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STRUCTURE FOR COURSE OF STUDY

POSTGRADUATE PROGRAMME

AS PER

NATIONAL EDUCATION POLICY-2020
&
CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES-2024

M.Sc. (CHEMISTRY) With
[Course Work only] /
[Course Work + (Industrial Project/ Research Project)] /
[Research]
(w. e. f. 1 July 2026)



DEPARTMENT OF CHEMISTRY
GURUKULA KANGRI (DEEMED TO BE UNIVERSITY)
HARIDWAR
2026

GURUKULA KANGRI (DEEMED TO BE UNIVERSITY)

VISION

Reviving the ancient education of Brahmacharya (continence), of rejuvenating and resuscitating ancient Indian philosophy and literature, conducting researches into the Indian and western activities, of building up a Vedic Literature incorporating into itself all that is best and assailable in occidental thought, of producing good citizens possessed of a culture compound of the loftiest elements of the two civilizations.

MISSION

- To create a synthesis of our Indian intellectual tradition with the best of modern education.
- Inculcating national spirit and respect for Indian culture among the students and society in order to contribute to the nation-building.
- Focusing on the personality of the students to be developed by value-based education.
- Enriching and empowering all the beneficiaries through the participative, positive, harmonious teaching-learning environment.
- Developing inter-linkages across teaching, research and extension.
- Making students employable by imparting holistic education and developing skills.

CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES-2026-27

PROGRAMME- M.Sc. Chemistry

PROGRAMME SPECIFIC OUTCOMES (PSOs):

It is a job oriented, innovative and applied programme. The main objectives of the programme are to-

1. Provides opportunity to students as Quality Control Chemist, Research and Development Chemist,Analytical Chemist in various laboratories and institutions.
2. Develops analytical skill amongst students
3. To Acquire knowledge of modern as well as Vedic concept of chemistry
4. Equip students to step up in research and development

PROGRAMME OUTCOMES (POs):

After studying this programme students become able to -

1. Familiar with the knowledge of theoretical aspects of Inorganic, Organic, Physical and AnalyticalChemistry.
2. Explain working principle, instrumentation and application of various experiments by performingmore practices in the laboratories.
3. Develop skills to handle analytical techniques in industry, research and institutes.
4. Discuss modern as well as Vedic concept of chemistry.
5. Employ critical thinking and scientific knowledge to design, carry out, record and analyse the results.
6. Describe about environment, chemicals and pollution problems in details.
7. Accomplish their goals in professional and academic life.
8. Be provided with the knowledge to step up in Research and Development.

PG CURRICULAR FRAMEWORK 2024 BASED ON NEP 2020

- 2-year PG programme for those who have completed 3-year Bachelor's programme
- 1-year PG programme for students who have completed 4-year Bachelor's programme with Honours/Honours with Research
- An integrated 5-year Bachelor's/Master'sprogramme

ELIGIBILITY FOR THE PG PROGRAMME:

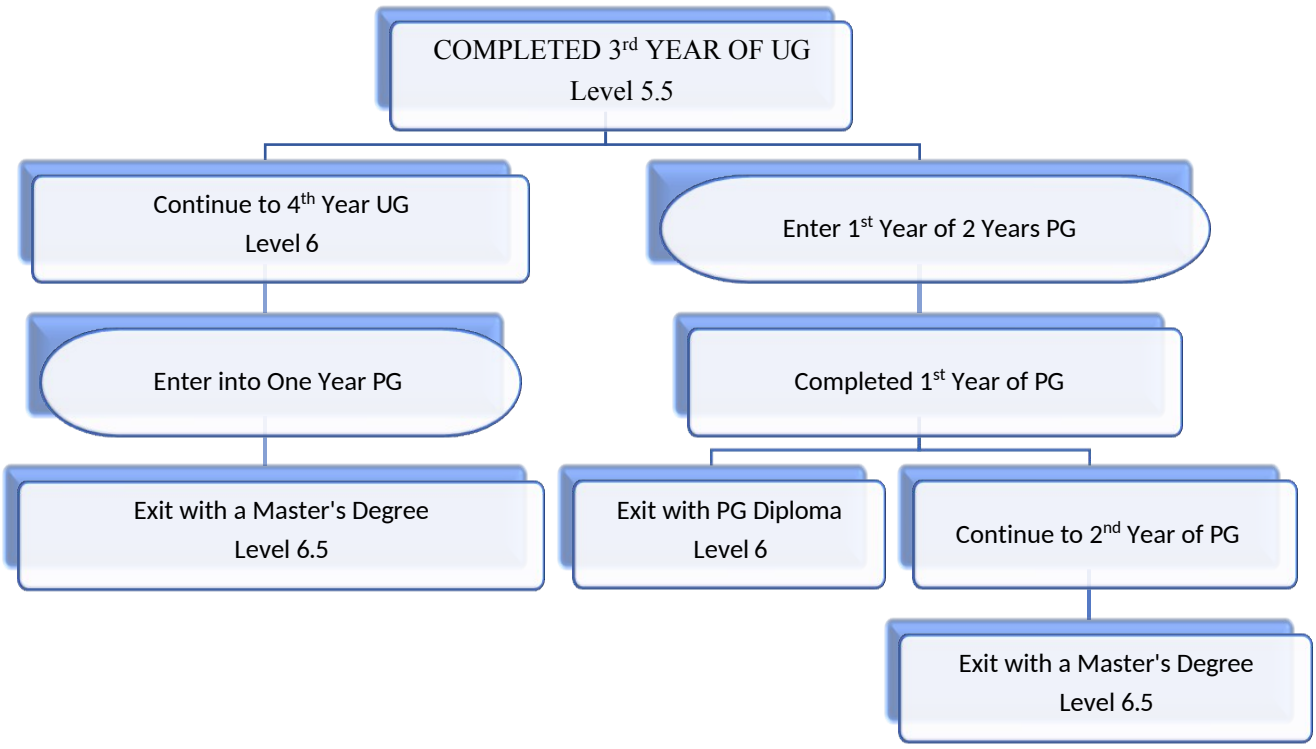
- A student is eligible for a PG programme in a discipline
  - Corresponding to **major** discipline in UG programme.
  - Corresponding to **minor** discipline in UG programme
  - However, irrespective of the major or minor disciplines chosen by a student in a UG programme, a student is eligible for admission in any discipline of PG programmes if the student qualifies the National level or University level entrance examination in the discipline of the PG programme.

ADMISSION IN PG PROGRAMME:

- University can admit the students in the PG programme based on the student's performance in the UG programme or through National level or University level

entrance examination.

PROGRESSION FROM UG TO PG



CURRICULAR COMPONENTS

2ND YEAR (III & IVTH SEMESTER)

2nd Year ~~of Two Year PG~~	**One Year of PG**
Level-6.5	**Level-6.5**
Only Coursework	
OR	
Course work & Research	
OR	
Only Research	

5-year Integrated Programme (UG+PG): At the PG level, the curricular component of 5- year integrated programme will be similar to that of 2-year PG mentioned above.

COURSE LEVELS

400-499: Advanced courses which would include lecture courses with practicum, seminar- based course, term papers, research methodology, advanced laboratory experiments/software training, research projects, hands-on-training, internship/apprenticeship projects at the undergraduate level or First year Postgraduate theoretical and practical courses

500-599: For students who have graduated with a 4-year bachelor's degree. It provides an opportunity for original study or investigation in the major or field of specialization, on an individual and more autonomous basis at the postgraduate level

CREDIT DISTRIBUTION: 1ST YEAR PG PROGRAMME

Level	Programme	Semester	Course Levels	Input	Minimum Credits	Total
6	**PG1st Year**	**I&II**	**400**	**Coursework**	**24**	**40**
			500	**Coursework**	**16**	
Exit Point: For those who join 2year PG programme, there shall only be one exit point. Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma in the concerned subject.						

CREDIT DISTRIBUTION: 2ND YEAR PG PROGRAMME AFTER FIRST YEAR/ ONE YEAR PG PROGRAMME AFTER 4 YEAR UG

Level	Semester	Input	Course Levels	Minimum Credits
6.5	**III & IV**	Coursework Only	500	**40**
6.5	**III**	Coursework	500	**20**
	IV	Research (Dissertation/Project/Patent)	--	**20**
6.5	**III & IV**	Research (Dissertation/Project/Patent) Only	--	**40**

1ST YEAR OF PG CURRICULAR STRUCTURE FOR 2 YEAR PG PROGRAMMES (3+2)						
Year	**Level**	**Semester**	**DSC (No. of course x Credits)**	**DSE (No. of course x Credits)**	**OPTIONAL 2 Credit Course (No. of course x Credits)**	**Total Credits Without Optional**
1	6	I	5x4	--	1x2 [Skill-based course/workshop/Specialised laboratory/ Hands on Learning]	20
1	6	II	3x4	2x4	1x2 [Skill-based course/workshop/Specialised laboratory/ Hands on Learning]	20

CURRICULAR STRUCTURES OF 2ND YEAR OF PG FOR TWO-YEAR PG PROGRAMME (3+2)
OR
ONE YEAR PG PROGRAMME AFTER COMPLETION OF FOUR-YEAR UG PROGRAMME (4+1)

STRUCTURE 1 (LEVEL6.5) : PG CURRICULAR STRUCTURE WITH COURSEWORK ONLY						
Year	**Level**	**Semester**	**DSC (No. of course x Credits)**	**DSE (No. of course x Credits)**	**OPTIONAL 2 Credit Course (No. of course x Credits)**	**Total Credits Without Optional**
2	6.5	III	2x4	3x4	1x2 Skill-based course/workshop/Specialised laboratory/ Internship/ Apprenticeship/ Hands on Learning	20
2	6.5	IV	2x4	3x4	1x2 Skill-based course/workshop/Specialised laboratory/ Internship/ Apprenticeship/ Hands on Learning	20

STRUCTURE 2 (LEVEL6.5): PG CURRICULAR STRUCTURE WITH COURSEWORK + RESEARCH						
Year	**Level**	**Semester**	**DSC (No. of course x Credits)**	**DSE (No. of course x Credits)**	**Research(Dissertation/ Project/ Patent)**	**Total Credits**
2	**6.5**	**III**	**2x4**	**3x4**	**--**	**20**
2	**6.5**	**IV**	**--**	**--**	**20**	**20**

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STRUCTURE 3 (LEVEL6.5): RESEARCH							
Year	**Level**	**Semester**	**DSC (No. of course x Credits)**	**DSE (No. of course x Credits)**	**Optional**	**Research(Dissertation/ Project/ Patent)Credits**	**Total Credits**
2	**6.5**	**III & IV**	**--**	**--**	**--**	**40**	**40**

The following outcomes must be achieved by the end of IVth Semester

1. Dissertation/Project Report certified by the Supervisor and Head of the Department.
2. Attained at least one of the following outcomes:
   - I. Developed a prototype or product which meets the Technology Readiness
   - II. Publication in WoS/Scopus indexed journals or the journals recommended by the concerned Department; having the student as the first author and Supervisor (s) as corresponding author (s)
   - III. Patent
   - IV. Publication of Book by Reputed National/International Publisher
   - V. Any other specific and measurable research achievement as recommended by the BoS

NOTE:

1. The Dissertation chosen should be an original work and not a repetition of work done in the 4thYear of the UG programme. It may be an extension of the work done in the 4th Year of UG programme.
2. PG programme should include vocational courses relevant to the chosen discipline.

EXAMINATIONS:

The examinations of the courses will be done as per the Examination and Evaluation Policy of GK (DU).

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SEMESTER-WISE STRUCTURE

M.Sc. I[st] Year

SEM	SL. NO	CLASSIFICATION		PAPER CODE	PAPER TITLE	CREDITS	L	T	P	LEVEL
I	1.	Discipline Specific Core	DSC	MCH26-C101	General Inorganic Chemistry	4	45	15		400-499
I	2.	Discipline Specific Core	DSC	MCH26-C102	General Organic Chemistry	4	45	15		400-499
I	3.	Discipline Specific Core	DSC	MCH26-C103	General Physical Chemistry	4	45	15		400-499
I	4.	Discipline Specific Core	DSC	MCH26-C151	Lab Course:1	4			120	400-499
I	5.	Discipline Specific Core	DSC	MCH26-C152	Lab Course:2	4			120	400-499
II	6.	Discipline Specific Core	DSC	MCH26-C201	Inorganic Chemistry and Related Techniques of Analysis	4	45	15		400-499
II	7.	Discipline Specific Core	DSC	MCH26-C202	Organic Chemistry and Related Techniques of Analysis	4	45	15		500-599
II	8.	Discipline Specific Core	DSC	MCH26-C251	Lab Course:3	4			120	500-599
II	9.	Discipline Specific Elective	DSE	MCH26-E201	Physical Chemistry and Related Techniques of Analysis	4	45	15		500-599
II	10.	Discipline Specific Elective	DSE	MCH26-E251	Lab Course:4	4			120	500-599

EXIT OPTION-I: PG DIPLOMA

M.Sc. II[nd] Year

STRUCTURE 1 (LEVEL 6.5): PG CURRICULAR STRUCTURE WITH ONLY COURSE WORK

III	11.	Discipline Specific Core	DSC	MCH26-C301	Analysis of Water and Waste Water	4	45	15		500-599
III	12.	Discipline Specific Core	DSC	MCH26-C302	Analysis of Oils, Fats, Soaps, Detergents, Essential oils,	4	45	15		500-599

					Paints and Varnishes					
III	13.	Discipline Specific Elective	DSE	MCH26-E301	Chemistry in Vedic Literature and Ayurvedic Drugs	4	45	15		500-599
III	14.	Discipline Specific Elective	DSE	MCH26-E351	Lab Course:5	4			120	500-599
III	15.	Discipline Specific Elective	DSE	MCH26-E352	Lab Course:6	4			120	500-599
IV	16.	Discipline Specific Core	DSC	MCH26-C401	Analysis of Cement, Minerals, Alloys and Trace Metals	4	45	15		500-599
IV	17.	Discipline Specific Core	DSC	MCH26-C402	Analysis of Soils	4	45	15		500-599
IV	18.	Discipline Specific Elective	DSE	MCH26-E401	Computer Application in Chemistry	4	45	15		500-599
IV	19.	Discipline Specific Elective	DSE	MCH26-E451	Lab Course:7	4			120	500-599
IV	20.	Discipline Specific Elective	DSE	MCH26-E452	Lab Course:8	4			120	500-599
COURSE COMPLETION: PG WITH ONLY COURSE WORK										
STRUCTURE 2 (LEVEL 6.5): PG CURRICULAR STRUCTURE WITH COURSE WORK + (INDUSTRIAL PROJECT / RESEARCH)										
III	11.	Discipline Specific Core	DSC	MCH26-C301	Analysis of Water and Waste Water	4	45	15		500-599
III	12.	Discipline Specific Core	DSC	MCH26-C302	Analysis of Oils, Fats, Soaps, Detergents, Essential oils, Paints and Varnishes	4	45	15		500-599
III	13.	Discipline Specific Elective	DSE	MCH26-E301	Chemistry in Vedic Literature and Ayurvedic Drugs	4	45	15		500-599
III	14.	Discipline Specific Elective	DSE	MCH26-E351	Lab Course:5	4			120	500-599
III	15.	Discipline Specific Elective	DSE	MCH26-E352	Lab Course:6	4			120	500-599
IV	21.	Industrial Project / Research (Dissertation/Project/Patent)	PR DIS/PR/PAT	MCH26-P471 MCH26-D471	Industrial Training cum Project / Dissertation	20			600	-
COURSE COMPLETION: PG WITH COURSE WORK + (INDUSTRIAL PROJECT / RESEARCH)										

STRUCTURE 3 (LEVEL 6.5): RESEARCH										
III & IV	22.	Research (Dissertation/Project/Patent)	DIS/PR/PAT	MCH26-R471	One Intensive Problem Based Research	40			1200	--

The following outcomes must be achieved by the end of IVth Semester

1. Dissertation/Project Report certified by the Supervisor and Head of the Department.
2. Attained at least one of the following outcomes:
   - I. Developed a prototype or product which meets the Technology Readiness
   - II. Publication in WoS/Scopus indexed journals or the journals recommended by the concerned Department; having the student as the first author and Supervisor (s) as corresponding author (s)
   - III. Patent
   - IV. Publication of Book by Reputed National/International Publisher
   - V. Any one of the following outcomes:
     - a) Submission of a manuscript arising from the dissertation work to a WoS-indexed journal or Scopus-indexed journal, with the student as the first author and the supervisor(s) as co-author(s)/corresponding author(s).
     - b) Acceptance for publication or publication of a manuscript arising from the dissertation work in a peer-reviewed journal approved by the concerned Department, with the student as the first author and the supervisor(s) as co-author(s)/corresponding author(s).
     - c) Filing or grant of a patent arising from the dissertation work.
     - d) Any other specific, measurable, and verifiable research achievement arising from the dissertation work certified by the Supervisor and approved by the Departmental Research Committee (DRC)/Project Evaluation Committee.

COURSE COMPLETION: PG WITH ONLY RESEARCH

M.Sc. : Semester-I	Course Type : DSC
Credits : 04	Course Code : MCH26-C101
Course Title : General Inorganic Chemistry	
Lectures : 60	

COURSEOUTCOMES:

On completion of this course, student shall be able to:

CO1: Understand the molecular orbital theory of coordination compounds.
CO 2: Learn the electronic spectra of coordination complexes.
CO3: Describe electromagnetic properties of transition metals.
CO4: Explain the molecular symmetry and their applications.
CO5: Describe the inorganic elements in biological systems.
CO6: Describe the oxygen carriers.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**COORDINATION CHEMISTRY**: Distortion in octahedral Complexes**,** Molecular orbital theory (M.O.T.) as applied to octahedral complexes, π - bonding in octahedral complexes, inert and labile complexes based on various theories, ligand substitution reaction in octahedral and square planar complexes, electron transfer reaction in coordination compounds.	11	4		15
Unit-II	**ELECTRONIC SPECTRA OF COMPLEXES**: Term symbols S,P,D,F, in a cubic field; splitting of term for d configuration; spectra of Transition metal complexes, selection rules and intensities of the transitions, nature of Electronic transitions in complexes, orgel energy level diagram, tanabe-sugano diagram. Calculation of Dq, B' and β for Cr III and Ni II complexes. Structural Evidence from Electronic spectra, charge-transfer spectra.	11	4		15
Unit-III	**MAGNETOCHEMISTRY:** Contribution of magnetic properties, Effect of the ligand field on spin-orbit coupling, measurement of magnetic properties, methods of magnetic susceptibility determination, temperature dependence of magnetism, application of magnetic data (Ref. book: Drago) **MOLECULAR SYMMETRY:** Symmetry elements, Symmetry operations and point groups, Character Tables (C_{2V}) and applications.	11	4		15
Unit-IV	**BIOINORGANIC CHEMISTRY**: General introduction to Bio-inorganic Chemistry; occurrence of Inorganic elements in organisms, classification of metallo bio-molecules; Biologically important features and functions of inorganic elements, Biologically important ligands for metal ions, co-ordination by proteins and Enzymatic catalysis. Role of metal ions and non-metals in Biological systems Na, K, Ca, Mg, Zn, Cl, Si, As, F, I, Se (Giving suitable examples) Biomineralisation. **OXYGEN CARRIERS:** Hemoglobin; non-porphyrin and porphyrin oxygen carriers, synthetic oxygen carriers. Recent trends in Nitrogen fixation, photosynthesis PS- 1 & PS - 11, superoxide Dismutase.	12	3		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Inorganic Chemistry by:James E. Huheey
2. Text Book of Inorganic chemistry by: Cotton and Wilkinson 5th Edition
3. Physical Methods in Inoganic Chemistry by: R.S. Drago
4. Selected Topics in Inorganic Chemistry by: Malik, Tuli& Madan
5. Bioinorganic and Supramolecular Chemistry by: A.K.Bhagi, G.R.Chatwal

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X				X		X	X				X
CO2	X		X		X		X	X		X		X
CO3	X						X	X				
CO4	X		X					X		X		
CO5	X		X				X	X		X		
CO6	X				X		X					X

M.Sc. : Semester-I	Course Type : DSC
Credits : 04	Course Code : MCH26-C102
Course Title: General Organic Chemistry	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Understand the different organic reactions and their mechanism.
CO 2: Familiarize the various types of substitution reaction and their mechanism.
CO 3: Learn the concept of Reaction Intermediates.
CO 4: Explain the use of important reagents in organic reaction.
CO 5: Explain the pericyclic reactions and its classification.
CO 6: Describe the photochemical reaction.
CO 7: Describe the versatile knowledge of rearrangements.

UNITS	CONTENTS	L	T	P	Total Hours
Unit - I	**Organic Reaction Mechanism:** **(a) Substitution or Displacement Reactions:** Nucleophilic and electrophilic substitutions with mechansim (S_N and S_E), Frie's rearrangement, Friedeal-Craft reactions, Reimer-Tiemann reaction, Chichibabin reaction. **(b) Addition Reactions**: Electrophilic and nucleophilic additions with mechanism, hydroboration, Michael addition; aldol, Perkin, Cannizaro reaction, Wittig reaction.	12	3		15
Unit - II	**Reaction Intermediates:** Carbocations, carbanions, free radicals, nitrines and benzyne, their formation, stability, detection and reactions. **Molecular rearrangements:** Involving electron deficient carbon, nitrogen and oxygen viz- Pinacol- pinacolone, Wagner-Meerwein, Beckmann, Hofman, Curtius, Schmidt rearrangements, Bayer- Villiger oxidation of ketones. Favorskii rearrangement.	11	4		15
Unit - III	**Reagents in organic synthesis:** Use of the following reagents in organic synthesis: Gilman's reagents, 1,3-dithiane, osmium tetroxide, selenium dioxide. **Pericyclic reactions:** Classification of Pericyclic reactions**,** Selection rules and stereochemistry of electrocyclic reactions, cycloaddition and sigmatropic shifts. Cope and Claisen rearrangements, ene reaction. **Photochemical reactions:** Norrish type I and II reactions of α, β unsaturated ketones, Paterno-Buchi reaction, photoreduction of ketones.	11	4		15
Unit - IV	**Stereochemistry:** Optical activity and Optical isomerism, Racemic mixture, Resolution, R-S nomenclature. Geometrical isomerism in the compounds containing C = C and C = N bonds, elementary idea of geometrical isomerism in cyclic compounds. E-Z nomenclature. Asymmetric induction. **Heterocyclic Compounds:** Aromaticity, synthetic methods and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Organic Chemistry by: Boyd and Morrison
2. Organic Chemistry by: I. L.Finar
3. Organic Chemistry by: Kapoor, Singh and Mukherjee
4. Organic Chemistry by: Bruice

5. Organic Chemistry by: Pine
6. A Guide Book to Organic Reaction Mechanism by: Peter Sykes

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	X				X		X	X				X
CO 2	X		X		X		X	X		X		X
CO 3	X						X	X				
CO 4	X		X					X		X		
CO 5	X		X				X	X		X		
CO 6	X				X		X					X
CO 7	X				X		X	X				X

M.Sc. : Semester-I	**Course Type : DSC**
Credits : 04	**Course Code : MCH26-C103**
Course Title: General Physical Chemistry	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Understand the kinetics of 3rd order reactions.

CO2: Understand the collision and activated state theory for reaction rates.

CO3: Explain the effect of different parameters on reaction rates as ionic strength.

CO4: Explain the use of important linear relationship between substituents and change in free energy of a reaction series.

CO5: Familiarize with the processes such as fluorescence, phosphorescence and photochemical reactions.

CO6: Understand the concept of Acid- Base catalysis.

CO7: Gain knowledge of macromolecules about their types, polymerization and methods to determine their molecular weight, polydispersity etc.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	Derivation of IIIrd order kinetic equation, collision theory for uni, bi and termolecular reactions, Steric factor, Theory of absolute reaction rates, Entropy of activation. Experimental techniques for the study of kinetics of slow and fast reactions. Opposing, Consecutive, Side and Induced reactions. Chain reactions and explosion limits. Effect of ionic strength, Bronsted-Bjerrum equation.	12	3		15
Unit-II	**Linear Free energy Relationships:** Effect of substituents on reaction rates, Basic idea of linear free energy relationships particularly Hammett, Taft, Brown and Okamoto, Sekigawa and Van - Bakkum plots (Introductory treatment only).	11	4		15
Unit-III	**Catalysis:** Acid- Base catalysis, Acidity function, Enzyme -catalysis, Michaelis-Menten equation. **Photochemistry:** Jabolinskii diagram, fluorescence, phosphorescence, chemiluminiscence and photosensitization, photophysical kinetics of unimolecular process.	11	4		15
Unit-IV	**Macromolecules:** Explaining the terms Isotactic, Atactic, Syndiotactic, Copolymers, Block copolymers, Linear, Branched and Cross linked polymers, Addition and condensation polymerisation. Degree of polymerisation and length of polymer chains. Requirement of purity for synthesis. Molecular weights and their distribution. Polydispersity. Determination of molecular weight by Osmotic pressure, Viscosity, light scattering and sedimentation equilibrium methods.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Chemical Kinetics by: K. J. Laidler
2. Enzyme Kinetics by: D. V. Roberts
3. Text book of Physical Chemistry by: S. Glasstone
4. Chemical Kinetics by: Ralphe Jr. Westron and A. S. Harold
5. Physical Chemistry by: G. M. Barrow
6. Physical Chemistry by: G. W. Castellan
7. Introductory Polymer Chemistry by: G. S. Misra

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X	X			X		X	X				X
CO2	X		X		X		X	X	X	X		X
CO3	X					X	X	X				
CO4	X		X					X		X	X	
CO5	X		X				X	X		X		
CO6	X	X		X	X	X	X		X			X
CO7	X				X		X	X				X

M.Sc. : Semester-I	Course Type : DSC
Credits : 04	Course Code : MCH26-C151
Course Title : **Lab Course 1**	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Understand the analysis of inorganic mixtures.
CO 2: Learn about the preparation of inorganic complex compounds.
CO3: Describe gravimetric analysis of two metal ions given in a mixture.
CO4: To illustrate the Depression of F.P./M.P., Elevation of B.P.
CO5: Describe the Distribution Law, different type of Adsorption.

UNITS	CONTENTS	L	T	P	Total Hours
A	**Inorganic Chemistry:** **(a)** Analysis of inorganic mixture for 08 ions including 04 cations. Special emphasis may be given on dry tests and spot tests (including rare earths). **(b)** Preparation of the following complexes and determination of their composition by volumetric and Gravimetric techniques; **(i)** Nickle complexes with ethylene diammine and mono or diketones. **(ii)** Cobalt Pentammine Chloride. $[Co(NH_3)_5\ Cl]Cl_2$ **(iii)** Tris acetyl acetonate Fe (III). **(iv)** Reactions of Transition Metals - A Laboratory Exercise to Study the Different Oxidation States of Vanadium by their Quantitative Evaluation. **(v)** Tris acetyl acetonate Mn (II). **(c)** Gravimetric analysis of two metal ions given in a mixture.			80	80
B	**Physical Chemistry:** (1) Cryoscopy (2) Ebullioscopy (3) Distribution Law (4) Adsorption			40	40
	Total (In Hrs.)			120	120

Suggested Readings:

1. Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Practical Physical Chemistry, M. Satish Kumar, Sankalp Publication.

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X				X		X	X				X
CO2	X		X		X		X	X		X		X
CO3	X						X	X				
CO4	X		X					X		X		
CO5	X		X				X	X		X		

M.Sc. : Semester-I	Course Type : DSC
Credits : 04	Course Code : MCH26-C152
Course Title : Lab Course 2	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Explain the separation of organic mixture and identification.

CO2: Estimation of phenolic group and amino group as well as estimation of N, S and Halogens.

CO3: Explain the Phase rule, Rate of Reaction, Rate Constant, Molecularity and order of reaction, Pseudo order reactions. Methods for determination of Rate of reaction. Different type of Heat changes.

Hands On Experiments:

A. Organic Chemistry:

(i) Separation of organic mixture and identification, confirmation by derivative preparation as far as possible.

(ii) Two step preparations of the organic compounds involving the reactions oxidation, reduction, hydrolysis, nitration.

(iii) Estimation of Phenolic group in Phenol and Amino group in Aniline (Volumetrically). Estimation of Carboxylic group and Glucose.

(iv) Estimation of N, S and Halogens.

B. Physical Chemistry: Experiments related to following techniques:

(1) Phase rule
(2) Chemical Kinetics
(3) Thermochemistry

Suggested Readings:

1. Practical Physical Chemistry, M. Satish Kumar, Sankalp Publication.
2. Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
3. Practical Organic Chemistry, F. G. Mann. &B. C. Saunders, Orient Longman, 1960.

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X				X		X	X				X
CO2	X		X		X		X	X		X		X
CO3	X						X	X				

M.Sc. : Semester-II	Course Type : DSC
Credits : 04	Course Code : MCH26-C201
Course Title: **Inorganic Chemistry and Related Techniques of Analysis**	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Categorize units of radioactivity on the basis of their practical utility. At the same time acquaintance to different techniques and apparatus for detection and measurement of radioactivity enhancing the knowledge in the field of nuclear chemistry

CO2: Understand the principle Recognize all components of the following instruments: Raman spectrophotometer, ESR spectrophotometer, Atomic Absorption spectrophotometer, Nephelo-turbidimeter and Inductively coupled plasma and interpret data from them

CO3: Know the capability and disadvantages of above mentioned techniques so as to be able to choose the most suitable technique, and optimize the conditions for sample. The analytical thinking ability gets feed by studying various spectroscopic techniques

CO4: Have in-depth understanding the principles and practical utility of thermogravimetry, differential thermal analysis and Differential scanning calorimetry

CO5: Understand the principle Fundamental and application of Inductively Coupled Plasma technique

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**Interaction of radiation with matter**: Units of Radioactivity (Ci, Ru, Bq, Specific activity), units of radiation energy (rad, Gray, RÖntgen, RDE, REM, Sievert),Measurements of activity, Geiger Muller counter, Proportional and scintillation counters, Application of Radioactive tracers, Isotopic dilution (IDA) and activation analysis (NAA).	11	4		15
Unit-II	**Raman Spectroscopy**: Base Concepts of Raman Spectroscopy, Principle, instrumentation and applications. Fundamentals of ESRspectrum, E.S.R. spectra of transition metal complexes, spin Hamiltonian, Instrumentation and application of E.S.R. spectroscopy	11	4		15
Unit-III	Principle, instrumentation and applications of Atomic absorption spectroscopy and atomic emission spectroscopy, flame photometric methods of estimation of alkali and alkaline metals, Nephelometry and Turbidimetry.	11	4		15
Unit-IV	**Thermal Analytical methods:** Scope, classification, Principles, instrumentation and applications of Thermo gravimetric analysis, Differential thermal analysis and differential scanning calorimetry. **Inductively Coupled Plasma:** Principle, Technique, Instrumentation and Applications. Analysis of mineralogical samples, Analysis of water, Applications in biological systems.	12	3		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Instrumental Methods of Chemical Analysis by: G.W. Ewing, McGraw Hill Book Company
2. A Textbook of Quantitative Inorganic Analysis by: A. I. Vogel
3. Inorganic Thermogravimetric Analysis by: Duval
4. Modern Methods of Chemical Analysisby: R. L .Pecsok and L. D. Shields
5. Thermal Analysis by: Antonin Blazek

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	X		X		X	X		X				X
CO 2	X	X			X		X			X		X
CO 3			X	X			X	X				
CO 4	X		X		X		X	X		X		
CO 5		X			X		X			X		

M.Sc. : Semester-II	Course Type : DSC
Credits : 04	Course Code : MCH26-C202
Course Title: **Organic Chemistry and Related Techniques of Analysis**	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Recognize the basic concept of Electromagnetic spectra and U.V.-Visible spectroscopy.
CO 2: To understand the important concept of IR spectroscopy for functional group identification.
CO 3: To understand the valuable concept of NMR spectroscopy for structure elucidation of molecules.
CO 4: To acquire knowledge about Mass spectrometry technique.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**UV-Vis Spectroscopy:** Electromagnetic spectrum, electronic band spectra (UV and Vis region), laws of absorption (Beer's-Lambert law), molar extinction coefficient. Types of electronic transitions, Elementary idea of chromophores, auxochromes, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, Principle and Instrumentation of UV-VIS Spectroscopy, Woodward-Fieser rules, solvent effects on π-π^* and n- π^* transitions, steric hinderance and coplanarity, Applications of UV-VIS spectroscopy. Problems pertaining to the structure elucidation of organic compounds using UVspectroscopic techniques.	12	3		15
Unit-II	**IR spectroscopy:** Vibrational rotational spectra- Principle, absorption of infrared radiation & molecular vibration-rotations. Fundamental vibration, overtones and combination tones. Finger print region, infrared vibration - active and forbidden (selection rules). Instrumentation, factors affecting vibrational frequencies, spectral study of different functional groups. Idea of rotational spectrum. Problems pertaining to the structure elucidation of organic compounds using IR spectroscopic techniques.	11	4		15
Unit-III	**NMR spectroscopy:** H^1-NMR; Basic concept, instrumentation, FTNMR, chemical shift, shielding & deshielding, homotopic and diasteriotopic protons, spin-spin coupling, coupling constant, AX and AX_2 type spectra, spin decoupling, lanthanide shift reagents. C^{13}-NMR spectroscopy, off-resonance decoupling. Applications of NMR spectroscopy. Problems pertaining to the structure elucidation of organic compounds using NMR spectroscopic techniques.	11	4		15
Unit-IV	**Mass spectrometry:** Basic principle, fragmentation pattern of major functional groups, instrumentation, Mclafferty rearrangement, metastable ions, retro Diels-Alder reaction, general applications. Problems pertaining to the structure elucidation of organic compounds using Mass spectroscopic techniques.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Organic Chemistry by: Boyd and Morrison
2. Organic Chemistry by: I. L. Finar
3. Organic Chemistry by: Kapoor, Singh and Mukherjee
4. Organic Chemistry by: Bruice
5. Organic Chemistry by: Pine
6. A Guide Book to Organic Reaction Mechanism by: Peter Sykes

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X		X		X		X	X	X	X		X
CO2	X		X		X		X	X	X	X		X
CO3	X		X		X		X	X	X	X		X
CO4	X		X		X		X	X	X	X		X

M.Sc. : Semester-II	**Course Type : DSC**
Credits : 04	**Course Code : MCH26-C251**
Course Title: Lab Course: 3	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Learn to draw calibration curve and to calculate the specific rotation, angle of rotation, refractive index, concentration of solutions by different techniques.

CO2: Analyze samples using techniques as Polarimetry, Refractometry, Turbidimetry/ Nephelometry, D.O. analyzer, Flame photometry.

CO3: Gain knowledge for separation and identification of different sample mixtures by Column chromatography, Paper chromatography, Thin layer chromatography and Gas-Liquid chromatography.

Hands On Experiments

Experiments involving the extensive handling of various apparatus and equipment related to following techniques:

- Polarimetry
- Refractometry
- Turbidimetry/ Nephelometry
- D.O. analyzer
- Flame photometry
- Column chromatography
- Paper chromatography
- Thin layer chromatography
- Gas-Liquid chromatography

Suggested Readings:

1. Hand Book of Chromatography for Chemists and Engineers by: M. K. Shingari
2. Analytical Chemistry by: I. M. Kolthoff
3. Quantitative Analysis by: Vogel
4. Qualitative Analysis by: Vogel
5. Molecular Spectroscopy by: C. J. Benwell
6. Manuals supplied by company with respective instruments

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1		X	X		X			X	X	X		X
CO2		X	X		X			X	X	X		X
CO3		X	X		X			X	X	X		X

M.Sc. : Semester-II	Course Type : DSE
Credits : 04	Course Code : MCH26-E201
Course Title: **Physical Chemistry and Related Techniques of Analysis**	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: To discuss about the accuracy, precision, errors, significant figures and criteria about the rejection of data.

CO2: To describe signal to noise ratio, sensitivity and detection limit and FT in emission spectroscopy

CO3: To understand the concept of polarization, overvoltage and polarographic technique in analysis in qualitative and quantitative analysis.

CO4: Familiar with ion exchange and solvent extraction technique for the analysis of various samples of daily use.

CO5: Able to gain knowledge of basic principle, technique and applications of conductometric, potentiometric and pH-metric titrations.

CO6: To explain principle, experimental technique and simple and general applications of paper, column, thin layer, gas solid, gas liquid and high performance liquid chromatography.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**Treatment of Data in Quantitative Analysis :** Accuracy, Precision, Methods for expressing the accuracy and precision, Standard deviation, Types of errors, Elimination and minimization of errors, Significant figures, Criterion for the rejection of data.	11	4		15
Unit-II	Signal, Noise, Sensitivity Detection Limits, FT: Elementary idea of signal to noise ratio, Sensitivity and detection limits, Types and sources of noise (Thermal, shot, Flicker and Environmental noise). Eliminations/Minimization of noise, Time domain & frequency domain plots in emission spectroscopy. Basic idea and applications of Fourier transformation.	11	4		15
Unit-III	**Polarisation and Overvoltage**: Theories of Hydrogen overvoltage, Ilkovic equation, d.m.e., Half wave potential, Diffusion current, Polarography and its simple and general applications (Specific applications not required) **Ion Exchange:** Cation and Anion exchangers, their Stability, Selectivity and Characteristics, General applications including Ion Exchange Chromatography.	11	4		15
Unit-IV	**Conductometric, Potentiometric and pH–metric Titrations**: Theory, Technique and applications of Conductometric, Potentiometric and pH-metric titrations **Chromatographic Techniques:** Basic principles, Experimental techniques, Simple and general applications of Column, Paper, Thin layer, Gas-solid,Gas-liquid and High-Performance Liquid Chromatography (excluding specific applications).	12	3		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Instrumental Methods of Analysis by: Willard Merit, Dean and Seatle
2. Instrumental Methods of Chemical Analysis by: G.W. Ewing
3. Textbook Physical Chemistry by: S. Glasstone
4. Hand Book of Chromatography for Chemists and Engineers by: M. K. Shingari
5. Analytical Chemistry by: I. M. Kolthoff
6. Quantitative Analysis by: Vogel
7. Qualitative Analysis by: Vogel

8. Mathematics and Statistics for Chemists by: C. J. Brooks, I. G. Betteley and S. M. Lexsten
9. Molecular Spectroscopy by: C. J. Benwell

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X	X			X			X	X	X		X
CO2					X			X	X	X		X
CO3	X		X	X		X			X	X		X
CO4								X	X	X	X	X
CO5	X		X	X		X		X				
CO6	X		X					X	X	X	X	X

M.Sc. : Semester-II	**Course Type : DSE**
Credits : 04	**Course Code : MCH26-E251**
Course Title: Lab Course: 4	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Develop the key practical skills in pH-metry, Conductometry, Potentiometry, Spectrophotometry and Photoflourimetry likewise.

CO2: Applying above mentioned techniques for determination of pH, conductivity and potential of different solution

CO3: Determine the Absorption maxima and calculate the concentration of solution Spectrophotometrically and photo fluorometrically likewise.

Hands On Experiments

Experiments related to

- pH metry
- Conductometry
- Potentiometry
- Photofluorimetry
- Spectrophotometry
- Electrophoresis

Suggested Readings:

1. Instrumental Methods of Analysis by: Willard Merit, Dean and Seatle
2. Analytical Chemistry by: I. M. Kolthoff
3. Quantitative Analysis by: Vogel
4. Qualitative Analysis by: Vogel
5. Molecular Spectroscopy by: C. J. Benwell
6. Organic Chemistry by: Kapoor, Singh and Mukherjee
7. Manuals supplied by company with respective instruments

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1		X	X		X		X	X	X	X		X
CO2		X	X		X		X	X	X	X		X
CO3		X	X		X		X	X	X	X		X

M.Sc. : Semester-III	**Course Type : DSC**
Credits : 04	**Course Code : MCH26-C301**
Course Title: Analysis of Water and Waste Water	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Understand the principles of sampling, storage and physico-chemical analysis of water samples.
CO 2: Familiarize the chemical constituents present in water and their analysis for water quality assessment.
CO 3: Learn the bacteriological examination of water and interpretation of potability of water.
CO 4: Describe water pollution, effluent treatment processes and analysis of treated water for different uses.
CO 5: Explain the water quality standard parameters for agricultural, municipal and industrial purposes.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	Sampling and storage of water samples. Analysis of water samples for the following: Colour, Odour, Taste, turbidity, conductivity, total solids, filterable, non-filterable, fixed and volatile solids, pH, total alkalinity, CO3-- and HCO3– alkalinity, acidity, B.O.D., C.O.D. and D.O. Significance of major physico-chemical parameters in water quality monitoring.	12	3		15
Unit-II	Chemical analysis of water samples for NH3, NO3, NO2, organic N, total N, inorganic phosphates, silica, SO4--, hardness (Ca and Mg), Na, K, residual chlorine. Interpretation of chemical constituents in relation to water quality.	11	4		15
Unit-III	Optimum alum dose, its determination and industrial significance. Bacteriological examination of water: Preparation of culture media and nutrient agar. Total counts and Coliform MPN with interpretation of test data from industrial and municipal points of view (Potability of water). Basic concept of disinfection in water treatment.	11	4		15
Unit-IV	Water pollution and its sources. Basic concepts of effluent treatment processes. Analysis and evaluation of treated water for agricultural/municipal supplies and industries. Water quality standard parameters (WHO, BIS and CPCB).	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Standard Methods for Examination of water and Waste water by: APHA
2. Commercial Methods of Chemical Analysis by: F. D. Snell and F. M. Biffen
3. Chemical and Biological Method for Water Pollution Studies by: R. K.Trivedi and P. K. Goel
4. Water and Waste water Testing- A Laboratory Manual by: R. P. Mathur
5. Indian Standards for water Analysis (I. S. I.Publications)
6. Environmental Chemistry by: A. K. De
7. Environmental Pollutional Control Engineering by: C. S. Rao

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X	X	X		X	X	X	X	X			
CO2	X	X	X		X	X	X	X	X	X		X
CO3	X	X	X		X	X	X	X				
CO4	X		X		X	X		X		X	X	
CO5	X		X	X	X	X	X	X		X		X

M.Sc. : Semester-III	**Course Type : DSC**
Credits : 04	**Course Code : MCH26-C302**
Course Title : Analysis of Oils, Fats, Soaps, Detergents, Essential oils, Paints and Varnishes	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Gain fundamental knowledge on basics of chemistry involved in the oils/fats especially in context of drying Oils.

CO2: Understand the basics of soaps, surfactants and detergents and Able to explain the composition of soaps and detergents. Interpret the effect of use of new generation of surfactants in formulation and comment on quality standards of soaps, surfactants and detergents.

CO3: Learn the isolation and extraction process along with properties and chemical synthesis of some bio-active natural products. Explain the general methods in structure determination of terpenoids. Understand the fundamental knowledge on perfumery chemicals with an extended application in the field of pharmaceuticals.

CO4: Classify different types of organic coatings on the basis of its properties and applications. Understand fundamental knowledge on basics of chemistry involved in the Paints. Summarize various defects, their causes and cure surfacing out on application of different paints.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**Oils and Fats:** General idea, Classification, Occurrence, Basic idea of the function of oils and fats, Physical and chemical properties of oils and fats, Applications of oils and fats. **Analysis of oils and fats:** Determination of physical constants like M.P. and B.P., Specific gravity, Refractive index, Total volatile matter, Determination of Acid value, Iodine value, Saponification value, R. M. value and Polenske number	12	3		15
Unit-II	**Soaps and detergents:** Idea of common soaps, Cleansing action of soaps, Varities of soaps and their uses, Idea of detergents, Hazards of soaps and detergents. **Analysis of soaps and detergents:** Determination of Matter insoluble inalcohol, Free alkali and free acids, Matter insoluble in water, Glycerol content (Dichromate method), Foaming capacity and its comparision in different samples of soaps and detergents, Effect of sodium carbonate on the foaming capacity of soap.	11	4		15
Unit-III	**Essential Oils:** Introduction, nomenclature, constituent terpenoid. Isolation, separation of terpenoids from essential oils. General properties of terpenoids. Isoprene & Special Isoprene rule, Gem-dialkyl rule, Classification of terpenoids, Citral, Geraniol, Nerol, Linalool and Menthol, including constitution.	11	4		15
Unit-IV	**Paints, Varnishes and Lacquers:** General introduction of organic protective coatings, Essential ingradients of paints, Important functions of a pigment, a filler, a vehicle, a thinner, extenders, solvents and diluents, film forming materials and binders, distampers, plastisizers, emulsion paints, oil paints, epoxy paints, alkyd resins, phenolic resins, urea-formaldehyde and malamine-formaldehyde resins. Lacquers, drying, oxidative drying, curing, stoving, coatings, cold curing coatings. Various defects on paint surfaces and their rectification.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Methods of Sampling and Test for oils and fats, I. S. I, New Delhi
2. Methods of Sampling and Test for soaps and detergents, I. S. I, New Delhi
3. Organic Chemistry by Kapoor, Singh and Mukherjee

4. Organic Chemistry of Natural Products Vol. I and II by: Chatwal
5. Chemistry in Engineering and Technology by: Kuriacose and Raja Ram

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X		X					X	X			X
CO2	X		X		X	X		X	X	X		X
CO3			X				X	X	X			X
CO4						X	X	X	X			X

M.Sc. : Semester-III	**Course Type : DSE**
Credits : 04	**Course Code : MCH26-E301**
Course Title : Chemistry in Vedic Literature and Drugs	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Pursue "philosophy of life" by itself as one of the Indian knowledge systems and understanding Vedic worldview as the context of various Indic knowledge disciplines.

CO 2: Perceive the Vedic outlook regarding life in the here and hereafter and the cycle of life

CO 3: Commemorate the comprehensive and seamless nature of Vedic knowledge. Understand the concepts of *Svadharma*, free will and duty oriented action.

CO 4: Understand the purpose and utility of Vedic knowledge systems in enriching human life comprehending the Vedic world view of knowledge, its purpose and its universal and holistic nature

CO 5: Correlate the Ancient Indian System of knowledge with role of Chemistry in Modern Living.

CO 6: Grasp of vocabulary, models used and the process and practice of Chemistry as a Science in context to *Rasasastra*.

CO 7: Gain knowledge of ISM by studying various aspects of herbs and natural products. Deduce knowledge in analysis of drugs of ayurvedic and allopathic nature as well in order to infer regarding the pharmacodynamics of drugs in a better way.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**Chemistry in vedic literature and Indian philosophy-:** Kanad's atomic theory, Concept of Parmanu, Formation of molecules, Concept of SAMATA and VISHAMTA Vs Maxwell-Boltzmann's distribution of velocities and energies. First and Second law of thermodynamics in daily life. Law of helplessness of mankind in thermodynamics and Indian philosophy. Entropy in life and concept of Pralaya.Dhananjay Vs Concept of Radioactivity – Life after death. Atomic Spectrum Vs Concept of Kundalini.	12	3		15
Unit-II	**(a) Metallic Medicines in Ayurveda:** Shodhan and Marna, Doshas of Mercury and Astadasa sanskara. **(b)Concept of Tridosha and Saptdhatu in Ayurveda** **(c)Pharmacodynamics of Ayurvedic drugs:** Brief description of Rasa, Guna, Vipaka, Virya, and Prabhava.	11	4		15
Unit-III	**(a) Classification and Constituents of Crude Drugs:** Brief and introductory idea of drug constituents and their Morphological, Chemical and Pharmacological classification. **(b) Plant Analysis:** Methods of extraction, Isolation separation and identification of various constituents (Introductory description). Isolation of Caffine from Tea leaves Isolation of Piperine from black piper and Isolation of curcumine from turmeric.	11	4		15
Unit-IV	(a) **Analysis of Ayurvedic Drugs**: General idea of analysis of active constituents and standardization of Ayurvedic drugs, namely Rasa, Bhasma, Pisti and Herbs. (b) **Analysis of Modern drugs**: Assay and identification of Aspirin, Ibuprofen, Quiniodochlor, Diclofenac, Ascorbic acid, Paracetamol and chloroquine phosphate.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Alchemy and Metallic Medicines in Ayurveda by: Vaidya Bhagwan Das
2. History of Hindu Chemistry by: P. C. Ray
3. Ayurvediya Rasa Shastra by: Siddhinandan Misra
4. Ayurvediya Rasa Shastra by: Dr. Chandra Bhushan Jha
5. Indian Alchemy by: Dr. S. Mahdihassan
6. Indian Pharmacopoea 2010
7. Text Book of Pharmacognosy by: Mahammed Ali
8. Rasajalnidhi Vol. I - III
9. Ancient Scientists of India by Satya Prakash
10. Phytochemical Methods by: J. B. Harborne (Chapmann & Hall)
11. Vaisheshik Darshan by Kanad
12. Phytochemistry by R.K.Shukla

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1				X				X		X		
CO2				X				X		X	X	X
CO3				X				X		X	X	
CO4				X				X		X	X	
CO5	X			X				X		X	X	X
CO 6	X		X	X				X		X	X	
CO 7	X		X	X		X		X		X	X	

M.Sc. : Semester-III	**Course Type : DSE**
Credits : 04	**Course Code : MCH26-E351**
Course Title : Lab Course: 5	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Learn the sampling, preservation and physico- chemical analysis of water samples.

CO2: Interpretation of water analysis data.

CO3: Explain the significance of various tests for soaps and detergents. Implement the use of surfactants in industrial applications. Evaluate performance properties of soaps and detergents.

Hands On Experiments:

A. Analysis of water and waste water.

B. Analysis of Soaps and Detergents

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X		X			X	X	X	X			
CO2	X		X		X		X	X	X	X		X
CO3	X				X		X	X				

M.Sc. : Semester-III	**Course Type : DSE**
Credits : 04	**Course Code : MCH26-E352**
Course Title : Lab Course: 6	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Analyze and illustrate physical characteristics of oils like specific gravity, refractive index, color, viscosity etc. Evaluate chemical properties like acid value, saponification value, iodine value, RM value, Polanski value etc.

CO 2: Explain the difference in assay and identification of a drug.

CO 3: Analyze drugs to establish their purity and their quality.

Hands On Experiments:

A. Analysis of Oils and Fats,

B. Analysis of Drugs: Allopathic and Ayurvedic drugs, Assay and identification of Aspirin, Ibuprofen, Quiniodochlor, Diclofenac, Ascorbic acid, Paracetamol and chloroquine phosphate.

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1		X	X		X				X	X		X
CO2		X	X		X	X			X	X		X
CO3		X	X		X	X			X	X		X

M.Sc. : Semester- IV	**Course Type : DSC**
Credits : 04	**Course Code : MCH26-C401**
Course Title : Analysis of Cement, Minerals, Alloys and Trace Metals	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, students shall be able to:

CO 1: To impart knowledge of qualitative and quantitative analysis of limestone. Dolomite, and talcum powder.

CO 2: To discuss about Portland cement, cement. Gypsum. Admixtures, standard methods of chemical analysis of cement etc.

CO 3: To develop the ability to analyze the steel sample for its component elements.

CO 4: To describe the general aspects of Inorganic colorimetric trace analysis with some specific examples, methods for separation and isolation of traces of elements, general colorimetric reagents.

CO 5: To explain synthesis, polymerization, isolation and separation and physico-chemical properties of polymers.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**Analysis of Limestone, Dolomite, and Talcum powder:** Loss on ignition, Impure silica or insoluble matter, combined oxides (AI_2O_3 + Fe_2O_3), Calcium oxide, Magnesium oxide, Carbon dioxide, Volumetric procedure for the determination of calcium and Magnesium (EDTA Titration). Analysis of talcum powder: Determination of Ca and carbon dioxide in $CaCO_3$, Determination of Mg in Magnesium sulphate, Determination of phosphate in sodium phosphate.	12	3		15
Unit-II	**Cement:** Introduction, Portland cement, Manufacture (Outline), sampling, standard methods of chemical analysis of Portland cement, setting and hardening, Gypsum, Plasters and their setting, Weathering of cement and concrete, Chemical admixtures of concrete, other types of cement.	11	4		15
Unit-III	**Analysis of steels and alloys &. Colorimetry and spectrophotometry in trace metal analysis:** Determination of carbon by volumetric method, Determination of silicon by gravimetric method, Determination of Mn by the Bismuthate method, Determination of P, V, and Cr in alloyed steels, Determination of Iron in iron ore. Analysis of brass, Nickel coin, slag, and fluxes. Determination of Zn by the ferrocyanide method General aspects of Inorganic colorimetric trace analysis, Methods for the separation and isolation of traces of elements, General colorimetric reagents,	11	4		15
Unit-IV	**Synthesis and Analysis of polymers**: Purification of monomer, polymerization technique, synthesis of polymer of acrylonitrile, styrene, methyl methacrylate, ethylene glycol with maleic acid, Terephthaloyl chloride with ethylene diamine. Isolation and purification of polymers. Determination of glass transition temperature and Molecular weight. Determination of viscosity, pH, electrolytic stability, Hardness, tensile strength, and percentage elongation of polymers.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Analytical Chemistry in Metallurgy (Mir publishers) by: V. I. Posypanko and N. A. Vasina
2. Industrial Chemistry by: B. K. Sharma
3. Quantitative Inorganic Analysis by: Vogel
4. Chemistry in Engineering & Technology by: R. Ram &Kuriacose
5. Colorimetric determination of traces of metals by: E. B. Sandell

Mapping of course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X		X					X	X	X		X
CO2	X		X					X	X	X		X
CO3			X		X			X	X	X		X
CO4	X				X			X	X	X		X
CO5	X					X		X				

M.Sc. : Semester- IV	**Course Type : DSC**
Credits : 04	**Course Code : MCH26-C402**
Course Title : Analysis of Soil	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: To gain knowledge about composition of soil in terms of different phases, organic and inorganic minerals present in the soil.

CO 2: To do sampling, storage and physico-chemical analysis of soil samples by some conventional and modern methods of analysis.

CO3: To explain principle and method of determination of exchangeable hydrogen in soil.

CO4: To calculate the amount of lime requirement and gypsum requirement of the soil.

CO5: The students Familiarize with the processes oil testing and measure of soil fertility.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**(a) Phases Present in the soil:** Soil air, Soil solution and solids, Factors affecting the composition and concentrations of the salts in the soils. **(b) Inorganic Portion of the Soil:** Primary and secondary minerals, crystalline silicate, and Alumino silicates, Amorphous substances & salts, Relation of particle size and texture with the nutrients present in the soil.	12	3		15
Unit-II	**Organic Portion of the Soil:** Variable nature, Non-Humified organic part, Humic substances (Humic Acids, Fulvic Acids and Humins). (Only elementary knowledge of soil composition is required). **Soil sampling:** Handling, transport, and storage of samples, sieving and grinding.	11	4		15
Unit-III	**Physical Analysis of soil:** An analysis of soil samples for the porous nature, Water absorbing capacity, Moisture contents, Loss on Ignition, pH and conductivity. Cation exchange capacity and its determination.	11	4		15
Unit-IV	**Chemical Analysis of Soil:** Chlorides, Sulphates, Total alkalinity, soluble carbonates and Bicarbonates, Available phosphorus, total organic matter (by modified Walkley and Black Methods), Nitrogen by Kjeldahl digestion method, available nitrogen, exchangeable sodium and potassium.Determination of Gypsum requirement and water-soluble salts in saline and alkaline soils.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Standard Methods for Chemical Analysis Vol. III (VI edition) Instrumental Methods Part – B by: Frank J. Welcher
2. Agricultural Chemistry Vol. I by: B. A. Yogdin
3. Practical Manual for Introductory Courses in Soils by: Haryana Agricultural University
4. Chemical and Biological Methods for water pollution Studies by: R. K. Trivedi and P. K. Goel
5. Soil Chemical Analysis by: M. L. Jackson
6. USD A handbook to Diagnosis and improvement of Saline alkali soils by: I. B. M., New Delhi

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	X				X		X	X			X	X
CO2	X	X	X		X		X	X		X		X
CO3	X			X		X	X	X	X			
CO4	X		X					X		X	X	
CO5	X		X			X	X	X		X		X

M.Sc. : Semester-IV	**Course Type : DSE**
Credits : 04	**Course Code : MCH26-E401**
Course Title : Computer Applications in Chemistry	
Lectures : 60	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Understand the fundamentals and working of computer system.

CO 2: Enable to develop the simple programming in 'C' language.

CO 3: Apply the programming of 'C 'language in Physical, organic, inorganic and analytical Chemistry.

CO 4: Knowledge of software systems and application in software based modern instruments.

UNITS	CONTENTS	L	T	P	Total Hours
Unit-I	**Introduction to Computers:** Block diagram of computers; Input and output devices, Primary & secondary memory - RAM, ROM, Volatile and non-volatile memory; CPU - ALU and control unit; Hardware & software, Software - system software and application software. **Programming Languages, Number System and Operating System:** Introduction to Algorithms and Flow charts, Programming languages - Machine, Assembly and high level language. Number System: Bits and Bytes, Decimal, binary and octal number system and their arithmetic. Operating system and its functions: Microsoft windows. Applications of Microsoft Office, Google classroom and Google meet.	12	3		15
Unit-II	**C Programming:** Introduction; Style of C language; Character set; keywords, data types, variables and constants in C; Operators-Arithmetic, Relational, Logical, Bitwise, Ternary, Cast and Size of operators in C; Input and output statements in C language; Control and conditional statement in C; break and continue statement in loop. Storage classes in C; Functions (built in and user defined): Introduction to arrays.	11	4		15
Unit-III	**Computer applications in Physical and Analytical Chemistry:** Listing the C- program for the following: Determination of rate constant of first order reactions, determination of rate constant for second order reactions, study of rate constant with variation of ionic strength, obtaining the heat of reaction using Hess's law of constant heat summation, obtaining the heat of reaction at different temperatures using Kirchoff's equation. Determination of Normality, Molarity and Molality of solutions, Determination of concentration using Beer- Lambert's law.	11	4		15
Unit-IV	**Computer applications in Inorganic and Organic Chemistry:** Listing the C-program for the following: Determination of electronegativity of an atom from bond energy data using Pauling relation, determination of half life and average life of a radioactive nucleus. Determination of empirical formula of hydrocarbons and other organic compounds, Determination of molecular weights of organic compounds, Determination of molecular weights of organic compounds by Cryoscopic and ebullioscopic method. Determination of isoelectric point of amino acids. Chemdraw software and its applications.	11	4		15
	Total (in Hrs)	45	15		60

Suggested Readings:

1. Fundamentals of computer by V. Rajaraman
2. Programming in C (Schaum series outline) by Gotterfried.
3. Computers in Chemistry by K.V. Raman
4. Computer fundamentals and programming in C by Reema Thareja (2nd Edition)
5. Application of Computers in Modern Chemical Analysis by R.K.Shukla

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1				X				X	X			
CO2				X			X	X	X	X		
CO3				X			X	X	X	X		X
CO4		X	X	X				X	X	X		X

M.Sc. : Semester-IV	Course Type : DSE
Credits : 04	Course Code : MCH26-E451
Course Title : **Lab Course: 7**	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Learn the sampling, preservation and physico- chemical analysis of cement and steel samples.

CO2: Gain knowledge of analysis of cement and steel for different purposes by sampling, preservation and physico- chemical analysis.

CO3: Interpretation of cement and steel test data.

CO4: Learn the sampling, preservation and physicochemical analysis of polymer and paint /resins.

CO5: Gain knowledge of analysis of polymer and paint /resins for different purposes by sampling, preservation and physico- chemical analysis.

A. CEMENT ANALYSIS LABORATORY

1) Determination of Loss on Ignition (LOI) of Cement,
2) Determination of Insoluble Residue in Cement
3) Determination of Calcium Oxide by EDTA Method
4) Determination of Magnesium Oxide by EDTA Method
5) Determination of Iron Oxide (Fe_2O_3) in Cement
6) Determination of Aluminium Oxide (Al_2O_3) in Cement

B. STEEL ANALYSIS LABORATORY

1) Determination of Carbon in Steel
2) Determination of Silicon in Steel
3) Determination of Manganese by the Bismuthate Method
4) Determination of Iron in Iron Ore
5) Determination of Zinc by the Ferrocyanide Method
6) Analysis of brass alloy

C. BIOPOLYMER LABORATORY

1) Determination of moisture content, solubility of polymer material
2) Determination of the molecular weight of polymer materials.
3) Determination of the degree of substitution of modified polymer materials
4) Determination of Tensile strength, modulus and elongation for polymer film.
5) Preparation of adhesive coating by polymeric materials.
6) Functional group test for alcohol, amine, and carboxyl groups in polymers.

D. PAINT ANALYSIS LABORATORY

1) Measurement of the viscosity of resin/paint samples by Brookfield viscometer
2) Determination of the humidity of the painted film.
3) Synthesis of phenol-formaldehyde resin
4) Synthesis of Amine-formaldehyde resin
5) Synthesis of Melamine -formaldehyde resin
6) Synthesis of urea-formaldehyde resin

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1		X	X			X	X	X	X	X		X
CO2		X	X			X	X	X	X	X		X
CO3		X	X			X	X	X	X	X		X
CO4	X		X					X		X	X	
CO5	X		X			X	X	X		X		X

M.Sc. : Semester-IV	**Course Type : DSE**
Credits : 04	**Course Code : MCH26-E452**
Course Title : Lab Course: 8	
Practicals : 120	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Learn the sampling, preservation and physico- chemical analysis of soil samples.

CO 2: Gain knowledge of analysis of soil for different purposes by sampling, preservation and physico-chemical analysis.

CO 3: Handle the computer system for programming in C and few softwares of chemistry

Hands On Experiments:

A. Analysis of soils.

B. Computer Applications: Handling of computer with MS Word and Power point presentation. Internet and its application in Chemistry. Simple programming in C and C+ programs related to computer applications in Chemistry.

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Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1		X	X			X	X	X	X	X		X
CO2		X	X			X	X	X	X	X		X
CO3		X	X			X	X	X	X	X		X

M.Sc. : Semester-IV	Course Type : Industrial Project / Research (Dissertation/ Project/ Patent)
Credits : 20	Course Code : MCH26-P471/ MCH26-D471
Course Title : **Industrial Training cum Project / Dissertation Work**	
Field Work : 600	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Student acquires knowledge about industry/ institute work environment to achieve their goals in professional and academic life.
CO2: Makes them capable to interact at work place in society
CO3: Develop skills to handle analytical techniques in industry, institute and research.
CO4: Employ the knowledge of scientific thinking to design, carry out, record and analyze the results.
CO5: Students become equipped to step up in field of research and development.

1. The students shall undertake project work cum industrial training at an industry/institution under the supervision of one of the teaching staff members of the department. This work shall be submitted in typed and bound form after getting signed by the student and concerned supervisor and forwarded by the Head of the Department. The placement cell of University shall help and cooperate with the Department and students for undertaking the project work at industries. The placement officer shall get a *placement cum training brochure* printed and sent to various industries/ institutions in this regard.
2. A certificate by the industry/ institution and another by the supervisor along with the declaration by candidate shall be attached/ enclosed with the project report. *Self-declaration/ Affidavit can be submitted by the candidate in extraordinary situation like Corona spread etc in place of the certificate from Industry.*
3. Alternatively, the student can opt for undertaking dissertation work at Department of Chemistry, Gurukul Kangri University main campus or Kanya Gurukul, Hardwar as the case may be, under the supervision of a teaching staff member and submit the same by following the same procedure as already given above for submission of project. The student shall present the Project/ Dissertation work before a panel of two examiners consisting of the supervisor concerned and an expert/ examiner appointed by the University. One external expert shall not evaluate more than four Projects/ Dissertations. In case, a student opts for Dissertation, he/ she will have to deposit an additional fee of Rs. 3000/-. The University Administration is expected to remit or provide this fee as funds additional to the regular maintenance grants of the Department so as to meet the extra expenses in this regard.
4. In extraordinary situations like Corona spread etc, the student can be given an assignment (under the supervision of a teacher from department) in the form of writing a review after literature survey in place of Industrial Project or Dissertation. Although not necessary, but the student shall be encouraged for publishing this review in peer reviewed/ UGC CARE list journals. This Review report shall be evaluated in same way as in case of Industrial Project or Dissertation.

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1			X				X	X	X			
CO2			X				X	X	X	X		
CO3		X	X				X		X	X		X
CO4			X		X		X	X	X	X		X
CO5			X				X	X				

M.Sc. : II Year/ Semester-III & IV	Course Type : Research (Dissertation/ Project/ Patent)
Credits : 40	Course Code : MCH26-R471
Course Title : One Intensive Problem Based Research	
Field Work : 1200	

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Student acquires knowledge about institute work environment to achieve their goals in professional and academic life.
CO2: Makes them capable to interact at work place in society
CO3: Develop skills to handle analytical techniques in institute and research.
CO4: Employ the knowledge of scientific thinking to design, carry out, record and analyze the results.
CO5: Students become equipped to step up in field of research and development.

1. The selection of students for Dissertation work will be decided by DRC.
2. The student shall undertake dissertation work at the Department of Chemistry, Gurukula Kangri University in main campus or Kanya Gurukul Haridwar under the supervision of a teaching faculty of the department.
3. Initially students will submit a proposal of work plan of their research work in the department within 45 days.
4. At the end of Dissertation work students shall submit the work in typed and hard bound form after certified by the supervisor and Head of the Department.
5. Before submitting the Dissertation work the student must have achieved at least one outcome of Dissertation work.
6. The student shall present the Dissertation work before a panel of two examiners consisting of supervisor and an expert external examiner appointed by the University.

Mapping of Course outcomes (COs) with Program outcomes (POs) and Program specific outcomes (PSOs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
CO1			X				X	X	X			
CO2			X				X	X	X	X		
CO3		X	X				X		X	X		X
CO4			X		X		X	X	X	X		X
CO5			X				X	X				