KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, MS, JALGAON

SCHOOL OF CHEMICAL SCIENCES
(Academic Flexibility since 2009)

SYLLABUS

For

MASTER OF SCIENCE IN CHEMISTRY

(With specialization in Pesticides and Agrochemicals)

Department of Pesticides and Agrochemicals,
School of Chemical Sciences,
Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon, MS, India Pin 425 001

Semester I to IV
(Choice Based Credit System, 60:40 Pattern)
w. e. f. June 2019

Summary of Distribution of Credits under CBCS Scheme
for
M.Sc. in Pesticides and Agrochemicals
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 Pesticides and Agrochemicals, School of Chemical Sciences
Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon
M. Sc. Pesticides and Agrochemicals
Choice Based Credit System (Outcome Based Curriculum) with effect from 2019 -2020

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	3	12+0	**14**	4	0+8	8	1	2	2	**22**
II	3	12+0	**14**	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 Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	12	03	12	03	12	03	12	03	**48**
(B)	**Skill Based/ Subject Elective Courses**									
1	Theory	02	04	02	04	-	-	-	-	**04**
2	Practical	06	03	06	03	06	01	12	02	**30**
3	Subject Elective Courses	-	-	-	-	04	01	-	-	**04**
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	02	01							**02**
2	Personality and Cultural Development Related Course			02	01					**02**
3	Technology Related + Value Added Course					02	01			**02**
4	Professional and Social + Value Added Course							02	01	**02**
	Total Credit Value	**22**	**08**	**22**	**08**	**24**	**06**	**26**	**06**	**94**

***List of Audit Courses** (Select any ONE course of Choice from Semester II; Semester III and Semester IV)*

Semester I (Compulsory)		**Semester II** (Choose One) **Personality and Cultural Development**		**Semester III** (Choose One) **Technology + Value Added Course**		**Semester IV**(Choose One) **Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Practicing Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Practicing Yoga	AC-301C	Introduction to Research	AC-401C	Technical Report Writing
		AC-201D	Introduction to Indian Music	AC-301D	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 Pesticides and Agrochemicals
Common Course Structure for the First Year (60+40 Pattern)
(w. e. f. June 2019)

Semester-I

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
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

Semester-II

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
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 (Choose Any One out of five: PC/PA/IC/PH/ AN-204)	Basic Concepts of Polymer Chemistry	02	--	02	20	--	30	--	50	--	02
PA-204		Basic Concepts of Pesticides and Agrochemicals Chemistry	02	--	02	20	--	30	--	50	--	02
IC-204		Basic Concepts of Industrial Chemical Process	02	--	02	20	--	30	--	50	--	02
PH-204		Chemical Mathematics	02	--	02	20	--	30	--	50	--	02
AN-204		Basic Concepts of Instrumentation and Analysis	02	--	02	20	--	30	--	50	--	02
CH-205	Skill Based	Laboratory Course in Inorganic Chemistry-I	--	04	04	--	20	--	30	--	50	02
CH-206	Skill Based	Laboratory Course in Organic Chemistry-I	--	04	04	--	20	--	30	--	50	02
CH-207	Skill Based	Laboratory Course in Physical Chemistry-I	--	04	04	--	20	--	30	--	50	02
AC-201 (A)/(B)/ (C)/(D)	Audit Course	Choose one out of four (AC-201 (A)/(B)/(C)/(D)) (Personality and Cultural Development Related)		02	02		100	--	--	--	100	02

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

AC-201(A): Soft Skills, AC-201(B): Practicing Sports Activities, AC-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 Pesticides and Agrochemicals
School of Chemical Sciences
Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
Syllabus for M.Sc. Part-II Pesticides and Agrochemicals [Semester III and IV]
[w. e. f. June 2019]

Course Structure for Second Year

Semester-III

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
PA-301	Core	Pest and Pest Management	04	--	04	40	--	60	--	100	--	04
PA-302	Core	Pesticides Synthesis - I	04	--	04	40	--	60	--	100	--	04
PA-303	Core	Pesticides Formulations	04	--	04	40	--	60	--	100	--	04
PC-304	Elective (Choose one out of six PC-304/PA-304/IC-304/OC-304/PH-304/AN-304)	Physical Chemistry of Polymers	04	--	04	40	--	60	--	100	--	04
PA-304		Advanced Agrochemicals, Biopesticides and Fertilizers										
IC-304		Pharmaceutical Chemistry										
OC-304		Heterocyclic Chemistry										
PH-304		Physical Chemistry of Polymers										
AN-304		Modern Separation Science										
PA-305	Skill based	Laboratory Course in Pesticides & Agrochemicals – I	--	12	12	--	40	--	60	--	100	06
AC-301 (A)/(B)/ (C)/(D)	Audit Course	Choose one out of five (AC-301 (A)/(B)/(C)/(D)) (Technology + value added course)	02	--	02	100	--	--	--	100	--	02

List of elective courses to offered in Semester-III:

AC-301 (A): Computer Skills, AC-301 (B): Cyber Security, AC-301 (C): Introduction to Research, AC-301 (D): Seminar on Review of Research Paper

* The students appearing for the 3rd semester should select one audit course out of four [AC-301(A-D)]

Semester-IV

Course Code	Course Type	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
						Internal		External		Total		
			Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
PA-401	Core	Biochemistry and Toxicology of Pesticides	04	--	04	40	--	60	--	100	--	04
PA-402	Core	Pesticide Synthesis-II	04	--	04	40	--	60	--	100	--	04
PA-403	Core	Herbicides and Plant Growth Regulators	04	--	04	40	--	60	--	100	--	04
PA-404	Skill based	Laboratory Course in Pesticides & Agrochemicals – II	--	12	12	--	40	--	60	--	100	06
PA-405	Skill based	Short Term 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 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 Note: The projects will be initiated in the beginning of Semester III and the examination will be conducted at the end of Semester IV.**

Important Notes:

1. Each theory course prescribed for M. Sc. should be covered in 4 lectures, each of 60 minutes duration per week per course including lectures, tutorials, seminars, classroom discussions, etc. (Total 60 h / theory course)
2. Each practical course will require 12 h of laboratory work per week per semester. The research project will be extended over two semesters (06 h/week) and will be examined at the end of the year. (Total 180 h / practical course)
3. There should not be more than 10 students in a batch for M. Sc. Practical course.
4. For theory course the question paper (Internal/External) may include numerical, short answer, long answer, MCQ questions to test understanding of the subject.
5. Of the 60 lectures in each course about 10 lectures will include tutorials, student seminars, classroom discussions and tests.
6. The marks for each paper are distributed as external examination 60 marks and internal examination 40 marks. For internal assessment of each theory and practical course, 2 written tests will be taken.
7. The 80 % attendance of students is compulsory.
8. It is expected that students should visit chemical industries in two years of M. Sc. and submit the observations/report to the Department.
9. Students are expected to undergo one-month practical training (at their own cost) in relevant industries. The said training is proposed after II / III semester.
10. Organizing educational tour aiming at giving practical exposure to students is expected (at their own cost). At the end of tour, students should submit the observations/report to the respective department.

School of Chemical Sciences,

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon, MS, India

M. Sc. Chemistry (with specialization in Pesticides and Agrochemicals)

Program at a Glance

Name of the program (Degree)	: M.Sc. (Pesticides and Agrochemicals)
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, 06 subject elective credits and 08 audit credits)

School of Chemical Sciences,

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M. Sc. Chemistry (with specialization in Pesticides and Agrochemicals)

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 utilize 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 mold 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.

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

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

PO No.	PO	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 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 help 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**

School of Chemical Sciences,

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M. Sc. Chemistry (with specialization in Pesticides and Agrochemicals)

Program Specific Objectives for M.Sc. in Pesticides and Agrochemicals program:

- To offer the graduate theoretical and practical knowledge of agrochemicals along with methods of controlling pests.
- To offer recognition as a chemist with understanding of various pesticides with respect to synthesis of pesticides, their formulations development and analysis of physico-chemical properties.
- To make the graduate experienced to take up the responsible positions in academic and research as well as in agrochemicals manufacturing and formulation industries, R & D and QC laboratories and even make them capable to start their own business units.

Program Specific Outcomes (PSOs) for M.Sc. in Pesticides and Agrochemicals program:

Students who graduate with a Master of Science in Pesticides and Agrochemicals will:

PSO No.	PSO	Cognitive level
PSO1	Apply the fundamental knowledge of pest control methods including IPM and various agrochemicals containing botanicals and bio-pesticides, different ways of their formulations and analysis.	**4**
PSO2	Develop as a special chemist for agrochemical industries with thorough understanding of theoretical and practical applications of agrochemicals.	**6**
PSO3	Shoulder responsibilities in institutes of various fields particularly synthesis, characterization and formulations of agrochemicals and certain graduates can become entrepreneurs as they can easily prepare agrochemicals and develop formulations for suitable applications.	**6**

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.

Molecular Orbital Theory and its application. BeH_2, BF_3, CH_4, NH_3, H_2O.

Unit II **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** **12 h**

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 cytochrome, 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.
7. 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.	CO	Cognitive level
CH101.1	demonstrate knowledge of advanced content in the areas of inorganic chemistry such as in Molecular symmetry, organometallic compounds, bioinorganic compounds, Chemistry of non-transition element and ionic solids	**3**
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 their biochemical action as well as the techniques frequently used in bio inorganic chemistry such as oxygen transport, e-transfer, catalysis, transport, storage etc.	**4**

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 Stereoisomer's **B] Aromaticity -** Huckel's rule and Concept of Aromaticity, Non aromaticity and Antiaromaticity, Annulenes and Heteroannulenes, Fullerenes (C60).	**12 h**
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.	**12 h**
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.	**12 h**
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	**12 h**

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.

Unit V **Electrophilic additions to unsaturated carbon** **12 h**

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:

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.

Course Outcomes (COts):

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

CO No.	CO	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 in solving 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** **12 h**

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** **12 h**

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** **12 h**

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

Unit IV **Nuclear Chemistry** **12 h**

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** **12 h**

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, Addision Weslay.
4. W. J. Moore, Physical Chemistry, Orient Longman, 1998.
5. S. Glasstone, D. Van Nostrand, Thermodynamics for Chemist, 1965.

6. S. Glasstone, V. Nostrand, An Introduction to Electrochemistry, East-West 1965.
7. J. O'M Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. I and II, 2nd Edition, Plenum, 1977.
8. R. A. Robinson and R. H. Stokes, Electrolytic Solutions, Butterworths, London, 1959.
9. H. J. Arnikar, Essentials of Nuclear Chemistry, New Age Publication Ltd., 1995.
10. G. Friedlander, J. W. Kennedy, E. S. Macias, J. M. Miller, Nuclear and Radiochemistry, John-Wiley, 1981.
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.	CO	Cognitive level
CH103.1	Acquire knowledge on the fundamental and advance concepts of thermodynamics	**3**
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 **06 h**

A. History and importance of safety and health in Laboratory - Moral, legal 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 **06 h**

Personal Protective and other safety equipment and their uses and 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 earmuffs 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.

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 their discrepancies, Globally Harmonized System for Safety Data Sheets (SDS), label changes (2014).	**06 h**
Unit IV	Inventory Management, Storage and Disposal, Waste classification, Hazardous waste, Non-Hazardous waste, mixed waste, Waste disposal, Actions required for – Chemical spills, Mercury spills, Injuries, Fires, Building evacuations, Emergency evacuation procedure.	**06 h**
Unit V	Good Laboratory Practices (GLP)**,** Introduction and principles of GLP, 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.	**06 h**

Recommended Books:

1. L. Moran, T. Masciangioli, Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management, The National Academies Press, Washington, DC, 2010.
2. 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):

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

CO No.	CO	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, Textbook 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.	CO	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 Analysis and 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
3. L. D. Field, S. Sternhell, J. R. Kalman, Organic Structures from Spectra, 4th Edition, John Wiley & Sons, Ltd.

Course Outcomes (COts):

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

CO No.	CO	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 p^{Ka} 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 in aqueous 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, Textbook of Quantitative Inorganic Analysis.
3. R. C. Das and B. Behera, Experimental Physical Chemistry, 1984.
4. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing.
5. F. Daniels and J. Williams. Experimental Physical Chemistry, Mcgraw-Hill Publishing Co., Ltd
6. D. Shoemaker, Advanced Physical Chemistry Experiments.
7. 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.	CO	Cognitive level
CH-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**
CH-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 (Pesticides and Agrochemicals): 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)
    - 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):

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

CO No.	CO	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** **12 h**

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 and octahedral complexes, selection rule, noncrossing rule.

Unit II **Charge transfer transition** **12 h**

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** **12 h**

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

hydrolysis, stereochemistry, isomerisation reactions.

Unit IV **Catalysis** **12 h**

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** **12 h**

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:

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.
7. 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.
15. 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):

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

CO No.	CO	Cognitive level
C201.1	illustrate microstates, spectroscopic terms and orgel and Tanabe-Sugano diagram of inorganic molecules for octahedral and tetrahedral complexes	**3**
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** **12 h**

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** **12 h**

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

Unit III **Reagents in organic synthesis** **12 h**

Gilman's reagent, diisopropylamide (LDA), dicyclohexylcarbodimide (DCC), 1, 3-dithiane (reactivity umpolung), Trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and Prevost hydroxylation, osmium tetraoxide (OsO_4), DDQ, selenium dioxide, Chromic acid, phase transfer catalysts, B_2H_6, Peterson's synthesis, Wilkinson's catalyst, Baker's yeast.

Unit IV **Stereochemistry** **12 h**

Stereoisomers, Chirality, Enantiomers, Diastereo isomers, R-S nomenclature, E-Z isomerism, Meso Compounds, Threo and Erythro isomers. 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** **12 h**

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, amides, anhydrides, lactones and lactams. Effect of hydrogen bonding and

solvent effect on vibrational frequencies, applications of IR.

C] ^{1}H 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 & ^{1}H NMR.

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, Introduction to Spectroscopy.

Course Outcomes (COts):

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

CO No.	CO	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** **12 h**

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** **12 h**

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 viscometry and osmometry method), chain polymerization and its kinetics, kinetic chain length and its significance, step growth polymerization and its kinetics.

Unit III **Microwave Spectroscopy** **12 h**

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** **12 h**

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** **12 h**

Introduction, photochemical reactions, quantum yield, Jablonski diagram,

photosensitization reactions, fluorescence (resonance fluorescence, 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.
4. 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.
8. 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,
11. Rohatgi-Mukherjee, Fundamentals of Photochemistry, Wiley-Eastern Ltd., New Delhi, 1978.
12. 12. R. P. Wayne, Principles and Application of Photochemistry, Oxford University Press, 1988.

Course Outcomes (COts):

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

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

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 know basics 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)

Unit I	**Basic concepts and classification of polymers**	**06 h**
	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**	**06 h**
	Mechanisms of chain and step growth polymerizations, ring opening polymerisation, Miscellaneous polymerisations - electrochemical polymerisation, metathesis polymerisation, group transfer polymerisation	
Unit III	**Techniques of polymerisations**	**06 h**
	Bulk polymerisation, solution polymerisation, suspension polymerisation, emulsion polymerisation, melt polycondensation, solution polycondensation, and interfacial polycondensation, solid and gas phase polymerisation	
Unit IV	**Molecular weights and nomenclature of polymers**	**06 h**

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**

Polymer degradation and stability, thermal degradation, chain scission, non-chain scission, oxidative and UV stability, chemical and hydrolytic stability, radiation effect, mechano degradation, biodegradation – biodegradable polymers (PLA) and starch additives.

Recommended Books:

1. 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 Science, John Wiley and Sons, New Delhi, 1984.
7. 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):

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

CO No.	CO	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 Agrochemicals 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 study of the ways of pest control.

Course Contents (Topics and subtopics)

Unit I **Pests** **06 h**

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

Unit II **Pest Control** **06 h**

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 (Heliothis Armigera).

Unit III **Agrochemicals** **06 h**

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**

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

Unit V **Effects of Pesticides** **06 h**

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. Chattopadhyay, Principles and procedures of plant protection. Oxford & IBH Publishing Company, Pvt. Limited; 1991.
5. A. S. Atwal, Agricultural 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.	CO	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 related industries.	**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** **06 h**

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 process technology, Classification of chemical reactions, Batch and continuous operations, Industrial chemical reactions, Conversion, Selectivity and Yield.

Unit II **Unit Operations** **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** **12 h**

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.
3. 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.	CO	Cognitive level
IC204.1	Distinguish between unit processes and unit operations of chemical industries.	**5**
IC204.2	Apply the knowledge on newer techniques in industrially important products with the help of various unit processes.	**3**

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 rule, partial differentiation, numerical.	**06 h**
Unit III	Integration, integration formulas-indefinite and finite integrals, numerical.	**06 h**
Unit IV	Permutations and combinations: fundamental theorem, permutations, combinations, probability, numerical.	**06 h**
Unit V	Vectors, matrices, determinants, sterling approximation, numerical	**06 h**

Recommended Books:

1. P. W. Atkins, Physical Chemistry, ELBS, 1998
2. G. M. Barrow, Physical Chemistry, International student edition, 2003.
3. Principles of Physical Chemistry, Vishal Publishing Co., Jalandhar, 2008.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PH204.1	Get in-depth knowledge on fundamental and advance concepts of basic mathematics course, which is essential for chemical sciences.	**4**
PH204.2	This knowledge is also required for solving various mathematical equations that need to be solved in several physical chemistry courses.	**4**
PH204.3	Apply the knowledge to explore applications of chemical mathematics to student will be able to solve numerical problems in physical chemistry.	**3**

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:** **12 h**

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:** **12 h**

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:** **12 h**

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

Unit IV **Basic analytical process:** **12 h**

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**

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.	CO	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 copper by 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.
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.	CO	Cognitive level
CH204.1	Analyse the alloy concentration and Estimate volumetrically the concentration of Zn and Cu using titration method	**4**
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 coordination compounds	**6**

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 ^{1}H-NMR spectrum of above synthesized compounds.

(Any 06 Compounds)

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
3. L. D. Field, S. Sternhell, J. R. Kalman, Organic Structures from Spectra, 4th Edition, John Wiley & Sons, Ltd.

Course Outcomes (COts):

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

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

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, pH metry, 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.
3) 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.
4. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing.
5. F. Daniels and J. Williams. Experimental Physical Chemistry, McGraw-Hill Publishing Co., Ltd
6. D. Shoemaker, Advanced Physical Chemistry Experiments,
7. 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.	CO	Cognitive level
CH 207.1	Provide guidance and practice for each experiment.	**3**
CH 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 (Pesticides and Agrochemicals): 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** **02 h**

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** **04 h**

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.

Unit 3 **Communication Skills** **08 h**

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** **04 h**

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** **08 h**

Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking.

Analytical skills: Definition, Types, problem solving

Unit 6 **Life skills** **04 h**

Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities

Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course Outcomes (COts):

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

CO No.	CO	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-201(B): Practicing Sports Activities

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards sports and provide them required training.

SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

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

CO No.	CO	Cognitive level
AC201B.1	Identify one or more sports of their choice and develop more interest to participate at University/National level sport events.	**2**
AC201B.2	Practice the learned sports activities regularly in real life.	**3**

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
- Sukshma Vyayamas
- Suryanamaskar (12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - UttanPadaasan(Ekpad/Dwipad), Pavanmuktasana, ViparitakaraniAasan, Khandarasan, Shavasana
  - Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana (Ekpad/Dwipad), Makarasana
  - Standing (Dhandsthiti) - Tadasana , Tiryak Tadasana, Virasana, Ardh Chakrasana
- 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.	CO	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.

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- 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 Tabla.
- 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):
On completion of this course, the student will be able to:

CO No.	CO	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

PA-301: Pest and Pest Management
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- The points incorporated in this course will aid understanding of various types of pests and different methods of their control. Thus, the students will be able to know about alternative methods of pest control to chemical control

Course Contents (Topics and subtopics)

Unit I: **12 h**

a) Definition, importance & general classification of agrochemicals. Classification of pesticides on the basis of mode of action and chemical nature.

b) Definition of insect and classification of insects (orders).

Unit II: **12 h**

a) Definition, Introduction, classification of pests. Damage economic threshold level

Life cycle, morphology, nature of damage and management of following pests:

Public health pests- Mosquitoes, houseflies etc.

Agricultural pests- Boll worms, sucking pests, nematodes, grasshoppers etc.

Domestic pests- Bed bugs, cockroaches etc.

Animal husbandry pests- Stable flies, horn flies etc.

Structural pests- Termites and wood borers.

b) Methods of pest controls- Classification: Natural & applied control [physical, mechanical, cultural, biological, genetic, regulatory, chemical controls (including fumigants and fumigation)] Integrated pest management (IPM).

Unit III: **12 h**

a) Concept of insect pest- morphology & internal systems.

b) Plant pests- weeds, bacteria, molluscs, fungi, viruses, birds, mites, nematodes, insects, vermins, orthopods, and plant pathogens, causes of outbreak of pest, growth & development. Insect pest control- principles and practices.

Unit IV: **12 h**

a) Crop pests- Pests of grams, banana, sorghum, cotton, groundnut, tomato, and sugar cane: Nature of damage and pest management.

b) Plant diseases- definition, concept, classification of diseases, symptoms, occurrence, spread- diseases of wheat, banana, groundnut, cotton, citrus,

papaya plants.

Unit V: a) Herbs/Weeds- definition, classification, life cycle and methods of weed control- Physical, cultural, biological, mechanical, chemical etc. **12 h**

b) Pesticides (Insecticide) act & industry- role, shape, names and details.

Recommended Books

1. Handa SK. **Principles of pesticide chemistry**. Agrobios (India); 2012.
2. Hill DS. **Agricultural insect pests of the tropics and their control**. CUP Archive; 1983.
3. Chattopadhyay SB. **Principles and procedures of plant protection.** Oxford & IBH Publishing Company, Pvt. Limited; 1991.
4. Atwal AS. **Agricultural Pests of India and South-East Asia**. Agricultural pests of India and South-East Asia.. 1976.
5. Pradhan S. **Insect pests of crops**. University of California; 1969.
6. Subramanian S, Subramanian S, Mohamed A, Kumar J. **All about weed control**. Kalyani Publishers; 2001.
7. López Ó, Fernandez-Bolanos J, editors**. Green trends in insect control**. Royal Society of Chemistry; 2011.
8. Roberts DA. **Fundamentals of plant-pest control**. Freeman; 1978.
9. Dent D. **Insect pest management.** Cabi; 2000.
10. Chattopadhyay SB. **Principles and procedures of plant protection**. Oxford & IBH Publishing Company, Pvt. Limited; 1991.
11. Singh RS. **Plant diseases**. Oxford and IBH Publishing; 2009.
12. Shree Ramulu, **Chemistry of Insecticides and Fungicides**: U.S. Oxford & IBH Pub, 1995.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA301.1	Illustrate the various types of pests – Insect and non-insect pest.	**3**
PA301.2	Summarize the different methods of pest control.	**5**
PA301.3	Distinguish the advantages and disadvantages of each method.	**4**
PA301.4	Express importance of IPM	**2**

PA-302: Pesticides Synthesis - I
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- This course will offer knowledge of synthesizing organic molecules and Agrochemicals by Retrosynthetic approach. It will also provide knowledge of various types of disconnections. Students will learn everything about the agrochemicals mentioned here, including methods of synthesis by shortest, economical routes and using less hazardous chemicals.

Course Contents (Topics and subtopics)

Unit I: Synthetic Organic Chemistry **12 h**

Introduction to Disconnection, One group Disconnections, Two group Disconnections,

Unit II: **12 h**

a) Synthetic Organic Chemistry: Illogical two group disconnection
b) Retro synthesis of Agrochemicals.

Unit III: **12 h**

a) Introduction: History of pesticides, Innovation of pesticides chemistry, Development of Pesticides.
b) Chemistry of Pesticides: Brief introduction to classes of pesticides (Chemical class, targets), structures, chemical names, physical properties, chemical properties, synthesis, degradation, metabolism, formulations, mode of action, uses, toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc.), methods of analysis.

Unit IV: **12 h**

Insecticides: Classification and Study of following insecticides with respect to structure, chemical name, physical properties, chemical properties, synthesis, degradation, metabolism, formulations,
Mode of action, uses, toxicity,
Organophosphates and Phosphothionates: Acephate, Dimethoate, Chlorpyriphos, Monocrotophos, Temephos, Quinalphos, parathion-methyl.
Organochlorines: Endosulfan,
Carbamate: Cartap hydrochloride, Methomyl, Propoxur.

Unit V: **12 h**

a) Insecticides: Brief introduction to classes, structure, chemical name, physical properties, chemical properties, synthesis, degradation, metabolism, formulations,
Mode of action, uses, toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc.
Amide: Phthalic dicarboxamide,
Miscellaneous: Fipronil, Bifenthrin, Buprofezin, Decamethrin,

Fenvalerate, Imidachloprid, Indoxacarb, Acetamiprid, lufenuron.

b) Manufacturing processes of some pesticides: Lindane (BHC), DDT, Parathion and Phorate.

Recommended Books

1. Thomas A. Unger, **Pesticide Synthesis Handbook**, Prochrom Industrias Quimicas S/A Elsevier, 1996.
2. Roberts TR, Robert, Hutson DH, Jewess PJ, editors. **Metabolic pathways of agrochemicals: insecticides and fungicides**. Royal Society of Chemistry; 1998.
3. S. K. Handa, **Principles of Pesticide Chemistry,** Ed. By Agrobios (India) ISBN 9788177542165, 2008.
4. Vyas SC**. Handbook of Systemic Fungicides: Compounds**. Tata McGraw-Hill; 1993.
5. Zweig G. **Analytical methods for pesticides, plant growth regulators and food additives** Vol. I –XVII.
6. Matolcsy G, Nádasy M, Andriska V. **Pesticide chemistry**. Elsevier; 1989
7. Cremlyn R. **Pesticides. Preparation and mode of action**. John Wiley & Sons.; 1978
8. Jim A. Turner, **The Pesticide Manual: A World Compendium,** British Crop Production Council, 2018.
9. Baker DR, Fenyes JG, Steffens JJ. **Synthesis and chemistry of agrochemicals I-VI**. Washington, DC: American Chemical Society; 1992
10. Shreve RN, Austin GT. Shreve's **chemical process industries**. McGraw Hill Professional; 1984.
11. Rao MG, Sittig M. **Dryden's Outlines of Chemical Technology**. East-West Press Private Ltd. 1973.
12. Warren S. **Designing organic syntheses: a programmed introduction to the synthon approach.** John Wiley & Sons; 1978.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA302.1	Explain the retrosynthetic approach and various types of disconnections	**2**
PA302.2	Appraise chemistry and applications of agrochemicals	**4**
PA302.3	Decide synthesis by shortest, economical routes and using safe chemicals	**5**

PA-303: Pesticides Formulations
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- This course will convey knowledge requirement of pesticides formulations and types of formulations, advantages and disadvantages of each formulation. It is expected that students should learn about preparation of formulations, study of their properties and applications. In addition, the course will also provide them selective information about the use of adjuvants and their role.

Course Contents (Topics and subtopics)

Unit I: **12 h**

a) Introduction of pesticide formulations: Definition, history, purpose, types and codes, brief account of main types. Study of conventional formulations: Dusting Powders/ Dust Formulations (DP), Granules (GR), Water Dispersible Powders/Wettable powders (WDP/WP), Soluble Concentrates (SL), Emulsifiable concentrates (EC), Ultra Low volume (ULV) with respect to ingredients, advantages, and disadvantages.

b) Important parameters of pesticides formulations- particle size, bulk density, flowability, electrostatic charge, sorptivity, compatibility, surface acidity, alkalinity and their effects on stability, rain fastness, shelf life of formulation, Rheological properties

Unit II: **12 h**

a) Solvents and Adjuvants: General requirements, frequently used solvents, green solvents safer alternative to petroleum-based solvents, Carriers, additives, adjuvants- anti-drift, anti-setting, anti-freezing, antifoaming agents, penetrants, preservatives, dyes, thickeners, safeners, compatibility agents, stickers, buffers and synergists used in pesticide Formulations.
Surfactants: definition, structure, Role, types, Hydrophilic Lipophilic Balance (HLB), physical properties and examples of **Anionic** – Carboxylate, Sulphate, Sulphonate, Phosphates and their Esters, **Cationic** – Quaternary Ammonium Products, **Non-Ionic** – Ethoxylates of Fatty Acids, Castor oil, Phenol

b) Equipment for preparation. - Air jet mill, Extruders, Granulators, Sand/ Bead mill, Fluid Bed Dryer, Spray Dryer etc.

Unit III: **Study of Formulations: Composition, preparation, properties, application, advantages and disadvantages** **12 h**

a) Current trends: safer water-based formulations: Suspension

Concentrates (SC), Suspoemulsions (SE), Water Dispersible Granules /Wettable Granules (WDG/WG), Microcapsule suspension (CS), Oil Dispersion (OD), Microemulsions (ME), Emulsion in water (EW), and multiple emulsions, Tablets (TB), and Dispersion Concentrates (DC).

b) Formulations for specific Applications: Seed treatment: Brief study of Dry powder Seed Treatments (DS), Water Slurriable Powders (WS), Liquid Solution Seed Treatments (LS), Flowable Seed Treatments (FS), Emulsion Seed Treatments (ES), Microcapsule Seed Treatments (CF), Gel For seed Treatments (GF), Water dispersible Granules Seed Treatments (WG) Aerosols, Fogging formulations, Smoke generators, Baits, Soluble Powders (SP), Soluble Granules (SG).

Unit IV: **12 h**

a) Tests for quality control - A brief introduction on Parameters and Specifications of Pesticide technical and formulations (WHO/FAO/BIS) Methods of analysis of Physical properties of formulations- Suspensibility, Wettability, Emulsion stability, Wet sieve test, Acidity, Alkalinity, Moisture content, Specific gravity, Persistent foaming, Water runoff test, dry sieve test etc. and their significance during field application.

b) Regulatory Requirements and Regulations of Pesticides, Packaging, Labelling and use.

Unit V: **12 h**

a) Formulation packaging: introduction, current trends in single trip containers:

I) Liquid Formulations: rigid plastics, High Density Polyethylene, (HDPE), Polyethylene Terephthalate (PET), Ethylene Vinyl Alcohol (EVOH), Polyamide (PA).

II) Solid Formulations: Polyethylene, Laminates – Low Density Polyethylene (LDPE), Aluminum foil, LDPE plus ether, Polypropylene (PP), Polyester (PET), Polyamide (PA), Biodegradable plastic, Paper, Water soluble Films of PA on packaging material used to pack pesticides (technical and formulation) like Dust, EC, SC, WP, WDG).

b) Application of Pesticides and devices used – Dusters and sprayers, types of nozzles. Calculation of amount of formulation required for field application.

Recommended Books

1. Knowles A. **New developments in crop protection product formulation**. T&F Informa UK Ltd. 2005.
2. Ashworth R. CIPAC handbook. Volume 1. **Analysis of technical and formulated pesticides. CIPAC handbook**. Volume 1. Analysis of technical and formulated pesticides. 1970.
3. Van Wade. Velkenburg- Marcel & Delker, **Pesticide Formulations** Published by Marcel Dekker, New York, 1973.
4. B. S. Parmar, S. S. Tomar, **Pesticide Formulation : Theory**, CBS Publishers and Distributors, 2008
5. S.B. Shrivastava & V.K, **Agarwal Agrobase industries & pesticide formulations (Modern pesticides industry & their formulations)** Small Business Pub.
6. WadeVan Valkenburg, B. Sugavanam, Sushil K. Khetan, **Pesticide formulation- recent development and their application in developing countries**, UNIDO, 2008.
7. Foy C. L. and Pritchard D. W., **Pesticide Formulation and Adjuvant Technology,** CRC Press, 2008.
8. Salil Singhal, **Manual for pesticides users,** Pesticides Association of India, New Delhi,1989
9. H. B. Scher, **Advances in pesticides formulation technology**, ACS No. – 254, Washington, DC, 1984.
10. J. Miyamoto and P. C. Kearney **Pesticide Chemistry Human Welfare and the Environment vol. IV Pesticide Residue and Formulation Chemistry**, Pergamon press,1985.
11. M Bahadir and G. Pfister, **Chemistry of plant protection vol. 6,** Springer Verlag Berlin Heidelberg ,1990.
12. B. Cross and H.B. Scher, **Pesticides formulations,** ACS symposium series 371,1987.
13. World Health Organization. **International code of conduct on the distribution and use of pesticides:** guidelines for quality control of pesticides. World Health Organization; 2011.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA303.1	Practice preparation, study properties & packaging of different formulations	**3**
PA303.2	Recommend effective, economical formulations safe for operators and ecosystem	**5**

PA-304: Advanced Agrochemicals, Biopesticides and Fertilizers
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- Fundamental and applicative knowledge of biopesticides and bio-fertilizers, particularly insects, plant and microbes-based alternatives to chemical pesticides and fertilizers. Some speciality chemicals such as Chemosterilants, Pheromones, attractant, repellents, baits and insect growth regulators will also be covered here.

Course Contents (Topics and subtopics)

Unit I: **12 h**

a) Botanicals and biopesticides – Introduction:
   i. Potential pesticidal plants of India
   ii. Plant extraction and Bio-organisms - use and potential
   iii. Role of Neem in plant protection-constituents, Bioefficacy of various preparations, Azadirachtin and its role in pest control, Chemistry of Pyrethrins and Pyrethroids, Rotenone, Nicotine and nicotinoids.

b) Biological pest control- Use of predators (lady bird beetle, crysopa) and parasites (Trichogramma) in insect control, pathogens in disease and insect control (*Bacillus thuringiensis*, NPV).

c) Chemosterilants- (alpha-Naphthylthiourea (ANTU), Thiourea, Apholate, Tepa, Metepa).

Unit II: **12 h**

Pheromones, attractants, repellents – Introduction, types and application (8-Dodecen-1-ol, 10-cis-12-hexadecadienoic, Trimedlure, Cue-lure, methyl eugenol, N,N- Diethyl-m-toluamide, Dimethyl phthalate, Icaridin).
Baits- Metaldehyde, Iron (II) phosphate, Indoxacarb, Zinc Phosphide, Bromadiolone

Unit III: **12 h**

Insect Growth Regulators – Definition, types, mode of action and role in pest management
Natural and synthetic Juvenile hormones- JH- I, II, III, Methoprene, Fenoxycarb)
Chitin synthesis inhibitors - Novaluron, Buprofezin, diflubenzuron
Juvenile hormone analogs and mimics- Methoprene.
Moulting Hormone Agonists - Halofenozide, Tebufenozide
Moulting Hormones Ecdysone, Ecdysterone
Moulting Inhibitors - Diofenolan
Precocenes - I, II, III.

Unit IV: **12 h**

Biotechnology in Pest Management
Brief Introduction, BT methodology, genetically modified and transgenic

plants (BT cotton, Brinjal, Golden Rice, High Lysine maize)

Unit V: a) Fluid fertilizes – Brief introduction, Methods of fertilizer applications, fertigation, Types of fluid fertilizers, properties, characteristics, criteria of application. **12 h**

b) Biofertilizers – Introduction, definition, classification, Rhizobium, Azatobactor, Azospirillium, Azolla, Blue Green Algae, VAM, Vermicomposting.

Recommended Books

1. Singh SP, Parmar N, Kuhad RC. **Biological control of pests. Advances in horticulture III**. (pp.1591-616) Malhotra Publishing House, New Delhi, 1993.
2. López Ó, Fernandez-Bolanos J, editors. **Green trends in insect control**. Royal Society of Chemistry; 2011.
3. Coppel HC, Mertins JW. **Organisms Used in Classical Biological Insect Pest Suppression**. In Biological Insect Pest Suppression (pp. 73-165). Springer, Berlin, Heidelberg, 1977.
4. Hodgson E. **Safer Insecticides Development and Use: Development and Use.** CRC Press; 1990.
5. Jacobson M. **Insect sex pheromones**. Elsevier; 2012.
6. S. K. Handa, **Principles of Pesticide Chemistry** -, Ed. By Agrobios (India) ISBN 9788177542165, 2008.
7. Joshi SR. **Biopesticides: a biotechnological approach**. New Age International; 2006.
8. Ignacimuthu S, Sen A, Janarthanan S. **Biotechnological applications for integrated pest management.** Science Publishers, Inc.; 2000.
9. Maramorosch K. **Biotechnology for Biological Control of Pests and Vectors**: 0. CRC press; 2017 Dec 22.
10. Rimando, Agnes M., and Stephen O. Duke. **"Natural products for pest management."** 2006.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA304.1	Evaluate and spread information of Biological pest control, use of biotechnology and other pest control agents as alternative to Chemical pesticides	**4**
PA304.2	This can open an avenue to select employment and research activities in safe and effective pest control.	**5**

PA-305: Laboratory Course in Pesticides & Agrochemicals – I
(Minimum 14 practical, 100 Marks and 6 Credits)

Course Objectives (CObs):

- This laboratory course is constructed for learning different techniques such as organic synthesis, interpretation of spectroscopic data, identification of formulations, study of properties of formulations. The course also provides hands on training pertaining to prepare different formulations. Collection, identification and rearing of pests as well as termite control on site is also included in this course.

Practical's included

a) Spectroscopic Characterization: Identification of organic compounds and pesticides on the basis of given UV, IR, PMR and Mass data.

b) Synthesis of pesticides/ analogues:

1. Phenyl benzoate. 2. Acetanilide 3. p-Bromoacetanilide
4. p-Bromoaniline 5. Benzanilide. 6. N, N-Diphenyl benzanilide
7. Phthalimide

c) Preparation and analysis pesticides Formulations:

1. Identification of Pesticides formulations.
2. Determination of bulk density of pesticidal WP/WDG/Dust/SP.
3. Determination of wettability and wetting time of pesticidal WP/WDG/Dust/SP.
4. Performing wet sieve test of pesticidal WP/WDG/Dust/SP.
5. Determination of Suspensibility of pesticide formulation WP/WDG/SC.
6. Determination of acidity/alkalinity of pesticide formulation by titrimetric method.
7. Determination of moisture content of pesticide formulation by Dean-Stark method.
8. Preparation of granules/WDG formulation.
9. Preparation of WP formulation.
10. Volumetric determination of acidity/ alkalinity of WP.
11. Determination of stability of emulsion.
12. Estimation of available chlorine in bleaching powder.
13. Estimation of technical Lindane by hydrolysable chlorine method.
14. Estimation of Malathion content in a given sample.
15. Colorimetric estimation of Parathion.
16. Estimation of Phorate in a given formulation.
17. Determination of Quinalphos content.
18. Determination of amount of copper in given copper fungicide.
19. Determination of purity of copper fungicide.

d) Collection (Field visits) identification and classification of different insect pests- study about nature of damage and pest control. Termite control on site.

e) Rearing of – *Spodoptera Litura / Helothisarmigera* / Red cotton bug.

*Suitable experiments may be added as per need of subject.

Recommended Books

1. Ramulu U.S., **Methods of Pesticides Analysis**. Oxford & IBH Pub.; 1979.
2. Zweig G, Editor**. Principles, Methods, and General Applications: Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives.** Elsevier; 2013.
3. Vogel A.J., **Vogel's textbook of practical organic chemistry: including qualitative organic analysis**. 1978.
4. Bansal R. K., **Laboratory manual of organic chemistry.** New Age International; 2009.
5. Vishnoi N. K., **Advanced practical organic chemistry**. Vikas; 1979.
6. Martijn A**., Analysis of Technical and formulated pesticides. CIPAC Handbook.** 1988.
7. Silverstein, R.M. and Bassler, G.C., **Spectrometric identification of organic compounds**. 1963.
8. Sharma Y.R., **Elementary organic spectroscopy.** S. Chand Publishing; 2007

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA305.1	Focus on hands on training for formulation preparation and analysis	**4**
PA305.2	Experiment organic syntheses and interpretation of spectroscopic data	**4**
PA305.3	Collect, identify and rear insects as well as can perform termite control on site	**3**
PA305.4	Finally, students can organize themselves to work in synthesis or formulation R & D or independent research activities or can start own production unit	**4**

M.Sc. Part II Semester III (Pesticides and Agrochemicals): Audit Courses

AC-301(A): Computer Skills

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- To inculcate different daily useful computer skills among students.

Unit 1 Elements of Information Technology **02 h**

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 /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics

Unit 2 Office Automation-Text Processing **05 h**

2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, Reading Layout View
2.2 Working with Files: Create New Documents, Open Existing Documents, Save Documents 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, margins
2.4 Lists: Bulleted and Numbered Lists,
2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Move and Resize Tables, Moving the order of the column and/or rows inside a table, Table Properties
2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents
2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters
2.8 Types of document files: RTF, PDF, DOCX etc.

Unit 3 Office Automation-Worksheet Data Processing **05 h**

3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets
3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells
3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells
3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts

Unit 4 Office Automation- Presentation Techniques and slide shows **06 h**

4.1 Create a new presentation, Auto Content 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 or Text box properties, Bulleted and numbered lists, Adding notes
4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replace fonts, Line spacing, Change case, Spelling check, Spelling options
4.4 Working with tables: Adding a table, entering text, Deleting a table, Changing row width, 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: 04 h

5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing the Internet, 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 services

5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing

5.6 e-learning: e-Books, e-Magazines, e-Newspapers, OCW (open course wares): Sakshat (NPTEL) portal, MIT courseware

Unit 6 Cloud Computing Basics 03 h

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):

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

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

AC-301(B): Cyber Security

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- To make students aware of different daily useful cyber security skills/rules.

Unit 1 **Networking Concepts Overview** **03 h**

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

Unit 2 **Security Concepts** **07 h**

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.

Unit 3 **Security Threats and vulnerabilities** **07 h**

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

Unit 4 **Cryptography** **05 h**

Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure

Unit 5 **System & Network Security** **03 h**

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 **02 h**

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.

Unit 7 Security Laws and Standards **03 h**

Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.

Suggested readings:

1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon
2. BPB Publication, "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore, Aatif Jamshed
3. CreateSpace Independent Publishing Platform, "Cyber Security Basics", Don Franke, ISBN-13: 978-1522952190ISBN-10: 1522952195
4. Online references

Course Outcomes (COts):

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

CO No.	CO	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):

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

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):

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

CO No.	CO	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

PA-401: Biochemistry and Toxicology of Pesticides
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- This course is designed for understanding toxic effects of pesticides on health and environment. The course is also intended to study the Biochemistry and physiological significance of pesticides and precautions to be taken. Entry of pesticides in ecosystem and analysis of residues is also covered under this course.

Course Contents (Topics and subtopics)

Unit I: Biochemistry and Physiological significance of Pesticides: 12 h

a) Penetration - Mode of entry of pesticide.
b) Distribution - transfer within the organism, distribution, methodology.
c) Metabolism - biochemistry and physiological significance, microsomal and extra microsomal metabolism, metabolism of organo chlorinated, organophosphorus, carbamate, botanical & biopesticides.

Unit II: Pesticide Toxicology: 12 h

a) Introduction- basic principles of toxicology, areas of toxicology and categories of toxicologist, routes of exposure/exposure characteristics, chemical interaction of toxicants, dose-response relationships, GLP/protocols for toxicity studies (descriptive animal toxicity test) and their significance, natural defense mechanism.
b) Toxicology of organophosphates, carbamates and organochlorines- signs, symptoms and medical treatment for poisoning, bioactivation and inactivation, cholinesterase inhibition and mechanism, antidote action and mechanism.
c) Selectivity of pesticides- concept and significance, penetration & metabolism, excretion, experimental study of toxicology

Unit III: Health Effects of Pesticides 12 h

a) Action of pesticide on nervous system - physiology of nervous system, cholinesterase inhibition pesticide resistance.
b) Special effects of pesticides/ toxicants- teratogenic, mutagenic, carcinogenic effects (mechanism for cancer formation).
c) Resistance to pesticides- concept, types and significance

Unit IV: Safety with pesticides: **12 h**

a) First aid, antidotes, pesticide label and leaflet, pesticide deterioration tests.
b) Storage & transportation of pesticides.
c) Decontamination (pesticide spills, pesticide. containers, application equipments and safety equipments) Sanitary classification of pesticides.
d) Effluent treatment of agrochemicals, ETP for waste water streams generated in manufacture of Pesticides. (one Example).
e) Safety of pesticides to wildlife and public places.

Unit V: Pesticides residues and Analysis: **12 h**

a) Introduction- application of agrochemicals, dissemination pathways of pesticides, causes of pesticide residues, remedies.
b) Pesticides residues in atmosphere- entry into atmosphere, action of pesticides, effects on environments.
c) Pesticides residues in water - entry into water systems, action and effect in aquatic environment.
d) Pesticides residues in soil. entry into soil, absorption, retention and transport in soil, effects on microorganism, soil condition and fertility, decomposition and degradation by climatic factors and microorganism.
e) Effects of pesticides residue on human life- model ecosystem, studies of bio-concentration and biodegradation of pesticides on life, consequent effects on human life, use of pesticides in food and health of human.
f) Effect of pesticides residues on birds and animals- routes for exposure to pesticides, action of pesticides on birds and animals.
g) Analysis of pesticides residues- sample preparation, extraction of pesticides residues (soil, water and vegetables) simple methods and schemes of analysis, multiresidue analysis, statistical methods and validation. Methods of residue analysis: Brief methodology for few compounds from organochlorines, organophosphates, carbamates and other pesticides.

Recommended Books

1. Hassanali A., **Environmental Fate of Pesticides: Progress in Pesticide Biochemistry and Toxicology.** Edited by DH Hutson and TR Roberts John Wiley & Sons, Chichester, International Journal of Tropical Insect Science. 1990.
2. Nollet L.M., Rathore H.S., **Handbook of pesticides: methods of pesticide residues analysis.** CRC press; 2016.
3. Ellerbrock R.H., **Pesticide Residues: Significance, Management and Analysis** 2005.

4. Carlile B., **Pesticide selectivity, health and the environment**. Cambridge University Press; 2006.
5. Kumari B., **Effects of household processing on reduction of pesticide residues in vegetables**. ARPN Journal of Agricultural and Biological Science. 2008.
6. Clark J.M., Kenna M.P., **Fate and management of turfgrass chemicals**. American Chemical Society; 2000.
7. Clark B.W., Phillips T.A., Coats JR. **Environmental fate and effects of Bacillus thuringiensis (Bt) proteins from transgenic crops: a review**. Journal of agricultural and food chemistry. 2005
8. Nollet L.M., Rathore H.S., **Handbook of pesticides: methods of pesticide residues analysis.** CRC press; 2016.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA401.1	Explain toxicity and health issues related to pesticides and precautions to be taken	**4**
PA401.2	Summarize the entry of pesticides in ecosystem and analyse residues	**5**
PA401.3	Ultimately create awareness about occupational hazards amongst the students	**6**

PA-402: Pesticide Synthesis-II
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- This course will offer knowledge of synthesis, mode of action, degradation and metabolism and uses of insecticides, acaricides, fungicides, rodenticides, nematicides, molluscicides, fumigants and repellents

Course Contents (Topics and subtopics)

Unit I: Classification and Importance and role of Acaricides, Fungicides, Rodenticides, Nematicides, Molluscicides, Fumigants and Repellents **12 h**

Unit II: a) Manufacturing processes of some pesticides: Dimethyl phthalate, Copper Sulphate. **12 h**

b) Chemistry of Acaricides: Brief introduction to classes of pesticides, structure, IUPAC name, physical properties, chemical properties, synthesis, degradation and metabolism, formulations, mode of action, uses, toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc.

Organophosphate: Dichlorvos, Triazophos, Vamidothion.
Organosulfones: Oxydemeton methyl.
Phenyl Derivatives: Dinocap.

Unit III: Chemistry of Fungicides: Brief introduction to classes of pesticides, structure, chemical name, physical properties, chemical properties, synthesis, degradation and metabolism, formulations, mode of action, uses, toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc: **12 h**

Heterocyclic Compounds: Benomyl, Captafol, Carbendazim, Hexaconazole, Tebuconazole.
Dithiocarbamates: Ziram, Mancozeb
Amides: Metalaxyl
Inorganic fungicides: Chlorothalonil.

Unit IV: Chemistry of Rodenticides and Nematicides: Brief introduction to classes of pesticides, structure, chemical name, physical properties, chemical properties, synthesis, degradation and metabolism, formulations, mode of action, uses, toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc. **12 h**

Rodenticides: Bromadiolone, Coumachlor, Coumafuryl, Warfarin, Zinc Phosphide.
Nematicides: Aldicarb, Ethoprophos, Terbufos.

Unit V: Chemistry of Fumigants, Repellants and Molluscicides: Brief introduction to classes of pesticides, structure, chemical name, physical properties, chemical properties, synthesis, degradation and metabolism, formulations, mode of action, uses, toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc.) **12 h**

Fumigants: Aluminum Phosphide, Ethylene dibromide, Methyl bromide.
Repellents: DEET, Dimethyl phthalate.
Molluscicides: Fentin acetate, Metaldehyde.

Recommended Books

1. Thomson W.T., **Agricultural Chemicals Book III-Miscellaneous agricultural chemicals: fumigants, growth regulators, seed safeners, repellents, fish toxicants, bird toxicants, pheromones, rodenticides and others**. Thomson publications; 1991.

2. Roberts T.R., Robert, Hutson D.H., Jewess P.J., editors. **Metabolic pathways of agrochemicals: insecticides and fungicides**. Royal Society of Chemistry; 1998.
3. Nene Y.L., Thapliyal P.N., **Fungicides in plant disease control**. International Science Publisher; 1993.
4. Vyas S.C., Sobun N., Varma R.K., **Fungicides in plant disease control systemic fungicides.** Farmer and parliament. 1978.
5. Naumann K. Synthetic **pyrethroid insecticides: structures and properties**. Springer-Verlag GmbH; 1990.
6. Perry A.S., Yamamoto I., Ishaaya I., Perry R.Y.. **Insecticides in agriculture and environment: retrospects and prospects.** Springer Science & Business Media; 2013.
7. Baker D.R., Fenyes J.G., Steffens J.J., **Synthesis and chemistry of agrochemicals III.** Washington, DC: American Chemical Society; 1992.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA402.1	Illustrate synthesis of different pesticides having different structures.	**3**
PA402.2	Explain the properties and uses of various pesticides	**4**
PA402.3	Classify the degradation and metabolism pathway	**2**

PA- 403: Herbicides and Plant Growth Regulators
(60 h, 100 Marks and 4 Credits)

Course Objectives (CObs):

- The course is constructed for studying various applications of herbicides and plant growth regulators. It also covers the synthesis, mode of action, uses degradation and metabolism of above molecules.

Course Contents (Topics and subtopics)

Unit I: **PART A:** **12 h**

Herbicides:

a) Weed and weed control- brief account of Herbicides - Definition. Introduction and classification.

b) Chemical Control - according to action and chemical structures, selective, foliage, soil, aquatic contact, translocated, nonselective herbicides.

c) Methods of herbicide application – Pre-sowing, pre-emergence, post-sowing, post-emergence, direct, band, spot applications

Unit II: **12 h**

a) Persistence of herbicides.
b) Formulations of herbicides.
c) Mode of action of herbicides.
d) Herbicides Safener – Cloquintocet-mexyl, Dichlormid, Fenclorim

Unit III: **PART B:** **12 h**

Plant Growth Regulators (PGR):

a) Growth and development, factors affecting growth, measurement of growth.
b) **Plant growth regulators -** definition and introduction, important roles and actions of PGRs.
c) **Plant growth hormones -** Auxins, Gibberellins, Kinins, Growth inhibitors and ethylene - their responses, metabolism, assay and agricultural uses.

Unit IV: **12 h**

a) **Plant Physiology:**
Plant growth modification Dormancy and germination, breeding and propagation, retardation of vegetative growth, flowering, and fruit set and development, metabolic effects- ripening, yield increasing, defoliation. Desiccation, chemical pruning, abscission, photosynthesis.

b) **Chemistry, synthesis and uses of following Plant Growth Regulators:** Ancymidol, Chlormequat chloride, Chlorpropham, Ethephon, IAA, 1-Naphthaleneacetic acid (NAA), Trinexapac-ethyl.

Unit V: **12 h**

Chemistry, synthesis and uses of following herbicides:
Acifluorfen, Alachlor, Anilofos, Atrazine, 4-CPA, 2,4-D (manufacturing process), Daminozide, Desmedipham, Dicamba, Dichrorprop, Diuron, Maleic hydrazide, Metsulfuron methyl, Napropamide, Paraquat, Picloram, Propanil, Pritilachlor, Metoxuron, Sulfosulfuron, Glyphosate.

Recommended Books

1. Thomson W.T., **Agricultural Chemicals-Book II. Herbicides**. Agricultural Chemicals-Book II. Herbicides.. 1964.
2. Kearney P.C., Kaufman D.D. **Herbicides: chemistry, degradation and mode of action**. Marcel Dekker, Inc.; 1975.
3. Purohit S.S., editor. **Hormonal regulation of plant growth and development**. Springer Science & Business Media; 2012.
4. Nickell L.G., **Plant growth regulators. Agricultural uses.** Springer-

Verlag; 1982.
5. Roberts M.C., Croucher L., **Metabolic pathways of agrochemicals: part 1: herbicides and plant growth regulators**. Royal Society of Chemistry; 2007.
6. Panda H. **The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes**. NIIR Project Consultancy Services; 2003.
7. Petroski R.J., Tellez M.R., Behle R.W., **Semiochemicals in pest and weed control: An introduction.** 2005.
8. Arora R., Singh B., Dhawan A.K., **Theory and practice of integrated pest management.** Scientific Publishers; 2017.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA403.1	Consider Herbicides and PGR for different applications	**5**
PA403.2	Explain synthesis of different molecules with various functional groups	**4**
PA403.3	Compare the mode of action, uses, degradation and metabolism of herbicide and PGR molecules	**4**

PA-404: Laboratory Course in Pesticides & Agrochemicals – II
(Minimum 14 practical, 100 Marks and 6 Credits)

Course Objectives (CObs):

- This laboratory course is constructed for learning different techniques such as organic synthesis, interpretation of spectroscopic data, identification of formulations, study of properties of formulations. The course also provides hands on training pertaining to prepare different formulations. Collection, identification and rearing of weeds as well as household pest control on site is also included in this course.

Practical Includes

I. Spectroscopic Characterization Interpretation of UV, IR, PMR and Mass spectra of pesticides.

II.Synthesis of pesticides/ analogues:

1. Phenyl Urea,
2. 1-Naphthoxy acetic acid
3. Dimethyl phthalate,
4. Maleic / Phthalyl hydrazide
5. 2-Chlorophenoxy acetic acid,
6. Benzoyl glycine
7. 4-Chlorophenoxy acetic acid,
8. Ferbam /Nabam / Zineb/ Maneb

III. Pesticides Formulations - preparation

1. Preparation of EC formulations
2. Preparation of SC formulations
3. Preparation of SE formulations

IV. Pesticides Formulations - analysis

1. Estimation of copper from copper-oxy chloride.
2. Estimation of copper in copper sulphate pentahydrate
3. Estimation of Dichlorvos in a given formulation.
4. Estimation of Carbendazim in a given formulation.
5. Estimation of Phosphamidon/ Dicofol in a given sample.
6. Estimation of Carbaryl in a given formulation.
7. Estimation of Sulphur content from pesticides containing Sulphur
8. Estimation of Ziram by hydrolysis method.
9. Estimation of glyphosate in given formulation.
10. Gas chromatographic analysis of Pesticides
11. Estimation of barium in barium carbonate
12. Estimation of Simazine by colorimetric method.
13. Electrometric determination of acidity / alkalinity of WP.
14. Determination of moisture content by Karl-Fischer method.
15. Determination of saponification and acid values
16. Determination of Flash & Fire points
17. Optimization of emulsifier ratio for formulation of given pesticide
18. Determination of density of liquid formulations.

V. Analysis of Soil / Fertilizers.

1. Estimation of total P_2O_5 content in fertilizer.
2. Estimation of nitrogen from ammonium sulphate
3. Estimation of potassium content (soil/fertilizer) by flame photometer.
4. Determination of pH and conductivity of soil sample.
5. Estimation of Phosphorous from soil by colorimetric method
6. Estimation of nitrogen from soil by Kjeldahal's method.

VI. Collection, identification and classification of different Weeds - study about nature of damage and their management.

*Suitable experiments may be added as per need of the subject

Recommended Books

1. Ramulu U.S., **Methods of Pesticides Analysis**. Oxford & IBH Pub.; 1979.
2. Zweig G., editor**. Principles, Methods, and General Applications: Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives.** Elsevier; 2013.
3. Vogel A.J., **Vogel's textbook of practical organic chemistry: including qualitative organic analysis**. 1978.
4. Bansal R.K., **Laboratory manual of organic chemistry.** New Age International; 2009.
5. Vishnoi N.K., **Advanced practical organic chemistry**. Vikas; 1979.
6. Dyer, John R., **"Applications of absorption spectroscopy of organic compounds."** 147-147, 1965
7. Fleming I, Williams D.H., **Spectroscopic methods in organic chemistry**. New York: McGraw-Hill; 1966.

8. Ashworth R.D., **Analysis of technical and formulated pesticides**. CIPAC Handbook. 1980

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA404.1	Manage formulation preparation and analysis through well designed hands-on training.	**6**
PA404.2	Experiment organic syntheses and interpret spectroscopic data	**3**
PA404.3	carry out collection, identification and rearing of weeds as well as household pest control on site	**2**
PA404.4	Eventually develop to work in synthesis or formulation R & D or can undertake independent research activities or can apply knowledge and start own pest control services	**4**

PA-405: Short Term Research Project
(100 Marks and 6 Credits)

Course Objectives (CObs):

- The short-term research project for M. Sc. Chemistry (with specialization in Pesticides and Agrochemicals) is designed to learn review of literature, synthesis of new bioactive molecules/optimization of synthetic routes/study biological activities, preparation of conventional and new pesticide formulations and their stability performance. It is expected that project should provide hands on training to the students on various instruments. They should learn independent working through a short research project.
  Students are required to work for a specific topic of project under supervision of concerned faculty member.
  The allotment of the topic will be carried out at the beginning of third semester so that students can start their work in the third semester itself.
  Each student is supposed to work for at least 60 hrs. for project.
  At the end student has to submit his project report and present the work done at the time of viva voce.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
PA 405.1	Select, design and associate with the mini research problem	**2**
PA 405.2	Compile the literature survey	**6**
PA 405.3	Undertake construction of experimental set up, optimization of parameters Application of the work, that is independent laboratory work	**3**
PA 405.4	Interpret the results and draw conclusions	**3**
PA 405.5	Plan and write project report	**6**

M.Sc. Part II Semester IV (Pesticides and Agrochemicals): Audit Courses

AC-401(A): Human Rights

(Professional and Social + Value Added Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To make students aware about human rights and human values.

Unit 1 **Introduction to Human Rights** **06 h**

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** **08 h**

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** **08 h**

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** **08 h**

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.	CO	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 human rights to their friends, parents and relatives.	**5**

AC-401(B): Current Affairs
(Professional and Social + Value Added Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To make students updated about current affairs of India and world.

Unit 1	Politics & Economy	• National & International Political Activity, Organization. • Economy & Business, Corporate world	**08 h**
Unit 2	Awards and recognitions	• National & International Awards and recognitions • Books and authors	**07 h**
Unit 3	Science & Technology	• Software, Automobile, Space Research • New inventions and discoveries	**07 h**
Unit 4	Environment & Sports	• Summit & conference, Ecology & Climate, Organization. • National & International Games, Olympics, commonwealth etc.	**08 h**

Suggested readings (Use recent years' data and current literature):

1. India 2019, by Publications Division Government of India
2. Manorama Year Book by Philip Mathew,
3. India 2019, Rajiv Maharshi
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:

CO No.	CO	Cognitive 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.	**06 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.	**06 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	**06 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.	**06 h**
Unit 5	**Miscellaneous Reports** Writing research proposals, Writings project proposals, Lecture notes, Progress reports, Utilization reports, Scientific reports etc.	**06 h**

Suggested readings:

1. Academic Research & Report Writing By Dr. Samir Roy ,National Institute of Technical Teachers Training and Research, Kolkata
2. https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview
3. https://www.youtube.com/watch?v=Xp2PVO3do34
4. ttps://www.theiet.org/media/5182/technical-report-writing.pdf
5. http://www2.hawaii.edu/~sugihara/courses/HCU2016s_TC/notes/TechWriting1.html
6. A Step-by-Step Guide to Writing Academic Papers, by Anne Whitaker Sept. 2009
7. On Writing a Thesis by C P Ravikumar, IETE Journal of Education, 2000

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC401C.1	• Able to write reports on various activities including academic and research effectively and efficiently.	**3**
AC401C.2	• Apply the principles and techniques of report writing for	**3**

	effective dissemination of the academic and research findings.	

AC-401(D): Intellectual Property Rights (IPR)
(Professional and Social + Value Added Audit course; Practical; 2 Credits)
(Optional: Program-level)

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	**04 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.	**04 h**
Unit 3	Structure of IPR Offices in India, Fees of patenting in India, Restoration of Patents	**03 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 License	**04 h**
Unit 5	**Infringement of patent** Infringement of patent Rights and Offences, Actions against Infringement and Remedies and Relief	**04 h**
Unit 6	Discussion on Case studies - Trade secret, Geographical indication	**04 h**
Unit 7	Discussion on case studies – Trade mark, Compulsory License	**04 h**
Unit 8	Discussion on - Career in Intellectual Property Rights	**03 h**

Suggested readings:

8. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
9. Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub.
10. National Portal of India. http://www.archive.india.gov.in
11. Office of the Controller General of Patents, Design & Trademarks; Government of

India. http://www.ipindia.nic.in/
12. World Intellectual Property Organisation. http://www.wipo.int
13. World Trade Organisation. http://www.wto.org
14. https://www.youtube.com/watch?v=2YEr9hpuAfA&t=12s
15. Patent Act 1970 - https://www.youtube.com/watch?v=9r3OneOW6YE
16. Career in IP https://www.youtube.com/watch?v=iwI8lyo90mM
https://www.youtube.com/watch?v=vdJm7pY2JoU
17. Infringement of patenthttps://www.youtube.com/watch?v=6y5j7HoixhU
https://www.youtube.com/watch?v=7ihGrOxxe88
18. Geographical indication https://www.youtube.com/watch?v=7k5rCsnlMSI
19. 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.	CO	Cognitive level
AC401D.1	Understand basics of intellectual property rights.	**2**
AC401D.2	Able to know patent rights and ownership of patents.	**3**

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