हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Accredited by NAAC with A+ Grade with CGPA of 3.42)
(रसायन एवं रसायनिक विज्ञान विभाग)
शाहपुर परिसर, शाहपुर , जिला - काँगड़ा, हिमाचल प्रदेश – 176206

आज़ादी का अमृत महोत्सव

Minutes of the Eighth Board of Studies Meeting Held on 27th September, 2024 from 10:00 AM onwards Department of Chemistry and Chemical Sciences School of Physical and Material Sciences

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Accredited by NAAC with 'A+' Grade with CGPA of 3.42)

रसायन एवं रसायनिक विज्ञान विभाग/Department of Chemistry & Chemical Sciences
शाहपुर परिसर, जिला काँगड़ा, हिमाचल प्रदेश-176206

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आज़ादी का अमृत महोत्सव

The 8th **Board of Studies (BoS) Meeting** of the Department of Chemistry and Chemical Sciences (DCCS), School of Physical and Material Sciences (SoPMS) was held on 27th September, 2024 at Shahpur Campus of Central University of Himachal Pradesh, Dharamshala (CUHP).

Following members attended the meeting physically:

1. Professor Rajesh Kumar, Dean SoPMS, CUHP.
2. Dr. Vivek Sheel, Associate Professor and Head, DCCS, CUHP.
3. Dr Pramod Kumar, Assistant Professor, DCCS, CUHP.

Professor Ramesh Thakur, Department of Chemistry, H.P. University Shimla & **Professor Sunil Kumar**, Head, Department of Animal Sciences, CUHP participated in the meeting by online google meet mode. **Professor D.P. Goyal**, Department of Physics, Indira Gandhi University Meerpur, Rewari, Haryana expressed his inability to attend the meeting.

The Chairman started the meeting with introduction of Honorable Members of RDC and the following agenda of the meeting discussed:

1. **Agenda No.CCS-BOS-8/24-1:** Confirmation of Minutes of 7th BOS meeting of Department of Chemistry and Chemical Sciences held on 27th September 2023.

Resolution 1: The minutes of the 7th BOS meeting held on 27th September, 2024 is given in **Annexure I** are approved by honorable members.

2. **Agenda No.CCS-BOS-8/24-2:** Approval of Minutes of 2nd RDC of Department of Chemistry and Chemical Sciences held on 23rd September 2024.

Resolution 2: The minutes of the 2nd RDC meeting held on 23rd September, 2024 is given in **Annexure II** are approved by honorable members.

3. **Agenda No.CCS-BOS-8/24-3:** Approval and/or Modificattion of Syllabus of M.Sc. 1st & 3rd Semester Courses.

Resolution 3: Honourable members deliberated on the scheme at Length as given in **Annexure III** of 8th BOS Agenda. Honorable members discussed the syllabus semester wise and provided their valuable inputs. Professor Ramesh Thakur, External Subject Expert suggested to make the modification uniform and cohesive. The suggestions were incorporated and accordingly the agenda item is approved as such.

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4. Agenda No.CCS-BOS-8/24-4: It is for the information of BOS members that our School Board approved the minor change in the Course Name of M.Sc. II Sem. IKS 2 (CCS 527) as 'Bharatiya History Chemistry'.

Resolution 4: Honorable members discussed the minor change in the Course Name of M.Sc. II Sem. IKS 2 (CCS 527) and provided their valuable inputs **(Annexure IV)**. As per suggestion of External Subject Expert, Professor Ramesh Thakur, the course name of IKS 2 (CCS 527) may be 'Rasayan Vigyan Ka Bharatiya Ittihas' in place of 'Bharatiya History of Chemistry' and the agenda item can be placed before the School Board for further discussion.

5. Agenda No.CCS-BOS-8/24-5: Approval of the Swayam Course (Credit 4) added to the curriculum of M.Sc. II Sem. according to NEP only for 2023-24 session. So there is change in the credits from 4 to 2 as well as reduction of syllabus in two courses, Inorganic Chemistry- II (CCS 521) and Physical Chemistry-II (CCS 523) only for 2023-24 session.

Resolution 5: Honorable members discussed the Swayam Course (Credit 4) added to the curriculum of M.Sc. II Sem. and the reduction of syllabus in two courses **(Annexure V)**, Inorganic Chemistry- II (CCS 521) and Physical Chemistry-II (CCS 523) only for 2023-24 session. Professor Ramesh Thakur, External Subject Expert suggested to constitute an equivalence committee for monitoring and mapping of the Swayam online course in order to justify the deleted syllabus from Inorganic Chemistry- II (CCS 521) and Physical Chemistry-II (CCS 523). Further as per suggestion of Internal member Professor. Sunil Kumar, the syllabus will be remodified as and when future guidelines from university in this regard are released. Now the agenda item is approved as such.

The meeting ended with vote of thanks by Chairman BoS.

27/09/24
Dr. Vivek Sheel (Chairman)
Associate Professor & Head, DCCS, CUHP

Online
Dr. Ramesh Thakur (Member)
Associate Professor, Department of Chemistry, HPU, Shimla

27/9/24
Professor Sunil Kmar (Member)
Professor & Dean, SoLS, CUHP

27/9/24
Prof. Rajesh Kumar (Member)
Professor & Dean, SoPMS, CUHP

27/09/2024
Dr. Pramod Kumar (Member)
Assistant Professor, DCCS, CUHP

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
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रसायन एवं रसायनिक विज्ञान विभाग/Department of Chemistry & Chemical Sciences
शाहपुर परिसर, जिला काँगड़ा, हिमाचल प्रदेश-176206

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Annexure-I

Minutes of the Seventh Board of Studies Meeting Held on 23rd September, 2023 from 11:00 A.M. onwards Department of Chemistry and Chemical Sciences, School of Physical and Material Sciences

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The Seventh Board of Studies (BOS) Meeting of the Department of Chemistry and Chemical Sciences, SoPMS was held on **23rd September, 2023** at Shahpur campus of Central University of Himachal Pradesh.

Professor Devender Kumar Sharma, Professor Department of Chemistry, H.P University Shimla, **Professor Rajesh Kumar**, Dean SoPMS, **Professor Bhag Chand Chauhan**, Professor Department of Physics and Astronomical Science, CUHP, **Professor Sunil Thakur**, Department of Animal Sciences, School of Life Sciences, CUHP, **Dr. Rajender Kumar**, Professor, Department of Chemistry and Chemical Sciences, CUHP, **Dr. Neeraj Gupta**, Assistant Professor, Department of Chemistry and Chemical Sciences, CUHP and **Dr. Vivek Sheel**, Associate Professor and Head, Department of Chemistry and Chemical Sciences, CUHP were present in the Meeting.

Professor Shashi Kant Sharma expressed **his inability to** attend the meeting due to personal reason.

The Chairman started the meeting with introduction of Honourable Members of BOS and Following Business was transacted.

1. **Agenda No. CCS-BOS-7/23-1:** Confirmation of Minutes of 6th BOS meeting of Department of Chemistry and Chemical Sciences held on 26th December 2022. The Minutes of the 6th BOS meeting held on 26th December 2022 is given in **Annexure I.**

   Resolution No. 1: The Minutes of 6th BOS meeting held on 26th December 2022 as given in **Annexure I** are approved by Honourable members.

2. **Agenda No. CCS-BOS-7/23-2:** Approval of Minutes of 1st RDC of Department of Chemistry and Chemical Sciences held on 6th June 2023.

Resolution No. 2: The Minutes of 1st RDC meeting held on 6th June 2023 is given in **Annexure II** and are approved by Honourable members.

3. **Agenda No. CCS-BOS-7/23-3:** Approval and/or Modification of Syllabus of M.Sc. 4th Semester Course name: Subject Based Data Analysis and Interpretation (CCS 626) is given in **Annexure III.**

Resolution No. 3: The Honourable members approved the syllabus as such given in **Annexure III.**

4. **Agenda No. CCS-BOS-7/23-4.** Change of Course code of M.Sc. 1st Sem. CCS 527 as CCS 526 with course name 'Natural Products and Medicinal Chemistry' which was incorrectly included in the 5th BOS due to typographical error is given in **Annexure IV.**

Resolution No. 4: The course code of M.Sc. 1st Sem. CCS 526 corrected with course name 'Natural Products and Medicinal Chemistry' and approved by the Honourable Members as given in **Annexure IV.**

5. **Agenda No. CCS-BOS-7/23-5 :** Change in Course Name of M.Sc. II Sem. IKS 2 (CCS 527) as History of Chemistry which was incorrectly included in the 5th BOS is given in **Annexure V.**

Resolution No. 5: The Honourable Members approved the course Name of M.Sc. II Sem. IKS 2 (CCS 527) as History of Chemistry (CCS 527), as given in **Annexure V.**

6. **Agenda No. CCS-BOS-7/23-6:** Updated list of External Examiners is given in **Annexure VI.**

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Resolution No. 6: The updated list of External Examiners approved by Honourable Members as given in **Annexure VI.**

7. **Agenda No. 7:** It is for the information of BOS that one of the PhD student of Dr Rajender Kumar at his Previous Institute (Department of Chemistry, Saradar Vallabhbhai National Institute of Technology Surat, Gujarat) has been awarded PhD on dated 06/04/2023, after successful defense of Viva Voce. Dr. Rajender Kumar was acting her Co-Supervisor after leaving his previous institute. The detail is given in **Annexure VII.**

   Resolution No. 7: Honourable Members approved and Noted the Agenda item regarding completion of PhD of Student of Dr. Rajender Kumar, who was enrolled in his previous institute (Department of Chemistry, Saradar Vallabhbhai National Institute of Technology Surat, Gujarat) as given in **Annexure VII.**

8. **Agenda No. 8:** Approval and/or Modificattion of Syllabus of Review of Literature/ Research Proposal, CCS 616 (M.Sc. 3rd Semester, Credit 4) as given in **Annexure VIII.**

   Resolution No. 8: Honourable Members approved the modificattion of syllabus of Review of Literature/ Research Proposal, CCS 616 (M.Sc. 3rd Semester, Credit 4) as given in **Annexure VIII.**

9. **Agenda No. 9 :** Change in credits of Review of Literature/ Research Proposal (Lab) CCS 617 (M.Sc. 3rd Semester) course from 6 credits to 4 credits as given in **Annexure IX.**

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Resolution No. 10: Honourable Members approved the change in credits of Review of Literature/ Research Proposal (Lab) CCS 617 (M.Sc. 3rd Semester) as given in **Annexure IX.**

10. Agenda No. 10 : Item from Chair

Meeting ended with vote of thanks.

23/9/2023

Dr. Devender Kumar Sharma (Member)
Professor (Retd.), Department of Chemistry
Himachal Pradesh University Shimla-05

23-9-23

Dr. Rajender Kumar (Member)
Professor, Department of
Chemistry and Chemical Sciences
CUHP-176206

Dr. Rajesh Kumar (Member)
Dean SOPMS & Professor
Department of Physics and
Astronomical Science, CUHP-176206

Dr. Sunil Thakur (Member)
Professor, Department
of Animal Sciences Science, CUHP-17620

23/9/23

Dr. Bhag Chand Chauhan (Member)
Professor, Department of Physics and
Astronomical Science, SOPMS,CUHP-176206

23/9/23

Dr. Neeraj Gupta (Member)
Assistant Professor, Department of
Chemistry and Chemical Sciences
CUHP-176206

23/09/23

Dr. Vivek Sheel (Chairman)
Department of Chemistry and Chemical Sciences
CUHP-176206

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The Second Research Degree Committee (RDC) Meeting of the Department of Chemistry and Chemical Sciences (DCCS), School of Physical and Material Sciences (SoPMS) was held on 23rd September, 2024 at Shahpur Campus of Central University of Himachal Pradesh, Dharamshala (CUHP).

Following members attended the meeting physically:

1. Professor Rajesh Kumar, Dean SoPMS, CUHP.
2. Dr. Vivek Sheel, Associate Professor and Head, DCCS, CUHP.
3. Dr. Neeraj Gupta, Assistant Professor, DCCS, CUHP.
4. Dr. Manish Kumar, Assistant Professor, DCCS, CUHP.
5. Dr Shiwani Berry, Assistant Professor, DCCS, CUHP.
6. Dr Pramod Kumar, Assistant Professor, DCCS, CUHP.

Professor Ranjana Aggarwal, Director, (CSIR-NISCPR) Delhi, Professor S. K. Mehta, Vice-Chancellor, University of Ladakh and Rtd. Professor Neeraj Sharma, Department of Chemistry, H.P. University Shimla, participated in the meeting by online google meet mode.

The Chairman started the meeting with introduction of Honorable Members of RDC and the following agenda of the meeting discussed:

1. Agenda No. CCS-RDC-1/24-1: To approve the minutes of Departmental Research Committee (DRC) held on 27-09-2023 and 13-05-2024.

Resolution: The Minutes of DRC meetings held on 27-09-2023 and 13-05-2024 are given in Annexure I & Annexure II respectively and are approved.

2. Agenda No. CCS-RDC-1/24-2: Approval of Research Supervisors of admitted Ph.D students by Departmental Standing Committee (DSC) meeting held on 28-11-2023 in DCCS, CUHP.

Resolution: The list of admitted PhD Students along with allotted Research Supervisors, as approved in the DSC meetings on 28-11-2023 is given in Annexure III and is approved as such.

3. Agenda No. CCS-RDC-1/24-3: Re-allotment of Research Supervisor of Ms. Deeksha Gautam (CUHP21RDCHEM02) in highly exceptional-cum-unavoidable circumstances.

23.9.2024

Resolution: Ms. Deeksha Gautam (CUHP21RDCHEM02) has been enrolled for Ph.D under guidance of Prof. Rajender Kumar since 23-12-2021 in DCCS, CUHP and she has given a request to change her Research Supervisor in highly exceptional-cum-unavoidable circumstances. On her request and preference, DSC has re-allotted Dr. Neeraj Gupta, Assistant Professor in DCCS as a new Research Supervisor to her (Annexure IV). The Honourable Members of RDC approved Dr. Neeraj Gupta as her new Research Supervisor for Ph.D. in DCCS, CUHP.

4. Agenda No. CCS-RDC-1/24-4: Part time Ph.D case of Ms. Purnima Justa (CUHP20RDCHEM05), which was deferred by the previous RDC meeting (held on 06.06.2023) for wider discussion.

Resolution: Part time Ph.D case of Ms. Purnima Justa (CUHP20RDCHEM05), who is pursuing Ph.D under the supervision of Dr. Pramod Kumar in DCCS. Ms. Purnima Justa has deposited her fees to DCCS, CUHP on 27th July 2020 (Annexure V) & further joined on 2nd September, 2020 (Annexure VI) as Research Scholar in DCCS. After this, she has relieved from the DCCS on 1st March (AN) 2022 (**Annexure VII**) and joined as Trained Graduate Teacher (TGT Medical) in the Government of Himachal Pradesh on 2nd March 2022 (**Annexure VIII**). According to the CUHP, revised ordinance 42 (**Annexure IX**) notified by notification no 3-3/CUHP/GA/2010/Vol.IV/6744-59 dated 18.10.2021 (**Clause 3.4 and Clause 6.1**), her minimum residency period should be **one and half year** (including course work duration) for the Ph.D programme in DCCS, CUHP. Ms. Purnima Justa has fulfilled the required minimum residency period of one and half year in DCCS, so the Honourable Members of RDC approved her Part time Ph.D in DCCS as such.

The meeting ended with vote of thanks by Chairman RDC.

Professor Rajesh Kumar (Chairman)
Dean, SoPMS

Online
Professor Ranjana Aggarwal (Memb
Director, (CSIR-NISCPR) Delhi

Online
Professor Neeraj Sharma (Member)
Department of Chemistry
H.P. University

Online
Professor S.K. Mehta (Member)
Vice Chancellor, University of Lad

Dr. Vivek Sheel (Member)
Associate Professor & Head, DCCS,CUHP

Dr. Neeraj Gupta (Member)
Assistant Professor, DCCS,CUHP

Dr. Shiwani Berry (Member)
Assistant Professor, DCCS,CUHP

Dr. Pramod Kumar (Member)
Assistant Professor, DCCS,CUHP

Dr. Manish Kumar (Member)
Assistant Professor, DCCS,CUHP

Annexure III

M.Sc. Chemistry, Semester I

Course Code: CCS 511
Course Name: Inorganic Chemistry –I
Credits:2
Credits Equivalent: 2(one credit is equivalent to 15 hours)
Course Objectives:

1. To understand the concept of Valence bond theory, MOT and LCAO.
2. To understand the significant aspects of Crystal Field theory, splitting of d orbitals and Crystal field stabilization energies.
3. To understand the thermodynamic aspects of crystal filed splitting.
4. To be able to explain applications of nuclear chemistry as well as radioactive techniques.

Course Outcome (Cos):
The students will be able to
CO^1: Use VBT, MOT and LCAO for different type of molecules.
CO^2: Apply the crystal field theory for determining Crystal field stabilization energies.
CO^3: Find out the lattice energy, hydration energy and stability constants of complexes.
CO^4: Explain nuclear chemistry, radioactivity as well as radioactive techniques.

Attendance : Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course: Inorganic Chemistry -I							
	Programme Outcomes				Programme Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^2	PSO^3
CO1	3	2	3	2	3	2	2
CO2	1	3	3	2	3	2	3
CO3	1	2	2	3	3	3	2

Course Contents		
Unit	**Topic**	**Duration(Hrs)**
I	**Aspects of Chemical Bonding** Valence bond theory (VBT), resonance in VBT, VBT of homonuclear diatomic molecules, sigma and pi bonds, VBT of heteronuclear diatomic molecules, inadequacies of the simple VBT. Hybridization, participation of *d* orbitals in hybridization in polyatomic species. Molecular orbital theory (MOT), linear combination of atomic orbitals (LCAO), criteria for the formation of stable MOs. Sigma, Pi and Delta molecular orbitals. Homonuclear and heteronuclear diatomic molecules and ions.	12

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II	**Theory of Coordination Chemistry** *Crystal Field Theory*: Splitting of d orbitals in crystal fields of different symmetry for similar and dissimilar ligands (Octahedral, tetrahedral, Linear, trigonal planar, trigonal bipyramidal, square pyramid), crystal field stabilization energies (CFSE), spectrochemical series, octahedral site preference energy (OSPE) and their applications. Tetragonal distortion (Jahn-Teller effect). Thermodynamic aspects of crystal field splitting (variation of ionic radii, lattice energy, hydration enthalpy and stability constants of complexes – Irving Williams order).	12
III	**Nuclear Chemistry and Radioactive techniques** Nuclear stability, Nuclear cross-sections, Nuclear reactions: types of reactions, Nuclear fission-fission product and fission yields, Tracer technique, (neutron activation analysis), Counting techniques such as G.M. Ionization and proportional counters.	6

Preferred Text Books:

1. F.A Cotton & G. Wilkinson, Advanced Inorganic Chemistry:,Vth Edn. , Wiley-Interscience, New York
2. B.R.Puri, L.R.Sharma, K.C. Kalia, Principles of Inorganic Chemistry, Vishal Publishing Company
3. Gurdeep Raj, Advanced Inorganic chemistry, Goel Publishing House.
4. J.E.Huheey, E.A.Keiter and R.L.Keiter, Inorganic Chemistry –4th Edn, Pearson

Suggested Readings

1. **Coordination chemistry, Ajay Kumar, Second Edition**
2. **Inorganic Chemistry,** Gary L. Miessler, Paul J. Fischer, Donald A. Tarr, Fifth Edition

Course Code CCS 512
Course Name Organic Chemistry-I
Credits Equivalent 02
Course Objectives

- To understand the significant aspects of reaction mechanism in organic chemistry and structural effect on reactivity of the reaction schemes.
- To impart knowledge about reaction mechanism
- To impart the knowledge of Structure and Reactivity
- To understand Hammonds postulate, Curtin-Hammett principle.
- To impart knowledge about Methods of determining Reaction mechanisms
- To understand addition reactions which are happening through the nucleophiles and electrophiles
- To understand the reactivity of different carbonyl compounds towards nucleophilic reaction.
- To understand how to write the products of addition reaction to carbonyl compounds.
- To learn the mechanism of addition and elimination reaction
- To understand addition reactions between a hetero atom and double bonded carbon compounds.

Course Outcome (Cos) After the successful completion of this course, the student will be able to:

CO^1 Distinguish different types of reaction mechanism.
CO^2 Apply their literary knowledge to understand effect of structure on reactivity
CO^3 Understand the importance of Quantitative treatment, linear free energy relationship, Substituent and reaction constants,
CO^4 To learn the addition reactions which are happening through the nucleophiles and electrophiles
CO^5 To learn about the addition reactions between a hetero atom and double bonded carbon compounds

Attendance Students are expected to attend all lectures to be able to fully benefit from the course. A minimum of **75% attendance** is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course:.....														
	Program Outcomes								Program Specific Outcomes					
CO	PO^1	PO^2	PO^3	PO^4	PO^5	PO^6	PO^7	PO^8	PSO^1	PSO^2	PSO^3	PSO^4	PSO^5	PSO^6
CO1	--	2	2	1	--	1	1	1	--	2	1	--	2	2
CO2	2	2	2	2	--	--	--	2	2	2	2	--	2	2
CO3	1	3	3	3	--	3	--	--	--	3	3	3	2	--
CO4	3	3	3	3	--	--	3	--	2	2	2	3	--	3

Course Contents		
Unit	Topic	Duration
I	**Reaction Mechanism** Reaction Mechanism: Structure and Reactivity: Thermodynamic and kinetic requirements, Kinetic and Thermodynamic control, Hammonds	10 Credit Hours

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	postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates. Effect of Structure on reactivity: Resonance and field effects, steric effect. Quantitative treatment: Hammett equation and linear free energy relationship, Substituent and reaction constants, Taft equation. Methods of determining Reaction mechanisms.	
II	**Addition to C-C multiple bonds** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo selectivity, orientation and reactivity. Hydrogenation of double and triple bonds and aromatic rings. Hydroboration reaction, Sharpless asymmetric epoxidation.	**10 Credit Hours**
III	**Addition to Carbon-Hetero Multiple Bonds** Mechanism of metal hydride reaction of substituted and unsubstituted carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organo-Zn and organo-Li reagents to saturated and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation involving enolates.	**10 Credit Hours**

Preferred Text Books:

- March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, John Wiley and sons.
- A guide to mechanism in Organic Chemistry, 6th edition, 2009, Peter Sykes, Pearson education, New Delhi.
- Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002).

Suggested Readings:

- Mechanism and theory in Organic Chemistry, T. H. Lowry and K. C. Richardson, Harper and Row.
- Organic Reaction Mechanism, 4th edition, V. K. Ahluwalia, R. K. Parashar, Narosa Publication.
- Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P. Singh, Macmillan Publishers, India.
- Organic Chemistry, Part A and B, Fifth edition,2007, Francis A. Carey and Richard J. Sundberg, Springer.

Course Code: CCS 513
Course Name: Physical Chemistry-I
Credits Equivalent: One credit is equivalent to 15 hours of lectures.
Course Objectives: **1.** To study the fundamentals and applications of classical mechanics and quantum chemistry.
2. To understand the structure of an atom and different approximation methods.
3. Study the classical Maxwell-Boltzman and quantum statistics.
4. Know about partition functions and determining thermodynamic properties
5. Understand probability partition functions.
6. Apply the thermodynamic factors in various organic synthesis processes.
Course Outcome (COs): CO1 Understand the Fundamental Principles of Quantum Mechanics.
CO2 Capable to apply approximate methods in an atom.
CO3 Learning of Statistical Thermodynamics.
CO4 Knowledge of the thermodynamic properties of the system.
CO5 Detailed study of partition functions of diatomic molecules.
CO6 Thorough understanding of the reaction condition and reaction rate various depend on the thermodynamic factors.
Attendance: A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria: 1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course: Physical Chemistry-I							
	Program Outcomes				**Program Specific Outcomes**		
CO	**PO^1**	**PO^2**	**PO^3**	**PO^4**	**PSO^1**	**PSO^2**	**PSO^3**
CO1	2	1	3	2	2	3	2
CO2	3	2	1	1	1	1	3
CO3	3	1	2	3	3	3	2
CO4	2	1	2	3	2	1	3
CO5	1	2	3	3	2	3	1
CO6	3	2	1	2	1	2	3

Course Contents		
Unit	**Topic**	**Duration**
I	**Fundamental Principles of Quantum Mechanics:** Planck's radiation law, Black body radiations, Photoelectric effect, Compton effect, De-Broglie hypothesis, the Heisenberg's uncertainty principle, Rydberg relation for explaining atomic spectrum of hydrogen, Postulates of quantum mechanics, Operators, Commutative Property, Commutator, Hermitian property of operator, Linear operator, Momentum operator, Hamiltonian operator, Angular Momentum operator, Interpretation of wave function, Eigenvalues and Eigenfunctions, Normalization and Probability, Expectation Value, Concept of degenerecy.	**10**
II	**Applications of Quantum Postulates & Approximate Methods:** Applications of Schrodinger wave equation to for Hydrogen atom, One dimentional Simple Harmonic Oscillator, Rigid rotators, Particle in one and three dimensional box, degeneracy, Need for approximation methods, Perturbation and Variation methods and their application to Helium atom, Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.	**10**

III	**Statistical Thermodynamics:** Thermodynamic probability and entropy, Maxwell Boltzman, Partition function: rotational, translational, vibrational and electronic partition functions of diatomic molecules, calculation of thermodynamic functions and equilibrium constants. Microcanonical ensemble, Canonical ensemble distribution probability partition function, its relation with different thermodynamic state functions. Gibb's paradox and Sackur- Tetrode equation. Equipartition theorem and its validity.	10

Preferred Text Books: 1. Atkins, P., & De Paula, J. (2014). Atkins Physical Chemistry (X Edition). Oxford: Oxford University Press.
2. D. A. Mcquarrie, Quantum Chemistry, Pearson.
3. Kapoor, K. L. (2015). Text Book Physical Chemistry Vol. V. New Delhi: MacMillan India Ltd.
4. Ira N. Levine, Quantum Chemistry, City College of New York.
Suggested Readings: 1. Lavin, I. N. (2002). Physical Chemistry (V Edition). New Delhi: Tata-McGraw Hill Publishing Company.
2. Whittakar, A. G. (2001). Physical Chemistry. New Delhi: Mount & Heal Viva Books Pvt. Ltd.
3. Prasad R.K. Quantum Chemistry, 4th Revised Edition, New Age International Publishers, London, New Delhi.
4. S. Glasstone, Thermodynamics for Chemists.

Course Code: CCS 514
Course Name: Advance Analytical Techniques
Credits Equivalent: One credit is equivalent to 15 hours of lectures.
Course Objectives: 1. To know about chromatography.
2. To understand about high performance liquid chromatography, gas chromatography and GC-MS.
3. To know basic principle, instrumentation and applications of TEM, SEM, AFM and XPS
4. Complete information of TEM, SEM, AFM, XPS and DLS.
Course Outcome (COs): CO1 Understand the basic principle of chromatography.
CO2 Basic principle, methodology and application of high-performance liquid chromatography and gas chromatography
CO3 Learning of principle, methodology and application of liquid and gas chromatography – Mass spectrometry.
CO4 Knowledge of the principle, instrumentation, sample preparation, analysis and applications of TEM, SEM, AFM, XPS and DLS.
Attendance: A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria: 1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents		
Unit	**Topic**	**Duration**
I	**Introduction to Chromatography:** Principle of different Analytical techniques. Classification of different chromatographic methods. **Thin Layer Chromatography (TLC):** Basic principle, methodology & applications. **Gas chromatography:** Theory, Instrument description of equipment and different parts, columns (packed and capillary columns), Principles and Applications. **Liquid Chromatography:** Principle, methodology & applications. **HPLC:** Introduction, Principle, methodology & applications. **Liquid & Gas Chromatography – Mass Spectrometry:** Introduction, Instrumentation, principle, processing, Applications of GC-MS for Trace constituents. Drugs analysis, Environmental Analysis and others.	10
II	**Electron Microscopy:** Scanning Electron Microscopy **(SEM):** Basic principle, detector technology, qualitative and quantitative analysis, Electron-matter interaction, Imaging and Analysis, High-Resolution Imaging, field emission SEM. Secondary and Backscattered Electron Imaging: Image formation, contrast, and interpretation, Applications of SEM. **Transmission Electron Microscopy (TEM):** Basic principle, Instrumentation: Principles of electron beam generation, lens systems, and imaging modes. Sample Preparation for TEM, Working, Electron Energy Loss Spectroscopy (EELS), **High-Resolution TEM (HRTEM):** Atomic resolution imaging, phase contrast, image simulation and interpretation. Applications of TEM.	10
III	**Modern Techniques:** Atomic Force Microscopy **(AFM): Basic Principles:** Fundamentals of AFM, components, and types of forces involved (van der Waals, electrostatic, magnetic). **Instrumentation:** Description of key components—cantilever, tip, piezoelectric scanner system, feedback loop, and control electronics, AFM Imaging Modes, Applications of AFM. **XPS:** Basic concept: Photoelectric effect, binding energy. Instrumentation: X-ray sources (Al Kα, Mg Kα), electron energy analyzers, detectors, and vacuum systems. XPS Spectrum: binding	10

	energy, peak assignments, chemical shifts, and Auger peaks. Applications of XPS. **Light Scattering**: Introduction to Light Scattering: Basic Principle, Interaction of light with matter, Rayleigh scattering, Mie scattering, and Raman scattering. Instrumentation: Light sources (lasers, lamps), detectors (photomultiplier tubes, CCDs), and optical components. Dynamic Light Scattering (**DLS**), Static Light Scattering (SLS), Applications of Light Scattering.	

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Preferred Text Books: 1. A.Braithwaite and F.J, Smith , Chromatograhic Methods, KLUWER ACADEMIC PUBLISHERS.

2. Electron Microscopy and Analysis, Peter J. Goodhew, John Humphreys, Richard Beanland, 2000, 272pp, softcover.

Suggested Readings: 1. PETER EATON and PAUL WEST , Atomic Force Microscopy, Oxoford University Press.

2. Scattering , Absorption, Emission of Light by Small Particles , Michael I. Mishchenko . Larry D. Travis, Andrew A. Lacis.

3. An Introduction to Surface Analysis by XPS and AES , John F. Watts, John Wolstenholme.

4. Mark F. Vitha, Chromatography: Principles and Instrumentation, **Wiley.**

Course Code: CCS 516
Course Name: Spectroscopic techniques
Credits: 4
Credits Equivalent: (one credit is equivalent to 15 hours)

Course Objectives:

1. To understand the basics of Spectroscopy, Pure rotational spectroscopy, vibrational spectroscopy and its application of different molecules.
2. To understand in depth concept of IR and Basics of Raman spectroscopy.
3. To understand the concept of factors affecting the frequencies and band shapes.
4. To understand the Basic principles and Instrumentation of UV spectroscopy.
5. To understand the aspects of NMR spectroscopy such as Nuclear overhausser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic ions.
6. To understand basic instrumentation and other techniques of mass spectroscopy.

Course Outcomes:

The students will be able to
CO^1: Explain the compounds on the basis of Pure rotational spectroscopy, vibrational spectroscopy techniques
CO^2: Differentiate various types of vibrations in IR spectroscopy.
CO^3: Explain the different theories of IR absorption as well different scattering phenomenon in Raman spectroscopy.
CO^4: Understand the concepts of Nuclear Quadrupole Resonance, Nuclear electric quadrupole moment, Electric field gradient, Energy levels and NQR frequencies and Effect of magnetic field on spectra.
CO^5: Determine structure by different spectroscopic techniques.

Attendance: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

Course: Spectroscopic techniques							
Programme Outcomes					Programme Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^2	PSO^3
CO1	3	2	3	2	2	3	3
CO2	2	3	3	2	3	2	3
CO3	1	2	2	3	3	2	3
CO4	2	2	3	3	2	3	2
CO5	2	3	2	1	3	3	2

Course Contents		
Unit	**Topic**	**Duration(Hrs)**
I	**Basic Spectroscopy:** Introduction to spectroscopy, Nature of radiation, Energies corresponding to various kinds of radiation, types of spectra, basic features of spectrophotometer, Intensities of spectral lines, selection rules and transition moments, Line widths, Broadening of peaks, Molecular spectra. **Pure Rotational Spectra:** Rotational spectra of diatomic molecules, Relative intensities of spectral lines. Rotational spectra of polyatomic molecules, Classification of molecules according to their moment of inertia. Stark's effect. Applications of Microwave spectroscopy-Determination of molecular geometry by rotational spectrum, isotopic substitution effects.	14
II	**Vibrational Spectra:** Diatomic molecules, Force constants, Fundamental vibration frequencies, anharmonicity of molecular vibrations and its effect on vibrational frequencies. Vibrational spectra of polyatomic molecules CO_2, water and acetylene. P,Q and R branches.	10
III	***Infrared Spectroscopy:*** Theory of IR absorption, Types of vibrations, Observed number of modes of vibrations, Intensity of absorption bands, Theoretical group frequencies, Factors affecting group frequencies and band shapes (Physical state, Vibrational Coupling, Electrical effects, Resonance, Inductive effects, Ring strain). Basic Principle of Raman Spectroscopy, Differences between IR and Raman spectra.	12
IV	**UV spectroscopy:** Basic principles and Instrumentation of UV spectroscopy, Beer lambert law, absorbance, transmittance, Λ_{max}, ϵ_{max}, various fundamental transitions, solvent effect, Chromophores and Auxochromes. Rules for finding Λ_{max}.	10
V	**Nuclear Magnetic Resonance Spectroscopy:** - Introduction to Nuclear Magnetic Resonance, Chemical shift, Mechanism of electron shielding and factors contributing to the magnitude of chemical shift, Nuclear overhausser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic ions. Contact shifts. Experimental technique (CW and FT).	14

Preferred Text Books:

1. **Paula K Bruice, Organic Chemistry , 8th Edition, Pearson.**
2. Jag Mohan, Organic spectroscopy, Narosa Publishing House.
3. Y. R. Sharma, Elementary Organic Chemistry, S. Chand.
4. Organic spectroscopy, William Kemp 3rd Edition
5. C.N.Banwel, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill

Suggested Readings

6. B.R.Puri, L.R.Sharma, K.C. Kalia, Principles of Inorganic Chemistry, Vishal Publishing Company
7. Gurdeep R. Chatwal, Sham K. Anand, Instrumental methods of Chemical analysis, Himalya

Publishing House.

Course Code: CCS 517
Course Name: Commercial and Green Synthesis
Credits Equivalent: 2
Course Objectives:

5. *To know about the introduction and application of retro organic synthesis*
6. *To know the inter-conversion of functional groups.*
7. *Knowing the importance and principle of protection of functional groups.*
8. *To know about the green chemistry with their green synthetic approach.*

Course Outcome (Cos):
The students will be able to

CO1 *To know the disconnection approach*
CO2 *Protection of functional groups.*
CO3 *Twelve principles of green chemistry.*
CO4 *To know about green synthetic approach.*

Attendance:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

4. Mid Term Examination: 20
5. End Term Examination: 60
6. Continuous Internal Assessment: 20

Course: Commercial and Green Synthesis														
	Program Outcomes								**Program Specific Outcomes**					
CO	**PO^1**	**PO^2**	**PO^3**	**PO^4**	**PO^5**	**PO^6**	**PO^7**	**PO^8**	**PSO^1**	**PSO^2**	**PSO^3**	**PSO^4**	**PSO^5**	**PSO^6**
CO1	1	2	2	1	1	1	1	1	--	2	1	1	2	2
CO2	2	2	2	2	2	--	--	2	2	2	2	--	2	2
CO3	1	3	3	3	--	3	--	--	--	3	3	3	2	--
CO4	3	3	3	2	--	2	3	3	2	2	1	3	1	3

Course Contents		
Unit	**Topic**	**Duration**
I	**Unit – 1: Introduction to Retro Organic Synthesis** General introduction to organic synthesis, importance and types of organic synthesis, linear and Convergent synthesis, rational and irrational synthesis. Planning an Organic Synthesis: Intuitive approach, Disconnection approach – retrosynthetic analysis – the basic concepts and order of events, Introduction to synthons and synthetic equivalents. One group disconnection One group C-X and C-C along with two group C-X	**10 Hrs**

	disconnections (case studies of representative molecules are required), synthetic equivalents to common synthons.	
II	**Unit – 2: Applications of Retro Organic Synthesis** Latent polarity and functional group interconversions (FGI), Target molecules (TMs) with two functional groups. Reversal of Polarity (Reactivity Umpolung) and importance of functional group protection in organic synthesis. Principle of protection of alcohol, amine, carbonyl and carboxyl groups. Synthesis of cyclic molecules, FGIs of groups containing heteroatoms, and unsaturated hydrocarbons. Protection and deprotection of common functional groups.	**10 Hrs**
III	**Unit - 3: Green Synthesis: Principles and Applications** What is Green Chemistry? Need for Green Chemistry, Goals of Green Chemistry, Limitations/ Obstacles in the pursuit of the goals of Green Chemistry; Twelve principles of Green Chemistry with their explanations. Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Green solvents – supercritical fluids, water as a solvent for organic reactions, ionic liquids, solventless processes, immobilized solvents and how to compare the greenness of solvents. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.	**10 Hrs**

Preferred Text Books/ Suggested Readings:

- Warren S., Organic Synthesis – The Disconnection Approach, Pubs: Wiley Interscience. (1982).
- Wills Christine and Wills Martin, Organic Synthesis, Pubs: Oxford University Press (1994).
- Corey E.J. and X.M. Cheng, The logic of Chemical Synthesis, Pubs: Wiley Interscience(1989).
- Ahluwalia, V.K. & Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).
- Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
- Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
- Ryan, M.A. &Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).

Course Code : CCS 519
Course Name : Indian knowledge system
Credit : 02
Credits Equivalent : One Credit is Equivalent to 15 hours of Lectures
Course Objectives :

1. To provide students with a comprehensive understanding of the evolution of Bharatiya civilization and its knowledge systems, emphasizing the interconnectedness of various disciplines in ancient India.
2. To explore the richness of ancient Bharatiya arts, literature, and the contributions of scholars, fostering an appreciation of the cultural and intellectual heritage of Bharat.
3. To analyze and appreciate the contributions of ancient Bharat to the fields of science and mathematics, highlighting key discoveries, theories, and their impact on global knowledge.
4. To examine the advancements in engineering, technology, and architecture in ancient Bharat, understanding the principles, techniques, and materials used, as well as their influence on modern practice.
5. To foster interdisciplinary knowledge by integrating various aspects of ancient Bharatiya civilization, including science, technology, arts, literature, and environmental practices, demonstrating their holistic nature

Course Outcome (Cos) :

CO^1 Comprehensive understanding of Bharatiya civilization and its knowledge systems.
CO^2 Appreciation of ancient Bharatiya arts, literature, and scholarly traditions
CO^3 Recognition of significant contributions to science and mathematics globally
CO^4 Knowledge of ancient engineering, technology, and architectural innovations.
CO^5 Awareness of ancient environmental and health practices' contemporary relevance.

Attendance: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria :

7. Mid Term Examination: 20
8. End Term Examination: 60
9. Continuous Internal Assessment: 20

Course : Indian knowledge system							
	Program Outcomes				Program Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^1	PSO^1
CO^1	2	2	3	2	3	3	2
CO^2	2	3	2	1	2	2	3
CO^3	1	2	1	3	3	3	2
CO^4	2	1	2	3	2	1	3
CO^5	3	2	3	1	2	3	2

Course Contents

UNIT -I: Bhāratīya Civilization and Development of Knowledge System (4 hours)

Antiquity of civilization, Discovery of the Saraswatī River, the Saraswatī-Sindhu Civilization, Traditional Knowledge System, The Vedas, School of Philosophy (6+3), Ancient Education System, the Takṣaśilā University, the Nālandā University

UNIT-II: Arts, Literature, and Scholars in Ancient Bharat (4 hours)

Art, Music, and Dance, Naṭarāja– A Masterpiece of Bhāratīya Art, Literature, Life and works of Agastya, Lopāmudrā, Ghoṣā, Vālmīki, Patañjali, Vedavyāsa, Yājñavalkya, Gārgī, Caraka, Suśruta, Kaṇāda, Kauṭīlya, Pāṇini, Thiruvalluvar, Āryabhaṭa, Bhāskarācārya, Mādhavācārya.

UNIT-III: Ancient Bhartiya Contribution towards Science & Mathematics (4 hours)

Sage Agastya's Model of Battery, Vedic Cosmology and Modern Concepts, Concept of Zero and Pi, Number System, Phythagoras Theroem, and Vedic Mathematics; Kerala School for Mathematics and History of Culture of Astronomy, Astronomical ___ of day, year and Yuga.

UNIT-IV: Ancient Bhartiya Engineering, Technology & Architecture (4 hours)

Pre-Harappan and Sindhu Valley Civilization, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet–Dwārkā.

UNIT-V: Ancient Bhartiya Contribution in Environment & Health (4 hours)

Ethnic Studies, Life Science in Plants, Agriculture, Ecology and Environment, Āyurveda, Integrated Approach to Healthcare, Surgery, and Yoga, etc.

Preferred Text Books:

1. The History of Ancient India: From the Earliest Times to 1000 AD" by Rama Shankar Tripathi.
2. Indian Art and Architecture" by Harle, J.C.
3. Science in History: Volume 1: The Ancient World" by J.D. Bernal
4. History of Indian Architecture (Buddhist, Jain and Hindu Period)" by Percy Brown
5. Ayurveda: The Science of Self-Healing" by Vasant Lad.

Suggested Readings

6. Indian Temple Architecture: Form and Transformation" by Adam Hardy
7. A History of Indian Literature" by Maurice Winternitz.
8. Environmental Consciousness in Ancient India" by A.K. Bhattacharya.

M. Sc. Chemistry, Semester III

Course Code: CCS 611
Course Name: Inorganic chemistry Specialization I
Credits: 4
Credits Equivalent: (one credit is equivalent to 15 hours)

Course Objectives:

1. To understand the aspects of NMR spectroscopy such as Nuclear overhausser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic ions.
2. To understand the concepts of Nuclear Quadrupole Resonance, Nuclear electric quadrupole moment, Electric field gradient, Energy levels and NQR frequencies and Effect of magnetic field on spectra.
3. To understand the concept of Mössbauer Spectroscopy and application of MB spectroscopy in structural determination.
4. To understand the concept of Electron Spin Resonance Spectroscopy such as Hyperfine coupling in methyl, benzene and Naphthalene radicals, Factors affecting the magnitude of g-values. Zero field splitting and Kramer's Degeneracy.
5. To understand the concept of Mass spectroscopy, its basic instrumentation and modes of fragmentations.

Course Outcomes:

The students will be able to
CO^1: Explain different aspects and processes of NMR spectroscopy.
CO^2: Understand the concepts of Nuclear Quadrupole Resonance, Nuclear electric quadrupole moment, Electric field gradient, Energy levels and NQR frequencies and Effect of magnetic field on spectra.
CO^3: Explain the structure on the basis of Mössbauer Spectroscopy.
CO^4: Explain the concept of hyperfine splitting and structure on the basis of ESR spectroscopy.
CO^5 : Apply the Mass spectroscopy for the identification of different molecules.

Attendance : Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

Course : Inorganic chemistry Specialization I							
	Programme Outcomes				Programme Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^2	PSO^3
CO1	2	2	3	3	2	2	3
CO2	3	2	2	3	3	3	2
CO3	2	2	3	3	3	2	3
CO4	2	2	3	3	2	3	2
CO5	3	3	2	3	3	2	2

Course Contents		
Unit	**Topic**	**Duration(Hrs)**
I	**Nuclear Magnetic Resonance Spectroscopy:** Introduction to Nuclear Magnetic Resonance, Chemical shift, Mechanism of electron shielding and factors contributing to the magnitude of chemical shift, Nuclear overhausser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic ions. Contact shifts. Experimental technique (CW and FT).	**14**
II	**Nuclear Quadrupole Resonance Spectroscopy:** Basic concepts of NQR (Nuclear electric quadrupole moment, Electric field gradient, Energy levels and NQR frequencies), Effect of magnetic field on spectra, Factors affecting the resonance signal (Line shape, position of resonance signal) Relationship between electric field gradient and molecular structure.	**12**
III	**Mössbauer Spectroscopy:** Introduction, Principle, Conditions for Mössbauer Spectroscopy, parameters from Mössbauer Spectra, Isomer shift, Electric Quadrupole Interactions, Magnetic Interactions MB experiment, Application of MB spectroscopy in structural determination **Photo electron Spectroscopy**: Basic Principle of Photo electron Spectroscopy.	**10**
IV	**Electron Spin Resonance Spectroscopy:** Introduction, Similarities between ESR and NMR, Behaviour of a free electron in an external Magnetic Field, Basic Principle of an Electron Spin Resonance Spectrometer, Presentation of the spectrum, Hyperfine coupling in Isotropic Systems (Hydrogen, methyl, benzene and Naphthalene radicals). Zero field splitting and Kramer's Degeneracy, Line width in solid state ESR.	**12**
V	**Mass Spectroscopy:** Basic instrumentation, ion production - E1, C1, FD, FAB and MALDI techniques. Basic terms (Molecular ion, parent ion, base peak, m/z ratio, fragment ion, metastable ion etc.). Modes of fragmentations, Mass spectral fragmentation of typical organic compounds, common functional groups.	**12**

Preferred Text Books:

1. **Paula K Bruice, Organic Chemistry, 8th Edition, Pearson.**
2. Jag Mohan, Organic spectroscopy, Narosa Publishing House.
3. Y. R. Sharma, Elementary Organic Chemistry, S. Chand.
4. B.R.Puri, L.R.Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company
5. Gurdeep R. Chatwal, Sham K. Anand, Instrumental methods of Chemical analysis, Himalaya Publishing House.
6. B.K. Sharma, Instrumental methods of Chemical analysis, Goel Publishing House.

Suggested Readings

1. Organic spectroscopy, William Kemp 3rd Edition
2. C.N.Banwel, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill
3. Gurdeep R. Chatwal, Sham K. Anand, Instrumental methods of Chemical analysis, Himalya Publishing House.

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Course Code: CCS 612
Course Name: Organic Chemistry Specialization I
Credits: 4
Credits Equivalent: (one credit is equivalent to 15 hours)
Course Objectives:

1. **Introduction to heterocyclic compounds** provide students with a fundamental understanding of heterocyclic compounds, their classification, structure, and importance in organic chemistry.
2. **Study of specific heterocyclic compounds to** explore in detail five-membered and six-membered heterocycles such as pyrrole, furan, thiophene, pyridine, and their derivatives.
3. To know about terpenoids, alkaloids, carotenoids and plant pigments
4. Making the synthetic schemes for the compounds belonging to this class
5. Knowing the properties and applications of these compounds.

Course Outcomes:
The students will be able to
CO^1: Demonstrate knowledge of different synthetic routes and strategies to produce heterocyclic compounds.
CO^2: Predict and explain the chemical behavior of heterocyclic compounds, including their reactions and mechanisms.
CO^3: To know the basic properties of terpenoids, alkaloids, carotenoids and plant pigments.
CO^4: Identify the synthetic routes for few specific compounds belonging to this class.
CO^5: To know the biosynthesis of these compounds.

Attendance: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.
Evaluation Criteria:
1. Mid Term Examination: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

Course : Organic Chemistry Specialization I							
	Programme Outcomes				Programme Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^2	PSO^3
CO1	3	1	3	2	2	3	1
CO2	1	2	1	1	1	1	3
CO3	2	1	2	3	3	3	2
CO4	2	2	2	3	3	1	2
CO5	3	3	2	3	3	2	2

Course Contents		
Unit	**Topic**	**Duration(Hrs)**
I	**Chemistry of Heterocyclic Compounds I**	**14**

	Structure, reactivity and synthesis of three membered Heterocycles: (a) Oxirane: Sharpless method, Shi epoxidation, Jacobsen epoxidation, etc, (b) Aziridine; four membered Heterocycles: (a) Oxetane (b) Azetine, five membered Heterocycles: (a) Pyrrole: Paal Knorr, Hantzsch Methods, etc, (b) Thiophene: Paal Knorr, Hinsberg method, etc. (c) Furan: Paal Knorr, Fiest-Benary, Industrial Method, etc.; (d) Pyrazole, (e) Imidazole, (f) Oxazole, (g) Thiazole.	
II	**Chemistry of Heterocyclic Compounds II** Structure, reactivity and synthesis of six membered Heterocycles: (a) Pyridine, (b)Pyridazine,(c) Pyrimidine and (d) Pyrazine; Aromatic heterocyclics: a) Indole: Fischer indole synthesis, Bischler synthesis, and Madelung synthesis (b) Quinoline and Isoquinoline, (c) Coumarins and Chromones.	12
III	**Terpenoids and Carotenoids** Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination and synthesis of citral, geraniol, camphor, farnesol.	10
IV	**Alkaloids** Definition, nomenclature and physiological action, occurrence, isolation, general methods of elucidation, degradation, classification based on nitrogen heterocyclic ring, Structure and synthesis of ephedrine, nicotine, atropine, morphine.	12
V	**Plant Pigments** Introduction, Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Anthocyanins (Cyanin), polyphenols: Flavones (chrysin), Flavonols (quercitin) and isoflavones (daidzein) coumarin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.	12

Preferred Text Books:

4. "Heterocyclic Chemistry" by R. K. Bansal.
5. "Organic Chemistry of Natural Products and Heterocyclic Chemistry" by Gurdeep Chatwal and Harish Mehra.
6. "Chemistry of Natural Products" by O. P. Agarwal
7. "Organic Chemistry of Natural Products" by Gurdeep Chatwal
8. "Chemistry of Organic Natural Products" by P. S. Kalsi

Suggested Readings

9. "A Textbook of Heterocyclic Chemistry" by T. L. Gilchrist.
10. "Natural Products: The Secondary Metabolites" by J. Mann
11. "Natural Products Chemistry: Sources, Separations and Structures" by Raymond Cooper and Jeffrey Johnstone Gurdeep R. Chatwal, Sham K. Anand, Instrumental methods of Chemical analysis, Himalya Publishing House.

Course Code : CCS 613
Course Name : Physical Specialization-I
Credit : 04
Credits Equivalent : One Credit is Equivalent to 15 hours of Lectures
Course Objectives :

1. To knowledge about symmetry element and matrices.
2. To apply the concept of group theory.
3. To learn the concept of Great orthogonality theorem and character table and their applications.
4. To understand the various laws in electrochemistry.
5. To know about hydrogen fuel cells and other types of fuel cells and other energy storage devices.

Course Outcome (Cos) :

CO^1 Describe about symmetry element and matrices
CO^2 Illustrate the concepts in the group theory
CO^3 Describe about the connection of the Great orthogonality theorem and character table.
CO^4 Understand the various laws in electrochemistry.
CO^5 Identify the electronic transition and apply the concept of Debye-Huckel limiting Law to predict the over potential properties.

Attendance: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria :

1. Mid Term Examination: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

Course : Physical Specialization-I							
	Program Outcomes				Program Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^1	PSO^1
CO^1	3	1	3	2	2	3	1
CO^2	1	2	1	1	1	1	3
CO^3	2	1	2	3	3	3	2
CO^4	2	2	2	3	3	1	2
CO^5	2	2	3	1	2	2	3

Course Contents		
Unit	Topic	Duration (Hrs.)
I	***Group Theory*-I (Part-A)** The concept of group, Symmetry elements and symmetry operations, Symmetry properties of atomic orbital, Elements of group theory: groups, subgroups, classes and characters, classes of symmetry operations, symmetry point groups; representation of groups by matrices, Representation of symmetry operator transformation of basis vector, Symmetry transformation of operators.	8
II	***Group Theory*-I (Part-B)** The Great Orthogonality Theorem (without proof) and its consequences; construction and applications of character tables, representation of cyclic groups. Assignment of point groups to Inorganic molecules, Some general rules for multiplications of symmetry operations, Multiplication tables for water and ammonia, Representations (matrices, matrix	12

	representations for C_{2v} and C_{3v} point groups irreducible representations), Character and character tables for C_{2v} and C_{3v} point groups.	
III	***Group Theory*-II** Applications of group theory to chemical bonding (hybrid orbitals for σ-bonding in different geometries and hybrid orbitals for π-bonding. Symmetries of molecular orbitals in BF_3, C_2H_4 and B_2H_6. Application of Group Theory in Vibrational Spectroscopy: A brief idea about Infrared and Raman scattering spectroscopy. Vibrational modes as basis of group representations w.r.t. SO_2, $POCl_3$ and $PtCl^{2-}4$. Mutual exclusion principle, Classification of vibrational modes (i.e. stretching and angle deformation vibrations w.r.t. SO_2, $POCl_3$ and $PtCl^{2-}4$.	**15**
IV	**Electrochemistry-I** Kohlrausch law of independent migration of ions. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using hittorf and Moving Boundary methods. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.	**12**
V	**Electrochemistry-II** Application of EMF measurements in determining. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Debye-Huckel theory for the problem of activity coefficient, Debye-Huckel limiting Law, Debye-Huckel equation for appreciable concentration, Debye-Huckel Onsagar conductance equation and its extension to ion solvent interactions. Theory of double layers at semiconductor- electrolyte interface.	**13**

Preferred Text Books:

1. Raman, K.V. (2002). Group Theory and its Applications to Chemistry. New Delhi: Tata McGraw Publishing Company.

2. Cotton, F. A. (2003). Chemical Applications of Group Theory (III Edition). Texas: A Wiley Inter Science Publication.

3. Veera Reddy, K. (2009). Symmetry and Spectroscopy of Molecules. New Delhi: New Age International Pvt. Ltd.

4. Bahl, A., Bahl, B. S., & Tuli, G. D, (2014). Essentials of Physical Chemistry (VEdition). New Delhi: S. Chand &Company.

Suggested Readings

1. Puri, B.R., Sharma, L.R., & Pathania, M.S. (2015). Elements of Physical Chemistry. Jalandhar: Vishal Publishing House.

2. Laidler, K. J. (2004). Chemical Kinetics (III Edition). New Delhi: Pearson Education Publishing. Indian Branch.

3. Gurdeep Raj, Chemical Kinetics, Goel Publishing House.

2. A.A.Frost and R.G.Pearson, Kinetics and Mechanism, Wiley Eastern, Pvt. Ltd.

Course Code : CCS 614
Course Name : Research Methodology
Credit : 04
Credits Equivalent : One Credit is Equivalent to 15 hours of Lectures
Course Objectives :

1. Identify and discuss the role and importance of research in the social sciences.
2. Identify and discuss the issues and concepts salient to the research process.
3. Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.
5. To understand the format of primary data collection instruments.
6. To understand field work problems and techniques.
7. To be able to construct basic samples for use in marketing studies and learn how and when to use different sampling techniques.
8. To understand and use basic data analysis techniques.

Course Outcome (Cos) :

CO^1 Understand some basic concepts of research and its methodologies, identify appropriate research topics
CO^2 Select and define appropriate research problem and parameters
CO^3 Prepare a project proposal (to undertake a project)
CO^4 Organize and conduct research in a more appropriate manner.
CO^5 Build on their knowledge and understanding in tackling more advanced and specialized courses, and more widely to pursue independent, self-directed and critical learning.

Attendance: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria :

4. Mid Term Examination: 40
5. End Term Examination: 120
6. Continuous Internal Assessment: 40

Course : Research Methodology							
	Program Outcomes				Program Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^1	PSO^1
CO^1	2	2	3	1	2	2	3
CO^2	3	2	3	2	1	3	2

CO^1	2	1	2	3	3	3	2
CO^4	2	3	2	2	3	2	2
CO^5	2	2	3	1	2	1	3

Course Contents

Unit	Topic	Duration (Hrs.)
I	Meaning of research; Objectives of Research; Types of Research; Significance of Research, Research and Scientific Method, Research Process, Criteria of good research, Problems encountered by Researchers in India. What is research Problem, Selecting the Problem, Necessity and defining the Problem, Techniques involved in defining the Problem.	15
II	Hypothesis: Meaning, Characteristics, and importance of hypothesis in Research, Types and testing of Hypothesis, Problems in Formulating Hypothesis. Research Design: Meaning of Research Design: Need for Research Design, Features of a good Research Design, Types of Research Design: Exploratory, Descriptive, Diagnostic and Experimental.	13
III	Sampling Design; Census and Sampling Method, Area of Study, Universe of Study, Sample Design, Steps in Sampling design, Criteria for Selecting a Sampling Procedure; characteristics of a good sample design, Types of Sampling method.	12
IV	Techniques of Data collection; collection of Primary data; Questionnaire, Schedule, Interview, Observation, Case Study, Survey Method, Content Analysis, Collection of Secondary Data.	10
V	Thesis writing, Book review, references and Preparation of Bibliography- Citation styles and organization	10

Preferred Text Books:

1. C R Kothari, GauravGarg, "Research Methodology: Methods and Techniques", 4th edition, New A International Publishers.
2. A ThangamaniRamalingam, SN Senthil Kumar, "Essentials of Research Mrthodology", Jayp Brothers Publishers, 2019.
3. Dr. Baidyanath Mishra, Ashok Kumar Stapathy, Sujata Mishra, "Research Methodology: Metho Approaches & Techniques", ChaukhambaOrientalia Publishers, 2018 Edition.

Suggested Readings

1. Dr. S. Sachdeva, "Research Methodology", LaxminarayanAggarwal Publishers, 2022 Edition.
2. BL Aggarwal, "Comprehensive Research Methodology", 1st edition, New Age International (P) Ltd Publishers, 2015 edition.

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Course Code: CCS 615
Course Name: SOFTWARE BASED DATA ANALYSIS
Credits Equivalent: 4
Course Objectives:

- *To know about the introduction of different software used in research*
- *To know about the process of data handling and*
- *Knowing the importance of various software such as CHEM DRAW, Origin, Mendeley, X-pert HighScore etc.*

Course Outcome (Cos):
The students will be able to
CO1 *To know the basic analytical tools in chemistry*
CO2 *Gaining software skills for data handling*
CO3 *Learning about Chemdraw, Origin, Mendeley, MaterNova*

Attendance:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria
7. Mid Term Examination: 40
8. End Term Examination: 120
9. Continuous Internal Assessment: 40

Course: SOFTWARE AND DATA ANALYSIS														
	Program Outcomes								Program Specific Outcomes					
CO	PO^1	PO^2	PO^3	PO^4	PO^5	PO^6	PO^7	PO^8	PSO^1	PSO^2	PSO^3	PSO^4	PSO^5	PSO^6
CO1	--	2	2	1	--	1	1	1	--	2	1	--	2	2
CO2	2	2	2	2	--	--	--	2	2	2	2	--	2	2
CO3	1	3	3	3	--	3	--	--	--	3	3	3	2	--

Course Contents		
Unit	**Topic**	**Duration**
I	**UNIT-I: ChemDraw:** Introduction, application and uses. Drawing of simple chemical structure. Analysis of their molecular weight and NMR spectra using Chem Draw. Converting 2D structure into 3D structure and calculating energy using Chem Draw.	**12 Hrs**
II	**UNIT-II: Origin Software:** Introduction and uses. Data uploading, plotting of graphs, Different types of graphs that can be plotted using Origin, Combining/separating the graphs in Origin, To plot 2D, 3D graphs from Excel sheet using ORIGIN, fundamental statistical analysis using ORIGIN.	**12 Hrs**
III	**UNIT-III: Turnitin Software:** Introduction, application and uses. Web-based plagiarism detection software by the site Turnitin.com. to use Turnitin, to analyze the result after the plagiarism checking.	**12 Hrs**

IV	**UNIT-IV: Software for Analysis of NMR:** Introduction, Use and application of MNova software for the analysis of NMR Spectra. Spectral analysis of 1H NMR and 13NMR data using this software. Comparison of NMR analysis (1H and 13C) using ChemDraw and MasterNova Softwares.	**12 Hrs**
V	**UNIT-V: Statistical Data Analysis** Introduction, Precision Vs. Accuracy, Errors and their types. Statistical tools (Mean, Median, Mode, Standard Deviation, Variance). Calculation of limit of detection (LOD) and limit of quantification (LOQ). Regression and Correlation analysis.	**12 Hrs**

Preferred Text Books/ Suggested Readings:

- "Liborigin" Review article in Journal of Cheminformatics, Jan2018
- "Origin Viewer" Halford, Bethany (2014).
- "Reflections On ChemDraw" C&EN. 92 (33): 26-27. doi:10.1021/cen-09233-scitech1. Retrieved 20 August 2014.
- Cambridge Soft from Perkin Elmer

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Course Code: CCS 616
Course Name: Review of Literature/ Research Proposal
Credits: 4
Credits Equivalent: (one credit is equivalent to 15 hours)
Course Objectives:

1. To know the importance of literature review.
2. To became familiar with different search engines used for scientific literature search.
3. To become familiar with the concept of journals, research books and reviews.
4. To know what is difference between research proposal and research paper.
5. Knowing the strategies to compile the research work in the form of research papers and research proposals.

Course Outcomes:

The students will be able to
CO^1 Perform the proper literature search.
CO^2 Identify good publishers for publishing their research work.
CO^3 Apply their literary knowledge to formulate a research proposal.
CO^4 Learn the difference between research paper, review article and research proposal.
CO^5 Develop a deep understanding for formulation their research objectives.

Attendance: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
1. Mid Term Examination: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

Course : Review of Literature/ Research Proposal							
	Programme Outcomes				Programme Specific Outcomes		
CO	PO^1	PO^2	PO^3	PO^4	PSO^1	PSO^2	PSO^3
CO1	2	1	3	2	2	3	2
CO2	1	2	1	1	1	1	3
CO3	1	2	1	3	3	3	2
CO4	2	1	2	3	2	1	3
CO5	1	2	3	3	2	3	1

Course Contents		
Unit	Topic	Duration(Hrs)
I	**Literature Review:** Importance of literature review, Classification of literature into primary and secondary sources, Difference between primary and secondary sources, various tools for doing literature search specifically the Sci finder and Google scholar.	12
II	**Crafting of Research Proposal:** Basic information about a research oposal, need of research proposal. Different steps in writing a research oposal such as defining the research questions, defining of objectives, entifying the difference between research question and objective.	14

	mportance of research methodology in a proposal, difference between ublication and proposal.	
III	**Research Ethics:** Definition, introduction, importance of research ethics, Plagiarism and use of plagiarism detection softwares, copy right, citation and acknowledgement. Safety rules of laboratory acquaintance of experimental set up, importance of safety and security of data. Review of published research in the relevant field.	12
IV	**Publication Ethics:** Publication Ethics, Initiatives & Guidelines: COPE, WAME etc. Conflict of Interest, Publication Misconduct, Violation of Publication Ethics, Authorship and Contributorship; Identification of Publication Misconduct, Predatory Publishers & Journals	10
V	**Technical writing and reporting of research:** Types of research report: Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report etc. Structure and organization of research reports: Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgement, references, footnotes, tables and illustrations. Use of reference managing softwares (such as- MENDELEY, ENDNOTE). Impact factor, rating, indexing and citation of journals.	12

Preferred Text Books:

7. "Research Methodology: Methods and Techniques" by C. R. Kothari and Gaurav Garg
8. "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar
9. "Scientific Research Methodology" by P. Sam Daniel and Aroma G. Sam

Suggested Readings

10. "The Literature Review: Six Steps to Success" by Lawrence A. Machi and Brenda T. McEvoy
11. "Writing Research Proposals and Thesis: A Guide to Students in Social Sciences" by A. N. Sharma
12. "Research Proposals: A Practical Guide" by Martyn Denscombe.

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Annexure-IV

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Central University of Himachal Pradesh

[Established under Central Universities Act, 2009]

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय

नैति नैति चरैवेति चरैवेति

Minutes

Of

12th School Board Meeting of the School of Physical & Material Science held on 01st of January, 2024 at 10:30 AM onwards

VENUE: Seminar hall, Central University of Himachal Pradesh, Campus Shahpur, District - Kangra, Himachal Pradesh - 176206

01.01.2024

12th School Board Meeting of the School of Physical & Material Science held on 01st of January, 2023 at 11:30 AM at Seminar hall, Shahpur Parisar, Shahpur through Offline and Online Mode and The following members were present

1.	Prof. Rajesh Kumar (Dean)	Chairman
2.	Prof. O.S.K.S. Sastri	Member
3.	Prof. Bhag Chand Chauhan	Member
4.	Prof. Hum Chand	Member
5.	Prof. Nagesh Thakur	Subject Expert
6.	Prof. Dinesh Kumar	Subject Expert
7.	Prof. Prof. K.L. Yadav	Subject Expert
8.	Dr. Dalip Singh Verma	Member
9.	Dr. Vivek Sheel Head,CCS	Member
10.	Prof. Ambrish Kumar Mahajan	VC Nominee
11.	Prof. Rajender Kumar	VC Nominee
12.	Dr. Pramod Kumar	Member
13.	Dr. Surender Pratap	Member

The decisions taken in various items of the agenda and record of discussions held are as under:

ITEM.	Description	Annexure
SoPMS-SoB-12/24-1	To deliberate and approve the decision taken at the 11th School Board Meeting of the School of Physical and Material Sciences held on 17 February 2024.	Annexure-I
Decision:	Honorable members deliberated on the decision taken on various agenda points of the "11th School Board Meeting of the School of Physical and Material Sciences" and approve all the agenda items of the 11th School Board Minutes.	
SoPMS-SoB-12/24-2	To deliberate and approve the decision taken at the 14th Board of Studies Meeting of the Department of Physics & Astronomical Science held on 26th December 2023.	Annexure-II

	Honorable members deliberated on the decision taken on various agenda points of the "14th Board of Studies Meeting of the Department of Physics & Astronomical Science" and approve all the agenda items of the 14th Board of Studies Minutes.	
SoPMS-SoB-12/24-3	To deliberate and approve the decision taken at the 7th Board of Studies Meeting of the Department of Chemistry & Chemical Sciences held on 23rd September 2023.	Annexure-III
Decision:	Honorable members deliberated on the decision taken on various agenda points of the "7th Board of Studies Meeting of the Department of Chemistry & Chemical Sciences" and approve all the agenda items of the 7th Board of Studies Minutes except the following suggestion (i) The title of the course(CCS527) to be change to 'Bhartiya History of Chemistry' for to be consistence with its contents a	
SoPMS-SoB-12/24-4	Any other item with the permission of the chair.	

The meeting ended with the vote of thanks to all the members of the School Board.

Signatures:

1. **Prof. Rajesh Kumar**
   Chairman, School Board
   Dean
   School of Physical & Material Sciences, CUHP.
2. **Prof. OSKS Sastri**
   Member
   Department of Physics and Astronomical Science, CUHP.
3. **Prof. Hum Chand**
   Member
   Department of Physics and Astronomical Science, CUHP.
4. **Prof. B. C. Chauhan**
   Member
   Department of Physics and Astronomical Science, CUHP.
5. **Prof. Nagesh Thakur**
   External member
   HPU, Shimla

6. **Prof. Dinesh Kumar (Online)**
External member
Gurugram, University, Haryana

7. **Prof. K.L. Yadav (Online)**
External member
Indian Institute of Technology, Roorkee

8. **Dr. Vivek Sheel** 01/01/24
Member, Head
Department of Chemistry and Chemical Sciences, GHIP

9. **Dr. Dalip Singh Verma** 01/01/2024
Member
Department of Physics and Astronomical Sciences, GHIP

10. **Prof. Ambrish Kumar Mahajan**
VC-Nominee
Department of Environmental Sciences, GHIP

11. **Prof. Rajender Kumar** 01-01-2024
VC-Nominee
Department of Chemistry and Chemical Sciences, GHIP

12. **Dr. Pramod Kumar** 01-01-2024
Member
Department of Chemistry and Chemical Sciences, GHIP

13. **Dr. Surender Pratap**
Member
Department of Physics and Astronomical Sciences, GHIP

(1.1.2024)

ANNEXURE-V

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Accredited by NAAC with 'A+' Grade with CGPA of 3.42)
रसायन एवं रसायनिक विज्ञान विभाग Department of Chemistry & Chemical Sciences
शाहपुर परिसर, जिला कांगड़ा, हिमाचल प्रदेश-176206

Semester –II

Course Code: CCS 521 **Course Name:** Inorganic Chemistry –II
Credits: 4

Course Objectives:

1. To understand the significant aspects of Chemical bonding such as Valence bond theory, Molecular orbital theory, resonance and hybridization.
2. To be able to describe the concept of spin and orbital moments, stereochemistry of coordination compounds.
3. To be able to understand the different properties and reactions of organometallic compounds.
4. To be able to describe the complex chemistry, electronic configuration and magnetic properties of d and f block elements.

Course Outcomes:

The students will be able to

1. Understand the concept of valence band theory, Molecular orbital theory, hybridisation and resonance.
2. Explain the spin and orbital momentum as well as stereochemistry of coordination compounds.
3. Understand different properties and reactions of organometallic compounds.
4. Explain the complex chemistry, electronic configuration, magnetic properties as well as factor responsible for different properties of d and f block elements.

UNIT-I: Aspects of Chemical Bonding

LCAO-MO and VB treatments on H_2^+, H_2: Valence bond theory (VBT), resonance in VBT, VBT of homonuclear diatomic molecules, sigma and pi bonds, VBT of heteronuclear diatomic molecules, inadequacies of the simple VBT. Hybridization, participation of *d* orbitals in hybridization in polyatomic species. Molecular orbital theory (MOT), linear combination of atomic orbitals (LCAO), criteria for the formation of stable MOs. Sigma, Pi and Delta molecular orbitals. Homonuclear and heteronuclear diatomic molecules and ions. MO theory of polyatomic molecules and ions. MO theory of π bonding and multi-centre bonding. MO concept of metal-ligand bonding (pictorial approach); VSEPR Theory.

UNIT II: Coordination Chemistry I

Labile and inert complexes. Spin and orbital moments, spin-orbit coupling, quenching of orbital formula, temperature dependence of magnetic moment, Super exchange Dependence of Orbital contribution on the nature of the electronic ground state. Structural, isomerism and stereoisomerism of coordination compounds, optically active coordination compounds.

UNIT III: Organometallic compounds

Organometallic compounds, Classification, Organometallic compounds of various elements, ylides, Organometallic compounds with multicentre bonds, pi bond ligands and their bonding (bonding in alkenyl and alkynyl complexes), Ferrocene and its reactions, Aromaticity of cyclic C_nH_n ligands, Carbene, Carbyne and Carbide complexes.

UNIT-IV: Chemistry of d- and f- Block Elements (Comparative Study)

Electronic configuration, oxidation states; aqueous, redox and complex chemistry,spectral and magnetic properties of compounds in different oxidation states, horizontal and vertical trends in respect of 3d,4d, and 5d elements with references to Ti-Zr- Hf , Cr- Mo- W, Mn Tc-Re and Pt group metals.

Lanthanide and Actinide Elements: Electronic configuration, oxidation states, aqueous, redox and complex- chemistry; electronic spectra and magnetic properties (one example each). Lanthanide and actinide contractions and their consequences, separation of lanthanides and actinides and their applications (with examples).

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय

Central University of Himachal Pradesh

(Accredited by NAAC with 'A+' Grade with CGPA of 3.42)

रसायन एवं रसायनिक विज्ञान विभाग/Department of Chemistry & Chemical Sciences

शाहपुर परिसर, जिला काँगड़ा, हिमाचल प्रदेश-176206

CCS 521: Inorganic Chemistry II **Credit 2** **Sem: II**

Course Objectives:

1. To be able to understand the different properties and reactions of organometallic compounds.
2. To be able to understand the aromaticity of different complexes.
3. To be able to describe the complex chemistry, electronic configuration and magnetic properties of d and f block elements.

Course Outcomes:

The students will be able to

1. Understand different properties and reactions of organometallic compounds.
2. Understand the aromaticity of different complexes.
3. Explain the complex chemistry, electronic configuration, magnetic properties as well as factor responsible for different properties of d and f block elements.

UNIT I: Organometallic compounds

Organometallic compounds, Classification, Organometallic compounds of various elements, ylides, Organometallic compounds with multicentre bonds, pi bond ligands and their bonding (bonding in alkenyl and alkynyl complexes). Ferrocene and its reactions, Aromaticity of cyclic C_nH_n ligands. Carbene, Carbyne and Carbide complexes.

UNIT-II: Chemistry of d- and f- Block Elements (Comparative Study)

Electronic configuration, oxidation states; aqueous, redox and complex chemistry, spectral and magnetic properties of compounds in different oxidation states, horizontal and vertical trends in respect of 3d,4d, and 5d elements with references to Ti-Zr- Hf , Cr- Mo- W, Mn Tc-Re and Pt group metals.

Lanthanide and Actinide Elements: Electronic configuration, oxidation states, aqueous, redox and complex- chemistry; electronic spectra and magnetic properties (one example each). Lanthanide and actinide contractions and their consequences, separation of lanthanides and actinides and their applications (with examples).

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रसायन एवं रसायनिक विज्ञान विभाग/Department of Chemistry & Chemical Sciences

शाहपुर परिसर, जिला काँगड़ा, हिमाचल प्रदेश-176206

आजादी का अमृत महोत्सव

Semester –II

PHYSICAL CHEMISTRY II

Course Code: CCS 523 **Course Type:** Major

Course Credits: 4

Course Objectives:

1. *To provide knowledge on fundamental understanding of chemical kinetics and to establish a relationship between the rate of reaction and the concentration of the reactants (the rate law, or rate equation).*
2. *To apply the chemical kinetics concept to study the mechanisms.*
3. *To analyze the various types of reactions in solution and its effects.*
4. *To determination of molecular weight of polymers and kinetics mechanism.*
5. *To learn the concept of surface chemistry and their applications.*

Course Outcomes: After the successful completion of this course, the student will be able to

CO^1 Recall the theories of reaction rates, how reaction rates are measured and represented in rate laws

CO^2 Conclude the applications of chemical kinetics in studying mechanisms

CO^3 Classify the various types of reactions in solution and its effects.

CO^4 Discuss the kinetics of polymerization and kinetics mechanism.

CO^5 Discuss the BET equation and various method in adsorption.

Course Contents

UNIT-I

Chemcal Dynamics-I : Macroscopic and microscopic kinetics, Review of theories of reaction rate-Collision theory and Transition state theory, Comparison of collision theory with transition state theory, Arrhenious equation-characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermodynamical formulation of reaction rates (Wyne-jones and Eyring treatment), Reaction between ions in solutions – Influence of ionic strength on reaction rates (primary and secondary salt effects).Concept of Steady state kinetics, Chain reactions – chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-

Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane.Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.

UNIT II:

Chemcal Dynamics-II : Kinetics of homogeneous catalysis-kinetics of auto catalytic reactions, kinetics of acid-base catalysed reactions. Comparison of enzyme catalysed and chemical catalysed reactions, Mechanism (Lock and Key theory), Kinetics of enzyme catalyzed reactions – Henri-MichaelisMenten mechanism, Significance of Michaelis-Menten constant, Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity. Theories of unimoleuclar reactions: Perrin theory, Lindemann theory, and Hinshelwood theory.

UNIT III:

Polymers and Macromolecules:

Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques

UNIT IV:

Surface chemistry:

Surface chemistry- Types of adsorption isotherms, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena), Catalytic activity of surfaces.

SUGGESTED READINGS:

1. Bahl, A., Bahl, B. S., & Tuli, G. D, (2014). Essentials of Physical Chemistry (VEdition). New Delhi: S. Chand & Company.
2. Puri, B.R., Sharma, L.R., & Pathania, M.S. (2015). Elements of Physical Chemistry.
3. Jalandhar: Vishal Publishing House.
4. Laidler, K. J. (2004). Chemical Kinetics (III Edition). New Delhi: Pearson Education Publishing. Indian Branch.
5. Gurdeep Raj, Chemical Kinetics, Goel Publishing House.

A.A.Frost and R.G.Pearson, Kinetics and Mechanism, Wiley Eastern, Pvt. Ltd.

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय

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रसायन एवं रसायनिक विज्ञान विभाग/Department of Chemistry & Chemical Sciences
शाहपुर परिसर, जिला काँगड़ा, हिमाचल प्रदेश-176206

आज़ादी का अमृत महोत्सव

Semester –II

CCS 523 PHYSICAL CHEMISTRY II
(Credit-2)

Course Objectives

This course enables the students

1. To provide knowledge on fundamental understanding of chemical kinetics and to establish a relationship between the rate of reaction and the concentration of the reactants (the rate law, or rate equation).
2. To apply the chemical kinetics concept to study the mechanisms.
3. To analyze the various types of reactions in solution and its effects.

Course outcomes

On the completion of this course, students have to

1. Recall the theories of reaction rates, how reaction rates are measured and represented in rate laws.
2. Conclude the applications of chemical kinetics in studying mechanisms.
3. Discuss the kinetics of polymerization and kinetics mechanism.

UNIT-I

Chemical Dynamics-I : Macroscopic and microscopic kinetics, Review of theories of reaction rate-Collision theory and Transition state theory, Comparison of collision theory with transition state theory, Arrhenious equation- characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermo dynamical formulation of reaction rates (Wyne-jones and Eyring treatment), Reaction between ions in solutions – Influence of ionic strength on reaction rates (primary and secondary salt effects).Concept of Steady state kinetics, Chain reactions – chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions.

UNIT II:

Chemical Dynamics-II: Pyrolysis of acetaldehyde, Decomposition of ethane. Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method. Kinetics of homogeneous catalysis-kinetics of auto catalytic reactions, kinetics

of acid-base catalysed reactions. Comparison of enzyme catalysed and chemical catalysed reactions, Mechanism (Lock and Key theory), Kinetics of enzyme catalyzed reactions – Henri-Michaelis Menten mechanism, Significance of Michaelis-Menten constant, and Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity. Theories of unimoleuclar reactions: Perrin theory, Lindeman theory, and Hinshelwood theory.

SUGGESTED READINGS :

1. Bahl, A., Bahl, B. S., & Tuli, G. D, (2014). Essentials of Physical Chemistry (VEdition). New Delhi: S. Chand & Company.
2. Puri, B.R., Sharma, L.R., & Pathania, M.S. (2015). Elements of Physical Chemistry.
3. Jalandhar: Vishal Publishing House.
4. Laidler, K. J. (2004). Chemical Kinetics (III Edition). New Delhi: Pearson Education Publishing. Indian Branch.
5. Gurdeep Raj, Chemical Kinetics, Goel Publishing House.
6. A.A.Frost and R.G.Pearson, Kinetics and Mechanism, Wiley Eastern, Pvt. Ltd.