KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

SCHOOL OF CHEMICAL SCIENCES (Academic Flexibility since 2009)



MASTER OF SCIENCE in CHEMISTRY

(With specialization in Physical Chemistry)

(Choice Based Credit System, 60:40 Pattern)

w. e. f. June 2019

Summary of Distribution of Credits under CBCS Scheme for

M.Sc. in Physical Chemistry

at

School of Chemical Sciences

[at University Campus under Academic Flexibility w.e.f. 2019-20]

Sr.No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	12	12	12	12
02	Skill based	08	06	06	06
03	School Elective	-	02	04	
04	Project	-	-	-	06
05	Audit	02	02	02	02
06	Total Credits	22	22	24	26

Subject Type	Core	Skill based	School Elective	Project	Audit	Total
Credits	48	26	06	06	08	94

Total Credits = 94

Department of Physical Chemistry, School of Chemical Sciences Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon M. Sc. Physical Chemistry

Choice Based Credit System (Outcome Based Curriculum) with effect from 2019 -2020 *Course credit scheme*

Comostor	(A)	Core Cour	ses	(B) Ele) Skill Base ective Cou	ed / rse	(C) (No wei	Audit Cour ightage in C	rse (GPA)	Total
Semester	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	(A+B+C
Ι	3	12+0	12	4	0+8	8	1	2	2	22
II	3	12+0	12	4	0+8	8	1	2	2	22
III	3	12+0	12	2	4+6	10	1	2	2	24
IV	3	12+0	12	2	0+12	12	1	2	2	26
Total Credits		48			38			8		94

(T, Theory; P, Practical)

Structure of Curriculum

			First	Year			Second	d Year		Total
		Seme	ester I	Seme	ester II	Semes	ter III	Semes	ster IV	Credit
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	Value
	Prerequisite and Core Co	urses								
(A)	Theory	12	03	12	03	12	03	12	03	48
(B)	Skill Based/ Subject Elect	ive Cour	ses							
1	Theory	02	01	02	01					04
2	Practical	06	03	06	03	06	01	12	02	30
3	Elective course					04	01			04
(C)	Audit Course (No weighta	age in CG	SPA calcu	lations)						
1	Practicing Cleanliness	02	01							02
2	Personality and Cultural Development Related			02	01					02
	Course									
2	Technology Related +					02	01			02
3	Value Added Course					02	01			02
4	Professional and Social +							02	01	02
-	⁴ Value Added Course							02	01	02
	Total Credit Value	22	06	22	08	24	06	26	06	94

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester											
Somo	stor I	Semester II	(Choose One)	Semester	III (Choose One	e)	Semester IV(Choose One)				
(Comp	ulsory)	Personality Devel	and Cultural	Te Value	chnology + Added Course		Professional and Social + Value Added Course				
Course Code	Course Title	Course Code	Course Title	Course Code	Course Title	Course Title		Course Title			
		AC-201A	Soft Skills	AC- 301(A)	Computer Skil	Computer Skill		Human Rights			
		AC-201B	Sport Activities	AC- 301(B)	Cyber Security	/	AC-401B	Current Affairs			
AC-101	Practicing Cleanliness	AC-201C	Yoga	AC- 301(C)	Introduction research	to	AC-401C	Technical Report Writing			
	AC-201D Music AC- 301(D)		Seminar on Review of Research Paper		AC-401D	Intellectual Property Rights (IPR)					

School of Chemical Sciences Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

M. Sc. I Physical Chemistry Common Course Structure for the First Year (60+40 Pattern) (w. e. f. June 2019)

Semester-I

						Distril	ination					
Course Code	Course Type	Title of the Course	Contact hours/we		ours/week	Internal		Exte	ernal	Total		a u
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	Credits
CH-101	Core	Inorganic Chemistry-I	04		04	40		60		100		04
CH-102	Core	Organic Chemistry-I	04		04	40		60		100		04
CH-103	Core	Physical Chemistry-I	04		04	40		60		100		04
CH-104	Skill Based	Laboratory Safety and Practices	02		02	20		30		50		02
CH-105	Skill Based	Laboratory Course in Inorganic Chemistry-I		04	04		20		30		50	02
CH-106	Skill Based	Laboratory Course in Organic Chemistry-I		04	04		20		30		50	02
CH-107	Skill Based	Laboratory Course in Physical Chemistry-I		04	04		20		30		50	02
AC-101	Audit Course	Practicing Cleanliness		02	02		100				100	02

			G (, .]	Distrib 1	oution o Examir	of Ma natior	rks for 1	•	
Course Code	Course Type	Title of the Course	Conta	ct ho	urs/week	Inte	ernal	Exte	rnal	Total		Credita
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	Creans
CH-201	Core	Inorganic Chemistry-II	04		04	40		60		100		04
CH-202	Core	Organic Chemistry-II	04		04	40		60		100		04
CH-203	Core	Physical Chemistry-II	04		04	40		60		100		04
PC-204	Elective	Basic Concepts of Polymer Chemistry	02		02	20		30		50		02
PA-204	(Choose Any	Basic Concepts of Pesticides and Agrochemical	02		02	20		30		50		02
	One out of	Chemistry										
IC-204	five:	Basic Concepts of Industrial Chemical Process	02		02	20		30		50		02
PH-204	PC/PA/IC/PH/	Chemical Mathematics	02		02	20		30		50		02
AN-204	AN-204)	Basic Concepts of Instrumentation and Analysis	02		02	20		30		50		02
CH-205	Skill Based	Laboratory Course in Inorganic Chemistry-II		04	04		20		30		50	02
CH-206	Skill Based	Laboratory Course in Organic Chemistry-II		04	04		20		30		50	02
CH-207	Skill Based	Laboratory Course in Physical Chemistry-II		04	04		20		30		50	02
AC-201	Audit Course	Choose one out of four $(AC-201 (A)/(B)/(C)/(D))$		02	02		100				100	02
(A)/(B)/		(Personality and Cultural Development Related)										
(C)/(D)												

List of audit courses to be offered in Semester-II:

AC-201 (A):SoftSkills AC-201 (B): Practicing SportsActivitiesAC-203 (C):Practicing Yoga AC-204 (D): Introduction to Indian Music

* All theory courses of both First Years (Semester I and II) in the School are of 60 hrs each including 10-12 hrs of Tutorials / Home Assignments / Class Room Discussion / Seminars / Internal Tests and Assessment.

** Semester practical examination pattern. *** Students have to choose any one subject from CH-204 i.e. from PC-204/PA-204/IC-204/PH-204/AN-204 for semester II.

Department of Physical Chemistry School of Chemical Sciences Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon Syllabus for M.Sc. Part-II Analytical Chemistry [Semester III and IV] [w. e. f. June 2019]

Course Structure for Second Year

Semester-III

	C T	Title of the Course		ct ho	urs/wook		Distri	bution Exami	of Ma natior	rks for 1		
Course Code	Course Type	The of the Course	Conta	Contact nours, week			Internal External			Total		Credits
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
PH -301	Core	Quantum Chemistry, Symmetry and Group Theory	04		04	40		60		100		04
PH -302	Core	Solid State Chemistry and Nanoscience, Nuclear and Radiation Chemistry	04		04	40		60		100		04
PH -303	Core	Electrochemistry and Kinetics of Reactions	04		04	40		60		100		04
PC-304	Elective	Physical Chemistry of Polymers	04		04	40		60		100		04
PA-304	(Choose one	Advanced Agrochemicals, Biopesticides and	04		04	40		60		100		04
	out of six PC-	Fertilizers										
IC-304	304/PA-	Pharmaceutical Chemistry	04		04	40		60		100		04
OC-304	304/IC-	Heterocyclic Chemistry	04		04	40		60		100		04
PH-304	304/OC-	Physical Chemistry of Polymers	04		04	40		60		100		04
AN-304	304/PH-	Modern Separation Science	04		04	40		60		100		04
	304/AN-304 :)											
PH - 305	Skill based	Laboratory Course in Physical Chemistry-III		12	12		40		60		100	06
AC-301(A)/	Audit Course	Choose one out of five AC-301(A)/ 301(B)/	02		02	100				100		02
301(B)/		301(C)/301(D) (Technology + value										
301(C)/		added course)										
301(D)												

List of elective courses to be offered in Semester-III:

AC-301(A)	Computer Skill	
AC-301(B)	Cyber Security	
AC-301(C)	Introduction to research	https://swayam.gov.in/nd1_noc20_ge22/preview
AC-301(D)	Seminar on Review of Research Paper	

The students appearing for the 3rd semester should select one audit course out of five [AC:301-305] and visit the website of respective course for attending the lectures

Semester-IV

Course Code	Course Type			Contact hours/week		D	•					
	v I	Title of the Course				Internal		External '			otal	Credits
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
PH - 401	Core	Molecular Structure	04		04	40		60		100		04
PH - 402	Core	Statistical Thermodynamics, Phase Equilibria	04		04	40		60		100		04
		and Irreversible Thermodynamics										
PH - 403	Core	Surface Chemistry and Catalysis	04		04	40		60		100		04
PH - 404	Skill based	Laboratory Course in Physical Chemistry-IV		12	12		40		60		100	06
PH - 405	Skill based	A Short Research Project		06	06		40		60		100	06
AC-401 (A)/(B)/(C)/(D)	Audit Course	Choose one out of four (AC-401 (A)/(B)/(C)/(D)) (Professional and Social + value added course)	02		02	100				100		02

List of elective Audit courses to be offered in Semester-IV:

AC-401 (A): Human Rights,

AC-401(B): Current Affairs,

AC-401 (C): Technical Report Writing,

AC-401(D): Intellectual Property Rights

*Important Notes:

The projects will be initiated in the beginning of Semester III and the examination will be conducted at the end of Semester IV.

** Semester practical examination pattern.

Program at a Glance

Name of the program (Degree)	: M. Sc. (Physical Chemistry)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60 : 40 (60 marks University exam and 40 marks continuous internal departmental exam/assessment)
Passing standards (separate head of passing)	: 40% in each exam separately
Evaluation mode	: CGPA
Total Credits of the program	: 94 (48 core credits including 6 credits of project/dissertation, 26 skill enhancement credits, subject elective credits and 08 audit credits)

Program Objectives for M.Sc. Program:

- 1. To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts
- 2. To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.
- 3. To groom the students for all-round development and mould them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.
- 4. To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.
- 5. To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	РО	Cognitive level
PO 1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.	2
PO 2	Administer the skills in handling scientific instruments, planning and performing in laboratory experiments	3
PO 3	Analyse the given scientific experimental data critically and systematically and the ability to draw the objective conclusions.	4
PO 4	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively	3
PO 5	Model and formulate the real problems and find solution based-on knowledge acquired	6
PO 6	To evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.	5

Program Specific Objectives for M.Sc. in Physical Chemistry program:

- To provide the detail knowledge and skills on Analytical or Applied chemistry.
- To stimulate intellectual development, develops a power of critical analysis and ability to solve a problems.
- To train the students in practical skills for safe handling of chemicals and instruments.

Program Specific Outcomes (PSOs) for M.Sc. in Physical Chemistry program:

Students who graduate with a Master of Science in Physical Chemistry will:

PSO	PSO	Cognitive
No.		level
PSO1	Analyse fundamentals of Physical or applied chemistry	4
PSO2	Develop independent learning skill as well as experience of working in	6
	laboratory.	
PSO3	Create the students with knowledge and generic skill for the employment in	6
	various sectors such R and D, academics as well as professionals.	

Semester-I

CH-101: Inorganic Chemistry-I (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- The course offers the basic concepts of inorganic chemistry lying on synthesis, structure, bonding and properties of some selected main group elements.
- The course helps to build up a conceptual framework for understanding the principles and theories for chemical bonding and properties of inorganic compounds.
- The course furnishes detail knowledge about synthesis, types of bonding, properties etc.

Course Contents (Topics and subtopics)

Unit I	Molecular Symmetry and Applications	12 h
	Symmetry elements and operations, Classification of symmetry elements, Orbital	
	symmetry, point groups, Examples of C _n , C _{nv} , C _{nh} , D _n , D _{nh} , D _{nd} , T _d , T _h , O, O _h ,.	
	Identification of optical Isomerism and Dipole moment.	
Unit II	Molecular Orbital Theory and its application. BeH ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O. Organometallic compounds of transition metals	12 h
	Organometallic compounds, Molecule orbital theory and 18 electron rule,	
	Counting electrons in complexes. Alkyl and aryl complexes, Alkene complexes.	
	Metal π complexes- Metal carbonyl and metal nitrosyls.	
Unit III	Chemistry of non transition elements	12 h
	Hydrides-classification, electron deficient, precise and rich hydrides. Study of	
	PH ₃ , SbH ₃ , AsH ₃ , selenides, Tellurides. Synthesis, properties and structures of	
	alkali and alkaline earth metal compounds, Synthesis and reactivity of inorganic	
	polymer of Si and P. Metal Clusters: Boranes: Classification, synthesis, structure	
	and topology (B_2H_6 to $B_{10}H_{14}$) Carboranes: Classification, Synthesis and	
	structure.	
Unit IV	Ionic solids	12 h
	The Ionic solids. Classification of ionic structures, radius ratio rules, calculation	

of some limiting radius ratio values, close packing, Structures of ionic solids. A cautionary word on radius ratios. Lattice energy. The Born - Haber cycle, Applications of lattice energy. Resonance: resonance energy. Concept of formal charge, criteria for resonating structures. Hydrogen bonding concept and structure of water, alcohols, phenols, types, properties.

Unit V Bioinorganic chemistry

Introduction to bio-inorganic chemistry, Metalloproteins and metalloenzymes, amino acids in metal binding sites. Selective transport and storage of iron (siderophores, iron transport proteins in higher organisms, release of iron transferrin, ferritin, the cellular Fe store), electron transfer (General considerations, Electron transfer cyctochrome, FeS clusters, copper transfer centers), ionophores.

Recommended Books:

- 1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry Principles of Structures and Reactivity, 4th edition, New York, NY: Harper Collins College Publishers, 1993.
- 2. J. D. Lee, Concise Inorganic Chemistry, 5thedn., Blackwell Science, London, 2006.
- 3. A. G. Sharpe, Inorganic chemistry, 3rd edition, ISBN 9788131706992, Pearson Education, 1981.
- 4. F.A. Cotton, Chemical Applications of Group Theory, ISBN: 978-0-471-51094-9, 1990.
- 5. D.F. Shrivers, P.W. Atkins and C.H. Langfor, Inorganic Chemistry, CH Langford, 1990.
- 6. B.R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 2005.
- H. B. Gray, Electrons and Chemical Bonding. W. A. Benjamin, Inc., New York, 1965.
- 8. H. J. Emeleus and A.G. Sharpe, Modern Aspects of Inorganic Chemistry, Universal Book Stall, New Delhi.
- 9. K. lal, S.K. Agarwal, Advanced Inorganic Chemistry, Pragati Prakashan, Meerut, 2017
- 10. G. S. Manku, Theoretical Principles of Inorganic Chemistry, Tata McGraw-Hill Ed
- 11. B. Douglas, D.H. Mc. Daniel, J.J. Alexander, Concepts and Models of Inorganic Chemistry, 2nd edition.
- 12. R. Sarkar, General and Inorganic Chemistry, Part one, New Central Book

Agency, Kolkata.

- 13. P. K. Bhattacharya, Group Theory and its Chemical applications, Himalaya Publishing House.
- 14. F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advance Inorganic Chemistry, Sixth Edition, John Wiley & Sons, Inc.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
CH101.1	demonstrate knowledge of advanced content in the areas of inorganic	3
	chemistry such as in Molecular symmetry, organometallic compounds,	
	bioinorganic compounds, Chemistry of non transition element and ionic	
	solids	
CH101.2	understand fundamental reaction types and mechanisms in organometallics	2
CH101.3	identify point groups and illustrate MOT diagram of inorganic compounds	4
CH101.4	determine and explain the structure of ionic solids	5
CH101.5	analyze the chemical and physical properties of metal ions responsible for	4
	their biochemical action as well as the techniques frequently used in bio	
	inorganic chemistry such as oxygen transport, e-transfer, catalysis, transport,	
	storage etc.	

CH-102: Organic Chemistry-I

(Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- The course offers the basic concepts of Organic Chemistry.
- The course helps to understand the principles involved in organic Chemistry.
- The course also helps to understand the organic reactions with mechanism and their applications in laboratory as well as in industry.

Course Contents (Topics and subtopics)

Unit I A] IUPAC Nomenclature of Organic Compounds including Regio- and 12 h

Stereoisomer's

B] **Aromaticity** - Huckel's rule and Concept of Aromaticity, Non aromaticity and Antiaromaticity, Annulenes and Heteroannulenes, Fullerenes (C60).

Unit II Nucleophilic substitutions at saturated carbon

The Reaction Mechanism: Reactivity at a Saturated Carbon Atom, Available Pathways, The S_N1 Mechanism, S_N2 Mechanism. Stereochemistry of Nucleophilic Substitution: The S_N2 reaction, S_N1 reaction. The Variables in Nucleophilic Substitution: The Leaving Group, The Nucleophile, The Site of Substitution, Solvent Effects, Solvolysis, S_N1 versus S_N2 . Neighboring Group Participation.

Unit III Electrophilic aromatic substitution

Mechanism and Orientation in Electrophilic Aromatic Substitution: An Addition-Elimination Mechanism, Ortho, Meta and Para Orientation, Relative Rates of Substitution, The Rate Orientation Relation, Orientation in Multiply Substituted Aromatics, A Pi-complex intermediate.

Electrophilic Aromatic Substitution Reactions– Heteroatom's as the Electrophiles: Nitration, Halogenation, Sulfonation, Diazonium Coupling, Ipso Substitution. Carbon as the Electrophiles: Friedel-Craft Alkylation, Friedel-Craft Acylation.

Nucleophilic Aromatic Substitutions: The Addition-Elimination Mechanism, The Elimination-Addition Mechanism Benzyne, The Aryl Cation Mechanism - Diazonium Salts.

Unit IV Elimination reactions-alkenes and alkynes

The Reaction Mechanism: The E1, E2 &E1cB Mechanism, Mechanistic Variables, E1 VersusE2. Elimination Versus Substitution: Basicity Versus Nucleophilicity, Substrate Structure, Solvent, Temperature. The Direction of Elimination: Formation of the More-Substituted Alkene, Formation of the Less-Substituted Alkene. Stereochemistry: Anti Elimination, Stereo electronic Factors, Syn Elimination. Formation of Alkenes: Dehydrohalogenation, Dehalogenation, Dehydration, Hofmann Elimination, Pyrolytic Elimination, Catalytic Dehydrogenation. Formation of Alkynes.

12 h

12 h

Unit V Electrophilic additions to unsaturated carbon

The Mechanism of Electrophilic Addition: The Ad_E2 Mechanism, Structural Effects and Reactivity. Direction and Stereochemistry of Addition: Markovnikov Orientation, Stereochemistry of Addition. Additions to Alkenes and Alkynes: Halogenations, Hydrohalogenation, Hydration, Hydroboration, Epoxidation-Hydroxylation, Carbene Addition, Hydrogenation, Ozonolysis.

Additions to conjugated compounds:

Conjugated Dienes: The Mechanism of Electrophilic Conjugate Addition, Kinetic and Equilibrium Control. Double Bonds Conjugated with Carbonyl Groups: Mechanism of Nucleophilic Conjugate Addition, Conjugate Additions in Synthesis.

Recommended Books:

- J. Clayden, N. Greeves, S. Warren, Organic Chemistry, IInd Edition, Oxford University Press.
- 2. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson.
- 3. J. March, Advance Organic Chemistry: Reactions, Mechanisms and Structure, 4th Edition, Wiley.
- 4. S. H. Pine Organic Chemistry, 5th Edition, McGraw-Hill.
- 5. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 8th Edition, New Age International.
- **6.** D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, Revised 2ndEdition, New Age International.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
CH102.1	To memorize the fundamental and concepts of organic reaction mechanism	1
CH102.2	Explain Importance of types of organic reactions.	4
CH102.3	Study of Aromaticity	5

CH-103: Physical Chemistry-I (Core course; Practical; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- To impart intensive and extensive knowledge of the subject enriching graduate to understand the role of thermodynamic chemistry in the field of science.
- To develop skill and capabilities of student insolving problem of daily routine life using thermodynamic and statistical thermodynamics.
- To understand principles of quantum mechanics and their applications to various chemistry phenomenon's.

Course Contents (Topics and subtopics)

Unit I Thermodynamics

Laws of thermodynamics, Maxwell relations, thermodynamic equation of state, partial molar quantity and its significance, partial molar volumes, chemical potential, Gibbs-Duhem equation, thermodynamics of mixing-Gibb's free energy of mixing, entropy of mixing, enthalpy of mixing, volume of mixing.

Unit II Phase equilibria

Phase, components, degree of freedom, the Gibb's phase rule, derivation of phase rule, phase equilibria of one component system (water and carbon dioxide system), phase equilibrium of two component system (two component system solid-liquid equilibria and simple eutectic systems), phase equilibrium of three component system, Clapeyron equation, Clausius-Clapeyron equation, integrated form of Clausius-Clapeyron equation.

Unit III Electrochemistry

Anomalies of strong electrolytes, Debye-Hückel theory of strong electrolytes, relaxation effect (asymmetry effect), electrophoretic effect, activity coefficients of electrolytes, mean ionic activity coefficient, ionic

12 h

12 h

strength of a solution, Debye-Hückel limiting law equation (derivation not expected) and experimental verification of it.

Unit IV Nuclear Chemistry

Radioactive elements, types of radioactive decay, decay kinetics-the decay constant, the half life period and mean life, units of radioactivity, nuclear reactions, Bethe's notation, types of nuclear reactions, special nuclear reactions, cross-section, Q-value of nuclear reactions, nuclear fission, nuclear fusion, nuclear detectors (Proportional counter and Geiger-Muller counter).

Unit V Chemical Kinetics

Reaction rates, rate laws and rate constants, effect of temperature on reaction rates, complex reactions, types of complex reactions and their kinetics (opposing reactions, parallel reactions, consecutive reactions), chain reactions and its characteristics, kinetics of chain reactions, Michaelis-Menten mechanism and equation.

Recommended Books:

- 1. P. W. Atkins, Physical Chemistry, ELBS, 1998
- 2. G. M. Barrow, Physical Chemistry, International student edition, 2003.
- 3. G. W. Castellan, Physical Chemistry, AddisionWeslay.
- 4. W. J. Moore, Physical Chemistry, Orient Longman, 1998.
- 5. S. Glasstone, D. Van Nostrand, Thermodynamics for Chemist, 1965.
- S. Glasstone, V. Nostrand An Introduction to Electrochemistry, East-West 1965.
- J. O'M Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. I and II, 2nd Edition, Plenum, 1977.
- R. A. Robinson and R. H. Stokes, Electrolytic Solutions, Butterworths, London, 1959.
- H. J. Arnikar, Essentials of Nuclear Chemistry, New Age Publication Ltd., 1995.
- G. Friedlander, J. W. Kennedy, E. S. Macias, J. M. Miller, Nuclear and Radiochemistry, John-Wiley, 1981.

12 h

- 11. B. G. Harwey, Introduction to Nuclear Physics and Chemistry, Prentice Hall, 1963.
- 12. Source book of Atomic Energy, S. Glasstone, van Nostrand, 1967.
- 13. K. J. Laidler, Chemical Kinetics, McGraw Hill, 1985.
- 14. J. W. Moore, R. G. Pearson, Kinetics and Mechanism, John Wiley & Sons, 1981
- 15. G. L. Agrawal, Basic Chemical Kinetics, Tata McGraw-Hill Publishing Company Lid., New Delhi.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
CH103.1	Acquire knowledge on the fundamental and advance concepts of	3
	thermodynamics	
CH103.2	Familiarize with phase rule	4
CH103.3	Apply the knowledge to explore applications of electrochemistry	3
CH103.4	Get thorough knowledge about fundamental aspects on Nuclear chemistry	5
CH103.5	Understand fundamental as well as kinetics of Complex reactions	2

CH-104 Laboratory Safety and Practices

(Core course; Practical; 30 h, 50 Marks and 2 Credits)

Course Objectives:

- This course offers to create awareness about laboratory safety.
- This course offers to increase alertness about any hazardous handling at workplace.
- This course offers to increase awareness about personal protective equipment.

Course Contents (Topics and subtopics)

- Unit I A. History and importance of safety and health in Laboratory Moral, legal 06 h and financial reasons
 - B. Different types of Hazards at workplace handling chemicals
 - C. Physical, chemical, biological, allergens, hazards pertaining electrical system
 - Effect of hazards on health
 - Where to find Hazard information-Reading Labels

D. Safety Measures: Safe clothing, hair, dangling jewellery responsible attitude, good House Keeping, use of proper PPE, No food in the laboratories.

Unit II Personal Protective and other safety equipment and their uses and 06 h demonstration, Different types of safety goggles, apron, masks, different filters for masks, face shield, full body suit, safety shoes, helmet, breathing apparatus suit, safety belt and ear muffs along with inspection methods. Emergency exit, its location and approach path, periodic inspection fire extinguishers, first aid kit, its contents and need for monitoring. Eye wash fountains and safety showers, fire drill, and chemical accident drills, accident free days and incentives to follow safety rules, accident recording and investigation for future controls.

06 h

- Unit III Types of fire extinguishers and their method of use
 Material Safety Data Sheets, Globally Harmonised System (GHS)
 Signs(http://www.calstatela.ed/univ/ehs/msds.php) Importance and use of
 current 16 points format, Labels, Pictograms and some of
 theirdiscrepancies, Globally Harmonized System for Safety Data Sheets
 (SDS), label changes (2014).
- Unit IV Inventory Management, Storage and Disposal, Waste classification, 06 h Hazardous waste, Non-Hazardous waste, mixed waste, Waste disposal, Actions required for – Chemical spills, Mercury spills, Injuries, Fires,

19

Building evacuations, Emergency evacuation procedure.

Unit V Good Laboratory Practices (GLP), Introduction and principles of GLP, 06 h
 Performance of laboratory studies and calibration using Standard Operating
 Procedures (SOPs), Instrument validation, Reagent certification, Laboratory
 notebook maintenance to contemporary standards, maintenance of
 laboratory records based on instrument and reagent certification.
 Introduction to ISO and NABL accreditation.

Recommended Books:

- L. Moran, T.Masciangioli, Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management, The National Academies Press, Washington, DC, 2010.
- D. C. Finster, Safety in Academic Chemical Laboratory, Vol. II, ACS Publication, 7th Edition, 2003.
- 3. OECD Series on Principles of Good Laboratory Practices and Compliance Monitoring, 1997.
- 4. Handbook of Good Laboratory Practices, TDR, WHO, UNICEF, UNDP, 2009.
- 5. L. Huber, A Primer for Good Laboratory Practices and Good Manufacturing Practices, Agilent Technologies, 2002.
- 6. T. Kletz, What Went Wrong, Gulf Professional Publisher, 1998.

Course Outcomes (COts):

CO No.	СО	Cognitive level
CH104.1	To adapt the rules and regulations of safety practices in the laboratory	6
CH104.2	To develop the experimental skill while performing in the laboratory.	6
CH104.3	To practice for the laboratory working.	3

CH-105: Laboratory Course in Inorganic Chemistry-I (50 Marks and 2 Credits)

Course Objectives:

- The course offers to develop the experimental skills in inorganic chemistry.
- The course also offers to use different analysis techniques required in analysing inorganic compounds.
- The course helps in developing skills of the graduate in the preparation and purity estimation of inorganic compounds.

Course Contents (Topics and subtopics)

Perform any eight experiments out of the followings:

- 1. Pyrolusite ore Estimation of silica gravimetrically and Manganese volumetrically.
- 2. Analysis of Alloy: Solder alloy Estimation of Tin gravimetrically and Lead volumetrically.
- 3. Drug Analysis: Determination of iron from given drug sample.
- 4. Preparation and purity determination of Bis (ethylene diamine) copper (II) sulphate.
- 5. Preparation and purity determination of Chloro penta-ammino cobalt (III) chloride.
- 6. To determine the amount of copper present in given solution by iodometric method potentiometrically.
- 7. Preparation and purity determination of Tris (acetylacetanato) Iron (III).
- 8. Preparation and purity determination of Tris (ethylene diamine) nickel (II) thoisulsulphate.
- 9. Preparation and purity determination of potassium trioxalato Aluminate (III).
- 10. Preparation and purity determination of hexamine nickel (II) chloride.

Recommended Books:

- 1. A.I. Vogel, Text book of Quantitative Analysis, 4th edition, 1992.
- 2. A.B. P. Lever, Inorganic electronic spectroscopy. Amsterdam, The Netherlands: Elsevier, 1984.
- 3. Inorganic Synthesis (Vol. Series).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
CH105.1	Analyse the alloy concentration and Estimate volumetrically the concentration of Mn, Sn and Pb using titration method	4
CH105.2	carry out the preparation and purity determination of the metal complexes Potassium trioxalatoaluminate (III), Bis (ethylene diamine) copper (II) sulphate., Hexamminenickel(III) chloride.	4
CH105.3	Carry out Ca-Drug Analysisand the volumetric estimation of Ca.	4

CH-106: Laboratory Course in Organic Chemistry-I

(50 Marks and 2 Credits)

Course Objectives:

- This course offers the skills involved in utilization of different techniques required for purification of organic compounds.
- This course also offers skill development in the preparation of derivatives of selected organic compounds.
- This course also offers knowledge of utilizing computer software for drawing organic compounds.

Course Contents (Topics and subtopics)

1. Techniques: (At least one practical of each technique)

Crystallization, Sublimation, Distillation, Steam Distillation, Column Chromatography, Thin Layer Chromatography, Solvent Extraction.

2. Preparation of Derivatives: (Each Derivative of at least one Compounds)

Oxime, 2, 4-DNP, Acetyl, Benzoyl, Semicarbazone, Anilide, Amide, Aryloxyacetic acid, Ester.

3. Use of Computer - Chem Draw-Sketch, ISI – Draw: (Max. 09 Hours for each batch)

Draw the structure of simple aliphatic, aromatic, heterocyclic organic compounds with substituent's.

Get the correct IUPAC name.

Recommended Books:

- 1. A.J. Hannaford, A.R. Tatchell, B.S. Furniss, P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, 5th Edition
- 2. R. K. Bansal, Laboratory Manual of Organic Chemistry, New Age International Publisher
- L. D. Field, S. Sternhell, J. R. Kalman, Organic Structures from Spectra, 4th Edition, John Wiley & Sons, Ltd.

Course Outcomes (COts):

CO No.	СО	Cognitive level
CH106.1	Purify the organic compounds using different purification techniques or methods.	3
CH106.2	Prepare the derivatives of organic compounds.	6
CH106.3	Draw the structures and reactions using chem draw computer software.	3

CH-107: Laboratory Course in Physical Chemistry-I (50 Marks and 2 Credits)

Course Objectives:

- This course offers to develop the experimental skills in physical chemistry.
- This course also offers to analyse data based on instrumental methods for analysis.
- This course helps in determining the physical constants by different methods.

Course Contents (Topics and subtopics)

Perform any eight experiments in Semester I of the followings:

- 1. To determine the pKa value of a given weak monobasic acid potentiometrically.
- 2. To determine the redox potential of $Fe^{2+/}Fe^{3+}$ system potentiometrically.
- 3. To determine the hydrolysis constant of sodium acetate conductometrically.
- 4. To determine the concentration of hydrochloric acid and acetic acid in a given mixture by titrating it with a standard solution of sodium hydroxide conductometrically.
- 5. To determine the pH values of various mixtures of sodium acetate and acetic acid inaqueous solutions and find out the dissociation constant of the acid.
- 6. To determine the pKa value of the acetic acid pH-metrically.
- 7. To test the validity of Beer's-Lambert's law and hence determine the concentration of given unknown solution spectrophotometrically.
- 8. To investigate the kinetics of a reaction between potassium persulphate and potassium iodide.
- 9. To determine the concentration of a given solution of an optically

active substance by polarimetric measurements.

10. To determine the specific and molar refraction of a given liquid by refractometer.

Recommended Books:

- 1. J. A. Kitcher, Findlay's Practical Physical Chemistry, 1963.
- 2. A. I. Vogel, Text Book of Quantitative Inorganic Analysis.
- 3. R. C. Das and B. Behera, Experimental Physical Chemistry, 1984.
- J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing.
- F. Daniels and J. Williams. Experimental Physical Chemistry, Mcgraw-Hill Publishing Co., Ltd
- 6. D. Shoemaker, Advanced Physical Chemistry Experiments.
- H. H.; Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Jr. Instrumental Methods of Analysis.

Course Outcomes (COts):

CO No.	СО	Cognitive level
СН-107.1	Provide guidance and practice about each experiment by studying lab handouts and links therein	3
CH-107.2	Practice learned for safety requirements and lab skills to perform physico-chemical experiments	3
СН-107.3	Provide guidance and practice about to keep records of instruments, parameters, and experimental observations reporting of experimental result	4
CH-107.4	An appraise for modern problems and scientific controversies in physical chemistry	5
CH-107.5	Develop more interest to learn and practice new instruments	4

M.Sc. Part I Semester I Analytical Chemistry: Audit Courses

AC-101: Practicing Cleanliness (Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

•

• To make students aware of Clean India Mission and inculcate cleanliness practices among them.

Awareness program on

- Swachh Bharat Abhiyan (Clean India Mission)
- o Clean Campus Mission
- Role of youth in Clean India Mission
- Cleaning activities inside and surroundings of Department buildings.
- Tree plantation and further care of planted trees
- Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
- Planning and execution of collection of Garbage from different sections of University campus
- Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
- Cleanest School/Department and Cleanest Hostel contests
- Painting and Essay writing competitions

Course Outcomes (COts):

CO No.	СО	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	2
AC101.2	Plan and observe cleanliness programs at home and other places.	4
AC101.3	Practice Japanese 5-S practices in regular life.	3

Semester-II

CH- 201: Inorganic Chemistry-II

(60 h, 100 Marks and 4 Credits)

Course Objectives:

- This course offers to impart the basic knowledge about spectroscopy of inorganic compounds
- This course also offers to study the reaction mechanism in transition metal complexes.
- This course helps to understand catalysis and structure reactivity of molecules.

Course Contents (Topics and subtopics)

Unit I Spectroscopic term symbols

Microstates- significance and their determinations, Groundstate terms, energy ordering of terms, ,derivation of the total term symbols for a d^1 to d^5 configuration, correlation diagram for d^2 and d^8 configuration in tetrahedral and octahedral complexes, Orgel diagram for d^1 to d^{10} configuration in tetrahedral complexes, selection rule, noncrossing rule.

Unit II Charge transfer transition

Types of charge transfer transition, interpretation of electronic spectra of octahedral complexes, intensity of spectral bands, d-d bands, charge transfer bands Konig's methods for calculations of Dq, B and β parameters, numerical

Magnetic properties of complexes, paramagnetism, quenching of orbital angular momentum by ligand fields, Magnetic properties of A, E and T ground terms in complexes, Spin free - spin paired equilibria.

Unit III Reaction mechanism in transition metal complexes

Ligand substitution reaction, classification of mechanism, substitution of square planer complexes, nucleophilicity of entering group, shape of activated complexes, K1 pathway, substitution in octahedral complexes, rate law and their interpretation, activation of octahedral complexes, base

27

12 h

12 h

hydrolysis, stereochemistry, isomerisation reactions.

Unit IV Catalysis

Catalysis, description of catalyst, properties of catalyst, types of catalyst, catalytic steps in organotransition metal catalyst, hydrogenation of alkenes, hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, alkene polymerization, heterogeneous catalysis, nature of heterogeneous catalyst. examples of heterogeneous catalysts (hydrogenation, oxidation).

Unit V The Structure and Reactivity of molecules

VSEPR Theory, structures of molecules containing lone pair of electrons,Sulphurtetrafluoride, Bromine trifluoride, dichloroiodate(I)anion, pentafluorotellurate (IV)anion, tetrachloroiodate (III)anion, nitrogen dioxide, nitrite ion and nitryl ion, phosphorus trihalides, carbonyl fluoride, summary of VSEPR Rules,

Recommended Books:

- J. E. Huheey, E. A. Keiter, R. L. Keiter, Inorganic Chemistry Principles of Structures and Reactivity, 4th edition, New York, NY: Harper Collins College Publishers, 1993.
- J.D. Lee, Concise Inorganic Chemistry, 5thedn., Blackwell Science, London, 2006.
- A. G. Sharpe, Inorganic chemistry, 3rd edition, ISBN 9788131706992, Pearson Education,1981.
- F.A. Cotton, Chemical Applications of Group Theory, ISBN: 978-0-471-51094-9, 1990.
- D.F. Shrivers, P.W. Atkins and C.H. Langfor, Inorganic Chemistry, CH Langford, 1990.
- B.R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co.,2005.
- H. B. Gray, Electrons and Chemical Bonding. W. A. Benjamin, Inc., New York, 1965.
- 8. H. J. Emeleus and A.G. Sharpe, Modern Aspects of Inorganic

Chemistry, Universal Book Stall, New Delhi.

- K. lal, S.K. Agarwal, Advanced Inorganic Chemistry, Pragati Prakashan, Meerut, 2017.
- G.S. Manku, Theoretical Principles of Inorganic Chemistry, Tata McGraw-Hill Ed.
- B. Douglas, D.H. Mc. Daniel, J.J. Alexander, Concepts and Models of Inorganic Chemistry, 2nd edition.
- R. Sarkar, General and Inorganic Chemistry, Part one, New Central Book Agency, Kolkata.
- P.K. Bhattacharya, Group Theory and its Chemical applications, Himalaya Publishing House.
- F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advance Inorganic Chemistry, Sixth Edition, JOHN WILEY & SONS, INC.
- K. Arora, Concept and Applications of Group Theory, Anmol Publication Pvt. Ltd., New Delhi.
- 16. W.L.Jolly, Modern Inorganic Chemistry, 2nd edition, Tata McGraw Hill Co.

Course Outcomes (COts):

CO No.	СО	Cognitive level
C201.1	illustrate microstates, spectroscopic terms and orgel and Tanbesugano	3
	diagram of inorganic molecules for octahedral and tetrahedral complexes	
C201.2	classifies ligand substitution reactions and explains its kinetics and various mechanisms.	2
C201.3	understand theory and mechanism of catalytic action of catalysts	5
C201.4	understand VSEPR theory and explain the structures based on it	5

CH-202: Organic Chemistry-II

(60 h, 100 Marks and 4 Credits)

Course Objectives:

- The course offers to study the importance of stereochemistry and organic spectroscopy for structure elucidation with respect to laboratory and industrial applications.
- This course also offers to learn various name reactions, rearrangement and reagents used in organic chemistry.
- This course helps to understand the principles behind UV, IR, and NMR spectroscopy.

Course Contents (Topics and subtopics)

Unit I Selective name reactions

Strok Enamine Reaction, Michael addition, Mannich reaction, Sharpless asymmetric epoxidation, Ene reaction, Barton reaction, Hofmann Loffler-Freytag reaction, Shapiro reaction, Chichibabin reaction, Wittig reaction, Aldol, Perkin, Stobbe, Benzoin, Claisen, Dieckmann, Pechmann Condensation.

Unit II Rearrangements

Wagner-Meerwein, Pinacol, Wolff, Arndt-Eistert Synthesis, Hofmann, Curtius, Schmidt, Lossen, Beckmann, Baeyer-Villiger,Favorskii,Benzilicacid,Stevens, Wittig, Meisenheimer, Claisen, Cope.

Unit III Reagents in organic synthesis

Gilman's reagent, diisopropylamide(LDA), dicyclohexylcarbodimide (DCC), 1, 3-dithiane (reactivity umpolung), Trimethylsilyl iodide, tri-nbutyltin hydride, Woodward and Prevost hydroxylation, osmium tetraoxide (OsO₄), DDQ, selenium dioxide, Chromic acid, phase transfer catalysts, B₂H₆, Peterson's synthesis,Wilkinson's catalyst, Baker's yeast.

Unit IV Stereochemistry

Stereoisomers, Chirality, Enantiomers, Diastereoisomers, R-S Compounds, nomenclature, E-Z isomerism, Meso Threo and Erythroisomers. Interconversion of Fischer into Sawhorse and Newman Projections. Conformations and Stereoisomerism of acyclic compounds (ethane, propane, butane) and cyclic compounds (cyclohexane, substituted cyclohexanes).

Unit V A] U.V. spectroscopy

Woodward-Fisher rules for conjugated dienes and carbonyl compounds, applications of UV.

B] IR Spectroscopy

Characteristics vibrational frequencies of alkanes, alkenes, aromatic compounds, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters,

12 h

12 h

12 h

12 h

amides, anhydrides, lactones and lactams. Effect of hydrogen bonding and solvent effect on vibrational frequencies, applications of IR

C]¹H NMR Spectroscopy

Chemical shift, factors influencing chemical shift, shielding-deshielding, spin-spin coupling (n+1) rule, Pascals triangle, factors affecting on coupling constant.

Joint Problems based on UV, IR &1HNMR. Recommended Books:

- 1. J.Clayden, N. Greeves, S. Warren, Organic Chemistry, IInd Edition, Oxford University Press.
- 2. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th Edition, Pearson.
- 3. J. March, Advance Organic Chemistry: Reactions, Mechanisms and Structure, 4th Edition, Wiley.
- 4. S. H. Pine Organic Chemistry, 5th Edition, McGraw-Hill.
- 5. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 8th Edition, New Age International.
- 6. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, Revised 2ndEdition, New Age International.
- 7. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry Part-B: Reactions and Synthesis, 5th Edition, Springer.
- 8. E. L. Eliel, Stereochemistry of Carbon Compounds, McGraw-Hill.
- 9. P. S. Kalsi, Spectroscopy of Organic Compounds, 6th Edition, New Age International.
- 10. D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan, IntroductiontoSpectroscopy.

Course Outcomes (COts):

CO No.	СО	Cognitive level
202.1	Describe some basic named reactions of organic chemistry	2
202.2	Discuss useful rearrangement reactions	2
202.3	Understand and apply core study of spectroscopy	3
202.4	Use of stereochemistry and reagents in organic synthesis.	4

CH-203: Physical Chemistry-II (60 h, 100 Marks and 4 Credits)

Course Objectives:

- This course offers to gain the basic knowledge about quantum chemistry and macromolecule.
- This course helps to understand the principles and laws in photochemistry.
- This course offers to know about the theory behind microwave and infrared spectroscopy.

Course Contents (Topics and subtopics)

Unit I Quantum Mechanics

Introduction to quantum mechanics, wave function and its physical meaning, conditions for acceptable wave function, operators, algebra of operators (addition subtraction and multiplication), commutative property, linear operator, commutator operator, the operator ∇ and ∇^2 , eigen values and eigen functions, basic postulates of quantum mechanics

Unit II Macromolecules

Macromolecules, degree of polymerization, high polymers and oligomers, molecular weight of macromolecules (number average molecular weight and weight average molecular weight), determination of molecular weight of macromolecules (by viscometryand osmometry method), chain polymerization and its kinetics, kinetic chain length and its significance, step growth polymerization and its kinetics.

Unit III Microwave Spectroscopy

Introduction, the rotation of molecules, classification of molecules on the basis of the relative values of their three principal moments of inertia (linear, symmetric top, spherical top and asymmetric top molecules), rotational spectra of diatomic molecules, polyatomic molecules, Stark effect in microwave spectra, microwave oven, techniques and instrumentation.

Unit IV Infra-red Spectroscopy

Introduction, principle of infra-red spectroscopy, theory-molecular vibrations, vibrational frequency, force constant, calculations of number of fundamental modes of vibrations for linear and non-linear molecules, fundamental modes of vibrations of water molecule and carbon dioxide molecule and their infra-red activity, techniques and instrumentation.

Unit V Photochemistry

Introduction, photochemical reactions, quantum yield, Jablonski diagram, photosensitization reactions, fluorescence (resonance fluorescence,

12 h

12 h

12 h

12 h

sensitized fluorescence and quenching of fluorescence), phosphorescence, Stern-Volmer equation.

Recommended Books:

- 1. R. K. Prasad, Quantum Chemistry, Wiley Eastern Ltd, 1992.
- 2. Introductory to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill, 1979.
- 3. I. N. Levine, Allyn and Bacon Quantum Chemistry.
- M. Hanna, Quantum Mechanics in Chemistry, John Wiley and Sons 1970.
- 5. P. W. Atkins, Physical Chemistry, ELBS, 1998
- 6. G. M. Barrow, Physical Chemistry, International student edition, 2003.
- 7. F.W. Billmeyer Jr., Polymer Chemistry, John-Wiley and sons 1971.
- D. D. Deshpande, Polymer Chemistry of Macromolecules, Vishal Publications, 1984.
- 9. C. N. Banwell, E. M. Mac Cash, Fundamentals of Molecular Spectroscopy, fourth Edition, McGraw Hill.
- 10. G. M. Barrow.Molecular Spectroscopy,
- Rohatgi-Mukherjee, Fundamentals of Photochemistry, Wiley-Eastern Ltd., New Delhi, 1978.
- R. P. Wayne, Principles and Application of Photochemistry, Oxford University Press, 1988.

Course Outcomes (COts):

CO No.	СО	Cognitive level
C203.1	Get in-depth knowledge on fundamental and advance concepts of quantum	4
	chemistry	
C203.2	Know more about Macromolecules	4
C203.3	Describe theoretical aspect of spectroscopy, which is helpful in development	4
	of theoretical research in physical chemistry.	

PC-204 Basic Concepts of Polymer Chemistry/PA-204 : Basic Concepts of Pesticides and Agrochemical Chemistry/ IC-204 Basic Concepts of Industrial Chemical Processes/ PH-204: Chemical Mathematics/ AN-204 Basic Concepts of Instrumentation and Analysis

(Choose Any One out of five: PC/PA/IC/PH/AN-204)

PC-204 Basic Concepts of Polymer Chemistry

(30 h, 50 Marks and 2 Credits)

Course Objectives:

- The graduate will be able to knowbasics concepts of polymer chemistry.
- The graduate will also be able to study various mechanisms of polymerisation and learn different techniques of polymerisation.
- The graduate will also be able to understand biodegradation of polymers and its importance.

Course Contents (Topics and subtopics)

06 h

06 h

06 h

Unit I Basic concepts and classification of polymers

Basic concepts - polymer, monomer and polymerization, functionality and reactivity, Classification of polymers based on - source, chemical nature, thermal response, ultimate form and branched/network structures, homopolymer and copolymer (types)

Unit II Mechanisms of polymerisations Mechanisms of chain and step growth polymerizations, ring opening polymerisation, Miscellaneous polymerisations - electrochemical polymerisation, metathesis polymerisation, group transfer polymerisation

Unit III Techniques of polymerisations

Bulk polymerisation, solution polymerisation, suspension polymerisation, emulsion polymerisation, melt polycondensation, solution polycondensation, and interfacial polycondensation, solid and gas phase polymerization

Unit IV Molecular weights and nomenclature of polymers

Degree of polymerisation, various average molecular weights (Mn, Mw, Mv and Mz) and molecular weight distribution (MWD),nomenclature of polymers based on - source, structure, IUPAC

Unit V Polymer degradation

06 h

06 h

Polymer degradation and stability, thermal degradation, chain scission, nonchain scission, oxidative and UV stability, chemical and hydrolytic stability, radiation effect, mechano degradation, biodegradation – biodegradable

polymers (PLA) and starch additives.

Recommended Books:

- V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Limited, New Delhi, 1988.
- 2. M. P. Stevens, Polymer Chemistry an Introduction, 2nd Edition, Oxford University Press, New York, 1999.
- 3. J. R. Fried, Polymer Science and Technology, Eastern Economic Edition, Printice Hall of India, New Delhi, 2000.
- 4. C. E. Carraher Jr Introduction to Polymer Chemistry, Special Indian Edition, Taylor and Francis, New Delhi, First reprint, 2010.
- 5. P. Ghosh, Polymer Science and Technology, Plastics, Rubbers, Blends and Composites, , 3rd Edition, Tata McGraw Hill Education Private Ltd., New Delhi, 2011.
- 6. ,F. W. Billmayer, Text Book of Polymer ScienceJohn Wiley and Sons, New Delhi, 1984.
- G. Odian, Principles of Polymerisation, 3rd Edition, Odian, John Wiley & Sons (Asia) Pvt. Ltd., Singapore, 2002.
- 8. P. Bahadur and N. V. Sastry, Principles of Polymer Science, 2nd Edition, Narosa Publishing House, New Delhi, 2012.

Course Outcomes (COts):

CO No.	СО	Cognitive level
PC204.1	To recall the basic concepts and classification of polymers.	1
PC204.2	To explain the basic techniques of polymerisation.	4

PA-204: Basic Concepts of Pesticides and Agrochemical Chemistry

(30 h, 50 Marks and 2 Credits)

Course Objectives:

- This course gives basic knowledge and importance of agrochemicals.
- This course helps to distinguish types of pesticides based on their properties and their effects.
- This course offers to study the ways of pest control.

Course Contents (Topics and subtopics)

Unit I Pests

06 h

06 h

Definition, introduction, Classification of pests, Concept of insect pestdefinition, life cycle, Non-Insect pests Introduction, weeds, bacteria, molluscs, birds, mites, nematodes, vermins, arthropods, plant pathogens, bacteria, viruses, fungi,

Unit II Pest Control

Classification: Natural and applied control [Physical, mechanical, cultural, biological, genetic, regulatory, chemical controls] Integrated pest management. Chemo-sterilants, attractants, repellents, Pheromones, IGRs, Biotechnology in pest management, Life cycle, nature of damage and management strategy for mosquito (Aedes Aegypti), housefly (Musca domestica), red cotton bug (Dysdercuskoenigii), ballworm (HeliothisArmigera).

Unit III Agrochemicals

Definition, importance and general classification, Pesticides-History of pesticides, invention of pesticides chemistry, development of pesticides. Classification of pesticides based on mode of action, according to target species and chemical nature, Formulations-Conventional and Advanced formulations-Types, uses & current trends.

Unit IV Biopesticides

06 h

06 h

06 h

Botanicals and Bioorganisms: Azadirachtin and its role in pest management, Use of predators (lady bird beetle, crysopa) and parasites (Trichogramma) in pest management, pathogens in disease and insectpest management (Bacillus thuringiensis, NPV).

Unit V Effects of Pesticides

Pesticide residues, toxicity, warning symbols, safety with pesticides, First aid and antidotes.
Recommended Books:

- 1. S. K.Handa, Principles of pesticide chemistry. Agrobios (India); 2012.
- 2. A.Knowles, New developments in crop protection product formulation. T and F Informa UK Ltd. 2005.
- 3. D.S..Hill, Agricultural insect pests of the tropics and their control. CUP Archive; 1983.
- 4. S. B.ChattopadhyayPrinciples and procedures of plant protection. Oxford & IBH Publishing Company, Pvt. Limited; 1991.
- 5. A. S. AtwalAgricultural Pests of India and South-East Asia. Agricultural pests of India and South-East Asia. 1976.Pradhan S. Insect pests of crops. University of California; 1969.
- **6.** S. Subramanian, S. Subramanian, A. Mohamed, J. Kumar, All about weed control. Kalyani Publishers; 2001.
- **7.** Ó. López, J. Fernandez-Bolanos, editors. Green trends in insect control. Royal Society of Chemistry; 2011.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
PA204.1	To classify the basic terms in agrochemicals.	4
PA204.2	To apply the basic knowledge of pesticides and agrochemicals in the agriculture and industry.	3

IC-204 Basic Concepts of Industrial Chemical Processes

(30 h, 50 Marks and 2 Credits)

Course Objectives:

- This course offers to study basics concepts of industrial chemistry and studying various parameters required for chemical industries.
- This course offers to learn different unit processes and unit operations.
- Student will learn about development of variety of chemical reactions.

Course Contents (Topics and subtopics)

Unit I a) Chemical Industry

Introduction, Chemical production, Raw materials and their sources

b)Parameters of Chemical Industry

Plant location, Safety, Construction of plant, Management for productivity and creativity, Training for plant procedure and labour, Chemical processtechnology, Classification of chemical reactions, Batch and continuous operations, Industrial chemical reactions, Conversion, Selectivity and Yield.

Unit II Unit Operations

12 h

12 h

Introduction, Unit operations- Conveying, Crystallization, Distillation, Drying, Evaporation, Filtration, Leaching, Liquid-liquid extraction, Membrane separation, Particle size reduction and enlargements, Solid -solid separation.

Unit III Unit processes

Introduction, Industrial unit processes- Definition and examples of Alkylation, Amination by aminolysis, Calcination, Carbonylation, Double decomposition, Esterification, Halogenation, Hydro formulation, Hydrolysis, Nitration,

Oxidation, Polymerisation, Sulphonation.

Recommended Books:

- 1. P. G. More, Comprehensive Industrial Chemistry, Pragati Edition, Meerut, 2010.
- 2. P. H. Groggins, Unit Processes in Organic Synthesis- Tata McGraw-Hill, 5th Edition, New Delhi, 2010.
- M. Gopal Rao, Dryden's Outline of Chemical Technology, Marshall Sittig, East-West Press, 3rd Edition, 2014

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
IC204.1	Distinguish between unit processes and unit operations of chemical	5
	industries.	
IC204.2	Apply the knowledge on newer techniques in industrially important products	3
	with the help of various unit processes.	

06 h

PH-204: Chemical Mathematics

(30 h, 50 Marks and 2 Credits)

Course Objectives:

- This is a basic mathematics course, which is essential for chemical sciences.
- This knowledge is also required for solving various mathematical equations that need to be solved in several physical chemistry courses.
- Student will be able to solve numerical problems in physical chemistry.

Course Contents (Topics and subtopics)

Unit I	Curve sketching, linear graphs and slopes, general equation of a straight line, slope-intercept from, slope-point form, two-point form, intercept form, parallel and perpendicular lines, curve sketching, graphs of linear equations.	06 h
Unit II	Differentiation, derivative of a function, differentiation formulas, the chain	06 h
	rule, partial differentiation, numerical.	
Unit III	Integration, integration formulas-indefinite and finite integrals, numerical.	06 h
Unit IV	Permutations and combinations: fundamental theorem, permutations,	06 h
	combinations, probability, numerical.	
Unit V	Vectors, matrices, determinants, sterling approximation, numerical	06 h
	Recommended Books:	
	1. P. W. Atkins, Physical Chemistry, ELBS, 1998	
	2. C. M. Domovy, Dhysical Chemistry, Intermetional student edition 2002	

- G. M. Barrow, Physical Chemistry, International student edition, 2003.
 Principles of Physical Chemistry, Vishal Publishing Co., Jalandhar,
- 3. Principles of Physical Chemistry, Vishal Publishing Co., Jalandhar, 2008.

Course Outcomes (COts):

CO No.	СО	Cognitive level
PH204.1	Get in-depth knowledge on fundamental and advance concepts of basic	4
	mathematics course, which is essential for chemical sciences.	

PH204.2	This knowledge is also required for solving various mathematical equations	4
	that need to be solved in several physical chemistry courses.	
PH204.3	Apply the knowledge to explore applications of chemical mathematics to	3
	student will be able to solve numerical problems in physical chemistry.	

AN-204: Basic Concepts of Instrumentation and Analysis

(30 h, 50 Marks and 2 Credits)

Course Objectives:

- This course covers both fundamental and practical aspects of chemical analysis.
- The student will learn about instrumentation, working and applications in chemistry.
- This course also covers solving numerical problems.

Course Contents (Topics and subtopics)

Unit I Theory of volumetric and gravimetric analysis:

Introduction, Titrimetric analysis, classifications of reactions in titrimetric analysis, standard solutions, preparation of standard solutions, primary and secondary standards, Indicators, theory of indicators, Acid–base titrations in non-aqueous media. Gravimetric Analysis.

Unit II Errors, statistics and sampling:

Accuracy and precision, Error, types of error, systematic and random errors, minimisation of errors, mean and standard deviations, reliability of results, confidence interval, comparison of results, student T test, F test, Comparison of two samples (Paired T test), correlation and regression, correlation coefficient and liner regression, Sampling , the basis of sampling, sampling procedure, sampling statistics.

Unit III Ultra purity and ultra trace analysis:

Ultra purity and ultra trace analysis, laboratory dosing, purification of reagents, Preconcentration Techniques, , contamination control during analytical operation.

40

12 h

12 h

Unit IV Basic analytical process:

Separation methods, Precipitation, solvent extraction and chromatographic methods. Activation analysis, basic principles, fast neutron activation analysis, radiochemical methods in activation analysis.

Unit V Complexometric equilibria:

12 h

12 h

Introduction, Titration curves, Types of EDTA titrations, Types of Complexometric Titrations (a) Direct Titration (b) Back Titration (c) Replacement titration (d) Indirect Titration (e) Applications of Complexometric Titrations.

Recommended Books:

- 1. H. H.; Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Jr. Instrumental Methods of Analysis.
- 2. G. R. Chattwal and S. Anand, Instrumental Methods and Chemical Analysis.
- 3. D. A. Skoog and D. M. West, Fundamentals of Analytical Chemistry", 4th Ed., CBS College, Publishing, New York.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AN204.1	To differentiate the fundamental methods of chemical analysis	4
AN204.2	To apply the basic analytical processes in chemical analysis	3

CH-205: Laboratory Course in Inorganic Chemistry-II

(50 Marks and 2 Credits)

Course Objectives:

- The course is designed to develop experimental skills and conceptual understanding related to analysis of alloy, ore and inorganic complexes.
- This course offers to develop experimental skills in quantitative

analysis.

• The student will earn knowledge about applications of coordination complexes in various field of chemistry.

Course Contents (Topics and subtopics)

Perform any eight experiments out of the followings:

- 1) Chalcopyrite ore Estimation of silica by gravimetrically and copperby volumetrically.
- 2) Analysis of Alloy:Brass alloy Estimation of copper and zinc by volumetrically.
- 3) Preparation and purity determination of Potassium trioxalato chromate (III).
- 4) Preparation and purity determination of Nitro penta-ammino cobalt (III) chloride.
- 5) Drug Analysis: Determination of calcium from given drug sample.
- 6) Determination of heat of dissociation and lattice energy of given salt.
- 7) Preparation and purity determination of Tris (thiourea) cuprous sulphate.
- 8) Determination of barium in the given sample solution by homogeneous precipitation by gravimetrically.
- 9) Preparation and purity determination of Tris (acetyl acetonato) manganese (III).
- 10) Chromite ore Estimation of Iron by gravimetrically and Chromium by volumetrically

Recommended Books:

- 1. A.I. Vogel, Text book of Quantitative Analysis, 4th edition, 1992.
- A.B. P. Lever, Inorganic electronic spectroscopy. Amsterdam, The Netherlands: Elsevier, 1984.
- 3. Inorganic Synthesis (Vol. Series).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
CH204.1	Analyse the alloy concentration and Estimate volumetrically the	4
	concentration of Zn and Cu using titration method	
CH204.2	Determine the lattice energy of various chemical ionic compounds	4
CH204.3	Carry out Fe-Drug Analysis and the volumetric estimation of Fe.	4
CH204.4	Perform experiment for the preparation and purity determination of	6
	coordination compounds	

CH-206: Laboratory Course in Organic Chemistry-II

(50 Marks and 2 Credits)

Course Objectives:

- This course is designed to develop the experimental skills in organic chemistry.
- This course offers to prepare organic compounds in single stage.
- This course also offers to interpret IR and NMR the spectra.

Course Contents (Topics and subtopics)

1. Preparations: Single Stage (Any 06 preparations)

- 1) Cyclohexanone to Adipic acid
- 2) Benzophenone to Benzhydral
- 3) Anthracene to Anthraquinone
- 4) Chlorobenzene to 2,4-Dinitrochlorobenzene
- 5) 2,4-Dinitrochlorobenzene to 2,4-Dinitrophenol
- 6) Acetoacetic ester to 1-Phenyl-3-methyl-5 pyrazolone
- 7) Benzaldehyde to Cinnamic acid
- 8) 4-Chlorobenzaldehyde to 4-Chlorobenzoic acid + 4-Chlorobenzyl alcohol
- 9) Benzene to β -Benzoyl propionic acid

- 10) Benzaldehyde to Dibenzylidene acetone
- 11) p-Aminobenzoic acid to p-Chlorobenzoic acid
- 12) N,N-Dimethylaniline to 4-Formyl-N, N-dimethyl aniline
- 13) Benzophenone to Benzpinacol
- 14) p-Nitrotoluene to p-Nitrobenzoic acid
- 15) Anisole to 2,4-Dinitroanisole
- 16) Phthalic anhydride to phthalimide
- 17) Phthalimide to Anthranilic acid
- 18) Acetanilide to p-Bromoacetanide
- 19) p-Bromoacetanide to p-Bromoaniline
- 20) m-Dinitrobenzene to m-Nitroaniline

2. Interpretation of UV, FT-IR and ¹H-NMR spectrum of above synthesized compounds.

(Any06 Compounds)

Recommended Books:

- A.J. Hannaford, A.R. Tatchell, B.S. Furniss, P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, 5th Edition
- 2. R. K. Bansal, Laboratory Manual of Organic Chemistry, New Age International Publisher
- L. D. Field, S. Sternhell, J. R. Kalman, Organic Structures from Spectra, 4th Edition, John Wiley & Sons, Ltd.

Course Outcomes (COts):

CO No.	СО	Cognitive level
CH 206.1	Solve the experimental problems in laboratory or industrial sectors	6
	related with organic chemistry.	
CH 206.2	Prepare and purify the organic compounds	6
CH 206.3	Determine the structure of organic compound from spectroscopic	3
	data.	

CH-207: Laboratory Course in Physical Chemistry-II (50 Marks and 2 Credits)

Course Objectives:

- The course is designed to develop the experimental skills in physical chemistry.
- To furnish the knowledge about the potentiometry, pHmetry, etc.
- To get acquitted with knowledge about verification of theoretical aspects such as reaction kinetics by experimental techniques.

Course Contents (Topics and subtopics)

Perform any eight experiments out of the followings:

- 1) To determine the amount of iodide and bromide present in their mixture by potentiometric titration.
- 2) To determine the solubility product of the given sparingly soluble salts by potentiometric method.
- To determine the equivalent conductance of a weak electrolyte at infinite dilution using the Kohlrausch law of independent migration of ions.
- 4) To determine the hydrolysis constant of the aniline hydrochloride pH-metrically.
- 5) To determine the dissociation constants of the given dibasic acid pH-metrically.
- 6) To determine the isosbestic point of given indicator (methyl red) spectrophotometrically.
- 7) To determine the order of reaction between potassium persulphate and potassium iodide by fractional change method.
- 8) To construct the phase diagram of toluene, alcohol and water system.
- 9) To determination the molecular weight of a given polymer by viscometry method.
- 10) To determination the transition temperature of sodium sulphate decahydrate by thermometric method.

Recommended Books:

- 1. J. A. Kitcher, Findlay's Practical Physical Chemistry, 1963.
- 2. A. I. Vogel, Text Book of Quantitative Inorganic Analysis.
- 3. R. C. Das and B. Behera, Experimental Physical Chemistry, 1984.
- J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing.
- F. Daniels and J. Williams. Experimental Physical Chemistry, McGraw-Hill Publishing Co., Ltd
- 6. D. Shoemaker, Advanced Physical Chemistry Experiments,
- H. H.; Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Jr. Instrumental Methods of Analysis.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
CH 207.1	Provide guidance and practice for each experiment.	3
СН 207.2	Know more about Safety requirements and lab skills	4
CH 207.3	Practice learned each instrument.	3

M.Sc. Part I Semester II: Audit Courses

	AC-201(A): Soft Skills (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	Course Objectives (CObs):	
	• To inculcate different soft skills among students.	
Unit 1	Introduction to soft skills	2 hrs.
	Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal	
	setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	
Unit 2	Self-Assessment Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non- verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	4 hrs.

Unit 3	Communication Skills	8 hrs.
	Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait,	
	dressing sense, facial expressions, peculiarity of speaker (habits).	
	Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes	
	to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver	
	speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them)	
	Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills	
	Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	
Unit 4	Formal Group Discussion, Personal Interview & Presentation skills	4 hrs.
	Topic comprehension, Content organization, Group speaking etiquettes, driving the	
	discussion & skills.	
	Preparation for personal interview: dress code, greeting the panel, crisp self-	
	introduction, neatness, etiquettes, language tone, handling embarrassing & tricky	
	questions, graceful closing.	
	Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds	
	of a GD for each group should be conducted and teacher should give them feedback.	
	Mock interview are to be conducted.	
Unit 5	Aptitude and analytical skills	8 hrs.
	Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test,	
	situational tests, logical thinking.	
	Analytical skills: Definition, Types, problem solving	
Unit 6		4 hrs.
	Time management, critical thinking, sound and practical decision making by dealing	
	Activity: The teacher can conduct a case study activity to train students for decision	
	Activity. The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a case study activity to train students for decision	
	students on how to manage stress. The teacher may conduct a stress reliaving activity in	
	the class. He/she may counsel students individually to know their problems and guide	
	them on dealing with them effectively	
Suggeste	and readings:	
1. Bas	ics of Communication In English: Francis Sounderai, MacMillan India Ltd.	
2. Eng	lish for Business Communication: Simon Sweeney, Cambridge University Press	
3. An	Introduction to Professional English and Soft Skills: Das, Cambridge University Press	
4. Qua	antitative Aptitude: R.S. Agrawal	

Course Outcomes (COts):

CO No.	СО	Cognitive level
AC201A.1	Identify their lacunas about some soft skills and try to overcome the same.	2
AC201A.2	Practice learned soft skills in real life and do their jobs more effectively.	3

		AC (Personality and Cul Course Objectives (COb • To motivate stu	-201(B): Practicing Sports tural Development Related Audit (Optional: Campus-level) s): dents towards sports and provide them t	Activities course; Practical; 2 C	Credits)	
	SR NO.	NAME OF THE SPORT/GAME (Select ONE of the	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMES	STER
		Following)		,		
	1	Volleyball	General Fitness		Total	30
	2	Athletics	Basic Fitness	Morning :	Hour	s in
	3	Badminton	Specific Fitness	07 to 09 AM	Eac	ch
	4	Cricket	• History of the Game		Seme	ster
	5	Basketball	• Basic Skill of the Game	OR		
	6	Handball	• Major Skill of the Game			
	7	Kabaddi	• Technique & Tactics of the	Evening :		
	8	Kho-Kho	Game	05 to 07 PM		
1	9	Table-Tennis	Game Practice			
	10	Swimming				

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AC201B.1	Identify one or more sports of their choice and develop more interest to	2
	participate at University/National level sport events.	
AC201B.2	Practice the learned sports activities regularly in real life.	

AC-201(C): Practicing Yoga

(Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)		
Course Objectives:		
• To motivate students towards yoga and provide them required training.		
Yog: Meaning, Definition & Introduction, Objectives		
Primary Introduction of Ashtanga Yoga		
Preparation of Yogabhyas		
Omkar Sadhana, Prayer, Guru Vandana		
• SukshmaVyayamas		
• Suryanamaskar (12 Postures)		
• Asanas :		
 Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha- 		
Pashchimotanasanan		
 Supine (Shayansthiti) - UttanPadaasan(Ekpad/Dwipad), Pavanmuktasana, 		
ViparitakaraniAasan, Khandarasan, Shavasana		
 Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, SaralhastaBhujangasana. 		

Shalabhasana(Ekpad/Dwipad), Makarasana

Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, ArdhChakrasana

- Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana 6 Types
- Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AC201C.1	Identify and practice some Yoga asanas regularly in their life to remain healthy.	2
AC201C.2	Provide guidance and practice about Yoga to their friends, parents and relatives.	3

AC-201(D): Introduction to Indian Music (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)		
Course Objectives:		
• To motivate students towards indian music and provide them minimum required training.		
• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc.		
• Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa.		
• Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information)		
Detailed information of Tambora		
• Detailed information of Harmonium and Tablaa.		
• Five filmy songs based on Indian Classical Music (Theory and Presentation)		
• Sound Management - Basic information of Sound Recording (including Practicals)		
Composition of Music as per the Story		
• Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.		

Course Outcomes (COts):

CO No.	СО	Cognitive level
AC201D.1	Identify different types of Indian music.	3
AC201D.2	Develop more interest to learn and practice Indian music.	4

Semester -III

PH-301: Quantum Chemistry, Symmetry and Group Theory (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- To aware various theories viz., classical, quantum and modern in physical chemistry.
- To get acquitted the graduate for mathematical foundations of quantum chemistry.
- To furnish the knowledge about the fundamentals of symmetry in quantum chemistry and group theory.

Course Contents (Topics and subtopics)

- **Unit I:** Wave theory of matter, failures of classical Mechanics, Black body **12 h** radiation and quantum theory, distribution of energy in the Black body radiation, Photoelectric Effect: Wave-particle duality of radiation, quantum theory and atomic spectra, the Bohr model, Wave-particle duality of material particles and de Broglie's hypothesis, the uncertainty principle, uncertainty of energy and time.
- Unit II: Theory of wave motion-classical waves and wave equation, stationary 12 h waves in a clamped string, particle waves-the Schrödinger equation for particle waves, classical equation and Schrödinger equation, the wave function and its physical meaning, conditions for acceptable wave function, condition of Normalization of wave functions, condition of orthogonality.
- **Unit III:** Quantum mechanical operators, Eigen values and Eigen functions, **12 h** Hermitian operator, properties of Hermitian operator, rules for setting up quantum mechanical operators, momentum operator, Hamiltonian operator, angular momentum operator, particle in a box: infinite potential barriers, one-dimensional box, three- dimensional box.
- **Unit IV:** Method of variation, method of perturbation, Application of LCAO-MO **12 h** theory on the basis of Hückel approximation to conjugated aliphatic molecules and monocyclic conjugated polyenes.
- Unit V: Symmetry elements and Symmetry operations, Point groups, Nomenclature 12 h
 Schenflies and international, Transformation matrices, Multiplication tables,
 Representation of groups, Orthogonality theorem, Reducible and irreducible

Representations, Character tables, Molecular properties and Symmetry types, Orbital symmetries.

Reference Books:

- 1. Quantum Chemistry, R. K. Prasad, Wiley Eastern Ltd, 1992.
- 2. Introductory to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill, 1979.
- 3. Quantum Chemistry, I. N. Levine, Allyn and Bacon.
- 4. Quantum Mechanics in Chemistry M. Hanna, John Wiley and Sons 1970.
- 5. Physical Chemistry, P. W. Atkins, ELBS, 3rd Edition, 1986.
- 6. Physical Chemistry, G. M. Barrow, 5th Edition, 2007.
- 7. Basic Physical Chemistry by W. J. Moore, Prentice Hall, 1986.
- 8. Symmetry in Chemistry, H. H. Jaffe and M. Orchin, Wiley, New York, 1965.
- 9. Chemical Applications of Group Theory, F. A. Cotton, Wiley, New York, 1971.
- 10. Group theory and its applications to chemistry by K. V. Ramen, Tata McGraw Hill.

Course Outcomes (COts):

CO No.	POS	Cognitive level
PH-301	Quantum Chemistry, Symmetry and Group Theory	
PH-301.1	To focus various theories viz., classical, quantum and modern in physical	4
	chemistry.	
PH-301.2	To justify acquitted the graduate for mathematical foundations of quantum	5
	chemistry.	
PH-301.3	To develop the knowledge about the fundamentals of symmetry in quantum	6
	chemistry and group theory.	

PH-302: Solid State Chemistry and Nanoscience, Nuclear and Radiation Chemistry

(Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- To make aware of the structure of solids, the importance of chemical and physical bonds, crystal (dis)order and defects of materials properties.
- To teach the students phenomenon of Nuclear reactions their applications.
- To make the students aware about nano-science and technology as well as their applications in various fields.

Course Contents (Topics and subtopics)

- Unit I: Crystal structure, cubic unit cells, types of cubic unit cells (simple, bodycentred and face-centred), the percentage efficiency of packing in cubic unit cells, density of unit cell, classification of crystals on the basis of bonds, coordination number of a crystal structure, radius ratio rule, Lattice energy of an a ionic crystal, the Born-Haber cycle and thermochemical calculations, structure of metal crystals (hexagonal close packed structure and closed packed structure) and packing, Density of closed packed structure, Ionic structures, Metallic bonding and bond theory, insulators and semiconductor, Defects in solids.
- **Unit II:** Band theory of conductors, semiconductors and insulators, **12 h** superconductivity, low temperature superconductivity and high temperature superconductivity, crystal defects (point, line and plane), Schottky defect and calculations of number of it, Frenkel defect and calculations of number of it.

Solid state reaction or shake 'n' bake methods, Nucleation and growth, epitaxy and topotaxi, Examples of solid state reactions: Li₄SiO₄, Na \Box/\Box'' alumina and YBa₂Cu₃O₇, Sol-gel methods for MgAl₂O₄ and silica glass, Preparations of YBCO super conductor, Electrochemical and Chemical vapour deposition methods for thin film preparations.

Unit III: Introduction to nanoscience and technology, terminology and history, **12 h** optical and semiconducting properties of nanoparticles, metallic nanoparticles, top-down and top-up fabrication, Principles of SEM and TEM technique, applications of SEM and TEM for characterization of

nanoparticles, carbon nanotubes, applications of C60, nano-TiO2.

- Unit IV: Typical reactions involved in the preparation of radioisotopes (Tritium, 12 h Carboc-14, Sodium-22, Phosphorous-32, Sulphur-35), The Szilard-Chalmer's reaction, typical applications of radioisotopes as tracers in analytical applications: Direct Isotope Dilution Analysis (DIDA) and Neutron Activation Analysis (NAA).
- Unit V: Radiation chemistry, interaction of radiation with matter: primary effects 12 h due to charged particles/radiation, radiation tracks spurs and X-rays, linear energy transfer, units for measuring radiation absorption (linear, mass, atomic and electron absorption coefficient) radiation dosimetry: units of radiation energy, primary radiolytic product (prp) of water, Samuel-Magee model and Lea-Gray-Platzmann model.

Reference Books:

- 1. Introduction of Solid, Leonid V. Azaroff, Tata McGraw Hill, New Delhi, 1977.
- 2. Solid State chemistry and its Application, A. R. West, Plenum.
- 3. Basic Solid State Chemistry, A. R. West, John Wiley and sons Ltd., 1999.
- 4. Solid State Chemistry, D. K. Chakraborty, New Age International.
- 5. Solid State Chemistry, C. N. R. Rao, Dekker, N. Y.
- 6. Essentials of Nuclear Chemistry, H. J. Arnikar, Wiley Eastern Ltd, 1995.
- 7. Source-book of Atomic Energy, S. Glasstone, Van Nostrand Company.
- 8. Introduction to Nuclear Physics and Chemistry, B. G. Harvey, Prentice Hall, 1963.
- 9. Nuclear and Radiochemistry, G. Friedlander, J. W. Kennedy and J. M. Miller, John Wiley and sons, 1981.
- 10. Introduction t o Radiation Chemistry, J. W. T. Spinks and R. J. Woods, John Wiley, 1990.
- 11. Principles of radiochemistry, D.D. Sood, N. Ramamoorthy and A.V.R. Reddy.
- 12. Radiation, Detection and Measurement, G.F. Knoll, John Wiley & Sons, New York, 1979.
- 13. Radiation Chemistry-An Introduction, A.J. Swallow, Longman, 1973.
- 14. Source book of an Atomic energy, S. Glasstone, Van Nostrand, New York, 1969.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	POS	Cognitive level
PH-302	Solid State Chemistry and Nano-science, Nuclear and Radiation	
	Chemistry	
PH-302.1	To describe of the structure of solids, the importance of chemical and physical	2
	bonds, crystal (dis)order and defects of materials properties.	
PH-302.2	To explain the students, phenomenon of Nuclear reactions their applications.	3
PH-302.3	To tell the students about nano-science and technology as well as their	1
	applications in various fields.	

PH-303: Electrochemistry and Kinetics of Reactions (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- To get acquitted about Ion-Solvent and Ion-Ion interactions and their importance in Physical Chemistry.
- Application of the concept of Diffusion and to study the different relations between diffusion coefficients.
- > To understand different models that explains various aspects of electrochemistry and its applications.

Course Contents (Topics and subtopics)

- Unit I: Structure of water, structure of water when a charged ion is present in it, the ion-quadrupole model of ion-solvent interactions, the ionic cloud around a central ion, thickness of the ionic cloud, Debye-Hückel theory, activity coefficient and mean ionic activity coefficients, conversion of theoretical activity coefficient expressions into a testable form (Debye-Hückel limiting law equation), experimental verification of Debye-Hückel limiting law equation.
- **Unit II:** Diffusion, Fick's laws, drift velocity, mobility of ions (absolute and **12 h** conventional mobility), the current density associated with the directed movement of ions in solution in terms of ionic drift velocities, Einstein relation between the absolute mobility and the diffusion coefficient, Stokes-Einstein equation, Nernst-Einstein equation and their limitations.
- Unit III: Structure of electrified interfaces, structure of the electric double layer, 12 h Helmholtz-Perrin theory, Gouy-Chapman theory and Stern's theory, cathodic and anodic current density, Overpotential, Butler-Volmer equation, Tafel plot.

Unit IV: Theories of reaction rates: Collision theory of bimolecular reaction rate, **12 h** unimolecular reaction and collision theory, the transition state theory-absolute reaction rate theory, influence of ionic strength of solution on reaction rates: salt effect (primary and secondary salt effect), diffusion controlled and activation controlled reactions in solution, rate constant of diffusion controlled reaction.

Unit V: Eyring equation, activation parameters. 12 h
 Fast reactions, techniques for the study of fast reactions: flow methods, relaxation methods, flash photolysis.

Reference Books:

- 1. An Introduction to Electrochemistry, S. Glasstone, Van Nostrand, East-West 1965.
- 2. Modern Electrochemistry, Vol. I and II, 2nd Edition, J. O'M Bockris and A. K. N. Reddy, Plenum, 1977.
- 3. Electrolytic Solutions, R. A. Robinson and R. H. Stokes, Butterworths, London, 1959.
- 4. Physical Chemistry, P. W. Atkins, ELBS, 1986.
- 5. Physical Chemistry, 4th Edition, Silbey, Alberty, Bawendi, Wiley, India, 2007.
- 6. Chemical Kinetics, 2nd Edition, K. J. Laidler, TMH.
- 7. Kinetics and Mechanism, 2nd Edition, A. A. Frost and R. G. Pearson.
- 8. Basic Chemical Kinetics, G. L. Agrawal, Tata McGraw-Hill Publishing Company Lid., New Delhi.

Course Outcomes (COts):

CO No.	POS	Cognitive level
PH-303	Electrochemistry and Kinetics of Reactions	
PH-303.1	To develop acquitted about Ion-Solvent and Ion-Ion interactions and their importance in Physical Chemistry.	6
PH-303.2	Apply the concept of Diffusion and study different relations between diffusion coefficients.	3
PH-303.3	To recognise different models that explains various aspects of electrochemistry and its applications.	6

PH-304: Physical Chemistry of Polymers (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- > To educate the students about the basic physical concept of polymers.
- To furnish the knowledge about different methods of polymerization, determination of molecular weight and effect of shape and size on the properties of molecules.
- > To get acquitted with kinetics of polymerisation, gel formation and self-assembly process.

Course Contents (Topics and subtopics)

Unit I: Fundamental Concepts

12 h

Definitions of polymer, monomer and polymerization, molecular weight and molecular-weight distribution, classification of polymers based on source, chemical constituents, thermal response, branched/network structures and homopolymer/copolymer/graft copolymer

 Unit II:
 Chemical Bonding, Phase States and Phase Transitions of Polymers
 12 h

Molecular forces and chemical bonding in polymers, primary bonds (ionic, bond, covalent bond, coordinate bond, metallic bond), Secondary-bond forces (dipole forces, induction forces, dispersion forces, hydrogen bond) intermolecular forces and physical properties

General concepts of phase states and phase transitions, crystallizability of polymers, melting temperature of polymers, amorphous polymers

Unit III: Transition of Polymers from the Rubber-like to the Glassy and 12 h Viscoelastic States

Relaxation nature of glass transition, mechanism of glass transition, methods of determining glass transition temperature of polymers (DSC, DTA, DMA, TMA and Dilatometry), effect of molecular mass of polymers on its glass transition temperature and on flow temperature, relationship between Tg and Tm of polymers, chemical constituents of polymers and glass transition temperature

Unit IV: Polymer-Low-Molecular Weight Liquid Systems

12 h

Thermodynamics of polymer solutions-thermodynamics of simple liquid mixtures, ideal solutions and other types of mixing, entropy and heat of mixing of polymer solutions (Flory-Huggins theory)

True solution of polymers, gels of polymers, colloidal dispersion of polymers, preparation of polymer solutions and their refining, fractionation of polymers, resistance of polymeric material to solvents.

Unit V: Rheology and the Mechanical Properties of Polymers:

Rheology, viscous flow (phenomena of viscous flow and dynamics of polymer melts), flow measurement (rotational and capillary viscometry), molecular weight and shear dependence, temperature dependence of viscosity, kinetic theory of rubber elasticity, thermodynamics of rubber elasticity (the ideal elastomer, entropy elasticity and stress-strain behaviour of elastomers), models of viscoelastic behavior-Maxwell, Kelvin-Vigot models and mechanical spectra

Reference Books:

- 1. Text Book of Polymer Science, F. W. Billmayer, John Wiley and Sons, New Delhi, 1984.
- 2. Polymer Science, V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, New Age International (P) Limited, New Delhi, 1997.
- 3. Physical Chemistry of Polymers, A. Tager, Mir Publication, Moscow, 1972.
- 4. Principles of Polymer Chemistry, P. J. Flory, Cornell University Press, Ithaka, 1953.
- 5. Physical Chemistry of Macromolecules, D. D. Deshpande, Vishal Publication, Jalandhar, 1997.
- 6. Polymer Chemistry An Introduction, 2nd Edition, Malcolm P. Stevens, Oxford University Press, New York, 1999.
- 7. Physical Chemistry, G. M. Barrow, Tata McGraw Hill, New Delhi, 2007.

Course Outcomes (COts):

CO No.	POS	Cognitive level
PH-304	Physical Chemistry of Polymers	
PH-304.1	To explain the students about the basic physical concept of polymers.	3
РН-304.2	To design the knowledge about different methods of polymerization, determination of molecular weight and effect of shape and size on the properties of molecules.	6
PH-304.3	To develop acquitted with kinetics of polymerisation, gel formation and self- assembly process.	3

PH-305: Laboratory Course in Physical Chemistry-III

Course Objectives:

- The course is designed to develop the experimental skills.
- To impart the basics of theoretical knowledge through experiments

Course Contents (Topics and subtopics)

Perform any fifteen experiments in Semester III of the followings:

- 1. To determine the stoichiometry and the instability constant of silver-ammonia complex potentiometrically.
- 2. To determine the solubility of lead iodide with Ag/AgI electrodes by potentiometrically.
- 3. To determine the dissociation constants of a given dibasic acid pH metrically.
- 4. To determine to Hammett constant of $p \Box$ nitro benzoic acid pH metrically.
- 5. To titrate pH metrically a solution of phosphoric acid against a standard alkali and to determine the dissociation constants of phosphoric acid.
- 6. To determine the and hydrolysis constant for aniline hydrochloride conductometrically.
- 7. To determine the critical micelle concentration of sodium lauryl sulphate in aqueous solutions conductometrically.
- 8. Simultaneous determination of cations from their binary mixture spectrophotometrically.
- 9. To determine the stoichiometry and stability constant of Fe (III) and salicylic acid complex by Job's and Mole-ratio method.
- 10. To determine the unknown concentration of Riboflavin in a given solution using spectrofluorometer.
- 11. To determine the latent heat of fusion of naphthalene in benzene by solubility measurement.
- 12. To determine the molar volume of ethanol and its partial molar volume at room temperature in dilute aqueous solutions.
- 13. To investigate the kinetics of iodination of acetone.
- 14. To study the kinetics between potassium iodide and potassium persulphate at different temperatures and obtained the energy of activation and frequency factor.
- 15. X-ray diffraction analysis of a given data.
- 16. To determine the specific and molecular rotation of an optically active substance and hence find out the intrinsic rotation of the substance.

17. Study the verification of inverse square law for a radiating system.

18. Determination of heat of oxidation using Bomb calorimeter.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	POS	Cognitive level
PH-305	Laboratory Course in Physical Chemistry-III	
PH-305.1	The course is designed to develop the experimental skills.	6
PH-305.2	To apply the basics of theoretical knowledge through experiments	3

M.Sc. Part II Semester III (Physical Chemistry): Audit Courses

AC-301(A): Computer Skills				
	(Technology + Value added Audit course; Practical; 2 Credits)			
	(Optional: Campus + Program level)			
Course	Objectives (CObs):			
• To in	nculcate different daily useful computer skills among students.			
Unit 1	Elements of Information Technology	2 L		
	 1.1 Information Types: Text, Audio, Video, and Image, storage formats 1.2 Components: Operating System, Hardware and Software, firmware 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM 			
T I ' ' O	/ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics	<i>-</i> - -		
Unit 2	Office Automation-Text Processing	5 L		
	2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View			
	2.2 Working with Files: Create New Documents, Open Existing Documents, SaveDocuments to different formats, Rename Documents, Close Documents			
	2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins2.4 Lists: Bulleted and Numbered Lists,			
	2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Moveand Resize Tables, Moving the order of the column and/or rows inside a table, TableProperties			
	2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents,			
	2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters2.8 Types of document files: RTF, PDF, DOCX etc.			

Unit 3	Office Automation-Worksheet Data Processing	5 L
	3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets,	
	3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows	
	3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions,	
	AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill,	
	3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts	
Unit 4	Office Automation- Presentation Techniques and slide shows	6 L
	 4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation,Open an Existing Presentation, PowerPoint screen, Screen Layout 	
	4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template, Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder orText box properties, Bulleted and numbered lists. Adding notes	
	4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replacefonts, Line spacing, Change case, Spelling check, Spelling options	
	4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing rowwidth, Adding a row/column, Deleting a row/column, Combining cells, Splitting a cell,Adding color to cells, To align text vertically in cells, To change table borders,Graphics, Add clip art, Add an image from a file, Save & Print, slide shows, slideanimation/transitions.	
Unit 5	Internet & Applications:	4 L
	5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing theInternet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers, Uniform resource locator	
	 5.2 Internet Resources: Email, Parts of email, 5.3 Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions. 5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking sorvinge 	
	 5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing 5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat(NPTEL) portal, MIT courseware 	
Unit 6	Cloud Computing Basics	3 L
	 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.) 	

Suggested readings:

- 1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & Bartlett Learning, 2010, ISBN: 1449609821, 9781449609825
- 2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: Cengage Learning, 2010, ISBN: 0538472464, 9780538472463
- 3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5, Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552
- 4. Cloud computing online resources

Course Outcomes (COts):

СО	CO	Cognitive
No.	0	level
AC301A.1	Identify their lacunas about some computer skills and try to overcome	2
	the same.	
AC301A.2	Practice the learned computer skills in real life and do their jobs more	3
	effectively.	

(Optional: Campus + Program level) Objectives (CObs): nake students aware of different daily useful cyber security skills/rules. Networking Concepts Overview Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet Security Concepts Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux. Security Threats and vulnerabilities	3 L 7 L
Objectives (CObs): nake students aware of different daily useful cyber security skills/rules. Networking Concepts Overview Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet Security Concepts Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.	3 L 7 L
 Networking Concepts Overview Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet Security Concepts Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux. 	3 L 7 L
 Networking Concepts Overview Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet Security Concepts Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux. Security Threats and vulnerabilities 	3 L 7 L
 Security Concepts Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux. Security Threats and vulnerabilities 	7 L 7 L
Security Threats and vulnerabilities	7 L
Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes	
Cryptography Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure	5 L
System & Network Security System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.	3 L
	countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes Cryptography Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure System & Network Security System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.

Unit 6	OS Security OS Security Vulnerabilities updates and patches, OS integrity checks, Anti- virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.	2 L
Unit 7	Security Laws and Standards Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.	3 L
Suggest 1. Skill for H 2. BPB Rath 3. Crea 13: 9	ed readings: as Factory, Certificate in Cyber Security, Text Book Special edition, Specially pub KBC NMU, Jalgaon Publication, "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar ore, Aatif Jamshed teSpace Independent Publishing Platform, "Cyber Security Basics", Don Franke, 978-1522952190ISBN-10: 1522952195	lished Singh ISBN-

4. Online references

Course Outcomes (COts): On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AC301B.1	Practice learned cyber security skills/rules in real life.	3
AC301B.2	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	2

AC-301(C): Introduction to Research

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To create interest of research amongst the students.
- To learn the basic knowledge and steps involved in the research.

Course layout

https://nptel.ac.in/courses/121/106/121106007/

https://onlinecourses.nptel.ac.in/noc20_ge22/preview

Week 1 : A group discussion on what is research; Overview of research;

Week 2 : Literature survey, Experimental skills;

Week 3 : Data analysis, Modelling skills;

Week 4 : Technical writing; Technical Presentations; Creativity in Research

Week 5 : Creativity in Research; Group discussion on Ethics in Research

Week 6 : Design of Experiments

Week 7 : Intellectual Property

Week 8 : Department specific research discussions

Course Outcomes (COts):

CO No.	CO	Cognitive level
AC301C.1	Understand literature survey, data analysis, report writing.	2
AC301C.2	To choose research problem.	3
AC301C.3	Develop interest of research.	3

AC-301(D): Seminar on Review of Research Paper

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

• To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant research paper.

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journals from ACS, RSC, Elsevier, Springer etc. to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation.

Course Outcomes (COts):

CO No.	СО	Cognitive level
AC301D.1	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	2
AC301D.2	Prepare seminar on research paper using ICT tools.	3
AC301D.3	Retrieve, analyze, comprehend the scientific information on a given research paper.	4

SEMESTER -IV

PH-401: Molecular Structure (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objectives:

- To transfer the knowledge to students about molecular structures and concerts basic concepts.
- > To furnish the knowledge about fundamentals of spectroscopies and applications.
- To explain in detail to the students to understand NMR, ESR, Mossbauer, Raman Spectroscopy etc.

Course Contents (Topics and subtopics)

- **Unit I:** Infra-red Spectroscopy: Introduction, the vibrating diatomic molecule-the **12 h** energy of a diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating rotator, the vibrations of polyatomic molecules, fundamental vibrations and their symmetry.
- Unit II: Raman Spectroscopy: Introduction, quantum theory of Raman effect, 12 h classical theory of the Raman effect, pure rotational Raman spectra for linear and symmetric top molecules, vibrational Raman spectra: Raman activity of vibrations (water molecule and carbon dioxide molecule), rule of mutual exclusion, techniques and instrumentation.
- Unit III: Nuclear Magnetic Resonance (NMR) Spectroscopy: Introduction, quantum 12 h description of NMR, spin and applied field: the nature of spinning particles (rules predicting spin numbers of nuclei and calculation of spin numbers of elements responding to NMR), interaction between spin and magnetic field, spin-spin coupling: splitting of signals, coupling constant, the Larmor precession, chemical shift, Hydrogen, Deuterium and ¹³C nuclei, techniques and instrumentation.
- Unit IV: Electron Spin Resonance (ESR) Spectroscopy: Introduction, comparison 12 h between NMR and ESR, theory of ESR (ESR spectrum of an unpaired electron), presentation of ESR spectrum, g-factor, hyperfine structure in ESR spectra, applications of ESR spectroscopy in structural elucidation, techniques and instrumentation.
- Unit V: Electric and Magnetic Propertied of Molecules: 12 h
 Polarizability, polarization of a molecule in an electric field (electronic, atomic and orientation polarization), Clausius-Mossotti equation, variation

of molar polarization with temperature: Debye equation, bond moments, dipole moments and molecular structure.

Magnetic susceptibility, molecular interpretations of diamagnetism and paramagnetism, Ferro, ferri and antiferromagnetic behavior, Curie and Neel temperatures, Measurements of magnetic susceptibility by Faraday and Gouy Technique.

Reference Books:

- 1. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, McGraw Hill International (UK), 1996.
- 2. Physical Chemistry, P. W. Atkins, ELBS, Oxford University Press, 1986.
- 3. Nuclear Magnetic Resonance Spectroscopy, R. K. Harris, Pitman, London, 1983.
- 4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, McGraw Hill, New York, 1980.
- Theory and Applications of Electron Spin Resonance, W. Gordy (ed), Techniques of Chemistry, XV, Wiley-Interscience, New York, 1980.
- Experimental Aspects of Mössbauer Spectroscopy, R. H. Herber and Y. Hazony, Techniques of Chemistry (A. Weissberger and B. W. Rossiter, eds), Wiley Interscience, New York, 1972.
- 7. Determination of Dipole Moments, C. P. Smiyth, Techniques of Chemistry (A Weissberger and B. W. Rossiter eds.) IV, Wiley Interscience, New York, 1972.
- 8. Introduction to Magnetochemistry, Alen Earnshaw, Acad. Press, London, 1968.
- 9. Magnetic Susceptibility- L. N. Mulay.
- 10. Molecular Structure and Molecular Spectra by G. Herzberg, Van Nostrand.
- 11. Molecular Spectroscopy by G. M. Barrow.

12. Molecular Spectroscopy by I. N. Levine, Willey Interscience.

Course Outcomes (COts):

CO No.	POS	Cognitive level
PH-401	Molecular Structure	
PH-401.1	To express knowledge to the students about molecular structures and concerts	6
	basic concepts.	
PH-401.2	To tell the knowledge about fundamentals of spectroscopies and applications.	1
PH-401.3	To explain in detail to the students to understand NMR, ESR, Mossbauer,	3
	Raman Spectroscopy etc.	

PH-402: Statistical Thermodynamics, Phase Equilibria and Irreversible Thermodynamics (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objective:

- To give the information about fundamental of statistical thermodynamics.
- To furnish the knowledge about different partition functions for diatomic molecules and applications of quantum statistics.
- To teach the students the derivation and applications of Phase rule.

Course Contents (Topics and subtopics)

- Unit I: Phase Space, Probability, Lioville's theorem, Configuration and weights, 12 h the most probable configuration, Ensembles, Boltzmann distribution for energies, Boltzmann, Bose-Einstein and Fermi-Dirac statistics.
- **Unit II:** Partition function, Rotational, translational, Vibrational and Electronic **12 h** partition functions for diatomic molecules.
- Unit III: Statistical basis of entropy, Calculations of thermodynamic functions and 12 h equilibrium constants using spectral data and partition function, Applications of quantum statistics to derive Planck's law and study of electron gas in metals, Entropies of o- and p- hydrogen, Theories of specific heat for solids.
- Unit IV: Chemical potentials and derivation of phase rule, Pressure-Temperature 12 h phase diagram, Interpretation of liquid phase diagrams, Immiscible liquids, Eutectic formation, Solid compound formation, Liquid-vapour, Pressure composition diagram, distillation, One component CO₂, H₂O, ice and SiO₂ systems, Lever rule for two component system, The system Fe-C- iron and steel making, Drawing of three components system, Zone refining.
- Unit V: Phenomenological laws, Concept of equilibrium, Free energy and entropy, 12 h
 First and Second principles of thermodynamics, Principle of microscopic
 reversibility, Onsager reciprority theory and relations, Entropy production
 in chemical reaction, fluxes and forces in closed and open system, Prigogine
 principle of minimum entropy production, Coupling of reactions and cross
 coefficients, Electrokinetic phenomena and Saxens relations.

Reference Books:

1. Theoretical Chemistry, S. Glasstone, Van Nostrand Co. Inc.

- 2. Thermodynamics for Chemist, S. Glasstone, Van Nostrand Co. Inc.
- 3. Elementary Statistical Thermodynamics, L. K. Nash, Addition-Wesley, Reading, 1968.
- 4. Statistical Thermodynamics, D. A. McQuarrie, Harper & Row, New York, 1976.
- 5. Statistical Thermodynamics, M. C. Gupta, Wiley Eastern Ltd., 1990.
- 6. Physical Chemistry, P. W. Atkins, 3rd Edition, ELBS, W. H. Freemax and Co., 1986.
- 7. Basic Solid State Chemistry, A. R. West, John Wiley & sons Ltd., New York, 1999.
- 8. Irreversible Thermodynamics: Illa Prigogine.
- 9. Thermodynamics of Steady State: Denbeigh
- 10. Advanced Physical Chemistry, J. N. Gurtu, A. Gurtu, A Pragati Edition, Meerat, 2008

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	POS	Cognitive level
PH-402	Statistical Thermodynamics, Phase Equilibria and Irreversible	
	Thermodynamics	
PH-402.1	To tell the information about fundamental of statistical thermodynamics.	1
PH-402.2	To assess the knowledge about different partition functions for diatomic molecules and applications of quantum statistics.	5
PH-402.3	To explain the students the derivation and applications of Phase rule.	4

PH-403: Surface Chemistry and Catalysis (Core course; Theory; 60 h, 100 Marks and 4 Credits)

Course Objective:

- > To introduce the basic concept of surface chemistry.
- > To furnish the knowledge about the various aspects of surface chemistry such as thermodynamics of physical adsorption and adsorption isotherm.
- > To give the information about the basic concept of catalysis and their application in the various field.

Course Contents (Topics and subtopics)

Unit I: Adsorption, types of adsorption (physisorption and chemisorption), **12 h** applications of adsorption, factors influencing adsorption, adsorption by solids, electrical phenomena at interfaces including electrokintic potentials, adsorption isobar and adsorption isostere, desorption, desorption activation energy.

Unit II: Adsorption isotherms, Freundlich adsorption isotherm, Langmuir 12 h

adsorption isotherm, B. E. T. theory of multilayer adsorption, measurement of surface area of adsorbent by Harkins and Jura method and B. E. T. method, types of adsorption isotherms (type I to V)

Unit III: Adsorption at liquid surfaces, Gibb's adsorption isotherms equation, **12 h** verification of Gibb's adsorption isotherms equation (microtome method and radio-activity method), heat of adsorption and its determination.

Modern techniques for investigating surfaces: Low energy electron diffraction, photoelectron spectroscopy, scanning tunneling microscopy.

- **Unit IV:** Catalysis, general characteristics of catalytic reactions, types of catalysis **12 h** (homogeneous and heterogeneous catalysis), kinetics of homogeneous and heterogeneous catalysis, acid-base catalysis, Enzyme catalysis and its characteristics, factors affecting enzyme-catalyzed reactions, mechanism and kinetics of enzyme-catalyzed reactions.
- Unit V: Activation energy and catalysis, theories of catalysis (intermediate 12 h compound formation theory and the adsorption theory), autocatalysis, oscillatory reactions: B-Z reactions, Lotka-Volterra mechanism, the Brussellator, the Oregonator.

Reference Books:

- 1. Physical Chemistry, Silbey, Alberty and Bawendi, 4th Edition, Wiley-India, 2007.
- 2. Physical Chemistry of Surfaces, A. W. Adamson, Interscience, New York, 1967.
- 3. Surfaces Chemistry: Theory and Applications, J. J. Bikerman, Academic Press, New York, 1972.
- 4. Adsorption, J. Oscik, John Wiley & Sons, New York, 1978.
- 5. Introduction to collide and surface chemistry by D. J. Shaw.
- 6. Theory of adsorption and catalysis by Alfred Clark.
- 7. Physical Chemistry, P. W. Atkins, ELBS, Oxford, 1986.

Course Outcomes (COts):

CO No.	POS	Cognitive level
PH-403	Surface Chemistry and Catalysis	
PH-403.1	To adapt the basic concept of surface chemistry.	6
PH-403.2	To develop the knowledge about the various aspects of surface chemistry such	3

	as thermodynamics of physical adsorption and adsorption isotherm.	
PH-403.3	To examine the information about the basic concept of catalysis and their application in the various field.	1

PH-404: Laboratory Course in Physical Chemistry-IV

Course Objectives:

The course is designed to develop the experimental skills.

Perform any fifteen experiments in Semester IV of the followings:

- 1. To determine the amount of chloride, bromide and iodide present in their mixture by potentiometric titration.
- 2. To determine the stability constant of the complex ion $Ag(S_2O_3)_2^{--}$ potentiometrically.
- 3. To determine the pKa values of carbonic acid pH metrically.
- 4. To determine the hydrolysis constant of the aniline hydrochloride pH-metrically.
- 5. To determine the isoelectric point and dissociation constant of glycine by pH– metric titration.
- 6. To determine the second order velocity constant for the hydrolysis of ethyl acetate by sodium hydroxide conductometrically.
- 7. To determine equivalent conductance at infinite dilution of monobasic weak acid by simultaneous application of Onsager equation and Kohlrausch law of independent ionic mobility.
- 8. To determine the stability constant of Ferric-thiocyanate complex using Frank-Ostwald's method spectrophotometrically.
- 9. To determine the pKa value of methyl red indicator spectrophotometrically.
- 10. To determine the dimerization constant of benzoic acid in benzene by distribution method.
- 11. To investigate the influence of ionic strength on the rate constant of a reaction between potassium iodide and potassium persulphate.
- 12. To investigate the autocatalysis reaction between potassium permanganate and oxalic acid.
- 13. To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir adsorption isotherms.
- 14. To determine the molecular weight of a given polymer by viscosity measurement.

- 15. Find % error in the given experimental data by method of least squares.
- To determine the half-wave potential and unknown concentration of Cd⁺² ions polarograhically.
- 17. Determine the linear and mass attenuation coefficient of a given isotope using G. M. counting system.
- 18. Concentration studies for Na+ and K+ ions in water using flame photometry.

Reference Books:

- 1. Practical Physical Chemistry, A. M. James and P. E. Prichards, Longman Group Ltd.
- 2. Findlay's Practical Chemistry, S. P. Levitt (Editor), Longman Group Ltd.
- 3. Experimental Physical Chemistry, Das and Behra, Tata McGraw Hill.
- 4. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publication, Meerut.
- 5. Advanced Experiments in Physical Chemistry, J. Rose.
- 6. Experiments in Physical Chemistry, Schoemaker.
- 7. Advanced Analytical Chemistry, Meits and Thomos.
- 8. Experimental Analytical Chemistry, Willard, Merritt and Dean.
- 9. Vogel's Textbook of Quantitative Chemical Analysis, by J. Mendham, R.

Denney, J. Barnes and M. Thomos, ELBS, Pearson, Delhi, 2007.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	POS	Cognitive level
PH-404	Laboratory Course in Physical Chemistry-IV	
PH-404.1	The course is designed to develop the experimental skills	6

PH-405: A Short Research Project

Course Objectives:

The course is designed to develop the experimental skills which give the idea about research.

The student shall undertake project for 100 marks. He/she can study theoretical, computational, analytical or experimental work with advanced technique or developed technique by him or herself. One has to select topic of his / her interest having utility / applications in science. He or she at the end will submit report (typed) in two copies to the institute as well as has to make presentation as a seminar. The assessment will be carried out by both internal and external examiner jointly at the end of practical examination of Semester IV.
Course Outcomes (COts): On completion of this course, the student will be able to:

CO No.	POS	Cognitive level
PH-405	A Short Research Project	
PH-405.1	The course is designed to develop the experimental skills which give the idea about research.	6
PH-405.2	The student shall undertake project for 100 marks. He/she can study theoretical, computational, analytical or experimental work with advanced technique or developed technique by him or herself. One has to select topic of his / her interest having utility / applications in science. He or she at the end will submit report (typed) in two copies to the institute as well as has to make presentation as a seminar. The assessment will be carried out by both internal and external examiner jointly at the end of practical examination of Semester IV.	3

M.Sc. Part II Semester IV: Audit Courses

	AC-401(A): Human Rights (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Ontional: Campus-level)	
	Course Objectives (CObs):	
	• To make students aware about human rights and human values.	
Unit 1	Introduction to Human Rights	6 hrs.
	1.1 Concept of Human Rights	
	1.2 Nature and Scope of Human Rights	
	1.3 Fundamental Rights and Fundamental Duties	
	1.4 Interrelation of Rights and Duties	
Unit 2	Human Rights in India	8 hrs.
	2.1 Meaning and Significance of :	
	1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4)	
	Right to Freedom of Religion, 5) Cultural and Educational Rights, and 6)	
	Right to Constitutional Remedies.	
	2.2 Constitutional Provisions for Human Rights	
	2.3 Declaration of Human Rights	
	2.4: National Human Rights Commission	
Unit 3	Human Values	8 hrs.
	3.1: Meaning and Definitions of Values	
	3.2: Importance of values in the life of Individual	
	3.3: Types of Values	
	3.4: Programmes for conservation of Values	
Unit 4	Status of Social and Economically Disadvantaged people and their rights	8 hrs.
	4.1: Rights of women and children in the context of Social status	
	4.2: The Minorities and Human Rights	
	4.3: Status of SC/ST and other Indigenous People in the Indian Scenario	
	4.4: Human rights of economically disadvantaged Society	

Suggested readings:

- 1. Human rights education YCMOU, Nasik
- 2. Value education SCERT, Pune
- 3. Human rights reference handbook Lucille whare

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AC401A.1	Practice the learned issues under human rights and human values in real life.	3
AC401A.2	Provide social justices to people around them and provide guidance about	5
	human rights to their friends, parents and relatives.	

	(Professio	AC-401(B): Current Affairs nal and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	<i>Course Objecti</i>To make stu	ves (CObs): dents updated about current affairs of India and world.	
	Title	Content	Hours
Unit	Politics &	• National & International Political Activity, Organization.	08
1	Economy	• Economy & Business, Corporate world	
Unit 2	Awards and recognitions	 National & International Awards and recognitions Books and authors 	07
Unit 3	Science & Technology	Software, Automobile, Space ResearchNew inventions and discoveries	07
Unit 4	Environment & Sports	 Summit & conference, Ecology & Climate, Organization. National & International Games, Olympics, commonwealth etc. 	08
Suggesta 1. Ind 2. Ma 3 Ind	ed readings (Us ia 2019, by Publi norama Year Bo ia 2019, Rajiy M	e recent years' data and current literature): ications Division Government of India ok by Philip Mathew, jaharshi	

- 4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts
- 5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.

Course Outcomes (COts):

On completion of this course, the student will be able to:

No. CO	level
AC401B.1 Identify important issues currently/ recently happening in India or world.	5
AC401B.2 Summarize current affairs regularly.	6

	AC-401(C): Technical report writing (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Program-level)	
	 Course Objectives (CObs): To provide basic knowledge of report writing and their implications. To identify, who you're producing the report for, why you're producing the report and what information you're covering 	
Unit 1	Introduction Importance of report writing in academics and research. Various kinds of academic and research activities. Necessity of report writing for achievement of academic and research goals. Various kinds of reports / presentations. Characteristics of academic and research reports / presentations.	6 h.
Unit 2	Research paper writing Types of research papers, Structure of research papers, Research paper formats, Abstract writing, Methodology, Results and discussions, Different formats for referencing, Ways of communicating a research paper.	6 h
Unit 3	Thesis writing Structure of a thesis, Scope of the work, Literature review, Experimental / computational details, Preliminary studies, Results and Discussions, Figures and Tables preparation, Conclusions and future works, Bibliography, Appendices	6 h
Unit 4	Tools and Techniques Various word processors, e.g, MS Word, Libra-office, Latex etc. Making effective presentations using Power Point and Beamer, Uses of plagiarism detection tools.	6 h
Unit 5	Miscellaneous ReportsWriting research proposals, Writings project proposals, Lecture notes,Progress reports, Utilization reports, Scientific reports etc.	6 h
Suggested read 1. Ac Te 2. ht 3. <u>ht</u> 4. ttp 5. <u>ht</u> 6. A 7. Or	dings: cademic Research & Report Writing By Dr. Samir Roy ,National Insechnical Teachers Training and Research, Kolkata tps://onlinecourses.swayam2.ac.in/ntr21_ed23/preview tps://www.youtube.com/watch?v=Xp2PVO3do34 os://www.theiet.org/media/5182/technical-report-writing.pdf tp://www2.hawaii.edu/~sugihara/courses/HCU2016s_TC/notes/TechWriting Step-by-Step Guide to Writing Academic Papers, by Anne Whitaker Septem n Writing a Thesis by C P Ravikumar, IETE Journal of Education, 2000	stitute of <u>1.html</u> ber 2009

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AC401C.1	• Able to write reports on various activities including academic and research effectively and efficiently.	3

AC401C.2	٠	Apply the principles and techniques of report writing for effective	3
		dissemination of the academic and research findings.	

	AC-401(D): Intellectual Property Rights (IPR) (Professional and Social + Value Added Audit course; Practical; 2 Credits)	
	 Course Objectives (CObs): To provide basic knowledge on intellectual property rights and their implications. To understand patent rights and ownership of patents. 	
Unit 1	Intellectual Property Rights: What is IPR?, Types of IPR- Patent, Copyright, Designs, Trade mark, Trade secret, Domain names, Geographical indications, Difference between IP and IPR, Relevance of IPR in today's world	4 h.
Unit 2	Patents:- History of Indian Patent System, Indian patent Law 1970 at a glance, Criteria for patenting an invention, Routes to file patents in India, Procedure to file patent in India,	4 h
Unit 3	Structure of IPR Offices in India, Fees of patenting in India, Restoration of Patents,	3 h
Unit 4	Patent rights and ownership of patents: Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Compulsory Licence	4 h
Unit 5	Infringement of patent Infringement of patent Rights and Offences, Actions against Infringement and Remedies and Relief	4 h
Unit 6	Discussion on Case studies - Trade secret, Geographical indication	4 h
Unit 7	Discussion on case studies – Trade mark, Compulsory Licence	4 h
Unit 8	Discussion on - Career in Intellectual Property Rights	3 h
Suggested 1. C P 2. G N	I readings: omplete Reference to Intellectual Property Rights Laws. (2007). Snow ublication Oct. anguli, P. (2001). Intellectual property rights: Unleashing the knowledge eco we Delhi: Tata McGraw-Hill Pub.	White onomy.
3. N 4. O 5. W	ational Portal of India. http://www.archive.india.gov.in office of the Controller General of Patents, Design & Trademarks; overnment of India. http://www.ipindia.nic.in/	
5. W 6. W 7. <u>h</u> 8. P 9. C 10. <u>h</u> 11. Ir	Vorld Trade Organization. <u>http://www.wto.org</u> <u>ttps://www.youtube.com/watch?v=2YEr9hpuAfA&t=12s</u> atent Act 1970 - <u>https://www.youtube.com/watch?v=9r3OneOW6YE</u> areer in IP <u>https://www.youtube.com/watch?v=iwI8lyo90mM</u> <u>ttps://www.youtube.com/watch?v=vdJm7pY2JoU</u> afringement of patenthttps://www.youtube.com/watch?v=6y5j7HoixhU	

- 12. https://www.youtube.com/watch?v=7ihGrOxxe88
- 13. Geographical indication <u>https://www.youtube.com/watch?v=7k5rCsnlMSI</u>
- 14. Copyright act https://www.youtube.com/watch?v=owhEPIEb5JA

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	СО	Cognitive level
AC401D.1	Understand basics of intellectual property rights.	2
AC401D.2	Able to know patent rights and ownership of patents.	3
