List of Courses which focuses on Professional Ethics, Gender, Human Values, Environment & Sustainability and other value framework

Department : *Chemistry*

Programme Name : *B. Sc.*

Academic Year : 2023-24

Courses which focuses on Professional Ethics, Gender, Human Values, Environment & Sustainability and other value framework:

Sr. No.	Course Code	Name of the Course
01.	CYUFTT1	Green Chemistry
02.	CYUFLT1	Green chemistry practical
03.	CYUFTD1	Environmental Chemistry
04.	CYUATA1	History of Indian Science
05.	CYUBTA1	Renewable Energies (Solar & Biogas)
06.	CYUCTA1	Water remediation and conservation studies

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Scheme and Syllabus

Semester wise Theory Papers and Practical

B.Sc. Hon's (Chemistry): LOCF 2021-2022

Department of Chemistry, School of Physical Sciences

Course Opted	Course Code	Name of the course	Credit	Hour/ week	Internal Assess	End Sem Exam
Semester I						
CC-I Theory	**CYUATT1**	Inorganic Chemistry-I	3	3	30	70
CC-I Practical	**CYUALT1**	Inorganic Chemistry Practical-I	2	4	30	70
CC-II Theory	**CYUATT2**	Organic Chemistry-I	3	3	30	70
CC-II Practical	**CYUALT2**	Organic Chemistry Practical-I	2	4	30	70
AEC-I Theory	**CYUATA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
SEC-I Theory	**CYUATL1**	Select one from the Pool of SEC Courses offered	2	2	30	70
GEC-I Theory	**CYUATG1**	1A Physics-I, 1B Mathematics-I, 1C Zoology-I 1D Botany-1, 1EAnthropology-1, 1F Biotechnology-1, 1G Forensic Science-1	3	3	30	70
GEC-I Practical	**CYUALG1**	Generic Elective- Practical-I	2	4	30	70
Additional Credit Course I	**CYUATC1**	Select one from the Pool of Value added Courses offered				
		TOTAL	**19**	**25**	**240**	**560**
Semester II						
CC-III Theory	**CYUBTT1**	Physical Chemistry-I	3	3	30	70
CC-III Practical	**CYUBLT1**	Physical Chemistry Practical-I	2	4	30	70
CC-IV Theory	**CYUBTT2**	Organic Chemistry-II	3	3	30	70
CC-IV Practical	**CYUBLT2**	Organic Chemistry Practical-II	2	4	30	70
AEC-II Theory	**CYUBTA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
SEC-II Theory	**CYUBTL1**	Select one from the Pool of SEC Courses offered	2	2	30	70
GEC-II Theory	**CYUBTG1**	2A Physics-I, 2B Mathematics-I, 2C Zoology-I 2D Botany-1, 2EAnthropology-1, 2F Biotechnology-1, 2G Forensic Science-1	3	3	30	70
GEC-II Practical	**CYUBLG1**	Generic Elective- Practical-II	2	4	30	70
Additional Credit Course II	**CYUBTC1**	Select one from the Pool of Value added Courses offered				
		Total	**19**	**25**	**240**	**560**
Semester III						
CC-V Theory	**CYUCTT1**	Physical Chemistry-II	3	3	30	70
CC-V Practical	**CYUCLT1**	Physical Chemistry Practical-II	2	4	30	70
CC-VI Theory	**CYUCTT2**	Organic Chemistry-III	3	3	30	70
CC-VI Practical	**CYUCLT2**	Organic Chemistry Practical-III	2	4	30	70
CC-VII Theory	**CYUCTT3**	Molecular Spectroscopy & Photochemistry	3	3	30	70
CC-VII Practical	**CYUCLT3**	Spectroscopy Practical	2	4	30	70
AEC-III Theory	**CYUCTA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
GEC-III Theory	**CYUCTG1**	3A Physics-I, 3B Mathematics-I, 3C Zoology-I 3D Botany-1, 3EAnthropology-1, 3F Biotechnology-1, 3G Forensic Science-1	3	3	30	70
GEC-III Practical	**CYUCLG1**	Generic Elective- Practical-III	2	4	30	70
Additional Credit Course III	**CYUCTC1**	Select one from the Pool of Value added Courses offered				
		Total	**22**	**30**	**270**	**630**
Semester IV						
CC-VIII Theory	**CYUDTT1**	Physical Chemistry-III	3	3	30	70
CC-VIII Practical	**CYUDLT1**	Physical Chemistry practical-III	2	4	30	70
CC-IX Theory	**CYUDTT2**	Inorganic Chemistry-II	3	3	30	70
CC-IX Practical	**CYUDLT2**	Inorganic Chemistry practical-II	2	4	30	70
CC-X Theory	**CYUDTT3**	Introduction to Quantum Chemistry	3	3	30	70
CC-X Practical	**CYUDLT3**	QuantumChemistry Practical	2	4	30	70

AEC-IV Theory	**CYUDTA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
GEC-IV Theory	**CYUDTG1**	4A Physics-I, 4B Mathematics-I, 4C Zoology-I 4D Botany-1, 4EAnthropology-1, 4F Biotechnology-1, 4G Forensic Science-1	3	3	30	70
GEC-IV Practical	**CYUDLG1**	Generic Elective- Practical-IV	2	4	30	70
Additional Credit Course IV	**CYUDTC1**	Select one from the Pool of Value added Courses offered				
		Total	**22**	**30**	**270**	**630**
Summer Internship*	**CYUDLF1**		6*	90	30	70
Semester V						
CC-XI Theory	**CYUETT1**	Inorganic Chemistry-III	3	3	30	70
CC-XI Practical	**CYUELT1**	Inorganic Chemistry Practical-III	2	4	30	70
CC-XII Theory	**CYUETT2**	Analytical Chemistry	3	3	30	70
CC-XII Practical	**CYUELT2**	Analytical Chemistry Practical	2	4	30	70
AEC-V Theory	**CYUETA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
DSE-I Theory	**CYUETD1**	Select one from the Pool of DSE Courses offered	3	3	30	70
DSE-I Practical	**CYUELD1**	Select one from the Pool of DSE Courses offered	2	4	30	70
DSE-II Theory	**CYUETD2**	Select one from the Pool of DSE Courses offered	3	3	30	70
DSE-II Practical	**CYUELD2**	Select one from the Pool of DSE Courses offered	2	4	30	70
Additional Credit Course V	**CYUETC1**	Select one from the Pool of Value added Courses offered				
		TOTAL	**22**	**30**	**270**	**630**
Semester VI						
CC-XIII Theory	**CYUFTT1**	Green Chemistry	3	3	30	70
CC-XIII Practical	**CYUFLT1**	Green Chemistry Practical	2	4	30	70
CC-XIV Theory	**CYUFTT2**	Materials Chemistry	3	3	30	70
CC-XIV Practical	**CYUFLT2**	Materials Chemistry Practical	2	4	30	70
DSE-III Theory	**CYUFTD1**	Select one from the Pool of DSE Courses offered	3	3	30	70
DSE-III Practical	**CYUFLD1**	Select one from the Pool of DSE Courses offered	2	4	30	70
Seminar	**CYUFSS1**	Followed by report submission and seminar	2	4	30	70
Dissertation/Project	**CYUFL**	Followed by report submission, presentation and Viva-Voce.	7	14	30	70
Additional Credit Course VI	**CYUFTC1**	Select one from the Pool of Value added Courses offered				
MOOC's**						
			2-5	2-5		
		TOTAL	**24**	**34**	**240**	**560**
TOTAL CREDITS AND MARKS			**134**			

As per UGC LOCF guidelines, University / departments have liberty to offer GEC and SEC courses offered by any department to students of other departments.
The No. of GE course is four. One GEC course is compulsory in first 4 semesters each. In present scheme it is proposed to have minimum two GEC courses (from one subject) in first twosemester after which student shallchange twoGEC for another subject in IIIrd and IVth semester, so that all the student can have exposure of one additional subject.
* May be offered during summer. Summer Internship: duration will be 2-4 weeks (minimum 90 working hours).
** MOOC's courses may be offered at least one time during entire PG programme for the any of Core Course, Generic elective, Discipline specific elective, AEC course, Skill enhancement course available on MOOC's platform time to time. If any such course related to your subject is not available on MOOC's platform, department may continue with regular courses.

Abbreviations:

CC= Course code; AEC= Ability Enhancement Course;
GEC= Generic Elective Course; SEC= Skill Enhancement Course;
DSE= Discipline Specific Elective Course.

CHEMISTRY-DSE I-IV (ELECTIVES) (CREDIT: 05 EACH)

1. Medicinal Chemistry
2. Electrochemistry
3. Polymer Chemistry
4. Environmental Chemistry
5. Advanced Material Chemistry
6. Advanced Analytical Chemistry
7. Nuclear & Radiation Chemistry
8. Organic Spectroscopy
9. Heterocyclic Chemistry
10. Biochemistry
11. Organometallics and Bioinorganic Chemistry
12. Introduction to Nanochemistry & Applications

SKILL ENHANCEMENT COURSE (ANY FOUR) (CREDIT: 02 EACH)

1. Science Communication andPopularization
2. Biofertilizer
3. Personality Development
4. Computer Applications in Chemistry
5. Herbal Science & Technology
6. Fermentation Science & Technology
7. Environment Impact Analysis
8. IT Skill for Chemist
9. IPR and business skill for chemist
10. Analytical Clinical Biochemistry
11. Mushroom Culture Technology

ABILITY ENHANCEMENT COURSE (AEC) offered by Department of Chemistry (CREDIT: 02 EACH)

1. Chemistry in Everyday life
2. History of Indian Science
3. English for communication
4. Intellectual Property Rights
5. Good Laboratory Practices
6. Introduction to Forensic Science &
7. Technology
8. Renewable Energies (Solar & Biogas)
9. Cheminformatics
10. Water remediation and conservation studies
11. Research methodology
12. Chemistry of food, nutrition and preservation

VALUE ADDED COURSES (Optional,CREDIT: 03 EACH)

1. Fuel Chemistry (Course Coordinator- Dr. S. S. Thakur and Prof. G. K. Patra)
2. Cosmetic Formulation (Course Coordinator- Dr. S. Banerjee)
3. Polymer Chemistry (Course Coordinator- Dr. A. Srivastava)
4. Eco-Friendly Lubricants – Chemistry And Application (Course Coordinator- Dr. B. L. Sahu and Dr. B. Mondal)
5. Efficient Technologies for Food Processing and Shelf Life Extension (Course Coordinator- Dr. Niraj Kumari and Dr. A. Srivastva)

Semester	Course	Name of the course	Credits
VI	CC 13	Green Chemistry	Theory:3
			Practical: 2

Learning objective:

After completion of the course, the learner shall be able to understand:

- Green chemistry and itsprinciples.
- Green synthesis andreactions.
- Green chemistry for sustainablesolutions.
- Understanding principles of greenchemistry.
- Understanding design of chemical reactions/chemical synthesis using green chemistry principles.
- Atom economy and design of chemical reactions using theprinciple.
- Understanding the use of green chemistry principle and processes in laboratoryreactions.

Green Chemistry (Theory)

UNIT-I: Introduction to Green Chemistry **4 Lectures**

Basic introduction and explaining goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry

UNIT-II: Principles of Green Chemistry and Designing a Chemical synthesis 12 Lectures

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on Designing a Green Synthesis using these principles (Prevention of Waste/ byproducts;maximumincorporationofthematerialsusedintheprocessintothefinalproducts,Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions).

UNIT-III: Green Synthesis / Reactions **16 Lectures**

1. Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis).
2. Microwave assisted reactions in water: (Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylationreaction).
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative toIodine)
4. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning ofgarments.
5. Designing of Environmentally safe marineantifoulant.
6. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made fromcorn.
7. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats andOils

UNIT-IV: Future Trends in Green Chemistry **8 Lectures**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C_2S_3); Green chemistry in sustainabledevelopment.

Recommended Books/References:

1. Ahluwalia, V.K., Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers(2005).
2. Anastas, P.T. & Warner, J.K, *Green Chemistry- Theory and Practical*, Oxford University Press(1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker(2001).
4. Cann, M.C.and Connely, M.E. *Real-World cases in Green Chemistry*, ACS(2000).
5. Ryan, M.A. and Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, (2002).
6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, Second Edition,2010.

Green Chemistry (Practical)

Any six experiments may be conducted

1. Preparation and characterization of nanoparticles of gold using tealeaves.
2. Preparation of biodiesel from vegetable/ waste cookingoil.
3. Use of molecular model kit to stimulate the reaction to investigate how the atom economy illustrates GreenChemistry.
4. Reactions like addition, elimination, substitution and rearrangement may also be studied for the calculation of atomeconomy.
5. Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead ofcyanide).
6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dryice.
7. Mechanochemical solvent free synthesis ofazomethines
8. Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II)complex.
9. Photoreduction of benzophenone to benzopinacol in presence ofsunlight.

Note: Experiments may be added/deleted subject to availability of time and facilities

Recommended Books/References:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC(2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC(2002).
4. Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph, International Publishing ISBN 978-93-81141-55-7(2013).
5. Cann, M.C. and Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society(2008).

Semester	Course	Name of the course	Credits
V,VI	DSE4	Environmental Chemistry	Theory: 3
			Practical: 2

Learning Objectives:

After completion of the course, the learner can be able to understand:

- Compositon of atmosphere
- Biogeochemical cycles
- Hydrological cycle
- Water qualityparameters
- Atomospheric chemical phenomon and environmentalpollution
- Water pollution, parameters of water pollution, treatment of pollutedwater.

Unit 1: Environment

Composition of atmosphere, temperature variation of earth atmospheric system (temperature vs. altitude curve), biogeochemical cycles of C, N, P, S and O system.

Unit 2:Hydrosphere

Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determination fluoride, chromium and arsenic, residual chlorine and chlorine demand, purification and treatment of municipal water and waste water.

Unit 3: Atmosphere

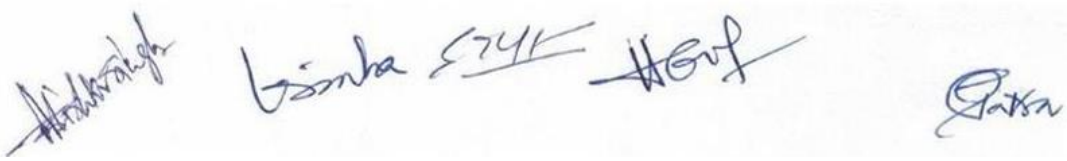
Chemical composition of atmosphere – particle, ions, and radicals in their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, and O and their effect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution and control.

Unit 4: Aquatic chemistry

Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity, hardness) and its determination, Industrial, municipal water treatment processes, Waste water treatment procedure (primary, secondary and tertiary), Solid waste treatment. Soil pollution and Noisepollution.

Recommended Books/References:

1. De.A.K.Environmental Chemistry, Wiley Eastern Ltd,1990.
2. Miller T. G. Jr., Environmental Science, Wadsworth publishing House, Meerut Odum. E. P. 1971.
3. Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co., Philadelphia
4. S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewispublisher
5. Environmental chemistry, Sharma and Kaur, 2016, Krishnapublishers
6. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.



Semester	Course	Name of the course	Credits
I,II	AEC 3	History of Indian Science	Theory:2

Learning outcomes

On completion of this course, the students will be able to:

- Develop understanding of various branches of science during differenteras
- Analyze the role played by different Indian organizations inscience
- Learn about the science and techniques used in ancient India
- Appraise the contribution of different Indian Scientists inscience

Keywords:

Astronomy, Ancient India, Colonial India, Modern India, Agricultural techniques, Green revolution

Unit I: Science in Ancient and MedievalIndia **8 Lectures**

History of development in astronomy, mathematics, engineering and medicine subjects in Ancient India, Use of copper, bronze and iron in Ancient India, The geography in literature of Ancient India. Influence of the Islamic world and Europe on developments in the fields of mathematics, chemistry, astronomy and medicine, innovations in the field of agriculture-new crop introduced new techniques ofirrigation.

Unit II: Indian Science in before and after Independence **7 Lectures**

Introduction of different surveyors, botanists and doctors as early scientist in Colonial India, Indian perception and adoption for new scientific knowledge in Modern India, Establishment of premier research organizations like CSIR, DRDO and ICAR and ICMR, Establishment of Atomic Energy Commission, Launching of the space satellites, Botanical survey ofIndia.

Unit III: Prominent Indian scientists **8 Lectures**

Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhtatta, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna, Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak. Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha and Vikram Sarabhai.

Unit IV: Prominent research in Plant Sciences in Republic of India **7 Lectures**

History of plant tissue culture from India, Green revolution in India: causes, details, and outcomes. First gene cloning in plants, First genome sequencing from India.Premier Plant Research institutes and scientists in India, GM Mustard. Allelopathy Plant research in India

Practical:

There is no experimental lab based Practical. However, the students are expected to prepare some term paper reports on the Life and works of some noted Indian Scientists especially the Botanists. Likewise, students need to prepare and organize some discussion on the ancient and medieval science in India and trace the reasons of inadequate visibility in the world. Prepare term papers on GM Crops, the controversies and procedure for approval. Prepare term papers on the significance of Allelopathic research fromIndia.

Note: Experiments may be added/deleted subject to availability of time and facilities

Semester	Course	Name of the course	Credits
I,II	AEC 6	Renewable Energies (solar and biogas)	Theory:2

Learning Objective:

On completion of this course, the students will be able to:

- Know about the renewable energy sources
- Utilize various renewable energy technologies to solve future energy consumption problems
- Identify biomass sources
- Estimate chemical composition of biomasses

Unit I: **10 Lectures**

Introduction to renewable energy sources – solar, wind, small hydro, biomass, geothermal and ocean energy, energy flow in ecosystem Solar Energy Resources Solar radiation: Spectrum of EM radiation, sun structure and characteristics, extraterrestrial radiation, solar constant, air mass, beam, diffused and total solar radiation, spectraldistribution

Unit II: **10 Lectures**

Measurement of solar radiation Instruments: sunshine recorder, Pyranometer, Pyrheliometer, Albedometer. Radiation measurement stations in India (NIWE, IMD etc.), solar radiation data, graphs, Meteonorm and NASA-SSE databases Hands-on measurement of beam, diffuse and total radiation

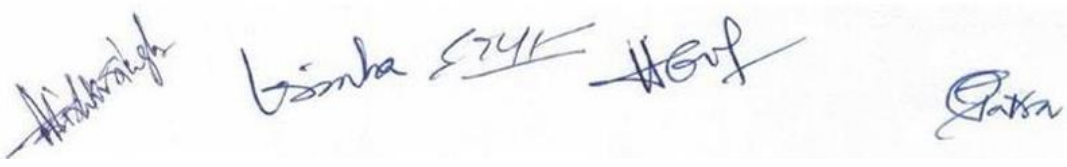
Unit III: **15 Lectures**

Solar mapping using satellite data, Typical Meteorological Year, Models and methods for estimating solar radiation, estimation of global radiation, estimation of diffused components

Basics Biomass resources: plant derived, residues, aquatic and marine biomass, various wastes, photosynthesis. Biomass resource assessment Estimation of woody biomass, non woody biomass and wastes, ASTM standards, Bulk chemical properties Moisture content, proximate and ultimate analyses, calorific value, waste water analysis for solids

Unit IV: **15 Lectures**

Chemical composition of biomass Cellulose, hemicelluloses and lignin content in common agricultural residues and their estimation, protein content in biomass, extractable, COD.Structural properties Physical structure, particle size and size distribution, permeability. Physical properties: Bulk density, angle of repose, thermal analysis (thermogravimetric, differential thermal and differential scanning calorimetry).Properties of microbial biomass: Protein estimation, flocculating ability, relative hydrophobicity of sludge, sludge volume index.



Semester	Course	Name of the course	Credits
I,II	AEC 8	Water remediation and conservation studies	Theory:2

Learning Objective:

On completion of this course, the students will be able to:

- Know about the various sources of water pollution
- Know the normal standard of potable water as per WHO recommendation
- Understand water conservation and erosion of soil
- Develop various water remediation and conservation studies

Unit-I **10 Lectures**

Sources of water pollutants, pollutants, Industrial and human contribution, WHO recommendation about potable water, current scenario of drinking water quality, chemistry of toxicants like arsenic, fluoride, chromium, lead and mercury, cause and effects of water pollution, remediation, techniques involved such as adsorption, coagulation-filtration, Nalgonada techniques, reverse osmosis, activated charcoal detoxification, applications of non-toxic oxides and mixed oxides, regeneration and recycling, mechanisms of detoxification, bio-remediation, need of green chemistry, futurescope.

Unit-II **10 Lectures**

Introduction to water conservation and erosion of soil, forms of water erosion, factors affecting water erosion, types of water erosion, mechanics of water erosion control, agronomical measures of water erosion control, Terraces for water erosion control:

Modeling of watershed processes, Case study of water-shed modeling for water conservation and water quality.

Recommended Books/references:

1. Cittenden J. C. , Trussell J. R., Hand D. W., Howe K. J., Tchobanoglous G. , Water treatment: Principles and Design MWHpublication.
2. De A. K. Environmental Chemistry, WileyEastern
3. Clarson D., Dara S. S. A text book of Environmental chemistry and pollution control, S Chand Co. Soil and water analyticalmethod
4. Edzwald J., Water Quality & Treatment: A Handbook on Drinking Water (Water Resources and Environmental EngineeringSeries)