSICS EXPERIMENTS I AND MICROPROCESSOR 8085 & MICROCONTROLLER 8051 PROGRAMMING	VPHL31	4
III	ELECTIVE V	SPECTROSCOPY	VPHE31	3
III	SEC - 2	SEWAGE AND WASTE WATER TREATMENT AND REUSE	VPHSE31	2
III		INTERNSHIP / FIELD VISIT / INDUSTRIAL VISIT/ RESEARCH KNOWLEDGE UPDATING ACTIVITY	VPHI31	2

Total Marks: 100 Internal Exam: 25 marks + External Exam: 75 marks

A. **Scheme for internal Assessment**:
Maximum marks for written test: **20 marks**
3 internal tests, each of **I hour** duration shall be conducted every semester.
To the average of the **best two** written examinations must be added the marks scored in. The **assignment** for 5 marks.

The break up for internal assessment shall be:
Written test- 20 marks; Assignment -5 marks Total - 25 marks

B. Scheme of External Examination
3 hrs. examination at the end of the semester
A – Part : 1 mark question two - from each unit
B – Part : 5 marks question one - from each unit
C – Part : 8 marks question one - from each unit

- **Conversion of Marks into Grade Points and Letter Grades**

S.No	Marks	Letter Grade	Grade point (GP)	Performance
1	90-100	O	10	Outstanding
2	80-89	A+	9	Excellent
3	70-79	A	8	Very Good
4	60-69	B+	7	Good
5	50-59	B	6	Above Average
6	40-49	C	5	Pass
7	0-39	RA	-	Reappear
8	0	AA	-	Absent

- **Cumulative Grade Point Average (CGPA)**

$$\mathbf{CGPA} = \frac{\mathbf{\Sigma\,(GP \times C)}}{\mathbf{\Sigma C}}$$

- **GP** = Grade point, **C** = Credit
- CGPA is calculated only for Part-III courses
- CGPA for a semester is awarded on cumulative basis

- **Classification**
  a) First Class with Distinction : CGPA $\geq$ 7.5*****
  b) First Class : CGPA $\geq$ 6.0
  c) Second Class : CGPA $\geq$ 5.0 and $<$ 6.0
  d) Third Class : CGPA$<$ 5.0

QUANTUM MECHANICS – II

Learning Objectives

- Formal development of the theory and the properties of angular momenta, both orbital and spin
- To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation.
- Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field
- To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts
- To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

UNIT I: SCATTERING THEORY

Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for S wave – Optical theorem – Transformation from centre of mass to laboratory frame.

UNIT II: PERTURBATION THEORY

Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability - Einstein‘s A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation .

UNIT III: RELATIVISTIC QUANTUM MECHANICS

Klein – Gordon Equation – Charge and Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Antiparticles – Spin of Electron - Magnetic Moment of an Electron Due to Spin.

UNIT IV: DIRAC EQUATION

Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman ‘s theory of positron (Elementary ideas only without propagation formalism)

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION

Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether‘s theorem – Quantization of real and complex scalar fields – Creation, Annihilation and

Number operators – Fock states – Second Quantization of K-G field.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. P.M.Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G.Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L.I.Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V.Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Nouredine Zettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017.

REFERENCE BOOKS

1. P.A.M. Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, London, 1973.
2. B.K. Agarwal & HariPrakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics, 1stedition,I.K.International Publishing house Pvt. Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E.Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970.

WEB SOURCES

1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf
2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf
3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf
4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf
5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

CONDENSED MATTER PHYSICS

Learning Objectives

- To describe various crystal structures, symmetry and to differentiate different types of bonding.
- To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat.
- To critically assess various theories of electrons in solids and their impact in distinguishing solids.
- Outline different types of magnetic materials and explain the underlying phenomena.
- Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNIT I: CRYSTAL PHYSICS

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (SC,BCC, FCC). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

UNIT II: LATTICE DYNAMICS

Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye‘s theory of lattice heat capacity - Thermal Conductivity - Umklapp processes.

UNIT III: THEORY OF METALS AND SEMICONDUCTORS

Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz Law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - De Hass-van Alphen effect.

UNIT IV: MAGNETISM

Diamagnetism - Quantum theory of Para-magnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons -

Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetic material - Neel temperature.

UNIT V: SUPERCONDUCTIVITY

Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Type I and II Superconductors. Theoretical Explanation: Thermodynamics of super conducting transition - London equations - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High Temperature Superconductors – SQUIDS.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. C.Kittel, 1996, Introduction to Solid State Physics, 7th Edition, Wiley, New York.
2. Rita John, Solid State Physics, Tata Mc-Graw Hill Publication.
3. A.J. Dekker, Solid State Physics, Macmillan India, New Delhi.
4. M.Ali Omar, 1974, Elementary Solid State Physics – Principle and Applications, Addison - Wesley
5. H.P. Myers, 1998, Introductory Solid State Physics, 2nd Edition Viva Book, New Delhi.

REFERENCE BOOKS

1. J.S. Blakemore, 1974 , Solid state Physics, 2nd Edition, W.B. Saunder, Philadelphia
2. H.M. Rosenburg, 1993, The Solid State, 3rd Edition, Oxford University Press, Oxford.
3. J.M. Ziman, 1971, Principles of the Theory of Solids, Cambridge University Press, London.
4. C.Ross-Innes and E. H. Rhoderick, 1976, Introduction to Superconductivity, Pergamon, Oxford.
5. J.P. Srivastava, 2001, Elements of Solid State Physics, Prentice-Hall of India, New Delhi.

WEB SOURCES

1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html

2. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html
3. https://www.britannica.com/science/crystal
4. https://www.nationalgeographic.org/encyclopedia/magnetism/
5. https://www.brainkart.com/article/Super-Conductors_6824/

NUMERICAL METHODS AND PROGRAMMING IN C++

Learning Objectives

- To make students to understand different numerical approaches to solve a problem.
- To understand the basics of programming and its application to solve physical problems

UNIT I -ROOTS OF EQUATION

Roots of equation: Bisection method – False position method – Newton Raphson method – Secant method – Order of convergence. Simultaneous Equations: Existence of solutions- Basic Gauss elimination method – Gauss Jacobi iteration method – Gauss Seidal iteration method – Inverse of a matrix using Gauss elimination method .

UNIT II - CURVE FITTING – INTERPOLATION

Curve fitting: Method of least squares – straight line, fitting a parabola, fitting y = axn , y = aebx type curves – **Interpolation**: Polynomial Interpolation – Lagrange polynomial – Newton polynomial - Forward and Backward differences – Gregory Newton forward and backward interpolation formula for equal intervals – Divided difference – properties of divided differences – Newton's divided differences formula – Lagrange's interpolation formula for unequal interval

UNIT III – EIGEN VALUES, DIFFERENTIATION AND INTEGRATION

Eigenvalues: Power method to find dominant Eigenvalue - Jacobi method

Numerical differentiation: Numerical differentiation – Formulae for derivatives – Taylors Series Method - Forward backward differences and central difference formula

Numerical Integration : Newton – cotes formula – Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, – Error estimates in trapezoidal and Simpson's rule – Monte Carlo Method.

UNIT IV - DIFFERENTIAL EQUATIONS

Ordinary differential equation: Solution by Taylor's series –- Basic Euler method – Improved and Modified Euler method – Runge Kutta fourth order method – solution of simultaneous first order differential equations and second order differential equations by RK fourth order Method

Partial differential equation: Introduction- Classification of partial differential equation of the 2nd order – Finite Difference approximations - Solution of Laplace's equation – Solution of Poisson's Equation –standard five point formula and diagonal five point formula (Jacobi and Gauss Seidal Methods).

UNIT V : PROGRAMMING IN C++

Program structure and header files - Basic data types- operators - Control Structures: decision making and looping statements. Arrays, Strings, Structures, Pointers and File handling. Application programs – Solution to Algebraic and transcendental equations by Newton Raphson Method - Charging and discharging of a condenser by Euler's Method – Radioactive Decay by Runge Kutta fourth order method - Currents in Wheatstone's bridge by Gauss elimination method - Cauchy's constant by least square method - Evaluation of integral by Simpson's and Monte-Carlo methods - Newton's Law of cooling by Numerical differentiation.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

Books for Study

1. Introductory methods of numerical analysis, S. S. Sastry, Prentice Hall of India, 2010
2. Numerical methods for mathematics, science and engineering, John H. Matthews, Prentice Hall of India, 2nd Edition, 2000
3. M.K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering computation, 3 rd edition, New age international (P) Ltd, Chennai , 1998.
4. Object Oriented Programming with C++ by E. Balagurusamy, Tata McGraw-Hill , India, 4th Edition

Books for Reference

1. Computer Applications in Physics, S. Chandra, M.K. Sharma, Narosa, 3rd Edition,2014
2. M. K. Venketraman, Numerical Methods in Science and Engineering 2nd Ed., National Publishing Co., Chennai (2010).
3. E. Balagurusamy, Computer Oriented Statistical and Numerical Methods, Macmillan India Ltd, New Delhi (2000).

Related online resources:

1. https://youtu.be/LbKKzMag5Rc
2. https://youtu.be/Xb9Ypn77LBo
3. https://youtu.be/FfqAIlOxkoY

Advanced Physics Experiments – I and Microprocessor 8085 & Microcontroller 8051 Programming

Learning Objectives

- To make students to understand different concepts of physics
- To understand the basics of microprocessor and microcontroller programming

Section A (Any 6 Experiments)

1. Determination of Cauchy's Constant of the given prism – material. Obtain data by doing the Cauchy's Experiment and fitting a straight line using any software.
2. Determination Rydberg constant using Hydrogen Vapor lamp source.
3. Determination of Magnetoresistance of the given material.
4. Determination of Dielectric constant of the given liquid medium using Colpitt's oscillator or LCR circuit.
5. Photo Transistor Characteristics.
6. Temperature measurement using Si Diode as a Temperature Sensor (Calibrate the sensor using LM35)
7. Analysis of rotation and vibration spectrum /Interpretation of vibrational spectra of a given material
8. Determination of e/k using Transistors
9. Temperature coefficient of a Thermistor using 555 timer or any other method.
10. To study I-V Characteristics, Load Response, and Spectral Response of Photovoltaic Solar Cell
11. Pspice Simulation: Designing and simulating an Astable Multivibrator using a 555 Timer for the given frequency.
12. Pspice Simulation: Simulation of a Zener diode characteristics and voltage regulator.

Section B : Microprocessor 8085 and Microcontroller 8051 Programming (Any 6 Experiments)

All Programs should contain Algorithms and Flowcharts

8085 Microprocessor Programs

1. Arithmetic Operations

a) Addition of two 8 bit and two 16 bit numbers
b) Subtraction of two 8 bit and 16 bit numbers
c) Multiplication of two 8 bit numbers –16-bit result.

2. Data Manipulation

a) Arrange the given data items in Ascending or Descending order
b) Finding the Minimum or Maximum value in the given data set.
c) Search of a given character/number in the given data set.

3. System Call and Rolling character

a) Calculation of time delay for a given interval.
b) Roll a given character from Left to Right / Right to Left on the 7 segment displays with the specified time interval.

4. ADC Interfacing and Conversion

a) Interfacing ADC with 8085 – ADC chip Block diagram – 8085 - ADC interfacing diagram

b) Conversion of analog input to digital – Resolution – Graph between input and output.

5. DAC interfacing and Wave form generation.

Interfacing DAC with 8085 – DAC Chip Block diagram – 8085 - DAC - 8085 interfacing diagram

Wave Form Generation using DAC

a) Square wave with the specified period T

b) Rectangular Wave with Specified TH and TL

c) Ramp Wave

8051 Programs using Simulator - MCU8051 IDE (Freeware)

6. Data Transfer Programming

a) Write an assembly language program to transfer N bytes of data from location A: XX H to location B: YYH in the internal RAM

b)Write an assembly language program to exchange N bytes of data at location A: XX h and at location B:YY H.

7. Data Manipulation

a) Write an assembly language program to find the largest element in a given array of N =___ h bytes at location 4000h. Store the largest element at location 4062h.

b) Write an assembly language program to count number of ones and zeros in an eight bit number.

8. Arithmetic Programming

a) Write an assembly language program to perform the addition of two 16-bit numbers.

b) Write an assembly language program to perform the subtraction of two 16-bit numbers.

c) Write an assembly language program to perform the multiplication of two 8-bit numbers.

d) Write an assembly language program to find the square of a given number N.

9. Code Conversion

a) Write an assembly language program to convert a BCD number into ASCII.

b) Write an assembly language program to convert a ASCII number into Decimal.

c) Write an assembly language program to convert a decimal number into ASCII.

d) Write an assembly language program to convert a binary (hex) number into decimal.

e) BCD to 7 Segment Code

10. Counter

Write an assembly language program to implement a decimal counter and show the count on the 7segment display virtual hardware available in the simulator. Write and use a proper delay routine.

SPECTROSCOPY

Learning Objectives

- To comprehend the theory behind different spectroscopic methods
- To know the working principles along with an overview of construction of different types of spectrometers involved
- To explore various applications of these techniques in R &D.
- Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.
- Understand this important analytical tool

UNIT I: MICROWAVE SPECTROSCOPY

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra - Problems.

UNIT II: INFRA-RED SPECTROSCOPY

Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra – Simple applications.

UNIT III: RAMAN SPECTROSCOPY

Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle- determination of N_2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- Surface Enhanced Raman Spectroscopy.

UNIT IV: RESONANCE SPECTROSCOPY

Nuclear and Electron spin- Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan

Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR

UNIT V: UV SPECTROSCOPY

Origin of UV spectra - Laws of absorption – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications

TEXT BOOKS

1. C.N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, Vibrational Spectroscopy and Applications, New Age International Publication.
4. B.K. Sharma, 2015, Spectroscopy, Goel Publishing House Meerut.
5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th Edition), New Age International Publishers

REFERENCE BOOKS

1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link

WEB SOURCES

1. https://www.youtube.com/watch?v=0iQhirTf2PI
2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5
3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee
4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

SEWAGE AND WASTE WATER TREATMENT AND REUSE

Learning Objectives

- To gain basic knowledge in sewage and waste water Treatment procedures
- To gain industry exposure and be equipped to take up job.
- To harness entrepreneurial skills.
- To analyze the status of sewage and waste water management in the nearby areas.
- To sensitize the importance of healthy practices in waste water management.

UNIT I:
RECOVERY &REUSE OF WATER
Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication

UNIT II:
DISINFECTION
Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile - Bacteriostatic and Bactericidal - factors affecting disinfection.

UNIT III:
CHEMICAL DISINFECTION
Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs)

UNIT IV:
PHYSICAL DISINFECTION
Physical Disinfection: Introduction - Ultraviolet Radiation – Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.

UNIT V:
INDUSTRIAL VISIT
Industrial visit – data collection and analysis - presentation

UNIT VI:
PROFESSIONAL COMPONENTS
Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Drinking water and disinfection technique, Anirudhha Balachandra. CRC press (2013)
2. Design of Water and Wastewater Treatment Systems (CV-424/434), ShashiBushan,)0202(siai icl
3. Integrated Water Resources Management, Sarbhukan M M, CBS PUBLICATION (2013)
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007
5. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

REFERENCE BOOKS

1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020
2. Wastewater Treatment Technologies, MritunjayChaubey, Wiley, 2021.
3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002.
4. W.Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edn., McGraw Hill Inc., 1989
5. Lancaster, Green Chemistry: An Introductory Text, 2nd edition, RSC publishing, 2010.

WEB SOURCES

1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en
2. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648?
3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsACgM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsACgM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
5. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=g&hvrand=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi