Sir P. T. Sarvajanik College of Science

Autonomous

Affiliated to Veer Narmad South Gujarat University, Surat

Re-Accredited 'A+' with CGPA 3.35

SYLLABUS

FOR

SEM II

Program: M. Sc.

Course: Organic Chemistry

For

Academic year

2026-27

(NEP-2020)

(To be effective from June, 2026)

M. Sc. (CHEMISTRY) SEMESTER II

Core Course-4

COURSE NAME: INORGANIC CHEMISTRY-II

COURSE CODE: CHEMSC-S2P4-4CR26 [CREDITS - 04]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Describe quantum mechanics, angular momentum, explain the solution of Schrödinger equation. 2. Solve problems involving different types of operators and evaluate their uses. 3. Classify metal nitrosyls and metal clusters. 4. Describe structure and bonding of metal nitrosyls. 5. Explain vibrational spectra for bonding and structure elucidation in nitrosyls. 6. Evaluate electron counting scheme for HNCCS and Wade's rule and their synthetic application and solve problems involving Wade's rule. 7. Describe structure and bonding of halides type's clusters. 8. Describe the bioinorganic chemistry of structure and function of bioinorganic complexes containing Fe, Cu and Zn. 9. Discuss the functions of metal complexes in Medicine and anticancer activity of platinum complexes. 10. Differentiate the structure and functions between Hemoglobin, Hemocyanin and Myoglobin. 11. Define polymers and explain their classification, basic structural features including backbone bonding, branching, crosslinking, and stereochemical variability. 12. Describe molecular weight concepts of polymers (number average and weight average) and experimental techniques such as chemical methods and viscometry for molecular weight determination. 13. Explain the concept of polymer crystallinity, its importance and requirements, and apply different methods such as dilatometry, crystallography, spectroscopy, and colorimetry to determine percent crystallinity. 14. Explain and illustrate transition properties of polymers with respect to temperature using experimental techniques such as dilatometric analysis, bomb calorimetry, differential thermal analysis, and differential scanning calorimetry. 15. Describe the mechanical behaviour of polymers including elasticity, viscosity, and viscoelasticity and relate them to polymer structure. 16. Discuss the synthesis, structure, properties, and industrial applications of important inorganic polymers such as polyphosphazenes and polysiloxanes.

Module 1	QUANTUM MECHANICS	[15L]

Learning Objectives:

This module is intended to

- Make students familiarize with the advanced quantum mechanics in chemical systems

Learning Outcome: After the successful completion of the module, the learner will be able to • Describe quantum mechanics, angular momentum, explain the solution of Schrödinger equation • Solve problems involving different types of operators and evaluate their uses		
1.1	**Quantum Chemistry:** Recapitulation of classical mechanics, failure of classical mechanics, need for quantum mechanics, wave function, particle in 1D box, normalization and orthogonality of wave functions, importance of particle in 1D box, Dirac-bracket notation Operators: linear, commutator, Hamiltonian, Hermitian, vector, Laplacian, algebra of operators, properties of Hermitian operator Postulates of Quantum mechanics, average value and the expectation value of dynamic variables, particle in 3 D box, Schrodinger wave equation in polar coordinates, separation into R, θ and Φ, one dimensional harmonic oscillator, two particles rigid rotator, ordinary angular momentum, generalized angular momentum, Eigen function of angular momentum, Eigen value of angular momentum.	

Module 2	**METAL NITROSYLS AND CLUSTERS**	**[15L]**
Learning Objectives: This module is intended to • Make the students understand structure, bonding and synthesis of metal nitrosyls and clusters		
Learning Outcome: After the successful completion of the module, the learner will be able to • Classify metal nitrosyls and clusters • Describe structure and bonding of metal nitrosyls and clusters • Explain vibrational spectra for bonding and structure elucidation in nitrosyls • Evaluate electron counting scheme for HNCCS and Wade's rule and their synthetic application and solve problems involving Wade's rule • Describe structure and bonding of halides types clusters		
2.1	Metal Nitrosyls: Introduction, coordination compounds of metal nitrosyls, preparation properties of nitrosyl compounds like nitrosyl halides, nitrosyl cyanides, hydroxides and nitrosyl aquo compounds Complex of NO^+ iron, EAN and structures of nitrosyls. Metal Clusters: Introduction, classification, carbonyl cluster, Low Nuclearity Carbonyl Clusters (LNCCs), High Nuclearity Carbonyl Clusters (HNCCs), electron counting scheme for HNCCs, Wade's rules. Halides types clusters: dinuclear clusters, trinuclear clusters, tetranuclear	

	clusters, hexanuclear cluster. Chevrel phases and Zintl ions, Carboranes, metalloboranes, metallo carboranes, higher boranes (Hexaborane-10, Decaborane-14), number and types of bonds present in higher boranes.	
Module 3	**BIOINORGANIC CHEMISTRY**	**[15L]**
Learning Objectives: This module is intended to make the students • Learn the biological chemistry of Iron, Copper and Zinc. • Understand the biological chemistry of Copper, and Metal complexes in medicine and anticancer activity of complexes.		
Learning Outcome: After the successful completion of the module, the learner will be able to • Describe the bioinorganic chemistry of structure and function of Hemoglobin, Myoglobin, Ferritin and Transferrin. • Discuss the functions metal complexes in Medicine and anticancer activity of Platinum complexes. • Differentiate the functions between Hemoglobin, Hemocyanin, Myoglobin • Distinguish the structure and function between blue-copper proteins and non-blue copper proteins		
3.1	[A] Biochemistry of Iron: Transport of Iron, Hemoglobin and Myoglobin; Storage and Transport of Iron viz. Ferritin and Transferrin, Cytochromes, Iron-Sulfur Proteins. [B] Biochemistry of Copper: Structural features of different Cu-Proteins, Blue Copper Proteins (Plastocyanin, Azurins and Blue Oxidases), Non-blue copper proteins (Galactose Oxidase, Amine Oxidase). [C] Biochemistry of Zinc: Carboxypeptidase and carbonic anhydrase. [D] Metal complexes in Medicine: Disease due to metal deficiency and its treatment: Fe, Cu, Zn and Mn, metals used in diagnosis: MRI [E] Anticancer activity of Platinum complexes.	
Module 4	**INORGANIC POLYMERS**	**[15L]**
Learning Objectives: This module is intended to make students understand • polymers and their classification, basic structural features including backbone bonding, branching, crosslinking, and stereochemical variability. • molecular weight concepts of polymers (number average and weight average) and experimental techniques such as chemical methods and viscometry for molecular weight determination. • concept of polymer crystallinity, its importance and requirements, different methods such as		

dilatometry, crystallography, spectroscopy, and colorimetry to determine percent crystallinity.

- transition properties of polymers with respect to temperature using experimental techniques such as dilatometric analysis, bomb calorimetry, differential thermal analysis, and differential scanning calorimetry.
- mechanical behaviour of polymers including elasticity, viscosity, and viscoelasticity and relate them to polymer structure.
- synthesis, structure, properties, and industrial applications of important inorganic polymers such as polyphosphazenes and polysiloxanes.

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Define polymers and explain their classification, basic structural features including backbone bonding, branching, crosslinking, and stereochemical variability.
- Describe molecular weight concepts of polymers (number average and weight average) and experimental techniques such as chemical methods and viscometry for molecular weight determination.
- Explain the concept of polymer crystallinity, its importance and requirements, and apply different methods such as dilatometry, crystallography, spectroscopy, and colorimetry to determine percent crystallinity.
- Explain and illustrate transition properties of polymers with respect to temperature using experimental techniques such as dilatometric analysis, bomb calorimetry, differential thermal analysis, and differential scanning calorimetry.
- Describe the mechanical behaviour of polymers including elasticity, viscosity, and viscoelasticity and relate them to polymer structure.
- Discuss the synthesis, structure, properties, and industrial applications of important inorganic polymers such as polyphosphazenes and polysiloxanes.

4.1	Introduction: Definition of polymers and their depiction, classification of inorganic polymers, characterization of inorganic polymers (physical properties)-by molecular weights, number average, weight average. Experimental techniques-determination of molecular weight of polymers by chemical method and viscometry, uses of molecular weights, molecular weight distribution, structural features of polymers-backbone bonding, branching and crosslinking, chemical and stereo chemical variability. Crystallinity of polymers-importance and requirements, methods for determining percent crystallinity-Dilatometry, crystallography, spectroscopy and colorimetry Transition properties (w.r.t. temperature): definition, illustrative representation-dialometric results, calorimetric results-Bomb calorimetry, Differential thermal analysis, and differential scanning calorimetry. Mechanical properties: elasticity, viscosity, viscoelasticity. Synthesis, properties, structure and uses of polyphosphazenes and polysiloxanes	

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23. https://courses.lumenlearning.com/suny-albany-chemistry/chapter/development-of-quantum-theory-2/
24. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/02.physical_chemistry-i__/01._introduction_to_quantum_chemistry/et/7419_et_et.pdf
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stry-i__/03._fundamentals_of_quantum_mechanics_%E2%80%93_ii/et/7421_et_et.pdf
26. https://archive.nptel.ac.in/courses/104/108/104108057/
27. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/11.inorganic_chemistry-iii/29._metal-metal_bonds_and_their_evidences/et/9108_et_et_29.pdf
28. https://egyankosh.ac.in/bitstream/123456789/101567/1/Unit-8.pdf
29. https://www.sciencedirect.com/topics/physics-and-astronomy/metal-cluster
30. https://archive.org/details/bioinorganicchem0000roat
31. https://chem.libretexts.org/Courses/Saint_Marys_College_Notre_Dame_IN/CHEM_342%3A_Bio-inorganic_Chemistry
32. https://books.rsc.org/books/monograph/2078/chapter/6395059/Introduction-to-Inorganic-Rings-and-Polymers
33. https://www.sciencedirect.com/topics/materials-science/inorganic-polymer

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.	√										
2.	√		√				√				
3.	√	√									
4.	√										
5.	√										
6.	√		√				√				
7.	√										
8.	√										
9.	√										
10.	√	√									
11.	√										
12.	√										
13.	√	√	√				√				
14.	√	√	√				√				
15.	√										
16.	√										

M. Sc. (CHEMISTRY) SEMESTER II
Core Course-5
COURSE NAME: ORGANIC CHEMISTRY-II

COURSE CODE: CHEMSC-S2P5-4CR26 [CREDITS - 04]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Comprehend the step- by-step mechanisms involved in each reaction, including bond formation, bond breaking, and electron movement. 2. Apply the above knowledge to design efficient synthetic routes to target molecules by strategically selecting appropriate starting materials and reaction conditions. 3. Define aromaticity and describe its significance in organic chemistry, to determine aromatic character in organic compounds and apply Frost circle diagrams to predict aromatic behavior. 4. Explain the structure and stability of benzene and its derivatives, analyze the factors contributing to the stability of aromatic compounds compared to non-aromatic counterparts. 5. Discuss and compare the aromatic behavior of various compounds such as benzenoid and non- benzenoid, azulene, and annulenes. 6. Discuss structure and synthesis of purine (adenine, guanine) and pyrimidine (cytosine, thymine, uracil) bases and base pairing. 7. Explain the structure of nucleosides (base + sugar) and nucleotides (base + sugar + phosphate). 8. Explain structure of DNA, RNA and protein synthesis. 9. Describe transcription, translation, and protein biosynthesis. 10. Discuss classification, nomenclature and factors affecting catalytic activity of enzymes. 11. Explain different types of inhibition.Define and explain the fundamental principles of photochemistry, including the interaction of molecules with light, electronic excitation, and the mechanisms of photochemical reactions. 12. Recognize and describe photophysical processes such as fluorescence, phosphorescence, and intersystem crossing, which govern the behavior of molecules upon exposure to light.

Module 1	ORGANIC NAME REACTIONS	[15L]

Learning objectives:

This module is intended to learn general nature, mechanism and synthetic application of various name reactions.

Learning outcomes:

After the successful completion of the module, the learner will able to

- Comprehend the step- by-step mechanisms involved in each reaction, including bond formation, bond breaking, and electron movement.
- Apply the above knowledge to design efficient synthetic routes to target molecules by strategically selecting appropriate starting materials and reaction conditions.

1.1	General nature, method, mechanism and synthetic applications of the following reactions: (i) Arndt Eistert reaction (ii) Dakin reaction (iii) Darzen's glycidic ester synthesis (iv) Willgerodt reaction (v) Leucart reaction (vi) Heck reaction (vii) Suzuki reaction (viii) Buchwald-Hartwig reaction (ix) Sonogashira reaction (x) H. V. Z. reaction	
Module 2	**AROMATICITY**	**[15L]**

Learning Objectives:

This module aims to enable students to

- Comprehend aromaticity principles, analyze structural stability, predict aromatic behavior using theoretical models
- Evaluate experimental methods, compare different aromatic compounds, critically assess aromaticity in complex molecules, design synthetic strategies, communicate effectively, in aromatic chemistry

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Define aromaticity and describe its significance in organic chemistry, to determine aromatic character in organic compounds
- Explain the structure and stability of benzene and its derivatives, analyze the factors contributing to the stability of aromatic compounds compared to non-aromatic counterparts
- Apply Frost circle diagrams to predict aromatic behavior
- Compare the aromatic behavior of various compounds such as benzenoid and non-benzenoid, azulene, and annulenes

2.1	Aromaticity and aromatic character; modern theories of structure and stability of benzene, concept of aromaticity; Resonance and chemical stabilization; criteria to check aromatic character-IR, UV & NMR, heat of hydrogenation; Huckel's rule; Huckel Molecular Orbital (HMO) theory, Frost Circle method to prepare MO Diagram for cyclic polyenes, Resonance Energy per π-Electron (REPE) Antiaromaticity, Homoaromaticity, Nonaromaticity, Benzenoid Aromatic compounds and Heteroaromatic compounds: naphthalene, pyrene. Aromaticity Non- Benzenoid aromatic compounds: Azulene (Craig's rule), Tropolones, Charged rings, Annulenes, Fullerenes, Meso-ionic compounds	
Module 3	**NUCLEIC ACIDS & ENZYMES**	**[15L]**
Learning Objectives: This module is intended to • Understand the different concepts of nucleic acids, DNA, RNA and enzymes		
Learning Outcome: After the successful completion of the module, the learner will be able to • Discuss structure of purine (adenine, guanine) and pyrimidine (cytosine, thymine, uracil) bases and base pairing • Explain the structure of nucleosides (base + sugar) and nucleotides (base + sugar + phosphate) • Explain structure of DNA and RNA and their application in protein synthesis • Describe transcription, translation, and protein biosynthesis • Discuss classification, nomenclature and factors affecting catalytic activity of enzymes • Explain different types of inhibition		
3.1	(A)**Nucleic Acids** Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding, chemical and enzymatic hydrolysis of nucleic acids, structure of nucleosides and nucleotides, DNA, RNA (Basics structures only), DNA replication, transcription, translation, protein biosynthesis. (B) **Enzymes** Classification, nomenclature and inhibition, factors affecting catalytic activity and specificity in action, regulation of enzyme activity	
Module 4	**PHOTO CHEMISTRY**	**[15L]**
Learning objectives: This module is intended to • Understand photochemistry, various types of its reaction, photochemical cleavage of carbonyl compounds, their mechanism and application in synthesis		
Learning outcomes:		

After the successful completion of the module, the learner will able to

- Define and explain the fundamental principles of photochemistry, including the interaction of molecules with light, electronic excitation, and the mechanisms of photochemical reactions
- Recognize and describe photophysical processes such as fluorescence, phosphorescence, and intersystem crossing, which govern the behavior of molecules upon exposure to light

4.1	[A] Energy of molecules, photochemical energy, electronic excitation, Jablonski diagram, laws of photochemistry, quantum efficiency. [B] Photochemistry of carbonyl compounds- α-cleavage of acyclic, cyclic and α-β unsaturated cleavage of carbonyl compounds, β-cleavage of inter and intramolecular hydrogen abstraction, addition to carbon-carbon double bond, photo reduction of carbonyl compounds. [C] Photo induced rearrangement of enones, dienones and alkenes. Photochemistry of alkenes and aromatic compounds-isomerization, dimerization and addition reactions.	

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6. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7. Name Reactions by A. R. Parikh & H. A. Parikh.
8. Name reaction: A collection of detailed reaction mechanism by Jie Jack Li.
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13. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.

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4. https://ggsestc.digimat.in/nptel/courses/video/104106077/L29.html
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10. https://archive.nptel.ac.in/courses/104/106/104106077/

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√									
2.	√	√	√	√		√	√				
3.	√	√	√				√				
4.	√	√									
5.	√	√					√				
6.	√	√									
7.	√	√									
8.	√	√									
9.	√	√									
10.	√	√									
11.	√	√									
12.	√	√									

M. Sc. (CHEMISTRY) SEMESTER II

Core Course-6

COURSE NAME: PHYSICAL CHEMISTRY-II

COURSE CODE: CHEMSC-S2P6-4CR26 [CREDITS - 04]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Describe the conductance of electrolytes in solutions, explain importance of polarization, relaxation effect, electrophoretic effect, decomposition potential and over voltage in electrolysis process and relate its application in industries. 2. Solve numerical problems involving activity coefficient, ionic strength and other similar parameters 3. Explain the fundamental aspects of surface chemistry and describe & illustrate monolayer and multilayer adsorption and its isotherm graphs and BET and Gibb's adsorption isotherms. 4. Describe the origin of intermolecular and surface forces between gases and solid interfaces. 5. Recognize colloids types and preparation methods, colloidal electrical properties the formation of the electrical double layer, and analyze factors influencing zeta potential. 6. Apply electrophoresis and DLVO theory to determine zeta potential and colloidal stability, discuss surfactant types and their effects. 7. Identify the types of radiation in the atomic and molecular spectroscopy and discuss its various types. 8. Discuss the fundamentals of rotational spectroscopy with example of linear rigid diatomic molecules, symmetric tops, spherical tops, asymmetric tops and effect of isotopic substitution. 9. Discuss IR Spectroscopy and determine force constant, Amplitude of vibration, The anharmonic oscillator, Morse potential, vibrational transitions. 10. Explain and differentiate Vibrational – Rotational spectra of diatomic molecule (CO molecule) and apply Vibrational rotational spectra in elucidation of structure, solve problems (Numericals) related to Molecular spectroscopy.

Module 1	THEORIES OF ELECTROLYTIC CONDUCTANCE AND OVER VOLATEGE	[15L]

Learning Objectives:

This module is intended to

- Acquire knowledge of conductivity behavior of strong electrolytes in solution, factors affecting electrolysis process

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Describe the conductance of electrolytes in solutions. Explain importance of polarization, relaxation effect, electrophoretic effect etc.
- Define decomposition potential and over voltage in electrolysis process and relate its application in industries
- Determine experimentally the activity coefficient, dissociation constants and over voltage
- Solve numerical problems involving activity coefficient, ionic strength and other similar parameters

3.1	Theories of electrolytic conductance and over voltage: Debye-Hückel theory of strong electrolytes, relaxation effect and electrophoretic effect, Debye-Falkenhagen effect, Wein effect, ionic strength and its determination, Debye-Hückel limiting law. Activity and activity coefficient, determination of activity coefficient by (i) solubility product principle (ii) EMF method (cell without transference), determination of dissociation constant of monobasic acid by conductance method and approximate EMF method, electrolytic polarization, dissolution and decomposition potential, concentration polarization, decomposition potential and its determination, over voltage, determination of over voltage, theories of over voltage: combination of atom as slow process (Tafel theory), numericals.	
Module 2	**SURFACE CHEMISTRY**	**[15L]**

Learning Objectives:

This module is intended to

- Understand the basics of adsorption and surface chemistry from the physical-chemical perspective
- Understand the phenomenon occurring on the surfaces of adsorbent during the sorption process
- Learn solving numerical based on the above topics

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Explain the fundamental aspects surface chemistry
- Differentiate the monolayer and multilayer adsorption and its isotherms
- Describe the different adsorption isotherm graphs
- Describe and illustrate derivation of BET and Gibb's adsorption isotherm
- Describe the origin of intermolecular and surface forces between gases and solid interfaces
- Describe the concept of interfacial energy and surface pressure

2.1	Adsorption, multilayer adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation, derivation of Langmuir equation from BET equation, explanation of different adsorption isotherms, change in enthalpy, entropy and free energy of adsorption, adsorption at the surface of liquid: Gibbs adsorption isotherms (derivation), thermodynamic treatment of adsorption, surface active substances and surface inactive substances, orientation of surfactants on the surface of solution, surface pressure, insoluble surface films on liquid, numericals.	
Module 3	**COLLOIDS**	**[15L]**

Learning Objectives:

This module is intended to

- Understand types of colloids and their preparation and properties
- Understand formation of electrical double layer and its various theories
- Understand of zeta potential using electrophoresis and factors affecting it
- Understand DLVO theory and how it affects stability of colloids
- Understand electro kinetic properties
- Understand surfactants and its types

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Recognize colloids types and preparation methods.
- Comprehend colloids electrical properties and the formation of the electrical double layer, and analyse factors influencing zeta potential
- Apply electrophoresis to determine zeta potential, apply DLVO theory to assess colloids stability, and understand surfactant types and their effects
- Evaluate theories explaining the double layer formation and surfactant effectiveness

3.1	Types of colloids systems, preparation of lyophobic colloids, properties of Colloids systems: (i) electrical properties origin of charges on colloids, Helmholtz-Perin, Guoy-Chapmann and Stern theory electrical double layer, Zeta potential and its determination by electrophoresis, factor affecting zeta potential, Explanation and derivation DLVO theory of colloid stability (ii) Electrokinetic properties: electrophoresis, electro-osmosis, surface active agents, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization: mass action and phase separation model, solubilization, emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of microemulsion, theories of microemulsion.	

Module 4	MOLECULAR SPECTROSCOPY	[15L]

Learning Objectives:

This module is intended to

- Make the students familiar with fundamentals of spectroscopic methods such as microwave, IR and Raman spectrometry
- Make the students analyze and interpret the data without any ambiguity

Learning Outcome:

- Identify the types of radiation in the atomic and molecular spectroscopy and discuss its various types
- Discuss the fundamentals of rotational spectroscopy with example of linear rigid diatomic molecules, symmetric tops, spherical tops, asymmetric tops and effect of isotopic substitution
- Explain techniques of instrumentation of rotational spectrum
- Discuss IR Spectroscopy and determine force constant, amplitude of vibration, the anharmonic oscillator, Morse potential, vibrational transitions
- Explain and differentiate vibrational – rotational spectra of diatomic molecule (CO molecule) and apply vibrational rotational spectra in elucidation of structure
- Solve problems (numericals) related to Molecular spectroscopy

4.1	Molecular spectra, microwave spectroscopy (rotational spectroscopy): the rotation of molecules, linear molecule, symmetric tops, spherical tops, asymmetric tops, rotational spectra of rigid diatomic molecule, intensities of spectral lines, effect of isotopic substitution, techniques and instrumentation of rotational spectrum, IR spectroscopy: classical frequency of harmonic oscillator, the classical potential energy of harmonic vibration of a diatomic molecule, quantum expression of potential energy, energy level diagram, relative population of energy levels, mechanism of interaction with radiation, selection rule, determination of force constant, amplitude of vibration, the anharmonic-vibration or oscillator, Morse potential, vibrational energy of diatomic molecule following the Morse potential, energy level diagram, vibrational transitions. vibrational – rotational spectra of diatomic molecule (CO molecule) application of vibrational rotational spectra numerical	

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e-Resources:

1. https://courses.lumenlearning.com/suny-mcc-chemistryformajors-2/chapter/introduction-to-electrochemistry/
2. Swayam Prabha: http://www.youtube.com/embed/A8nTdZpi2pc
3. Swayam Prabha: https://www.youtube.com/watch?v=9DIjXSivByQ CH8 Course Name: Electrochemistry-Electrolytic Conductance
4. https://archive.nptel.ac.in/courses/113/104/113104082/
5. https://alasia.recherche.usherbrooke.ca/courses/Advanced%20Electrochemistry%20Book.pdf

UNIT: II

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2. Engel, T. & Reid, P. Physical Chemistry, Pearson
3. Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007)
4. Maron, S. & Prutton Physical Chemistry, Collier Macmillan Ltd

e-Resources:

1. https://archive.nptel.ac.in/courses/104/104/104104130/
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4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000665/M026469/ET/1515661953CHE_P10_M23_etext.pdf

UNIT: III

1. Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, Vishal Publishing Co.
2. Engel, T. & Reid, P. Physical Chemistry, Pearson.
3. Maron, S. & Prutton Physical Chemistry, Collier Macmillan Ltd.
4. Colloid Science: Principles, Methods and Applications by T Cosgrove.
5. Physical Chemistry of Surfaces" by A W Adamson and A P Gast.

e-Resources:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==
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UNIT:IV

1. Fundamentals of Molecular Spectroscopy CN Banwell TATA MCGRAW-HILL15th edition.
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3. Introduction to Spectroscopy by Donald L. Pavia, George S. Kriz, Gary M. Lampman, James 4. R. Vyvyan.
5. Fundamentals of molecular spectroscopy by Walter S. Struve.
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e-Resources:

1. https://nptel.ac.in/courses/104101099
2. https://www.youtube.com/watch?v=jTWFPFt8baI&list=PLHldkO8JYV0PwHse8DvRvydyvHhzXXJE2&index=1
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4. https://www.youtube.com/watch?v=N_Knvmi9Ipo&list=PLHldkO8JYV0PwHse8DvRvydyvHhzXXJE2&index=3
5. https://www.youtube.com/watch?v=IHGCgcZtbI&list=PLHldkO8JYV0PwHse8DvRvydyvHhzXXJE2&index=4
6. https://www.youtube.com/watch?v=MP9rUbwrtd0&list=PLHldkO8JYV0PwHse8DvRvydyvHhzXXJE2&index=5
7. www.uou.ac.in/sites/default/files/slm/MSCCH-509.pdf

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.	√	√	√				√				
2.	√		√				√				
3.	√	√	√				√	√			
4.	√	√	√				√				
5.	√	√	√		√						
6.	√	√	√		√		√				
7.	√	√	√				√				
8.	√	√	√				√				
9.	√	√	√		√		√				
10.	√	√	√		√	√	√				

M. Sc. (CHEMISTRY) SEMESTER II

Vocational Course-1

COURSE NAME: VOCATIONAL COURSE-I

COURSE CODE: CHEMSC-S2VOC1-4CR26 [CREDITS - 04]

Course Learning Outcome		
After the successful completion of the Course, the learner will be able to: 1. Explain fundamental concepts of ^{1}H NMR and ^{13}C NMR Spectroscopy and determine structure of compound by spectroscopic methods. 2. Explain instrumentation of ^{1}H NMR Spectroscopy. 3. Explain the thermal methods of analysis by TGA. 4. Explain the calibration of temperature scale, and instrumental and experimental application. 5. Explain thermometric titration and its application. 6. Apply safety rules and measures while working in a chemical laboratory. 7. Define and illustrate the hazardous nature of various chemical substances. 8. Apply the knowledge of safe storage and disposal of chemicals in laboratory. 9. Identify industrial and laboratory accident and communicate it. 10. Discuss concepts on green and sustainable chemistry. 11. Explain various principles of green chemistry. 12. Apply knowledge of replacement of toxic chemicals with environment friendly green compounds in laboratory. 13. Discuss benefits of utilizing concept of green reagents and green catalyst.		
Module 1	**ORGANIC SPECTROSCOPY: NMR SPECTROSCOPY**	**[15L]**
Learning Objectives: This module is intended to • Understand theory and instrumentation of NMR spectroscopy with working of various parts of instruments • Get familiar with structure elucidation with the help of NMR spectra		
Learning Outcome: After the successful completion of the module, the learner will be able to • Explain fundamental concepts of ^{1}H NMR and ^{13}C NMR Spectroscopy and determine structure of compound by spectroscopic methods • Explain instrumentation of ^{1}H NMR Spectroscopy		
1.1	Theory and principles of NMR spectroscopy. **^{1}H NMR Spectroscopy** Aspects of PMR spectra- number of signals, chemical shift, factors influencing chemical shift, shielding, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic and aromatic), spin-spin coupling; (n+1) rule, coupling constant (J), factors	

	effecting coupling constant "J", Solvents used in NMR spectroscopy, effect of deuteration, Theory of FT-NMR, Structure elucidation of organic compounds with the help of UV, IR and NMR data., **2D NMR Techniques:** Preliminary idea of 2D-NMR, COSY, NOESY and HETCOR. **^{13}C NMR spectroscopy** Types of ^{13}C NMR Spectra: proton coupled and decoupled ^{13}C spectra, off-resonance and DEPT of ^{13}C Spectra, chemical shift, calculations of chemical shifts of aliphatic carbons.	
Module 2	**THERMAL METIIODS OF ANALYSIS**	**[15L]**
Learning Objectives: This module is intended to • Get familiar with the thermal methods, their instrumentation, and effect of various factors on the experimental results and their application in various field.		
Learning Outcome: After the successful completion of the module, the learner will be able to • Explain the thermal methods of analysis by TGA • Explain the calibration of temperature scale, and instrumental and experimental application • Explain thermometric titration and its application		
2.1	Thermal methods of analysis thermogravimetry: Principles Thermogravimetry, Instruments for TGA- thermobalance and furnace, Calibration 'of temperature scale (Curie Point & Melting Point), Factors affecting TGA results instrumental and experimental, Applications (Mixture, Proximate analysis, Polymer identification, Carbon black and Structure of Copper Sulfate) Thermometric titration: Thermometric Titration (TT), Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometric Titration and Redox Titration.	
Module 3	**CHEMICAL AND INDUSTRIAL SAFETY**	**[15L]**
Learning Objectives: This module is intended to • make students aware of various parameters of safety measures to be followed in a chemical laboratory • To create awareness among students regarding industrial and laboratory accident, its causes & prevention		

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Apply safety rules and measures while working in a chemical laboratory
- Define and illustrate the hazardous nature of various chemical substances
- Apply the knowledge of safe storage and disposal of chemicals in laboratory
- Identify industrial and laboratory accident and communicate it

3.1	(A) Chemical Safety Safe chemical working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation, safe storage and use of a hazardous chemicals, procedure for working with substance that pose hazards, flammable or explosive hazards, procedures for working with gases at pressure above and below atmospheric level, chemical storage safety: bulk storage, solvent storage, explosive chemical storage, transportation storage, disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identifications, verification and segregation of a laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals, knowledge about the personnel safety and use of personnel protective equipment (PPE), Operate firefighting extinguisher and knowledge of the Fire prevention. (B) Industrial Safety Classification of accident, objectives of safety management, risk assessment: process risk assessment, industrial hygiene risk assessment, environmental risk assessment, fire & explosive risk management, static electricity, its hazards, and control measures, hazard identification: communication and symbol	
Module 4	**GREEN CHEMISTRY**	**[15L]**

Learning Objectives:

This module is intended to

- provide knowledge on green and sustainable chemistry
- understand various principles of green chemistry
- learn about the replacement of toxic chemicals with environment friendly green compounds and benefits of utilizing concept of green reagents and green catalyst

Learning Outcome:

After the successful completion of the module, the learner will be able to

- discuss concepts on green and sustainable chemistry
- explain various principles of green chemistry
- apply knowledge of replacement of toxic chemicals with environment friendly green compounds in laboratory
- discuss benefits of utilizing concept of green reagents and green catalyst

4.1	(A) Basics Concepts Of Green Chemistry: Basic principles of green chemistry: (i) Waste minimization (ji) Atom economy(iii) Hazardous products minimization (iv) Designing safer chemicals (v) Planning for minimum energy requirement for synthesis (vi) Proper Solvent selection (vii) Proper starting material selection (viii) Use of Protecting groups (ix) Use of catalysts (x) Biodegradable product designing (xi) Proper designing of manufacturing plants (xii) Strengthening analysis techniques (B) Green Reagents And Water Based Green Synthesis: Polymer based green reagents, water based reactions: Diels-Alder reaction, Claisen rearrangement, Michael reaction, Aldol condensation, Knoevenagel Reaction, Benzoin condensation, Claisen-Schmidt condensation and Heck reaction	

Reference Books:

1. R.M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D.H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi.
3. P.Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice – Hall, New Delhi.
4. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
5. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
6. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).
7. Fundamental of molecular spectroscopy C.N. Banwel, J Tata Mc Graw Hill Pub. Camp.
8. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw—Hill.
9. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., NewYork, 2nd edition.
10. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, NewYork), 5thedition.
11. Instrumental Methods of AnaIysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co.,New York), 6th edition.
12. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
13. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, New York).
14. Handbook of Analytical Chemistry: L. Meites (McGtaw- Hills, NewYork).
15. Spectrometric Identification of Organic Compounds; By Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8th edition, Published by Wiley
16. Introduction to Spectroscopy; By Donald L. Pavia, Gary M. Lampman, George S. Kriz, Vyvyan, Fourth edition, Published by Brooks cole.
17. Spectroscopic Methods in Organic Chemistry; By D.H Williams, I. Fleming, Sixth edition, Published by Tata McGraw-Hill Education.
18. Spectroscopy of Organic Compounds; By P S Kalsi, Sixth edition, New Age International

Publisher.
19. Organic Spectroscopy: Principles and Applications; By Jag Mohan, second edition, Published by Alpha Science International Ltd.
20. Organic Spectroscopy (NMR, IR, Mass rind UV); By Dewan S.K., First edition, CBS Publisher& Distributors Pvt Ltd.
21. Basic Principles of Spectroscopy; By Raymond Chang, Published by McGraw-Hill Inc.
22. Elementary Organic Spectroscopy; By Y R Shama, S. Chand &Company Pvt. Ltd.
23. Organic Spectroscopy: By William Kemp, Published by Palgrave Macmillan.
24. Chemical Hazards in the workplace, measurement and control, Gangadhar Choudhary, American Chemical Society.
25. Safety at work by John Ridley.
26. The safe handling of Chemicals in Industry, Vol. I and II, PA Carsion, CJ Mumford, Longmann & J W & Sons, New York.
27. Industrial Hygiene and Chemical Safety, M. H. Fulekar, I. K. International
28. Fundamentals of Industrial Safety and Health, Dr. K. U. Mistry, Siddharth Prakashan Ahmedabad
29. Industrial accidental prevention. H. W. Heinrich
30. Encyclopaedia of Occupational Health & Safety. ILO. Geneva. Switzerland
31. Accident Prevention Manual for Industrial Operation, NSC. USA.
32. V.K. Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Kluwer Academic Publishers, Boston, London, 2012, pp. 5-36 and the reference cited there in.
33. Paul T. Anastas and John C. Wamer: Green Chemistry, Theory and Practice, Oxford University Press, New York, 1998.
34. Colin Baird, Environmental Chemistry, W.H. Freeman, New York, 1999.
35. V.K. Ahluwalia and Renu Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi, 2001, pp.150-190 and the references cited therein.
36. P. T. Anastas and I.c. Wamer, Green Chemistry, Theory and Practice, Oxford University Press (1998).

e-Resources:

1. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Physical_Methods_in_Chemistry_and_Nano_Science_(Barron)/04%3A_Chemical_Speciation/4.07%3A_NMR_Spectroscopy.
2. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Spectroscopy/Magnetic_Resonance_Spectroscopies/Nuclear_Magnetic_Resonance/NMR%3A_Experimental/Carbon-13_NMR/Interpreting_C-13_NMR_Spectra
3. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000831ME/P001676/M030174/ET/1525933631Module-1_Unit-1_COM-I.pdf
4. https://archive.org/details/thermalmethodsof0000hain
5. https://archive.org/details/thermalmethodsof0000wend
6. https://www.iitb.ac.in/safety/sites/www.safety.iitb.ac.in/files/Chemical%20Safety_0.pdf
7. http://acl.digimat.in/nptel/courses/video/103107156/L02.html
8. https://archive.nptel.ac.in/courses/103/107/103107156/
9. https://archive.nptel.ac.in/courses/114/106/114106017/

10. https://event.unitar.org/full-catalog/green-and-sustainable-chemistry
11. https://chemicals.gov.in/green-chemistry

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.	√	√									
2.	√	√									
3.	√	√									
4.	√	√									
5.	√										
6.	√	√	√				√				
7.	√	√									
8.	√	√	√				√				
9.	√	√									
10.	√										
11.	√										
12.	√	√	√				√				√
13.	√	√	√				√				√

M. Sc. (CHEMISTRY) SEMESTER II

Practical Core Course-4

COURSE NAME: PRACTICAL INORGANIC CHEMISTRY-II

COURSE CODE: CHEMSC-S2PR4-2CR26 [CREDITS - 02]

Course Learning Outcome

After the successful completion of the Course, the learner will be able to:

1. Demonstrate the analysis of alloy and ore and calculation of molarity and mole ratio.
2. Describe methods to find copper, zinc gravimetrically and volumetrically.
3. Find available chlorine in Bleaching powder.
4. Determine calcium, lead, Iron, and chromium in admixture.
5. Illustrate different methods of Preparations of inorganic salts.
6. Appreciate good laboratory practices.

Learning Objectives

This module is intended to

- Impart basic knowledge for carrying out analysis of alloy
- Understand the types of complexometric titrations
- Understand and calculate the percentage purity of salt
- Determine physical constant and confirmation of product
- Learn estimation and determination of each radical quantitatively and qualitatively

Contents

Quantitative Analysis:

1. Analysis of Solder and Type metal (Alloy Analysis).
2. Determine the amount of Ca as $CaC_2O_4H_2O$ or as $CaCO_3$, in limestone.
3. Estimation of Cu^{+2} as CuSCN.
4. Estimation of iron in iron ore.
5. Estimation of available chlorine in bleaching powder.
6. Estimation of Ca^{+2} and Pb^{+2} in Admixture.
7. Determine the amount of Fe^{+3} and Cr^{+3} present in given Admixture.
8. Determine the percentage purity of the given sample of manganese salt.
9. Estimation of aluminium by back titration.

References:

1. A textbook of practical inorganic chemistry - A. L. Vogel.
2. Practical Chemistry by Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri.
3. Advance inorganic analysis by Agarwal, Keemti lal.
4. Qualitative Inorganic analysis – Vogel.

5. Inorganic practical chemistry by Chatwal and Anand.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.		√		√	√						
2.				√	√						
3.				√	√						
4.				√	√						
5.		√		√	√	√					
6.				√	√						√

M. Sc. (CHEMISTRY) SEMESTER II

Practical Core Course-5

COURSE NAME: PRACTICAL ORGANIC CHEMISTRY-II

COURSE CODE: CHEMSC-S2PR5-2CR26 [CREDITS - 02]

Course Learning Outcome

After the successful completion of the Course, the learner will be able to:

1. Demonstrate the basics to carry out reactions, nature of reaction and calculation of mole and mole ratio.
2. Establish mechanism and monitor a reaction at specified condition.
3. Demonstrate after the completion of reaction and purification and confirm product through the references.
4. Appreciate good laboratory practices.

Learning Objectives

This module is intended to

- Impart basic knowledge for carrying out preparation
- Understand nature of reaction and establishment of reaction condition with mechanism
- Understand calculation of mole and mole ratio for each reaction
- Learn isolation of product from individual step and purification by crystallization
- Determine physical constant and confirmation of product
- Learn concept of estimation and determination of each component quantitatively

Contents

Preparation of organic compounds

a. Bromination: p-Bromoacetanilide from acetanilide
b. Nitration : m-Dinitrobenzene from Nitrobenzene
c. Reduction: m-Phenylenediamine from m-Dinitrobenzene
d. Oxidation : p-Nitrobenzoic acid from p-Nitrotoluene
e. Diazotization reaction: Orange-II
f. Sandmayer reaction: p-Chloro toluene from p-toluidine
g. Friedl-Craft's reaction: Resacetophenone from Resocinol
h. Cannizzaro reaction: Benzoic acid from Benzaldehyde via KOH
i. Aldol condensation: Chalcone from Benzaldehyde + Acetophenone (Claisen Schmidt reaction)

Quantitative Estimations

a. Estimation of ester + acid

b. Estimation of amide + acid

c. Estimation of formaldehyde via oxime

d. Estimation of number of carboxylic acid (succinic acid, oxalic acid)

References:

1. A text book of practical organic chemistry – A. I. Vogel
2. Practical organic Chemistry – Mann and Saunders
3. A handbook of quantitative and qualitative analysis – H. T. Clarke
4. Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia & S. Dhingra.
5. Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia& R. Aggarwal Universities Press.
6. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.			√	√	√	√	√				
2.			√	√	√	√	√				
3.			√	√	√	√	√				
4.			√	√	√	√	√				
5.			√	√	√	√	√				

M. Sc. (CHEMISTRY) SEMESTER II

Practical Core Course-6

COURSE NAME: PRACTICAL PHYSICAL CHEMISTRY-II

COURSE CODE: CHEMSC-S2PR6-2CR26 [CREDITS - 02]

Course Learning Outcome

After the successful completion of the Course, the learner will be able to:

1. Utilize knowledge of preparation of solutions
2. Inspect the rate of reactions in chemical kinetics.
3. Demonstrate the use of pH-meter, potentiometer, conductivity bridge and colorimeter
4. Describe partitioning behavior of compound.
5. Determine the solubility and solubility product of sparingly soluble salts.

Learning Objectives

This module is intended to

- Study the physical chemistry parameters for reaction between acid and base
- Study rate of reaction by conductometry
- Determine the concentration of solution by colorimetry
- Understand the conductivity behaviour of electrolytic solutions
- Learn partitioning behaviour of component in two phases

Contents

1. Determine the dissociation constant and strength of borax solution pH-metrically.
2. Determine the velocity constant of the hydrolysis of ethyl acetate with sodium hydroxide at room temperature by conductance measurements.
3. Determine the solubility of silver chloride in water potentiometrically.
4. To determine the concentration of given components in a mixture colorimetrically.
5. Determine the equilibrium constant of the reaction $I^- + I^2 = I^{3-}$ by distribution method.
6. Investigate the reaction between H_2O_2 and HI at two different temperatures and calculate the energy of activation for the reaction.
7. Determine the formula of a complex between Cu^{+2} and NH_3 by distribution method.
8. Determine the CMC of a surfactant at room temperature and thermodynamic parameters using conductivity measurements.
9. Determination of CMC and area per molecule of a surfactant by surface tension measurement.

References:

1. Advanced Practical Physical Chemistry by Yadav J. B., Krishna Prakashan Media.
2. Practical Physical Chemistry, Dr. M. Satish Kumar Sankalp Publication.
3. Gurtu, J. N., Kapoor, R., Advanced Experimental Chemistry S. Chand & Co. Ltd.
4. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.	√	√	√			√					
2.	√	√	√			√	√				
3.	√	√	√	√	√	√	√				
4.	√	√	√			√	√				
5.	√	√	√			√	√				