FOUR-YEAR UNDERGRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	INORGANIC CHE	INORGANIC CHEMISTRY I						
Type of Course	MAJOR/MINOR							
Semester	Ι							
Academic Level	100-199							
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours			
		per week	per week	per week				
	4	3	-	2	75			
Pre-requisites	Scope of chemistry, Interdisciplinary areas involving chemistry. Fundamentals of periodic properties of elements, Atoms and molecules, Need for chemical bonding and its types, Awareness on nature of experiments and health risk, hazard associated with chemicals, Mole concept							
Course Summary	This course explores the importance of chemistry as a central discipline of science. It introduces the periodic properties of elements, concept of chemical bonding and explanation of inorganic molecular structure using hybridization and MO theory. A few basic topics of the emerging area of Nanochemistry are also introduced in this course. The basic laboratory safety, concepts in volumetric analysis and related practical experiments are also covered.							

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools used
		Level*	Category#	
CO1	Understand the role of chemistry in science and scientific research with emphasis on analytical data evaluation	U	С	Instructor- created exams/ Quizzes/Assignments
CO2	Conceptualize and predict chemical bonding, molecular structures using	An	Р	Instructor- created exams/ Quizzes/assignments

	dipole moment, hybridisation, and MO Theory							
CO3	Develop a basic understanding of the extraordinary properties of nanomaterials and its applications.	U	С	Instructor- created exams/ Quizzes/Assignments				
CO4	Apply the concepts of lab safety measurements and volumetric analysis	Ар	М	Instructor- created exams/ Assignments/problem solving				
CO5	Enable students to develop analytical skills in inorganic quantitative volumetric analysis.	Ар	Р	Group work /Viva Voce// Observation of practical skill				
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)								
# - Fa	# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive							
Know	vledge (M)							

Module	Unit	Content	Hrs	Marks
			(45+30)	
Ι	CI	HEMISTRY AS A SCIENCE DISCIPLINE &	8	17
	1	Science- Chemistry as a branch of science, History of	1	
		chemistry, Involvement of chemistry in daily life		
		(Mention only)		
	2	Introduction to analytical chemistry, Classification of	1	
		analytical methods: Qualitative and Quantitative		
		analysis (Mention with examples)		
	3	Treatment of analytical data - Significant figures -	3	
		Accuracy – Precision – Methods of representing		
		Accuracy, Absolute error, Relative error, Types of		
		errors, Constant errors, Proportional errors, Correction		
		of determinate errors		
	4	Methods of representing Precision -Mean, Average	3	
		deviation, Standard deviation, Relative standard		
		deviation, Coefficient of variation, Variance,		
		Rejection of a result: Q test, Methods of least squares		
II	C	HEMICAL BONDING AND MOLECULAR	17	38
		STRUCTURE		
	5	Periodic Properties and their Periodic Trends: (a)	2	
		Atomic and Ionic radius (include isoelectronic species		
		in discussion) (b) Ionisation energy: (c) Electron		

		affinity (d) Electronegativity (Pauling, Mulliken		
		Allred & Rochow scales).		
	6	Classification of bonds: Ionic bond - Definition,	1	
		Factors affecting the formation of ionic bond.		
		Characteristics of ionic compounds. Lattice energy		
	7	Born Haber cycle - Born Lande equation (derivation	2	
		not needed) - Covalent –(Mention polar and non polar		
		compounds) and Coordinate bond		
	8	Dipole moment and its applications: (Prediction of	2	
		linearity and symmetry of polyatomic molecules,		
		Prediction of position of substituents in aromatic		
		compounds, Measurement of bond angle)		
	9	Covalent Bond, Lewis concept of covalent bond,	2	
		Atomic orbital overlap, Concept of covalency,		
		Variable covalency and Maximum covalency		
	10	Prediction of Covalent character in ionic bond using	1	
		Fajans rule. Prediction of Ionic character in Covalent		
		bond using Hannary Smidth equation.		
	11	Structure of molecules by the concept of	3	
		Hybridisation: NO ₃ ⁻ , CO ₃ ²⁻ , SO ₄ ²⁻ , IF ₇ , XeO ₃ , XeO ₄ ,		
		XeF ₂ , XeF ₄ , XeF ₆ , ClF ₃ , BrF ₅ , SF ₄		
	12	Introductory MO Theory: Homoatomic molecules in	4	
		N_2 and O_2 and their ions (comparison of bond order,		
		bond length and stability), MO Theory: Heteroatomic		
		molecules like NO, CO, HCl, HF, LiF.		
III]	INTRODUCTION TO NANOMATERIALS	10	21
	13	Definition of Nanomaterials, Historical revolution of	2	
		Nanochemistry, Nanochemistry and		
		Nanotechnology, Classification of nanostructures		
		based on electron confinement (0D, 1D and 2D)		
	14	Synthesis of Nanomaterials: Bottom Up and Top	1	
		down approaches (Elementary idea with examples)		
	15	Metal nanoparticles (gold and silver nanoparticles),	2	
		Semiconductor nanoparticles (CdS and CdSe		
		nanoparticles), Metal oxide nanoparticles (zinc oxide,		
		iron oxide, silica and titania nanoparticles),		
		Nanocomposites, Nanoceramics (Definition with		
		examples), Carbon Based Nanomaterials: Graphene,		
		Carbon Nanotubes, Fullerenes, Carbon dots		
		(elementary idea only)		
	16	Characteristics of Nanomaterials: Surface area to	3	
		volume ratio and its significance, Novel properties of		
		= =		

		plasmon resonance), Electronic, Mechanical,		
		magnetic and catalytic properties (No deep discussion		
		is needed)		
	17	Applications of nanomaterials: Electronics (Batteries,	2	
		Solar cell) Biomedical (Drug Delivery) and	-	
		Environmental based applications (Water		
		Purification Dye Removal) (General idea only)		
IV	FUNT	AMENTALS OF ANALYTICAL CHEMISTRY	10	22
	18	Lab safety measurements: Awareness of material	2	
	10	safety data sheet (MSDS). Safe storage and handling	_	
		of hazardous chemicals Simple first aids: Electric		
		shocks fire Cut by glass and inhalation of poisonous		
		gas		
	19	Accidents due to acids and alkalis Burns due to	1	
	17	phenol and bromine Disposal of waste chemicals	1	
		Disposal of sodium and broken mercury thermometer		
		P and S phrases (elementary idea only) Personal		
		protective Equipment (PPE)		
	20	Mole concent Equivalent mass Methods of	2	
	20	expressing concentration: Weight percentage	2	
		molelity molerity normality mole fraction norm and		
		millimoles Numerical Problems related to basis		
		infinitioles - Numerical Problems related to basic		
	21	Volumetric Analysis Introduction Drimory and	3	
	21	volumente Anarysis. Introduction - Filmary and	3	
		titrations involving acids and bases		
		nurations involving actus and bases,		
		Ladimatery Presidentian and Complexemetric		
		titrations		
	22	Indiantons.	2	
	22	indicators: Theory of acid-base, fedox, adsorption and	2	
		titration: Principle and advantages		
V	INORC	ANIC CHEMISTRY PRACTICAL L	30	
•		VOLUMETRIC ANALYSIS	50	
	1	General Instructions: Use a safety coat, gloves,		
		shoes and goggles in the laboratory. For weighing		
		alastronia balance must be used Double burette		
		electronic balance must be used. Double burelle		
		uration method may be used for titrations. Standard		
		solution must be prepared by the student. A minimum		
		of 7 experiments must be done from Section B and C.		

Section D is open-ended and the experiments can be
selected by the teacher
SECTION A
Importance of lab safety – Burns, Eye accidents,
Cuts, Gas poisoning, Electric shocks, Treatment of
fires, Precautions and Preventive measures.
Weighing using electronic balance, Preparation of
standard solutions.
SECTION B
Neutralization Titrations
1. Acidimetry and Alkalimetry: Strong acid Vs
Strong base
2. Acidimetry and Alkalimetry: Strong acid Vs
Weak base
SECTION C
Redox Titrations
1. Permanganometry: Estimation of $Fe^{2+}/FeSO_{4.}$
7H2O/Mohr's salt
2. Permanganometry: Estimation of Oxalic acid
3. Permanganometry: Estimation of Calcium using
std KMnO4
4. Dichrometry: Estimation of $Fe^{2+}/FeSO_{4.}$ 7H2O
/Mohr's salt
5. Dichrometry: Estimation of Ferric iron
6. Iodometry and Iodimetry: Estimation of Copper
7. Iodometry and Iodimetry: Estimation of Iodine
SECTION D
Open Ended (Any two experiments are to be
conducted. may be selected from the below list or
the teacher can select related experiments)
1. Determination of acetic acid content in vinegar
by titration with NaOH.

2. Determination of alkali content in antacid tablets	
by titration with HCl.	
3. Determination of available chlorine in bleaching	
Powder.	
4. Estimation of Cu in Brass	

- 1. C. N. R. Rao, Understanding Chemistry, Universities Press India Ltd, Hyderabad, 1999
- 2. George Gamow, One, Two, Three...Infinity: Facts and Speculations of Science, Dover
- 3. Publications, 1988.
- 4. Resonance Journal of Science Education, Indian Academy of Sciences.
- 5. Nature Chemistry, Nature Publishing Group.
- 6. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 7. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, Fundamentals of Analytical
- 8. Chemistry, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
- 9. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
- 10. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
- 11. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008
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- C.N.R., Rao, A. Müller, and A.K. Cheetham, (Eds.), "Chemistry of Nanomaterials", Wiley – VCH. 2005
- 15. T., Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
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- 17. V. S. Muralidharan, A. Subramania, *Nano Science and Technology*, CRC Press, London.
- 18. R. H. Hill, D. Finster, *Laboratory Safety for Chemistry Students*, 1st Edn., Wiley, Hoboken, NJ, 2010.

Further Reading

- 1. H. Collins, T. Pinch, *The Golem: What Everyone Should Know about Science*, Cambridge University Press, Cambridge, 1993.
- 2. C.R. Kothari, Research Methodology: Methods and Techniques, 2nd Revised Edition,

New Age International Publishers, New Delhi, 2004.

- 3. http://www.vlab.co.in
- 4. http://nptel.iitm.ac.in
- 5. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 5rd Edn., Oxford University Press, New York, 2010.
- 6. M. C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
- 7. G. L. Miessler, D A. Tarr, Inorganic Chemistry, Pearson, 2010
- 8. K.J. Klabunde (Ed.), "Nanoscale Materials in Chemistry", John Wiley & Sons Inc. 2001
- 9. G., Schmidt, Nanoparticles: From theory to applications –Wiley Weinheim 2004.

	PSO 1	PSO	PSO 3	PSO	PSO	PSO	PO 1	PO 2	PO 3	PO 1	PO 5	PO	PO 7
C O 1	3	2	5	2	1	1	3	2	5		3	1	1
C O 2	2	2					2				2		1
C O 3	2		1	2	2	3	2			1	2	1	2
C O 4			3		2	2	2		1		1	1	1
C O 5			3		2	3	3		1		2	1	2

Mapping of COs with PSOs and POs:

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/ Viva/ Seminar	Practical skill evaluation	End Semester Examinations
CO 1	\checkmark	\checkmark		\checkmark
CO 2	\checkmark	\checkmark		\checkmark
CO 3	\checkmark	\checkmark		\checkmark
CO 4	\checkmark	\checkmark		\checkmark
CO 5	\checkmark	\checkmark	\checkmark	

FOUR-YEAR UNDER GRADUATE

PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

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Programme	B.Sc Chemistry					
Course Title	BASIC INORGANIC CHEMISTRY AND METALLURGY					
Type of Course	MINOR					
Semester	Ι					
Academic Level	100-199					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	-	2	75	
	Concept of atom and	molecule				
Pre-requisites	Constituents of the at	om, Rutherfo	ord's model o	of the atom.		
	Periodic table and cla	ssification of	f elements to	different bloc	ks,	
	Basic knowledge of c	qualitative an	d quantitative	e analysis		
	Titration and use of i	ndicators				
Course Summary	This course is intend	ed to provide	e basic knowl	edge in inorga	anic chemistry and	
	nanochemistry. The s	tudent gets a	n understandi	ng of the Boh	model of the atom	
	and the modern quant	um mechani	cal model of t	he atom throu	gh the first module	
	of this course. Different	ent types of c	hemical bone	ding are also i	ncluded in the first	
	module. General pro	perties of the	e atom and th	e variation of	these properties in	
	the periodic table are	also discusse	ed in this cour	rse. Basic prin	ciples of analytical	
	chemistry are include	ed in the thir	d module of	this course wl	nich includes acid-	
	base titration, redox	titration, cor	nplexometric	titration, and	l mixture analysis.	
	This course also tries to explore processes in metallurgy including extraction of					
	metals and alloy forr	nation. To m	aster the lab	oratory skills	acid-base titration,	
	and redox titration ex	periments ar	e incorporate	d into this cou	irse structure.	

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Understand the structure of atoms and rules regarding the arrangement of electrons in an atom.	U	С	Instructor- created exams / Quiz
CO2	To discuss the chemical bonding, theories of chemical bonding and predict molecular shapes using VSEPR theory	U	F	Class test /Assignment / Quiz

CO3	To Comprehend periodic properties,			Class test		
	understand laws and the concept of	U	F	/Assignment /		
	the modern periodic table, and its			Quiz		
	implications					
CO4	To Master the principle of volumetric			Class test		
	analysis, understand the separation of	U	С	/Assignment /		
	cations in qualitative analysis			Quiz		
CO5	To Comprehend the process in			Class test		
	metallurgy including extraction of	U	F	/Assignment /		
	metals and alloy formation			Quiz		
CO6	To Perform different titrations and					
	execute open-ended experiments	Ap	Р	Lab work		
	safely and effectively					
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)						
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)						
Metao	cognitive Knowledge (M)					

Module	Unit	Content	Hrs	Marks	
	Atomic structure and Chemical Bonding				
	 Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature. 				
	2 Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.		2		
	3	Quantum numbers and their significance	1		
Ι	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2		
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2		
	6 VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O, PCl ₅ , SF ₄ , ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ . NH ₄ ⁺ , SO ₄ ²⁻				
	7 Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP ² (ethylene), SP ³ (CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)				
	8	Molecular Orbital theory: LCAO – Electronic configuration of H ₂ , B ₂ , C ₂ , N ₂ , O ₂ and CO – Calculation of	2		

		bond order and its applications.(Bond length and bond		
		strength), Comparison of VB and MO theories		
		Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves, X-		
		ray studies of Henrry Mosley, Mosleys periodic law -	2	
		Modern periodic law – Long form periodic table.		
II	10	Periodicity in properties: Atomic and ionic radii, Ionization		
		enthalpy - Electron affinity (electron gain enthalpy) -	3	
		Electronegativity, valency, Oxidation number		
		(Representative element), metallic and non-metallic		
		character, inert pair effect,		
		Analytical Chemistry	15	34
	11	Atomic mass - Molecular mass - Mole concept – Molar	2	
		volume - Oxidation and reduction – Equivalent mass.		
	12	Methods of expressing concentration: Molality,	2	
		molarity, normality, ppm, and mole fraction.		
	13	Dilution formula, Theory of volumetric analysis – Acid-	3	
		base, redox, and complexometric titrations :		
тт	14	acid-base, redox, and complexometric indicators.	2	
111		Double burette method of titration: Principle and		
		advantages.		
	15	Principles in the separation of cations in qualitative	2	
		analysis		
	16	Common ion effect and solubility product and its	2	
		applications in qualitative analysis –		
	17	Microanalysis and its advantages. Accuracy & Precision	2	
		(mention only).		
		Metallurgy	10	20
	18	Ores and minerals, Concentration of ores – Calcination and	2	
		roasting – Reduction to free metal.		
	19	Electrometallurgy – Hydrometallurgy. Refining of metals:	2	
		Electrolytic refining, zone refining		
TX 7	20	Extractive metallurgy of Al, Fe	2	
IV				
	21	Alloys: Definition – Composition and uses of German	2	
		silver, brass, bronze, guillinetar and anneo. Steer. Open hearth process (brief description only)	2	
	22	Classification of steel – Composition and uses of stainless		
		steels and applications of industrially important stainless	2	
		steel types- (AISI Grade mention only)	-	
 		Basic Inorganic Chemistry Practical	30	
		Acid-Base titrations and Redox titrations		
	L			

		General Instructions	
		For weighing electronic balance must be used. For	
		titrations, double burette titration method should be used.	
		Standard solution must be prepared by the student. Use a	
		safety coat, gloves, shoes and goggles in the laboratory. A	
		minimum of 7 experiments must be done. Out of the seven	
		experiments, one is to be open-ended which can be	
		selected by the teacher	
		Importance of lab safety – Burns, Eye accidents, Cuts, gas	
		poisoning Electric shocks Treatment of fires Precautions	
		and preventive measures	
		Weighing using electronic balance Preparation of	
		standard solutions	
		Neutralization Titrations	
		1 Strong acid _ strong base	
	т	2 Strong acid – weak base	
	1	3. Weak acid – strong base.	
		Redox Titrations - Permanganometry:	
		4. Estimation of oxalic acid.	
17	п	5. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt	
v		Reday Titrations - Dichrometry	
		6 Estimation of Feed/FeSO4 7H2O/Mohr's salt using	
		internal indicator	
		7 Estimation of Fe2//FeSO4 7H2O/Mohr's salt using	
		external indicator	
		Redox Titrations - Iodimetry and Iodometry:	
		8 Estimation of jodine	
		9 Estimation of copper	
		Open-ended experiments - Suggestions	
		Iodometry: Estimation of chromium.	
	ш	Determination of acetic acid content in vinegar by titration	
		with NaOH.	
		Determination of alkali content in antacid tablets by	
		titration with HCl.	
		Determination of available chlorine in bleaching powder	
	1		

- 1. C. N. R. Rao, Understanding Chemistry, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
- 3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
- 4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.

- 5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
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- 10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

	PSO	PSO	PSO	PSO	PSO	PSO	PO	PO	PO	РО	PO	PO	PO
	1	2	3	4	5	6	1	2	3	4	5	6	7
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	1				2		1				1		
3													
CO	1		1		2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Correlation Levels :

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	\checkmark		✓ ✓
CO2	\checkmark	\checkmark		\checkmark
CO3	1	\checkmark		\checkmark
CO4	1	\checkmark		✓
CO5	✓	\checkmark		\checkmark
CO6		1	1	

Mapping of COs to Assessment Rubrics

FOUR-YEAR UNDER GRADUATE

PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

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Programme	B.Sc Chemistry						
Course Title	BASIC INORGANIC AND NUCLEAR CHEMISTRY						
Type of Course	MINOR						
Semester	Ι						
Academic Level	100-199						
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours		
		per week	per week	per week			
	4	3	-	2	75		
	Concept of atom and	molecule					
Pre-requisites	Constituents of the at	om, Rutherfo	ord's model o	of the atom.			
	Periodic table and cla	ssification of	f elements to	different bloc	ks,		
	Basic knowledge of c	lualitative an	d quantitative	e analysis			
	Titration and use of in	ndicators					
Course Summary	This course is intende	ed to provide	basic knowl	edge in inorg	anic chemistry and		
	nanochemistry. The s	tudent gets a	n understandi	ng of the Boh	r model of the atom		
	and the modern quant	um mechanio	cal model of t	the atom throu	igh the first module		
	of this course. Different	ent types of c	hemical bond	ding are also i	ncluded in the first		
	module. General pro	perties of the	e atom and th	e variation of	these properties in		
	the periodic table are	also discusse	ed in this cour	rse. Basic prin	ciples of analytical		
	chemistry are include	ed in the third	d module of	this course wi	hich includes acid-		
	base titration, redox	titration, cor	nplexometric	titration, and	d mixture analysis.		
	This course also tries to examine nuclear chemistry, the N/P ratio, and the						
	application of radioactive isotopes. To master the laboratory skills acid-base						
	titration, and redox	titration exp	periments are	e incorporated	d into this course		
	structure.						

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Understand the structure of atoms			Instructor-
	and rules regarding the arrangement	U	С	created exams
	of electrons in an atom.			/ Quiz
CO2	To discuss the chemical bonding,			Class test
	theories of chemical bonding and	U	F	/Assignment /
	predict molecular shapes using VSEPR			Quiz
	theory			

CO3	To Comprehend periodic properties,			Class test			
	understand laws and the concept of	U	F	/Assignment /			
	the modern periodic table, and its			Quiz			
	implications						
CO4	To Master the principle of volumetric			Class test			
	analysis, understand the separation of	U	С	/Assignment /			
	cations in qualitative analysis			Quiz			
CO5	To Examine nuclear chemistry, the			Class test			
	N/P ratio and the application of	U	F	/Assignment /			
	radioactive isotopes			Quiz			
CO6	To Perform different titrations and						
	execute open-ended experiments	Ap	Р	Lab work			
	safely and effectively						
* - Re	* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)						
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)							
Metao	cognitive Knowledge (M)						

Module	Unit	Content	Hrs	Mark		
		Atomic structure and Chemical Bonding	15	34		
	Heisenberg uncertainty principle, Louis de Broglie's					
	matter waves – dual nature.					
	2	Schrödinger wave equation (Mention the equation and				
		the terms in it), - Concept of orbitals, comparison of	2			
		orbit and orbital.				
	3	Quantum numbers and their significance	1			
Ι	4	Pauli's Exclusion principle - Hund's rule of maximum				
		multiplicity - Aufbau principle – Electronic	2			
		configuration of atoms.				
	5	Chemical Bonding: Introduction – Type of bonds.				
		Ionic bond, Covalent bond, Coordinate bond, and	2			
		hydrogen bond (Intermolecular and intramolecular				
		hydrogen bond with examples).				
	6	VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O,	2			
		PCl5, SF4, ClF3, XeF2, SF6, IF5, XeF4, IF7 and XeF6. NH4+,				
		SO4 ²⁻				
	7 Valence Bond theory - Hybridisation involving s, p					
	and d orbitals: SP (acetylene), SP ² (ethylene), SP ³					
		(CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)				
	8	Molecular Orbital theory: LCAO – Electronic				
		configuration of H ₂ , B ₂ , C ₂ , N ₂ , O ₂ and CO – Calculation	2			

		of bond order and its applications.(Bond length and		
		bond strength), Comparison of VB and MO theories		
		Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves, X-		
		ray studies of Henrry Mosley, Mosleys periodic law -	2	
		Modern periodic law – Long form periodic table.		
II	10	Periodicity in properties: Atomic and ionic radii,		
		Ionization enthalpy - Electron affinity (electron gain	3	
		enthalpy) – Electronegativity, valency, Oxidation number		
		(Representative element), metallic and non-metallic		
		character, inert pair effect,		
		Analytical Chemistry	15	34
	11	Atomic mass - Molecular mass - Mole concept – Molar	2	-
		volume - Oxidation and reduction – Equivalent mass.	_	
	12	Methods of expressing concentration: Molality	2	
	12	molarity normality norm and mole fraction	-	
	13	Dilution formula Theory of volumetric analysis – Acid-	3	
	15	hase redox and complexometric titrations :	5	
	14	acid-base redex and complexemetric indicators	2	
III	14	Double burette method of titration. Principle and	4	
m		advantages		
	15	Principles in the separation of cations in qualitative	2	
	10	analysis	_	
	16	Common ion effect and solubility product and its	2	
	10	applications in qualitative analysis –	_	
	17	Microanalysis and its advantages. Accuracy &	2	
		Precision (mention only).	_	
		Nuclear Chemistry	10	20
	18	Nuclear stability $- N/P$ ratio $- Packing fraction - Mass$	2	
	10	defect – Binding energy	-	
	19	Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen	1	
	17	bomb.	-	
117	20	Nuclear forces - Exchange theory and liquid drop model -	2	
1 V		Nuclear reactors. Decay series – group displacement law	_	
	21	Isotopes, Separation of isotopes by gaseous diffusion		
		method and thermal diffusion method	2	
	22	Application of radioactive isotopes – ¹⁴ C dating – Rock		
		dating – Isotopes as tracers – Study of reaction mechanism	3	
		(ester hydrolysis) – Radio diagnosis and radiotherapy		
		Basic Inorganic Chemistry Practical:	30	
		Acid-Base titrations and Redox titrations		
		General Instructions		

		Ean maishing algothemic holonge must be used. Ean	
		For weighing electronic balance must be used. For	
		titrations, double burette titration method should be used.	
		Standard solution must be prepared by the student. Use	
		safety coat, gloves, shoes and goggles in the laboratory.	
		A minimum of 7 experiments must be done. Out of the	
		seven experiments, one is to be open-ended which can be	
		selected by the teacher	
		Importance of lab safety – Burns, Eye accidents, Cuts,	
		gas poisoning, Electric shocks, Treatment of fires,	
		Precautions and preventive measures.	
		Weighing using electronic balance, Preparation of	
		standard solutions.	
		Neutralization Titrations	
		1. Strong acid – strong base.	
	Ι	2. Strong acid – weak base.	
		3. Weak acid – strong base.	
		Redox Titrations - Permanganometry:	
V		4. Estimation of oxalic acid.	
	II	5. Estimation of Fe2+/FeSO4./H2O/Mohr's salt	
		Redox Titrations - Dichrometry	
		6. Estimation of Fe ₂₊ /FeSO ₄ ,7H ₂ O/Mohr's salt	
		using internal indicator.	
		7. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using	
		external indicator.	
		Redox Titrations - Iodimetry and Iodometry:	
		8. Estimation of iodine.	
		9. Estimation of copper	
		Open-ended experiments - Suggestions	
		Iodometry: Estimation of chromium.	
	III	Determination of acetic acid content in vinegar by	
		titration with NaOH.	
		Determination of alkali content in antacid tablets by	
		titration with HCl.	
		Determination of available chlorine in bleaching powder.	

- 1. C. N. R. Rao, Understanding Chemistry, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
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- 5. W. U. Malik, G. D. Tuli, R. D. Madan, Selected Topics in Inorganic Chemistry, S. Chand

and Co., New Delhi, 2010.

- 6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
- 7. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 5th Edn., Pearson, 2009.
- 8. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn., New Age International (P) Ltd.,
- 9. New Delhi, 1995.J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook* of *Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	01	O2	O3	O4	05	06							
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	1				2		1				1		
3													
CO	1		1		2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Mapping of COs with PSOs and POs

Correlation Levels :

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		1
CO3	✓	1		1
CO4	✓	✓		1
CO5	✓	✓		1
CO6		1	1	

FOUR-YEAR UNDER GRADUATE

PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

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Programme	B.Sc Chemistry								
Course Title	COORDINATION CHEMISTRY								
Type of Course	MINOR								
Semester	Ι								
Academic Level	100-199				-				
Course Details	Credit	Credit Lecture Tutorial Practical Total Hours							
		per week	per week	per week					
	4	3	-	2	75				
Pre-requisites	Classification of elem f block elements base General idea about tr Concept of coordinat Concept of covalent l Theoretical and pract	nents to diffe ed on electror ansition and e bond, valer bond, and org ical knowled	rent blocks, c nic configurat inner transition cy. ganic compou ge about volu	comparative st tion. on elements, ind. umetric analys	udy of s, p, d and				
Course Summary	This course explains familiarises some of the It also gives insight in the bonding in coordination It covers the practical A brief discussion of preparation of compli- course.	the character the important ato coordination anation comp application of Organome lex compoun	eristics of s, compounds on compound ounds. of complex f tallic compo ds and colou	p, \overline{d} and \overline{f} b of main group ds and various ormation in qu unds, comple trimetry is als	lock elements and o elements. theories to explain uantitative analysis exometric titration, so included in this				

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Elucidate the trends in physical and			Instructor-
	chemical properties of s and p block	U	F	created exams
	elements			/ Quiz
CO2	To Evaluate the general properties of			Class test
	transition metals and to distinguish between	U	F	/Assignment /
	lanthanides and actinides			Quiz
CO3	To Unlock the Complexity of Coordination			Class test
	Compounds: Structures, Properties, and	U	F	/Assignment /
	Applications			Quiz
CO4	To demonstrate different theories to explain	U	С	Class test
	the formation of coordination compounds			/Assignment /
				Quiz

CO5	To explore the characteristics of	U	F	Class test					
	organometallic compounds			/Assignment /					
				Quiz					
CO6	To Perform complexometric titrations,								
	colourimetry experiments and	Ар	Р	Lab Work					
	preparation of complex compounds.								
* - Re	emember (R), Understand (U), Apply (Ap), Ar	nalyse (An),	Evaluate (E), C	reate (C)					
# - Fa	# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)								
Metao	cognitive Knowledge (M)								

Module	Unit	Content	Hrs	Mark
		s & p BLOCK ELEMENTS	15	33
	1	s block elements - General properties: Ionization	2	
		Energy, Flame coloration, photoelectric effect,		
		metallic character, hydration energy.		
	2	p-block elements: comparative study- halides,	2	
		sulphates, carbonates and bicarbonates (solubility		
		and thermal stability).		
	3	Oxidation number and inert pair effect, Comparison	1	
_		of Lewis acidity of boron halides.		
I	4	Preparation, properties, structure and uses of	3	
		Diborane, Boric acid, Borazine and Boron nitride.		
		Structure and bonding of oxides of N (N ₂ O, NO, NO ₂ ,		
		N ₂ O ₄) and S (SO ₂ and SO ₃)		
	5	2		
		HOCl ₂ , HOCl ₃ ,HOCl ₄) (structure and acid strength).		
	6	Colour and bond dissociation energy of halogens.	2	
		Interhalogen compounds: Preparation, properties		
		ClF ₅ and IF ₇), Electropositive character of iodine		
	7	Pseudo halogen: Comparison of pseudo halogen	3	
		(Cyanogen as example) and halogens. structure of		
		poly halide ions (ICl ₂ ⁻ , ICl ₄ ⁻ and I ₅ ⁻). Noble gases:		
		Isolation of noble gases: Dewar's method-		
		Separation by charcoal adsorption method, Uses of		
		He, and Ne		
		TRANSITION AND INNER TRANSITION	8	17
		ELEMENTS		
	8	Transition Metals: General characteristics: Metallic	2	
		character, oxidation states, size, density, melting		

		point, boiling point. ionization energy, colour,		
		magnetic properties, catalytic properties		
п	9	non-stoichiometric compounds, complex formation and alloy formation. Difference between first row and other two rows.	2	
	10	Lanthanides: Electronic configuration and general characteristics. Occurrence of lanthanides – Importance of beach sands of Kerala – Isolation of lanthanides from monazite sand – Separation by ion exchange method.	2	
	11	Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides. Actinides: Electronic configuration and general characteristics – Comparison with lanthanides [Mention only].	2	
		COORDINATION COMPOUNDS	15	34
	12	Double salt and complex, ligand, type of ligands: (mono, bi, tri, tetra, hexa, ambidentate, chelate and macrocyclic ligands) coordination number,	2	
	13	Isomerism - structural and stereoisomerism, IUPAC Nomenclature of complexes,	2	
	14	Postulates of Werner's theory, EAN rule, application of co-ordination complexes in quantitative and qualitative analysis.	2	
	15	Theories of bonding, VBT (valence bond theory) , geometry of co-ordination numbers 4 and 6,	2	
ш	16	Limitations of VBT, Crystal field Theory: CFSE of low spin and high spin octahedral complexes, Factors affecting crystal field splitting.	2	
	17	Spectrochemical series, Crystal field splitting of d orbitals in Tetragonal and Square planar Complexes.	2	
	18	Magnetism (spin only magnetic moment) and colour (d-d transition),	1	
	19	Distorted octahedral complexes, merits and demerits of CFT.	2	
		Organometallic Compounds	7	14
IV	20	Definition – Classification based on the nature of metal-carbon bond, Zeise's salt. 18-electron rule.	2	
	21	Metal carbonyls - Mononuclear and Polynuclear carbonyls of Fe, Co and Ni (structure only) – Bonding in metal carbonyls.	2	

	22	Ferrocene: Preparation, properties and bonding	3	
		(VBT only). Catalysis: Zeigler Natta catalyst in the		
		polymerization and Wilkinson catalyst in the		
		hydrogenation of alkene.		
		PRACTICAL :	30	
		Complexometric titrations and Inorganic Preparations		
		A minimum of 7 experiments must be done. Out of the		
		seven experiments, one is to be open-ended which		
		can be selected by the teacher		
		1. Estimation of zinc.		
	Ι	2. Estimation of magnesium.		
		3. Estimation of calcium.		
		4. Determination of total hardness of water.		
		Preparation of complex compounds		
	II	5. Preparation of tetramminecopper(II) sulphate.		
		6. Preparation of Nickel (II) dimethylglyoxime		
v		7. Preparation of trithioureacopper(1) sulphate		
		Colorimetry		
		8. Verification of Beer-Lambert law for KMinO4 &		
	III	solution		
		9 Estimation of iron		
		10. Estimation of chromium.		
	IV	Open-ended experiments - Suggestions		
		1. Preparation of double salt/Complex compounds.		
		2. Determination of alkali content in antacid tablets by		
		titration with HCl.		
		3. Determination of available chlorine in bleaching		
		powder.		
		4. Analysis of Ores		

- 1. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Wiley India Pvt. Ltd., 2008.
- 2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
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- 4. F. A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn., John Wiley, New York. 1999.
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- 7. P. Powell, *Principles of Organometallic Compounds*, 2nd Edn., Chapman and Hall, London, 1988.

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- 9. D. N. Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry; For I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012.

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	01	O2	O3	O4	O5	06							
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	2				2		1				1		
3													
CO	2				2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Mapping of COs with PSOs and POs

Correlation Levels :

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	\checkmark	\checkmark		\checkmark
CO2	\checkmark	\checkmark		\checkmark
CO3	\checkmark	\checkmark		~
CO4	\checkmark	\checkmark		~
CO5	1	\checkmark		✓
CO6		1	1	

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

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Programme	B. Sc. Chemistry							
Course Title	ENVIRONMENTAL CHEMISTRY							
Type of Course	MDC							
Semester	Ι	Ι						
Academic	100-199							
Level								
Course Details	Credit	Lecture per	Tutorial	Practical	Total Hours			
		week	per week	per week				
	3	3	-	-	45			
Pre-requisites	What is Environ	nment.						
	Basic idea of environmental pollution.							
Course	This course ensures that the students acquire a profound knowledge and							
Summary	understanding on environmental pollution and the necessity of controlling							
	environmental	pollution.						

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Acquire the knowledge on ecosystem.	U	C	Instructor- created exams / Quiz
CO2	Recall the technical/scientific terms involved in pollution.	U	С	Instructor- created exams / Quiz
CO3	Recognize different types of toxic substances that cause environmental pollution.	U	С	Instructor- created exams / Assignment
CO4	Understand the effects of environmental pollution.	U	С	Seminar Presentation / Viva
CO5	Understand various pollution control measures.	U	С	Instructor- created exams / Quiz
CO6	Discuss and report local and global environmental issues based on the knowledge gained throughout the course.	Ар	Р	Group discussion and Seminar presentation/Viv a

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)
Metacognitive Knowledge (M)

Module	Unit	Hrs	Mark	
		Introduction to Environmental Chemistry	9	18
Ι	1	Environmental segments-Atmosphere, Hydrosphere, Lithosphere,	2	
		Biosphere		
	2	Interaction between different environmental spheres Concept of	2	
		ecosystem, abiotic and biotic components		
	3	Composition of Air, Water and Soil	2	
	4	Environmental pollution – Concepts and definition – Pollutant,	1	
		contaminant, receptor and sink		
	5	Classification of pollutants - Global, regional, local, persistent and non-	1	
		persistent pollutants.		
	6	Types of pollution	1	
II		Air Pollution	9	18
	7	Tropospheric pollution – Gaseous air pollutants – Hydrocarbons,	2	
		oxides of sulphur, nitrogen and carbon (Elementary idea only)		
	8	Global warming, green house effect, acid rain	1	
	9	Particulates - Smog: London smog and photochemical smog -	2	
	10	stratospheric pollution - depletion of ozone layer, chlorofluorocarbons -	2	
		Automobile pollution.		
	11	Control of air pollution	2	
III		Water Pollution	10	20
	12			20
	12	Impurities in water – cause of pollution – natural and anthropogenic –		
		Marine water pollution – Underground water pollution.		
	13		2	
		Source of water pollution – Industrial waste, Municipal waste,		
		Agricultural waste, Radioactive waste, Petroleum, Pharmaceutical,		
		heavy metal, pesticides, soaps and detergents.		
	14	Types of water pollutants: Biological agents, physical agents and	2	
		chemical agents – Eutrophication- biomagnification and		
	1.5	bloaccumulation.		
	15	15 Water quality parameters: DO, BOD, COD, alkalianity, hardness,		
		chloride, fluoride and nitrate. Toxic metals in water and their effects:		
		Cadmium, lead and oil pollution in water.		
		· •		
	16		2	
		water pollution control methods		

IV	Soil, Thermal, and Radioactive Pollutions						
	18	Soil pollution: Sources by industrial and urban wastes. Non-degradable, degradable and biodegradable wastes. Hazardous waste.	2				
	19 Pollution due to plastics, pesticides, biomedical waste and <i>e-waste</i> (source, effects and control measures) – Control of soil pollution - Solid waste Management – Open dumping, Landfilling, Incineration, Re- use, reclamation, recycle, composting.						
	20 Thermal pollution – definition, sources, harmful effects and prevention.						
	21	Radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study).	2				
V		Open Ended Module: Environmental issues	9				
	1	Environment and society Pollution case studies: Chernobyl disaster, Bhopal tragedy, Endosulfan disaster in Kerala (brief study) etc.					

- 1. A. K. De, *Environmental Chemistry*, 6thEdn., New Age International.
- 2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
- 3. Balram Pani, Textbook of Environmental Chemistry, I. K. International Pvt Ltd, 2010.

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8. J. M. H. Selendy, *Water and Sanitation-Related Diseases and the Changing Environment*, John Wiley & Sons, Inc.

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- 12. Gabi Mocatta(2015) Environmental Journalism, Deakin University Open School of Journalism.
- 13. D. S. Poornananda (2022), Environmental Journalism: Reporting on Environmental Concerns and Climate Change in India, SAGE Publishing India'
- 14. Frome, Michael. (1998) Green Ink: An Introduction to Environmental Journalism. Salt Lake City: University of Utah Press.
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- 17. Hansen, Anders. (2010) Environment, Media and Communication. London: Routledge

P					- 05	•							
	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	1	1	1			2	1		
CO 2	1		-	-	1	1	1			1	1	1	1
CO 3	-	-		1	2	2	1			2	2	1	
CO 4	-	-			1	2	1			1	1	1	1
CO 5	-		-	1	2	2	1			1		1	1
CO 6	-	-	-	1	2	2	1			1	1	1	1

Mapping of COs with PSOs and POs :

Correlation Levels:

Level	Correlation		
-	Nil		
1	Slightly / Low		
2	Moderate /		
	Medium		
3	Substantial /		
	High		

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

	Internal Exam	Assignm ent/viva	Quiz/seminar/ Goupdiscussio n	End Semester Examinations
CO 1	\checkmark		\checkmark	\checkmark
CO 2	\checkmark		\checkmark	\checkmark
CO 3	\checkmark	\checkmark		\checkmark
CO 4		\checkmark	\checkmark	\checkmark
CO 5	\checkmark		\checkmark	\checkmark
CO 6		\checkmark	\checkmark	

Mapping of COs to Assessment Rubrics :