UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
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1. APPLICABILITY

These regulations shall apply to the Masters in Chemistry programme from the session 2020-21.

2. Minimum eligibility for admission

A three/four years Bachelor's degree or equivalent with chemistry as one of the subject in final year awarded by University or Institute established as per law and recognized as equivalent by university with minimum 45% marks for general and OBC (SC/ST 40%) or equivalent grade shall constitute the minimum requirement for admission to the Masters in Chemistry Programme.

3. Programme Objectives

I. To enable the students to learn about the Periodic Table, Coordination Chemistry and Structure of Molecules, Properties of Compounds, Structural Determination of Complexes using theories and instruments.
II. To make the students to learn about the physical aspects of Atomic Structure, Dual Behaviour, Reaction Pathways with respect to time, various Energy Transformations, Molecular assembly at Nanolevel, Significance of Electrochemistry, Molecular Segregation using their symmetry.
III. To learn about the potential uses of Analytical, Industrial and Medicinal chemistry.
IV. To understand and apply principles of Organic Chemistry for understanding the Reaction mechanisms, Stereochemistry, Organic Synthesis, complex chemical structures, instrumental method of chemical analysis, Molecular rearrangements and separation techniques. To carry out laboratory experiments taught in Core Theory papers and to learn the principles of good laboratory practices.
V. To help the students' develop ability to make mathematical models for physical systems.
VI. To inculcate interest in research and provide to exposure to various research methodologies.

1. Programme Outcomes

PO-1. Demonstrate, solve and an understanding of major concepts in all disciplines of Chemistry independently and in group as well as draw logical conclusions through Project and Seminar Presentation.
PO-2. Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of Chemistry experiments
PO-3. Equip students to face the employment challenges and instil confidence to turn into entrepreneur and also step into research career.
PO-4. Generation of new scientific insights or to the innovation of new applications of chemical research
PO-5. Present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
PO-6. Apply modern methods of analysis to chemical systems in a laboratory setting.
PO-7. The students will become well versed in the mechanisms of all types of high level and complicated chemical reactions.
PO-8. The students will improve their competencies on par with their counterparts in premier institutions across the nation.

4. Programme Specific Outcomes

PSO-1. Appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
PSO-2. Gathers attention about the physical aspects of atomic structure, dual behaviour, reaction pathways with respect to time, various energy transformations, molecular assembly in nanolevel, significance of electrochemistry, molecular segregation using their symmetry.
PSO-3. Learns about the potential uses of analytical, industrial chemistry and medicinal chemistry.
PSO-4. Understand and apply principles of Organic Chemistry for understanding the scientific phenomenon in Reaction mechanisms, Stereochemistry, Organic Synthesis, complex chemical structures, instrumental method of chemical analysis, molecular rearrangements and separation techniques.
PSO-5. Study of organometallic reactions.
PSO-6. Study of biological mechanisms using amino acids.
PSO-7. Learn the classical status of thermodynamics.

PSO-8. Carry out laboratory experiments taught in Core Theory papers and to understand good laboratory practices with safety.
PSO-9. Enhance students' ability to develop mathematical models for physical systems.
PSO-10. Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR/UGC – NET examination
PSO-11. Discipline specific competitive exams conducted by service commission

5. Course Structure

The course structure of the Masters in Chemistry programme shall be as under.

No.	Name of the Couse	Credit	Remark
	Semester I		
CHCC-101	Inorganic Chemistry	**04**	Core Course
CHCC-102	Organic Chemistry	**04**	Core Course
CHCC-103	Physical Chemistry	**04**	Core Course
CHCC-104A CHCC-104B CHCC-104C	Inorganic Chemistry Practical Organic Chemistry Practical Physical Chemistry Practical	**04** **04** **04**	Core Course
CHVNC-101	* Separation Techniques Or * Chemistry of Analgesics and Antipyretics	**00**	Value Added (Non Credited)
	Semester Total	**24**	
	Semester II		
CHCC-201	Inorganic Chemistry	**04**	Core Course
CHCC-202	Organic Chemistry	**04**	Core Course
CHCC-203	Physical Chemistry	**04**	Core Course
CHCC-204A CHCC-204B CHCC-204C	Inorganic Chemistry Practical Organic Chemistry Practical Physical Chemistry Practical	**04** **04** **04**	Core Course
CHVNC-201	* Science of Technology of Cosmetics * Or * Bioethanol as Fuel	**00**	Value Added (Non Credited)
	Semester Total	**24**	
	Semester III		
CHCC-301	Inorganic Chemistry	**04**	Core Course/MOOC
CHCC-302	Organic Chemistry	**04**	Core Course
CHCC-303	Physical Chemistry	**04**	Core Course
CHCC-304	Advance Chemistry Practical-I	**04**	Core Course
CHEL-301A CHEL-301B	Environmental Chemistry Chemistry of Natural Products	**00**	Elective (Non Credited)
CHIN-301	Summer Internship	**04**	Summer Internship
CHIER-301	Concepts of Chemistry	**04**	Interdepartmental
	Semester Total	**24**	
	Semester IV		
CHCC-401	Advanced Chemistry Practical-II	**04**	Core Course
Students have to choose total of three papers, one papers from each CHEL-402A or CHEL-402B CHEL-403A or CHEL-403B CHEL-404A or CHEL-404B			
CHEL-402A	Bioinorganic and Supramolecular Chemistry	**04**	Elective/ Intradepartmental Course

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No.	Name of the Couse	Credit	Remark
CHEL-402B	Organotransition Metal Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-403A	Organic Synthesis	**04**	Elective/ Intradepartmental Course
CHEL-403B	Medicinal Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-404A	Polymer Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-404B	Electrochemistry	**04**	Elective/ Intradepartmental Course
CHMT-401	Project and Dissertation, Evaluation and Viva-voce on submitted Dissertation (Internal)	**08**	Master Thesis
	Semester Total	**24**	
	GRAND TOTAL	**96**	

* The offered courses shall be announced by the Head, Chemistry Department in the beginning of session every year.

CH – Subject; CHCC – Core Course; CHVNC –Value Added (Non-credited); CHEL – Elective; CHIER – Interdepartmental Course; CHIRA – Intradepartmental Course

Course Outlines

PROGRAMME STRUCTURE

The Master of Science in Chemistry is a Two Year Full Time Course consisting of Four Semesters.
Semester I
Semester II
Semester III
Semester IV

Sem	Core Course			Elective Course			Open elective Course			Value Added		Total Credit
	No. of Paper	Credits (L+T/	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Papers	Credit	
I	4	12+12	24	0	0+0	0	0	0+0	0	1	0	24
II	4	12+12	24	0	0+0	0	0	0+0	0	1	0	24
III	5	12+8	20	0	0+0	0	1	4+0	4	0	0	24
IV	2	4+8	12	3	4+4+4	12	0	0+0	0	0	0	24
Total Credits			80			12			4		0	96

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Semester II Syllabus
Core Course
Paper Code CHCC-201: Inorganic Chemistry

Credits 04 **Hours 60**

Course Objective:
The objective of this course is to provide students coming in the first year of Masters program understanding into molecular vibrational properties, solution behavior, kinetics and reaction mechanism of the coordination complexes. Also, some comparatively unknown but highly applicable organometallic complex syntheses and properties.

Course Outcome:

CO-1. In this semester students learn the reaction mechanism and vibrational properties associated with inorganic coordination complexes which now-a-days are gaining importance as
Homogenous catalysts
Electron transfer agents
Sensors to detect ions as well as molecules such as nitro-aromatic compounds a noxious compound utilized as an ingredient in explosives
Sensitizers in new-generation solar cells

CO-2. To asses and describe the bonding properties in the targeted compounds which have been designed for above mentioned applications Fourier-Transform IR Spectroscopy and Raman spectroscopy have to be utilised. So, the student after accomplishing this semester is supposed to become expert in assessing the bonding situations in varied types of compounds.

CO-3. The bond formation is an important phenomenon in chemistry. In this semester students learn about the design of different highly reactive but potent organometallic compounds.

CO-4. This information can be a stepping stone to such students who are willing to excel themselves in industries in particular dealing with pharma sector.

Unit I

Metal ligand equilibria in solution:

Stepwise and overall formation constant, trends in stepwise constant, factors affecting the stability of metal complex with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin.

Metal Clusters:

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyls and halide clusters. Compounds with metal-metal multiple bonds

Unit II

Reaction mechanism of transition metal complexes:

Energy profile of reaction, reactivity of metal complexes, inert and labile complexes, kinetics of octahedral substitution, substitution of square planar complexes, the trans effect, mechanism of the substitution reaction, redox reaction, electron transfer reaction, outer sphere type reactions, cross reaction and Marcus-Hush theory, inner sphere type reaction

Unit III

Organometallic Chemistry:

Organoberyllium and silicon compounds: preparation stability and important reaction of transition metal alkyl and aryls. Metal carbonyls–reactions, structure and bonding, vibrational spectra of metal carbonyls for structural elucidation.

Unit IV

Infrared spectroscopy:

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength, vibration of polyatomic molecules, selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factor affecting the band position and intensities, Far IR region metal ligand vibrations, normal coordinate analysis.

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Unit V

Raman spectroscopy:

Classical theories of Raman effect. Pure vibrational, vibrational-rotational Raman spectra, selection rule, mutual exclusion principle. Resonance Raman spectroscopy, Coherent Anti Stockes Raman spectroscopy (CARS).

Microwave spectroscopy:

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequency, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field applications.

Recommended Books:

1. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill.
2. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
3. Theory and Applications of UV Spectroscopy, H. H. Jaffe and M. Orchin, IBH- Oxford.
4. Introduction to Magnetic Resonance, A. Carrington and A..D. Maclachalan, Harper & Row.
5. Physical Methods for Chemistry, R. S. Drago, Saunders Company.
6. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
7. Organometallic Chemistry: A Unified Approach by R. C. Mehrotra and A. K. Singh

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Semester II Syllabus

Core Course
Paper Code CHCC-202: Organic Chemistry

Credits 04 **Hours 60**

Course Objective:
The objective of this course is to provide students coming in the first year of Masters program new and advance understanding mechanistic approaches in organic chemistry and basic characterization of organic compounds into electronic and IR spectroscopy.

Course Outcome:
After the completion of the course the students will acquire knowledge of:

CO-1: what are aromatic electrophilic and nucleophilic substitutions and their mechanism with the help of suitable examples.

CO-2: free radical reactions, their mechanism and also the reactivity towards aliphatic and aromatic substrates.

CO-3: addition reactions between carbon- carbon multiple bonds and hetero atom and carbon multiple bonds and mechanism of some specific name reactions.

CO-4: elimination reactions and rules used to study elimination reactions with the help of specific examples of elimination reactions.

CO-5: how to determine the structure of organic molecules using UV and IR spectroscopic techniques, λ_{max} for polyenes and α, β-unsaturated carbonyl compounds, IR range for functional groups, solving structural problems based on UV-Vis, IR spectral data.

Unit I

Aromatic Electrophilic substitution

The arenium ion mechanism, Orientation and reactivity, energy profile diagram. The ortho / para ratio, ipso attack, orientation in other ring system. Diazonium coupling, Vilsmeir reaction, Gatterman-Koch reaction.

Aromatic Nucleophilic substitution

The S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity-effect of substrates structure, leaving group and attacking nucleophile. The Von Richter, Sommelet–Houser and Smiles rearrangements.

Unit II

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Alicyclic halogenation (NBS), oxidation of aldehyde to carboxylic acid, auto-oxidation, coupling of alkynes. Sandemeyer reaction. Hunsdiecker reaction.

Addition to Carbon – Carbon multiple bonds

Mechanistic and stereochemical aspects of addition reaction envolving electrophiles. Nucleophiles and free radicals, regio-and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, Michaels reaction.

Unit III

Addition to Carbon – Hetero multiple bonds

Witting reaction. Mechanism of condensation reaction involving enolates-aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Sotobbe reaction. Hydrolysis of ester and amides, ammonolysis of esters.

Elimination Reactions

The E2, E1 and E1cB mechanism. Reactivity-effects of substrates structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Unit IV

Applications of Spectroscopy:
Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800 nm), Beer-Lambert Law, effect of solvent on electronic transitions, ultraviolet bands for unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and unsaturated carbonyl compounds. Steric effect in biphenyls.

Infrared Spectroscopy

Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FTIR.

Unit V

Molecular Spectroscopy

Energy level, molecular orbital, vibronic transition, vibrational progressions and geometry of the exited states, Franck-Condon principle, electronic spectra of the polyatomic molecules. Emission spectra, radiative and nonradiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD)

Definition, deduction of absolute configuration, octant rule for ketones.

Recommended books:

1. Silversteine and Basser, Spectrometric Identification of Organic Compounds, Willey.
2. Organic Spectroscopy, P.S. Kalsi, New Age International (P) Limited.
3. Spectroscopy of Organic Compounds, Pavia, Mery Finch Publication.
4. Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press.)
5. Organic Spectroscopy, I Fleming, McGraw-Hill Inc., US.
6. H.O. House, Synthetic Organic Chemistry.

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Semester II Syllabus
Core Course
Paper Code-CHCC-203: Physical Chemistry

Credits 04 **Hours 60**

Course Objective:
The objective of this course is to provide students coming in the first year of Masters program new and advance understanding into classical/statistical thermodynamics and quantum mechanics.

Course Outcome:
Students will recognize the importance of:

CO-1. the limitation of classical thermodynamics, Statistical thermodynamics and Non equilibrium thermodynamics.
CO-2. the difference between the classical and quantum mechanics.
CO-3. the connections between common approximation methods and standard chemical frame works (e.g. Born oppenheimer approximation, molecular orbital theory).

Unit I

Unifying Principal:

Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, results of the time dependent perturbation theory, transition moment, selection rules, intensity of spectral line, Born-Oppenheimer approximation, rotational, vibrational and electronic energy level.

Quantum Chemistry and its introduction to Quantum mechanical results:

The Schrodinger equation and the postulates of quantum mechanics. Discussion of solution of the Schrodinger equation to the some model system viz. particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.

Unit II

Approximate methods:

The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Simple application of variation method in perturbation theory.

Molecular Orbital Theory:

Huckel theory of conjugated system, bond order and charge density calculation. Application to ethylene, butadiene etc. Introduction to extended Huckel theory.

Unit III

Angular Momentum:

Ordinary angular momentum, eigen functions for angular momentum, eigen values of angular momentum.

Electronic structure of atom:

Electronic configuration, Russell-Saunders term and coupling schemes, Slater-Condon parameter, term separation energy of p^nconfiguration, term separation energy for the d^nconfiguration, magnetic effects: spin-orbit coupling and Zeeman splitting.

Unit IV

Classical Thermodynamics:

Partial molar quantities and their physical significance. Concepts of fugacity and determination of fugacity. Application of phase rule to three component system, second order phase transition.

Non Equilibrium Thermodynamics:

Thermodynamic criteria for non – equilibrium state, entropy production and entropy flow, entropy balance equation for different irreversible processes (e.g. heat flow, chemical reaction etc.) transformation of generalized fluxes and forces, non equilibrium stationary states, phenomenological equation, microscopic reversibility and Onsager's reciprocity relation, electrokinetic phenomena, diffusion, electric conduction.

Unit V

Statistical Thermodynamics:

System, assembly, ensemble averaging. Canonical, grand canonical and microcanonical ensembles. Thermodynamic probability and most probable distribution (Boltzman distribution law) and its mathematical derivation.

Partition functions- translational, rotational, vibrational and electronic partition function, calculation of thermodynamic properties in the term of partition function. Application of partition function in equilibrium constant and heat capacity of solids.

Recommended Books:

1. P.W. Atkins, Physical Chemistry, Oxford University Press, New York.
2. S. Glasston, Physical Chemistry, Nostrand
3. Advance Physical Chemistry (Vol-1,2,3,4), K.L. Kapoor,Mac Millan, India
4. Puri Sharma Pathania, Advance Physical Chemistry.
5. J.O.M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol.2, Plenum Press,New York
6. Statistical Thermodynamics, Second Edition, New Age International Limited Publisher, India by M.C. Gupta
7. Introductory Quantum chemistry by A.K Chandra, Second Edition,Tata Mc Graw-Hill publishing company Limited, India
8. Quantum chemistry Through problems and solution by R.K Prasad ,New age International PvtLmtd, Publishers
9. Molecular quantum Mechanics By P.W.Atkins Oxford University Press, Oxford New York
10. Physical Chemistry By Ira N. Levine

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Semester II Syllabus

Core Course Paper Code CHCC-204A: Inorganic Chemistry

PracticalPaper Code CHCC-204B: Organic Chemistry

Practical Paper Code CHCC-204C: Physical Chemistry Practical

Credits 12 (4+4+4)

Course Objective:

The objective of this course is to provide students coming in the first year and second semester of Masters program about the new quantitative analyses and syntheses of some typical coordination complexes and organic compounds and their relevant spectroscopic characterization as well as the use of spectrophotometer and electrochemical set-ups.

Course Outcome:

In order to make students understand the theories taught to them in M.Sc. semester (II) indifferent branches of chemistry e.g. Inorganic, Organic and Physical, the followingpracticals are introduced .Students will learn:

CO-1. Qualitative analysis and determination of two metal ions volumetrically and gravimetrically.

CO-2. The preparation of selected inorganic compounds and their characterization by spectroscopic method.

CO-3. Two steps synthesis involving different name reactions.

CO-4. The basic knowledge like preparation of solution, standardization of secondarysolution, dilution, calibration, and handling of some sophisticated electronic relatedto the practical syllabus.

CO-5. The basic knowledge of conductance measurement, Ostwald dilution law, solubilityof sparingly soluble substance, potentiometery, pH- metery, order of reaction,saponification of an ester, phase diagram of three component system, inversion ofcane sugar by polarimetry and kinetics using Visible spectrophotometer.

CO-6. To focus their aim for future prospects of Ph.D. programme and Pharmaceuticalindustry.

INORGANIC CHEMISTRY (CH-204A)

Quantitative analysis

Separation and determination of two metal ion Cu-Ni, Cu-Zn., Cu-Fe etc. involving volumetric and gravimetric methods.

Preparation and their characterisation

Preparation of selected inorganic compound and their studies by I.R., electronic spectra, Mössbaur, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compound.

1. $VO(acac)_2$
2. $TiO(C_9H_8NO)_2.2H_2O$
3. cis-$K[Cr(C_2O_4)_2(H_2O)_2]$
4. $Na[Cr(NH_3)_2(SCN)_4]$
5. **[**$Mn(acac)_3$]
6. $K_3[Fe(C_2O_4)_3]$
7. Prussian Blue, Turnbull's Blue
8. $Co[(NH_3)_6][Co(NO_2)_6]$
9. cis-$[Co(triene)(NO_2)_2]Cl.H_2O$
10. $Hg[Co(SCN)_4]$
11. $[Co(I)(py)_2Cl_2]$
12. $[Ni(NH_3)_6]Cl_2$
13. $Ni(DMG)_2$
14. $[Cu(NH_3)_4]SO_4.H_2O$

ORGANIC CHEMISTRY (CH-204B)

Two steps synthesis involving-

1. Acetylation
2. Oxidation

3. Grignard reaction
4. Aldol condensation
5. Sandmeyer reaction
6. Acetoacetic ester Condensation
7. Cannizzaro reaction
8. Friedel Craft reaction
9. Aromatic Electrophilic Substitution

PHYSICAL CHEMISTRY (CH-204C)

Conductance measurements

1. Determine the equivalent conductance of a weak electrolyte at different concertration and hence test the validity of Ostwald's dilution Law. Determine the dissociation constant K_a/K_b of the weak electrolyte.
2. Determine the solubility of sparingly soluble substance in water at given temperature by conductance method.

Potentiometry-Electrochemistry (EMF – Measurements)

3. Determine the EMF of a given a concentration cell by potentiometer and find out the effect of dilution on the EMF of cell.
4. Determine the pH a given buffer solution using given quinhydrone electrode.

Chemical Kinetics

5. Determine the velocity constant and order of reaction for hydrolysis of ethyl acetate by sodium hydroxide at given temperature (saponification of an ester)

Phase Equilibria

6. Construct the phase diagram for three component system (eg. Ethanol, benzene and water or chloroform, acetic acid and water).

Polarimetry

7. Determine the rate constant for inversion of cane sugar using a polarimeter.

Spectrophotometer

8. Study the kinetics of decomposition of the complex formed between sodium sulphide and sodium nitroprusside spectrophotometrically, and also find the order and rate constant of the reaction.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H. Middeton, AdwardArnoid.
11. Handbook of Organic Analysis Qualitative and Quantitative, H. Clark, Adward Ar.
12. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
13. Practical Physical Chemistry, A.M. James and F.E. Prichand, Longman.
14. Findley's Practical Physical Chemistry revised, B.P. Levitt, Longman.
15. Experimental Physical Chemistry, R.C. Das and Bebera, Tata Mc Grawhill.
16. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Barg (R. Chand and Co., Delhi)
17. Experimental Physical Chemistry by D.P. Shoemaker Mc Grawhill, 7th Edition 2003.
18. Experiments in Chemistry, D.V. Jahagirdar, Himalaya Publishing House.
19. Practical Physical Chemistry, B. Vishwanathan and P.S. Raghwan, Viva Books.
20. General Chemistry Experiments, Anil J Elias, University Press (2002)
21. Experimental Physical Chemistry, V.D. Athawale, ParulMathur, New Age International (P) Limited.
22. Systematic Experiment in chemistry, ArunSethi, New Age International (P) Limited.
23. Experiments in Physical chemistry, J.C. Ghosh, BharatiBhavan.
24. Advanced Practical Physical Chemistry, JB Yadav.
25. Practical Organic Chemistry, Mann and Saunders.

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Semester II Syllabus

Value Added (Non Credited)
Paper Code CHVNC-201A: Science and Technology of Cosmetic

Credit 00 **Hours 50**

Course Objective:

To provide students coming in the first year and second semester of Masters program better understanding into basic cosmetic technology which can form an apt platform for the student to move into cosmetic industry after completing their masters.

Course outcome:

CO-1. This course allows students to understand and learn about the chemistry of cosmetics.
CO-2. More specifically, this course aims to introduce the scientific aspects such as chemical, physical and biological functions of different ingredients present in the cosmetics.
CO-3. This course also gives information about the formulation and technology of cosmetics

Unit I

Basic concept of Cosmetics. Classification of cosmetic products for skin, hair and oral care.
Forms of cosmetics and their suitable examples: Solutions, creams, lotions, ointment, paste, gels, sticks, tablets, capsules, powders and aerosols.

Unit II

Cosmetic Ingredients and Classifications: Water, Surfactants, Foaming agents, Emulsifiers, and Solubilizers, rheological additives, Antioxidants, Antimicrobial and Chelating agents used as preservatives.

Unit III

Perfume: Classification of perfumes, Perfume ingredients
Colour Cosmetics: Building block and formulation of Lipsticks, mascara, and nail polish.
Hair conditioner**:** Building blocks and formulation of Hair conditioners, hair oils, hair dye.
Herbal cosmetics

Unit IV

Use of nanotechnology in cosmetics, suspensions, creaming, cracking and phase inversion
Micrometrics: Methods of determining particle size, optical microscopy, sieving, sedimentation measurements
Powders: porosity, densities, bulkiness and flow properties.

Unit V

Rheology of Cosmetics: Newtonian systems, law of flow, kinematic viscosity, effect of temperature on viscosity,
non-Newtonian systems – Plastic, pseudoplastic and dilant system, thixotropy determination of viscosity,

Recommended Books:

1. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
2. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
3. Drugs and Cosmetic act/rules by govt. of India Publication
4. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard
5. Maibach, Marianne MahieuInforma Healthcare USA, Inc.

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Semester II Syllabus
Value Added (Non Credited)
Paper Code CHVNC-201B:Bioethanol as Biofuels

Credit 00 **Hours 50**

Course Objective:
To provide students coming in the first year of Masters program knowledge about the transformation of carbohydrate products into alcohol which can form the basis of the development of bioethanol.

Course Outcomes:
CO-1. This course allows students to understand and learn about the chemistry of bioethanol as biofuels.
CO-2. More specifically, this course aims to introduce the scientific aspects such as chemical, physical and biological transformation of carbohydrate into bioethanol, a renewable source of energy.
CO-3. This course also gives information about the formulation and technology used for production of bioethanol.

Unit I
Biomass as energy resources - Classification and estimation of biomass - Source and characteristics of biofuels – Biodiesel – Bioethanol – Biogas - Waste to energy conversions.

Unit II
Renewable and non-renewable source of energy, bioethanol, bioethanol as oxygenated fuel,

Unit III
Advantages of domestic production of bioethanol, conversion of carbohydrate to bioethanol using pretreatment, dilute and concentrated acid hydrolysis, enzyme hydrolysis and fermentation.

Unit IV
Structure, function, configuration & conformation, reactions of glucose and its important derivatives; disaccharides (lactose, maltose and sucrose)

Unit V
Polysaccharides – structural polysaccharide (cellulose, lignocelluloses, chitin); storage polysaccharides (starch and glycogen).

Recommended Books:

1. Biological Functions of Carbohydrates (Tertiary Level Biology S), D.J. Candy
2. Essentials of Carbohydrate Chemistry, John F.Robyt
3. Bioethanol: Science and Technology of fuel alcohol, Graeme M. Walker.