(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

M.Sc. (Chemistry)

Vision of the Department:

The department of Applied Sciences is committed to inculcate expertise in the students in the field of basic sciences, technology and personality development so that they can make the world a better place.

Mission of the Department:

M1: Prepare the students' basics strongly to make a mark at global perspective.
M2: Culminate extraordinary analytical, logical and ethical skills to make them industry ready.
M3: Develop a good citizen and a good human being through all round development.

Course Objectives (COs):

CO1: Fundamental Knowledge: to attain skills in the fundamental concepts of basic sciences necessary for success in industry or in engineering practices as well as advanced study.
CO2: Specialization: prepare to pursue career choices in all branches of engineering or related interdisciplinary fields that will benefit from a strong background in applied sciences and engineering.
CO3: Design Skills: to imbibe with problem solving skills, laboratory skills, and design skills for technical careers in solving critical problems.

Program Outcomes (POs):

PO1Scientific Knowledge: To employ critical thinking and the scientific method to design not only with respect to science subjects but also in all aspects related to life.
PO2 Understanding and critical thinking: To demonstrate an understanding of major concepts in all disciplines of Science.
PO3 Problem analysis: To analyze the scientific data critically and systematically and the ability to draw the objective conclusions.
PO4 Design/development of solutions: To foster observation skills and drawing logical conclusions from the scientific experiments.
PO5 Conduct investigations of complex problems: To develop scientific temper to propose novel ideas in explaining facts and figures or providing new solution to the problems.
PO6 Scientist and Society: To cultivate rational outlook and analyze the results of experiments and get an awareness of the impact of Science on the environment, society, and other cultures outside the scientific community.

PO7 Environment and sustainability: To imbibe with new ideas for the sustainable developments.

PO8 Ethics and Responsibility: To nurture ethical, social and moral values in personal and social life paving a path to highly cultured and civilized personality.

PO9 Management and projects: Enhancing To acquire the analytical skills in handling scientific instruments, planning and performing in laboratory experiments.

PO10 Individual and Team Work: To apply knowledge and experience to foster personal growth and appreciate the diverse social world in which we live.

PO11Modern tool usage: To provide technology-oriented skills, tools and ability to develop creative solutions and engage in continuing professional development.

PO12 Life-long learning: To attain the knowledge of subjects in other faculties such as humanities, performing arts, social sciences etc. can have greatly and effectively influence which inspires in evolving new scientific theories and inventions.

Program Specific Outcomes (PSO):

PSO1: To carry out experiments in basic as well as certain advanced areas of Chemistry such as Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Physical Chemistry and Spectroscopy.

PSO2: To build a scientific temper and to learn the necessary skills to succeed in research or industrial field.

PSO3: To be able to define and resolve new problems in Chemistry and participate in future development of Chemistry.

PSO4: To develop strong student competencies in Chemistry and its applications in a technology--rich, interactive environment.

PSO5: Have necessary skills and expertise in field of research and development.

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DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

M.Sc (Chemistry)

1. **Duration of Course:**

1.1 The duration of Degree course shall be two academic years consisting of four (4) semesters i.e. two semesters in each year. The duration of each semester will be 18-20 weeks with ninety (90) teaching days.

1.2 The duration of Post-Graduate Diploma course shall be one academic years consisting of two (2) semesters i.e. two semesters in each year. The duration of each semester will be 18-20 weeks with ninety (90) teaching days

2. **Maximum period for passing M.Sc. Chemistry.**

2.1 The candidate must pass all the subjects of all the semesters of Degree course in M.Sc. Chemistryin two (2) years. If the candidate fails to pass all the subjects of the course within stipulated period, his/her registration will be cancelled.

2.2 The candidate must pass all the subjects of all the semesters of Post-Graduate Diploma course in M.Sc. Chemistryin one (1) years. If the candidate fails to pass all the subjects of the course within stipulated period, his/her registration will be cancelled.

3. **Eligibility for admission**

3.1 A candidate must be admitted to a two year Master's course with second year devoted entirely to research for those who have completed the three years Bachelor's course.

3.2 A candidate must be completed a four-years Bachelor's course with Honours/ Research may be admitted to a one year Master's course.

3.3 There may be an integrated five-year Bachleor's/Masters's Course.

3.4 The Entry Requirment for Masters's Course:

(i) A Bachelor's Degree (Honours/Research) for the one-year/two semester Master's degree course.

(ii) A Bachelor's Degree for the two-year/four semester Master's degree course.

(iii) A Bachelor's Degree for the one-year/two semester Post-Graduate Diploma course.

4. **Medium of Instructions**

The medium of instruction during the course and examinations shall be Punjabi/Hindi/English.

5. **Examination Schedule, examination fee and examination forms:**

5.1 The examination of Odd Semesters shall ordinarily be held in the month of December and that of Even Semesters in the month of May, or on such other dates as may be fixed by the competent authority.

5.2 The candidates will be required to pay examination fees as prescribed by the University from time to time.

5.3 The Examination Form must reach in the office of the Controller of Examinations as per the schedule notified, from time to time.

5.4 The Examination Forms must be countersigned by the Director/Head of the Department along with the following certificate :--

(i) that he/she has been on the rolls of the University Teaching Department during the academic term preceding the end semester examination;

(ii) that he/she has attended not less than 75% lectures delivered to that class in each paper; and

(iii) That he/she has a good moral character.

5.5 The shortage in the attendance of lectures of the candidate may be condoned by the Vice-Chancellor, on the recommendations of Head of the Department, as per rules.

6. Re-admission

In case name of a student is struck off from the rolls due to non-payment of fee or continued absence from classes in any subject for one month and he/she will be re-admitted after payment of re-admission fee as prescribed by the University from time to time. However, the student will be allowed to appear in the end semester examination of that paper (s) only after attending the required lectures/practical delivered to that paper(s). However, if a student falls short of attendance in all courses offered in a semester, he/she shall be required to repeat the semester, along with the next batch of students.

7. Scheme of Examinations

The examination in each semester shall be conducted according to the syllabus prescribed for the semester. The end semester examination for each paper shall be of three hours duration.

8. Minimum pass marks

The minimum number of marks required to pass in each semester shall be 40% marks in each in Theory and Practical/Laboratory/Seminar/Viva-Voce paper and in Internal Assessment, separately.

9. Grading of performances

9.1 Letter grades and grade points allocations:

Based on the performances, each student shall be awarded a final letter grade at the end of the semester for each course. The letter grades and their corresponding grade points are given here under: -

Percentage of marksobtained	Letter Grade	Grade Points	Performance
90.00 – 100	O	10	Outstanding
80.00 – 89.99	A+	9	Excellent
70.00 – 79.99	A	8	Very Good

60.00 – 69.99	B+	7	Good
50.00 – 59.99	B	6	Average
40.00 – 49.99	C	5	Pass
Less than 40.00	F	0	Fail
Absent	AB	0	Fail

9.2 Grades from 'O' to 'C' are pass grades.

9.3 A student who fails in any end semester shall be assigned a letter grade 'F' and a corresponding grade point of zero. He/she should reappear for the said evaluation/examination in due course.

9.4 A student who remains absent for any end semester examination shall be assigned a letter grade of 'AB' and a corresponding grade point of zero.

Semester Grade Point Average (SGPA) = $(\sum C_i G_i) / (\sum C_i)$

Where C i = No. of credits assigned to ith semester
G i = No. of Grade equivalent point assigned to ith semester.

Cumulative Grade Point Average (CGPA) = $\dfrac{\sum (SGPA_j \times C_j)}{\sum C_j}$

Where $SGPA_j$ = SGPA score of jth semester
C_j = Total no. of credits in the jth Semester

9.5 Percentage can be calculated as CGPA *10

10. Declaration of class and Division

The class shall be awarded on the basis of CGPA as follows:

CGPA: ≥7.5 provided that the candidate must have passed all the Semester Examinations in the first available attempt.	First Division with Distinction
CGPA: 6.0 to 7.49	First Division
CGPA: 5.0 to 5.99	Second Division
CGPA: 4.0 to 4.99	Third Division

11. Internal Assessment of failed candidate

The internal assessment award of a candidate who fails in the external examination shall be carried forward to the next Examination, if passed in Internal Assessment.

12. Grace Marks

12.1 The grace marks of 1% of total marks of the semester shall be given to a candidate to his best advantage so as to enable him to pass in one or more written papers, to make up aggregate to pass the examination/paper or for changing the result from FAIL to

COMPARTMENT/PASS. If a fraction works out to be half or more, it shall be counted as one mark and fraction less than half shall be ignored

12.2 If a candidate appears in an examination to clear re-appear/compartment paper, the grace marks of 1% will be given only on the total marks of that particular paper.

13. **Re-evaluation**

A candidate who is not satisfied with his result may apply to the Examination Branch for re-evaluation in a subject/paper within 15 days of declaration of result along with a fee as prescribed by the university from time to time.

14. **Re-checking**

A candidate who is not satisfied with his result may apply to the Examination Branch for re-evaluation in a subject/paper within 15 days of declaration of result along with a fee as prescribed by the university from time to time.

15. **Special examination**

A Special Examination will be conducted for those students who are passing out but having re-appear(s) in the last semester and/or in the lower semesters. The special examination will be conducted within one month of the declaration of final semester result. The student shall have to pay prescribed fee for Special Examination.

16. **Re-appear/Supplementary examination**

In case of re-appear examination, the University will adopt even/odd semester examination or open semester system. The student will be eligible to appear in the re-appear papers of odd semester along with the odd semester regular examinations of subsequent batches and re-appear of even semester's paper of the even semester regular examinations in the case of even/odd semester examination. The student will be eligible to appear in the re-appear papers of all semesters (even/odd) along with regular examinations of open semester examinations. Controller of Examination will implement any of the above examination system with the approval of the Vice-Chancellor.

17. **Mercy Chance**

The candidate will be given maximum two chances to appear in the supplementary examinations. After that, mercy chance may be given by the Vice-Chancellor on the recommendations of the Director of the concerned school on payment of a special fee.

18. **Syllabus for re-appear candidates**

A student who obtains re-appear(s) in a subject will be examined from the same syllabus which he/she studied as a regular student.

19. **Promotion Criteria**

19.1 A candidate who joins First Semester of M.Sc. Chemistrymay on completing attendance

requirements appear in 1st semester examination. He/she shall be allowed to continue his/her studies in the 2nd Semester even if he/she does not clear any paper of the 1st semester and on completing attendance requirements may appear in the 2nd Semester examination.

19.2 A candidate shall not be eligible to join 3rd Semester of M.Sc. Chemistryif he/she has yet to clear more than 50% papers of First and Second Semesters taken together. A candidate who has cleared 50% or more papers of M.Sc. Chemistry1st and 2nd Semesters taken together may join 3rd Semester and on completing attendance requirements may take 3rd Semester Examination. He/she shall be allowed to continue his/her studies in the 4th Semester even if he/she does not clear any paper of the 3rd Semester and on completing attendance requirements may appear in 4th Semester examination.

20. Division Improvement

A candidate who has passed M.Sc. Chemistryexamination from this University may re-appear for improvement of division in one or more subjects in the succeeding semesters with regular candidates in order to increase the percentage for obtaining higher division. However, final year candidates who have passed an examination of the University may re-appear for improvement of performance under special examination as per rules of the university.

21. Migration to this University

21.1 Migration to this University will be allowed only after completion of the 1st year and is applicable only to those students who are eligible to register for 3rd semester.

21.2 Migration shall be allowed after completion of the second semester but before start of the 3rd semester.

21.3 The candidates shall not be allowed to change his/ her discipline of study in the process of migration.

21.4 Migration to an affiliated College /Institute of the University from other recognized universities will be allowed 15 days prior to of the start of the 3rd semester. The following conditions shall be applying: -

i) The candidate should have passed all the courses of the first year of the University from where he/she wants to migrate.

ii) The courses studied by the candidate in first year must be equivalent to the courses offered in this University. Deficiency, if any, should not be of more than two subjects. The candidate would be required to furnish an undertaking that he/she will attend classes and pass these courses (found deficient). The institute and the University where the student is studying and the Institute, to which migration is sought, have no objection to the migration.

iii) There is a vacant seat available in the discipline in the college in which migration is sought.

22. Power of Relaxation:

Notwithstanding the existing Migration Rules, the Vice-Chancellor, after obtaining an undertaking/affidavit from the candidate, to his satisfaction, to be recorded in writing,

shall be authorized to consider the migration for the cases that are not otherwise covered under the above Migration Rules, with the approval of the Chancellor.

23. **Migration to any other University**

23.1 Migration to any other University will be allowed 15 days prior to of the start of the 3rd semester.

23.2 The candidate seeking migration from this University shall be apply for the approval of his migration to the University within 15 working days after passing the 2nd Semester/First Year Examination.

23.3 The Director/Head of the department concerned of the University will issue "No Objection Certificate" after the candidate has paid all the fees due for the remaining period of the full session as well as the annual dues as per rules. In addition to the above, Migration fee as prescribed by the University shall be charged from such candidates.

23.4 If a candidate, on completion of any course, applies for Migration Certificate, the same shall be issued on receipt of fee prescribed for Migration Certificate and on completion of other formalities etc.

24. **Award of Detail Marks Card**

Each candidate of First Year M.Sc. Chemistry(i.e. Semester-I & Semester-II) and Second Year (i.e. Semester-III & Semester-IV) on successfully completion of course and passing all the papers of each semester, shall be supplied Detail of Marks Cards indicating CGPA score and Division obtained by him/her in the examination.

25. **Award of Degree**

25.1 The Post-Graduate Diploma of Master of Science in Chemistryin the concerned stream stating the CGPA score and Division will be awarded to the candidate who has successfully completed the course and passed all the papers of all the semesters. The degree will be awarded at the University Convocation. However, a degree in absentia can be issued before the convocation, on completion of required formalities and payment of prescribed fee.

25.2 The degree of Master of Science in Chemistry in the concerned stream stating the CGPA score and Division will be awarded to the candidate who has successfully completed the course and passed all the papers of all the semesters. The degree will be awarded at the University Convocation. However, a degree in absentia can be issued before the convocation, on completion of required formalities and payment of prescribed fee.

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Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M. Sc (Chemistry)

Semester I

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCC-101	Inorganic Chemistry	CC	40	60	100	3	0	0	3
2.	MSCC-102	Inorganic Chemistry Lab	CC	40	60	100	0	0	2	1
3.	MSCC-103	Organic Chemistry	CC	40	60	100	3	0	0	3
4.	MSCC-104	Organic Chemistry Lab	CC	40	60	100	0	0	2	1
5.	MSCC-105	Physical Chemistry	CC	40	60	100	3	2	0	4
6.	MSCC-106	Physical Chemistry Lab	CC	40	60	100	0	0	2	1
Department Elective Courses (Select Any One)										
7.	MSCC-107	Mathematics for Chemists	DE	40	60	100	3	0	0	3
8.	MSCC-108	Biology for Chemists	DE	40	60	100	3	0	0	3
Life Skill Courses										
9.	DBEF-101	Foundations of Employability Skills	LSC	40	60	100	1	0	4	3
Total				320	480	800	13	2	10	19

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

(B.Sc. Non-medical students will take Biology for Chemists paper while B.Sc. Medical students will take the paper Mathematics for Chemists).

Course Code: MSCC-101
Title of the Course: Inorganic Chemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:
After undergoing this course student will be able to:
CO1: Describe advanced symmetry concepts of chemical molecules and its applications
CO2: Understand Dipole moment and bond order of the inorganic molecule.
CO3: Learn about geometry and shape of the molecule.
CO4: Known the preparation and properties of transition metal carbonyls

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	W	S	S	S	M	S	W	M	S	M	S	M
CO2	S	S	M	M	S	S	M	W	S	W	M	S
CO3	S	M	S	M	S	S	S	W	S	W	S	S
CO4	S	S	S	M	S	S	M	S	S	W	S	S

Unit	Course Outline	Hour(s)
I	**Chemical Bonding** The ionic bond, covalent bond, the variation method, ground state energy of hydrogen atom, the secular equations, the molecular orbital theory, electron distribution in hydrogen molecule ion, symmetric and antisymmetric energy states, the classical interaction energy, resonance contribution of ionic terms, sp^3hybridisation, three centered bond, Linnetts doublet - quartet approach, the Pauli's exclusion principle.	**9**
II	**Pi Bonding Ligand Complexes** Pi Acid Ligands CO as prototype, other pi acid ligands-isocyanide ligands, dinitrogen, the CS ligands, the NO ligands, pi acid ligands: trivalent phosphorus compound, multiple bonds from ligands to metal, pi complexes of unsaturated organic molecules : alkene & alkyne, enyl ligands, aromatic ring systems. Theories of Bonding in Transition Metal complexes – QualitativeApproach : Qualitative introduction to the molecular orbital theory, complexes with no pi bonding, complexes with pi-bonding, the crystal field & ligand field theories, orbital splitting and magnetic properties, the angular overlap model.	**9**

III	**Structural and Thermodynamic Consequences of Partly Filled-shells** Ionic radii, Jahn - Teller effects, thermodynamic effects of d-orbital splitting, magnetic properties of chemical compounds, origin of magnetic behavior, magnetic susceptibility and types of magnetic behavior : diamagnetism, paramagnetism, ferromagnetism : types of paramagnetic behavior : Large multiplet separation, small multiplet separations, spin only, heavy atoms, high spin-low spin cross overs. **Spectral Properties** Russel - Saunder's term, selection rules, break down of selection rules, band widths & shapes, energy level diagrams and dd complex spectra, Orgel diagrams - weak fields, charge - transfer spectra, photochemical reactions of chromium & ruthenium complexes.	**9**
IV	**Bioinorganic Chemistry** Introduction, the biochemistry of Iron : iron storage and transport ferritin, transferrin, bacterial iron transport, hemoglobin and myoglobin, nature of the heme-dioxygen binding, model systems, cooperativity in hemoglobin cytochromes, other iron – porphyrinbimolecule peroxidases & catalases, cytochrome P_{450} enzymes, other natural oxygen carriers - hemerythrins, iron - sulfur proteins. The biochemistry of other, metals : zinc, carboxypetidase A, carbonic anhydrase, metallothioneins, copper, superoxide dismutase (CuZn SOD) hemocyanins, oxidases, cobalt, molybdenum & tungsten, nitrogenases, miscellaneous other elements : vanadium, chromium & nickel metal ions and chelates in chemotherapy, synthetic metal chelates as antimicrobial agents, lithium and mental health, gold and its compounds, metal complexes as antitumour agents, chelation therapy.	**9**

Total: 36

List of Books

1. Advanced Inorganic Chemistry - Cotton & Wilkinson (3rd, 4th & 5th Ed.)
2. Theoretical Inorganic Chemistry - Day &Selbin.
3. Inorganic Chemistry - Shriver, Atkins & Lang Ford.
4. Inorganic Chemistry of Biological Processes - Hughes.
5. Bio-Inorganic Chemistry - R.W. Hay (John Wiley & Sons).
6. https://www.swayam.gov.in/nd1_noc20_cy03/preview

Text Books

1. Day, M.C and Selbin,J (1985): Theoretical Inorganic Chemistry, 2nd Edition,Affiliated East West Press Pvt.Ltd.

2. Cotton, F. A and Wilkinson,G (2009): Advanced Inorganic Chemistry,4th Edition,A Wiley-IntersciencePublication,John–Wiley &Sons,USA.

3. Huheey, J.E (1983): Inorganic Chemistry, 3rd Edition, Harper&Rowpublisher,Singapore

Course Code: MSCC-102
Title of the Course: Inorganic ChemistryLab

L	T	P	Credits
0	0	2	1

Course Outcomes:

At the end of the course, the student will be able to

CO1: To conduct the experiments for the preparation, characterization of metal complexes
CO2: Understanding the procedure for semi micro qualitative analysis
CO3: Estimates the accurate analytical procedure of analysis
CO4: Learns the steps involved in the complex formation process

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO'S	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	W	S	S	S	M	S	W	M	S	M	S	M
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	S	M	M	M	S	W	M	S	W	M
CO4	M	S	S	W	M	M	S	W	M	S	W	M

Preparation and Estimations

1. Preparation of Tris-thioureacuprous chloride
2. Estimation of Cu, and Chloride.
3. Preparation of HexathioureaplumbousnitratePb.6CS (NH2)2(NO3)2.
4. Estimation of cobalt.
5. Preparation of Tin tetraiodide.
6. Estimation of Sn.
7. Preparation of K3 [Fe(C2O4)3].
8. Estimation of iron.
9. Preparation of Hg [Co(NCS)4]
10. Simultaneous estimation of Hg and Co.
11. Preparation of (NH3)2Hg Cl2.
12. Estimation of Hg.
13. Mercuration of phenol and separation of the compound into o—, and p—, isomers.
14. Preparation of K3[Cr(C2O4)3]
15. Estimation of Cr and oxalate.
16. Spectrophotometric Estimation of
    (a) tin with toluene 3,4-dithiol (dithiol)
    (b) Chromium with diphenylcarbazide.
17. Chromatographic separation of ions.
    (a) Paper chromatography.
    (b) Thin layer chromatography.

(c)Column chromatography.

Course Code: MSCC-103

Title of the Course: Organic Chemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

After undergoing this course student will be able to:

CO1: Perform aliphatic nucleophilic substitution reactions Differentiate the various types of aliphatic nucleophilic substitution

CO2: Learn SN1, SN2 and SNi Mechanism and stereochemistry.

CO3: Learn classical and non-classical carbocation, NGP by pi and sigma bonds.

CO4: Solve the elimination problems.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO'S	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	W	S	S	S	M	S	W	M	S	M	S	M
CO2	S	S	S	S	S	S	M	W	S	W	M	W
CO3	S	S	S	M	S	S	S	M	W	W	S	M
CO4	S	S	S	S	S	S	M	S	S	W	S	S

Unit	Course Outline	Hour(s)
I	**(a) Recall Reactive Intermadiate** (i) Carbocations: Generation, Structure, Stability, Application of NMR spectroscopy in the detection of Carbocation, allylic and benzylliccarbocations. Stereochemistry and reactions.Non classical carbocations: Phenonium ion, norbornyl system, explaination based on rearrangement. (ii) Carbanions: Generation, Structure, stability, stereochemistry, Tautomerism, Prototropy and general reactions. (iii) Carbenes: Formation, Structure, Singlet & Triplet carbene, Stereochemsitry and reactions. (iv) Nitrenes: Formation, Structure Singlet & Triplet nitrene, Stereochemsitry and reactions. (v) Arynes: Formation, Structure and reactions. **(b) Reaction of Free Radicals** (i) Polymerisation (ii) Halogenation: Chlorination, bromination, Bromination by NBS, Iodination, Fluorination. (iii) Addition Reactions: Free radical addition of HBr, thiols and halogens.	**9**

	(iv) Auto-oxidation (v) Rearrangements	
II	**(a) Nature of Bonding in Organic Molecules** (i) Introduction to funllernes (ii) Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's Rule, anti-aromaticity, homo-aromaticity, PMO - approach. (iii) Bonding weaker than Covalent : (iv) Addition compounds, Crown ether complexes and Cryptands, inclusion compounds, Cyclodextrins, Catenanes and rotaxane. **(b) Techniques usedfor determination of reaction mechanism :** Use of optical, Stereochemical and isotopic techniques. Reaction studies from identification of products. Trapping of intermediate, crossover experiments use of Catalyst etc. use of isotopes in reaction mechanism studies in case of Favorskii, Claisen's and Benzyne reactions.	**9**
III	**(a) Elimination Reactions** E_2, E_1 and E_1 CB mechanism, Stereochemistry Product ratio, Orientation of double bond, Hofman Rule, Saytzeff Rule. Factors Governing E_2& E_1 Mechanism. **(b) Cyclic Elimination:** Amine Oxide, Esters, Xanthate, and Free radical elimination. Dehalogeriation by zinc.Triple bond by elimination.Elimination versus substitution.Effect of solvent, temperature, Nature of Base, Structure of the reactants. **(c) Aromatic Elimination:** Benzyne, Nucleophillic aromatic substitution, addition elimination.	**9**
IV	**Pericyclic Reactions** Molecular Orbital symmetry, Frontier Orbitals of ethylene, 1,3 - butadiene, 1, 3, 5-hexatrience and allylsystem. Classification of Pericyclic reactions. Woodward-Hoffman correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatorymotions 4n, 4n+2 and allylsystems. Cycloadditions - antarafacial and suprafacial additions 4S+2S Systems and 2S+2S addition of alkene. Sigmatropic rearrangement - suprafacial and antarafacial shift involving carbon moieties. 3, 3-and 5, 5-sigmatropic rearrangement Claisen, Cope-rearrangement reactions.	**9**

Total: 36

Books:

1. Advanced Organic Chemsitry - Reaction, Mechanism and Structure, Jerry March, Johny Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peer Sykes, Longman.

4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University, Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
6. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
7. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherjii and S.P. Singh, Macmillan.
9. L. Finar, Organic Chemistry, Vol.II, 5th ed., ELBS, 1975.
10. R.K. Bansal, Organic Reaction Mechanisms, Tata McGraw Hill, 1975.
11. R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th edition, Pearson, 1992.
12. J.M. Coxon, B. Halton, Organic Photochemistry, Camb. Uni. Press, 2nd edition, 1987.
13. G.R. Chatwal , Organic Photochemistry, Himalaya Publications house, 1st edition, 1998

E-Book:

1. https://www.swayam.gov.in/nd2_cec20_ma07/preview
2. https://www.nptel.ac.in/courses/104/103/104103110/
3. https://www.pdfdrive.com/organic-chemistry-e28008787.html

Course Code: MSCC-104

Title of the Course: Organic Chemistry Lab

L	T	P	Credits
0	0	2	1

Course Outcomes:

At the end of the course, the student will be able to

CO1: To Perform techniques involved in organic binary mixture separation specially solid-liquid mixture.

CO2: To perform distillation techniques for purification of organic compounds.

CO3: To apply the technique of separation, crystallization derivatization and function group detection

CO/PO mapping
(S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak

CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	W	S	S	S	M	S	W	M	S	M	S	M
CO2	M	S	S	W	M	M	S	W	M	S	W	S
CO3	S	M	S	M	M	M	S	W	M	S	M	M

Qualitative Organic Analysis

Separation and purification of components of binary mixture (Solid/solid, solid/liquid and liquid/liquid) on the basis of solubility behaviour and solvent extraction and their identification and conformation by chemical tests and preparation of suitable derivative.Preparative TLC separation for IR and PMR spectral studies of the respective component.

Organic Synthesis

Benzoylation	:	Hippuric acid
Oxidation	:	Adipic acid/p-Nitrobenzoic acid
Aldol condensation	:	Dibenzalacetone/Cinnamic acid
Sandmeyer's reaction	:	p-Chlorotoluene
BenzfusedHeterocycles	:	Benzimidazole
Cannizzaro's reaction	:	p-Chlorobenzaldehyde as substrate
Friedel Crafts reaction	:	S-Benzoylpropionic acid
Aromatic electrophilic substitution	:	p-Nitroaniline / p-Iodoaniline

Course Code: MSCC-105

Title of the Course: Physical Chemistry

L	T	P	Credits
3	2	0	4

Course Outcomes:

After undergoing this course student will be able to:

CO1: Apply the tools to derive the rate law and its mechanism

CO2: To explain the influence of different parameters on rate of reactions

CO3: Realize the terms ionic strength, activity coefficient, DHO equation.

CO4: Know the Eigen function, Eigen value, operator and postulates of quantum mechanics.

CO5: Learn two and three dimensional box, mechanics of particle.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO'S	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	M	S	W	M	S	W	S	S
CO2	S	S	S	S	S	S	M	W	S	W	M	W
CO3	S	S	S	M	S	S	S	M	W	M	S	M
CO4	S	S	S	S	S	M	M	S	S	W	S	S
CO5	S	S	M	S	W	M	M	S	S	S	S	S

Unit	Course Outline	Hour(s)
I	**Thermodynamics** (i) Recall: Concepts involved in first and second law of thermodynamics, Entropy, free energy and chemical equilibrium. Thermodynamic equation of state. Maxwell relations. (ii) Non-ideal systems: Excess functions for non-ideal systems. Activity and activity coefficients and their determination. Concept of fugacity and its experimental determination.Partialmolar properties and their determination. (iii) Third law of the thermodynamics:Identification of statistical and thermodynamic entropy. Nernst postulate, Plank's contribution. Alternate formulation of third law. Cooling by adiabatic and demagnetization.Evaluation of absolute entropy. (iv) Thermodynamic and living systems: Simultaneous or coupled reactions. Coupled reactions and metabolism. Free energy utilization in metabolism.Terminal oxidation chain. Overall metabolic plan. General thermodynamic consideration of living systems.	**9**

II	**Statistical Thermodynamics** (i) General introduction: Phase space, microstates, macro states, thermodynamic probability. Brief introduction to different types of statistics.Ensembleconcept. Canonical, grand canonical and microcanonicalensembles.Sterlingapproximation, Maxwell Boltzmann distribution law. (ii) Partition function and thermodynamic properties: Partition function and its factorization. Translational, rotational, vibrational; electronic and nuclear partition functions. Expressions for internal energy, entropy, Helmholtz function, Gibb's function, pressure, work and heat in terms of partition function. Thermodynamic properties of ideal gases. Vibrational, rotational, electronic and nuclear contributions to the thermodynamic properties.	**9**
III	**Electrochemistry** (i) Ion-solvent interactions: Born model of ion-solvent interactions, Structural models of ion - solvent interactions. Experimental determination of salt-solvent interactions. Relative heats of solvation of ions in the hydrogen scale. Evaluation of ion-solvent interactions from experimental data of salt-solvent interactions. (ii) Ion - ion interactions: Debye - Huckel theory of ion - ion interactions. Verification of Debye - Huckel limiting law. Activity, coefficients at moderate concentrations and higher concentrations. Activity coefficients as a function of ion-ion and ion-solvent interactions. Mean activity coefficients and their experimental determination. (iii) Conductance and Ionic nobilities:Conductance of electrolytic solution. Variation of equivalent conductance with concentration. Debye - Huckel - Onsager theory. Modification of Debe - Huckel - Onsager equation.Ionicconductance.Ion-association and ion-pair formation. Ion-triplets in electrolyte solutions. Ion-triplets and conductance.	**9**
IV	**Applied Electrochemistry** (i) Electrical Double layer: Electro kinetic phenomenon. Null point and its determination. Structure of electrical double layer, parallel plate condenser theory, diffuse layer theory and absorption theory of double layer. (ii) Electro catalysis: A chemical catalyst and an electrochemical catalyst, Electro catalysis in redox reactions. Electro catalysis in reactions involving absorbed species. Some specific feature of electro catalysis. (iii) Electrochemical Energy Conversion and Electricity storage: Direct energy convertors. Efficiency of electrochemical energy convertors. Some typical examples of electrochemical energy convertors. Advantages and applications of fuel cells.Electricity storage density and energy density. Various electricity stores and their applications. (iv) Corrosion of Metals: Classification of corrosion processes, theories of corrosion processes, passivation of metals. Corrosion monitoring and methods of corrosion prevention.	**9**

Total: 36

Recommended Books:

1. Bockris and Reddy, Modern Electrochemistry, Vol. I & II.
2. Antropov, Theoretical Electrochemisty.
3. Glasstone, Electrochemistry.
4. Aston and Fritz, Thermodynamic and Statistical Thermodynamics.
5. Lee, Seers and Turcotte; Statistical Thermodynamics.
6. Dickerson, Molecular Thermodynamics.
7. Glasstone, Thermodynamics for Chemists.
8. Agarwal, Basic chemical kinetics, Tata McGraw- Hill, 1990.
9. Bockris J.O.M and A.K.N. Reddy, Electrochemistry, volumes 1 and 2,Plenum,Newyork,1977.
10. Glasstone.S, An introduction to Electrochemistry Affiliated East West press, New Delhi, 1977.

E-Books:

1. https://www.swayam.gov.in/nd1_noc20_cy08/preview
2. https://www.nptel.ac.in/courses/104/101/104101099/
3. https://www.pdfdrive.com/physical-chemistry-in-brief-e4440232.html

Course Code: MSCC-106
Title of the Course: Physical Chemistry Lab

L	T	P	Credits
0	0	2	1

Course Outcomes:

At the end of the course, the student will be able to

CO1: To demonstrate the techniques involved in organic binary mixture separation

CO2: To use the technique of separation, crystallization derivatization and function group detection

CO3: To perform the methods for the preparation of useful compounds using named reaction.

CO/PO mapping
(S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak

CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	S	M	M	M	S	S	M	S
CO2	S	S	S	W	M	M	S	W	M	S	W	S
CO3	S	M	S	M	M	M	S	M	M	S	M	M

List of Experiments

1. To determine the Molecular weight of given polymer by viscosity method.
2. To find out the value of coefficient of expansion for the given liquid with the help of Pyknometer.
3. To determine the atomic Parachors of C, H & O.
4. To compare the cleansing powers of two samples of detergents by surface tension method.
5. To determine the interfacial tension between two immiscible solvents.
6. To find out the equilibrium constant for the reaction,
   $KI + I_2 \rightleftharpoons KI_3$ by partition method.
7. To determine the rate constant of the hydrolysis of ethyl acetate catalysed by an acid and also find out the half life period of the reaction.
8. To determine the order of saponification of ethylacetate with sodium hydroxide.
9. To find out the molar refractivities of homologous series of alcohols & also find out the atomic refractivities of C & H.
10. To find out the molar refractivity of the given solid.
11. To study the adsorption of acetic acid on activated charcoal & prove the validity of Freundlich Adsorption Isotherm.
12. To find out the molecular weight of benzoic acid in bezenecryoscopically& hence find out its degree of association.
13. To find out the degree of hydrolysis of sodium acetate cryoscopically.
14. To determine the density of given liquids with the help of Pyknometer.

Course Code: MSCC-107

Title of the Course: Mathematics for Chemists

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Calculate yields and enantiomeric excess.

CO2: Use logs and exponentials to convert between quantities such as Ka and pKa, $[H^+]$ and pH.

CO3: Assess the accuracy and precision of measurements.

CO4: Determine the uncertainty in derived quantities.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	M	S	W	M	S	W	S	S
CO2	S	S	S	S	S	S	M	W	S	W	M	W
CO3	S	S	S	M	S	S	S	M	W	M	S	M
CO4	S	S	S	S	S	M	M	S	S	W	S	S

Unit	Course Outline	Hour(s)
I	**Vectors and Matrix Algebra** Vectors: Vectors, dot, cross and triple products. The gradient, divergence and curl. Matrix Algebra: Addition and multiplication, determinants (upto 4th order) inverse, adjoint and transpose of matrices, special matrices (Symmetric, skew-symmetric, Hermitian; skew-Hermitian, unit, diagonal, unitary etc.) and their properties. Matrix equations : Homogeneous, non-homogeneous, linear equations and conditions for the solution, linear dependence and independence. Cayley Hamilton theorem, matrix eigenvalues and eigenvectors.	9
II	**Coordinate Geometry** Cartesian system of co-ordinates in the plane, slope of a line, parallel and perpendicular lines, intercepts of a line on the co-ordinate axes, Various forms of equations of a line-parallel to axis, slope intercept form, the point slope form, two point form, intercept form, normal form and general forms. **Trigonometry** Degree and radian measure of positive and negative angles, relation between degree and radian, definition of trigonometric functions with the help of unit circle, Periodic functions, Concept of periodicity of trigonometric functions, values of trigonometric functions for different	9

	angles, trigonometric functions of sum and differences of angles, addition and subtraction formulae.	
III	**Calculus** Differential Calculus: Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima. Functions of several variables, partial differentiation, Euler's theorem co-ordinate transformations (e.g. Cartesian to spherical polar). Integral calculus: Basic rules for integration, integration by parts, partial fraction and substitution definite integrals. Reduction formulae.	**9**
IV	**Elementary Differential Equations** Veriables - separable and exact, first order defferential equations. Homogeneous, exact and linear equations.Applications to chemical kinetics, secular equilibria, quantum chemistry etc. Solutions of differential equations by the power series method, Fourier series, solutions of harmonic oscillator and Legendre equation, spherical harmonics. **Permutation and Probability** Permutations and combinations, probability and probability theorems, probability curves, average, root mean square and most probable errors, examples from the kinetic theory of gases, curve fitting (including least square fit) with a general polynomial fit.	**9**

Total: 36

Recommended Books:

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Chemical Mathematics, D.M. Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt Wiley.

Supplementary Reading

1. Higher Engineering Mathematics, S. S. Grewal (Khanna Pub.)

Course Code: MSCC-108

Title of the Course: Biology for Chemists

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Understand the chemistry of water

CO2: Describe the chemistry of carbohydrates, lipids, proteins and nucleic

CO3: Learns the steps involved in the complex formation process

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	S	M	M	M	S	W	M	S	W	M

Unit	Course Outline	Hour(s)
I	**Origin of Life** Unique properties of Carbon, Chemical evolution and rise of living systems.Introudction of biomolecules, building blocks of biomolecules. **Cell Structure & Functions** Structure of prokaryotic .& eukaryotic cells, Intercellular organelles and their functions, Comparison of plant and animal cells. Overview of metabolic process - catabolism and Anabolism. ATP - the Biological energy currency. **Cell Division** Cell division stages of mitosis & meiosis. Significance of cell division and fertilization.	9
II	**Carbohydrates** Conformation of monosaccharides, structure & functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars, N-acetyl muramic acid, Sialic acid, disaccharide & Polysaccharides. Structural polysaccharides - cellulose and chitin. Storage Polysaccharides - starch and glycogen. Structure and Biological functions of glucosaminoglycans or mucopolysacc–harides, Carbohydrates of glycoproteins and glycolipids.Role of sugars in Biological recognition. Blood group substances, Ascorbic acid. Carbohydrate metabolism - Kreb's Cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, Pentose phosphate Pathway. **Lipids**	9

	Fatty acids, essential fatty acids, structure and function of triglycerotsglycerophospholipids, Sphingolipids, cholesterol, Bile acids, prostaglandins, Lipoproteins — composition and function role in atherosclerosis, Properties of lipid aggregates — micelles, bilayers, liposomes and their possible biological functions, Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism - b - oxidation of fatty acids.	
III	**Structure of Proteins** Chemical and enzymatic hydrolysis of Proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holiding of secondary structure, a. triple helix, b. sheets, super secondary structure, triple helix structure of collagen/Tertiary structure of protein — folding and domain structure. Quarternary structure. **Amino acid metabolism** Degradation and biosynthesis of amino acids, sequence determination : chemical/enzymatic/mass spectral, racemization/detection. Chemistry of oxytocin and tryptophan releasing harmone (TRH). **Enzymes** Enzymes as biological catalyst and mode of their action.	**9**
IV	**Structure of Nucleic Acids** Purines and Pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonuclic acids (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding' it Chemical and enzymatic hydrolysis of Nucleic acids. **Replication of DNA** The chemieal basis of heredity and overview of replication of DNA. **Protein synthesis & Genetic Code** Transcription, translation and genetic code, chemical synthesis of mono and trinucleoside.	**9**

Total: 36

Recommended Books:

1. Principles of Biochetnistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.

Course Code: DBEF-101
Title of the Course: Foundations of Employability Skills

L	T	P	Credits
1	0	4	3

The course is designed to achieve superior outcomes of placement, retention and progression of students through 21' century employability skills' training and assessment.

Skills development network shall provide Vocational curricula and e-content for high quality employability and work skills training through an online learning platform.

(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M.Sc (Chemistry)

Semester II

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCC-201	Natural Products	CC	40	60	100	3	0	0	3
2.	MSCC-202	Heterocyclic Chemistry	CC	40	60	100	3	0	0	3
3.	MSCC-203	Statistical Thermodynamics &Photochemistry	CC	40	60	100	3	0	0	3
4.	MSCC-204	Advanced Chemistry Lab I	CC	40	60	100	0	0	2	1
Department Elective Courses (Select Any One)										
5.	MSCC-205	Environmental Chemistry and Eco-Toxicology	DE	40	60	100	3	0	0	3
6.	MSCC-206	Fundamentals and Atmospheric Photochemistry	DE	40	60	100	3	0	0	3
Life Skill Courses										
7.	DBES-101	EVS	LSC	40	60	100	3	0	2	4
Total				240	360	600	15	0	4	17

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course, EVS- Environmental Studies

Course Code: MSCC-201

Title of the Course: Natural Products

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Understand the basic classification and role of alkaloids.

CO2: Learn the structural elucidation and degradation of alkaloids.

CO3: Understand the synthesis and structure of alkaloids.

CO4: Explain the isolation and structural determination of alkaloids.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	M	M	M	M	M	M	M	M
CO2	M	S	S	S	M	M	S	W	M	S	W	M
CO3	S	M	M	M	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	W	W	M

Unit	Course Outline	Hour(s)
I	**Introduction & General Methods** Isolation, purification, identification and standardization of natural products. Carbohydrates and metabolism: Introduction, stereoisomerism, mutarotation, configuration and ring structure of monosaccharides, disaccharides and polysaccharides. Glycolysis, alcoholic and lactic acid fermentation, citric acid cycle.	9
II	**Alkaloids and Terpenoids** Introduction, classification, isolation and purification of alkaloids and terpenoids. Structure elucidation of alkaloids (atropine, quinine, morphine) and terpenoids (camphor and menthol). Biosynthesis of alkaloids.	9
III	**Steroids** General introduction, isolation, purification and structure elucidation stereochemistry of sterols with special reference to cholesterol. Vitamin D group and bile acids. Biosynthesis of sterols.	9
IV	**Carotenoids and Vitamins** Introduction to carotenoids and vitamins, Carotenes. Vitamin A, xanthophyll, vitamin B complex, vitamin K and vitamin E group.	9

Total: 36

Text Books:

1. I.L. Finar, 'Organic Chemistry: Stereochemistry and The Chemistry Natural Products', Vol. II, 5th Edn., Longman Scientific & Technical, 1988.
2. O.P. Agarwal, 'Chemistry of Organic Natural Products', Vol. I, 40th Edn., Krishna Prakashan Media, 2010.
3. O.P. Aggarwal, 'Organic Chemistry Natural Products', Vol. II, 38th Edn., Krishna Prakashan Media, 2010.
4. https://www.pdfdrive.com/chemistry-of-plant-natural-products-stereochemistry-conformation-synthesis-biology-and-medicine-e175928173.html
5. https://nptel.ac.in/content/syllabus_pdf/104103068.
6. https://www.nccih.nih.gov/grants/natural-product-libraries
7. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford UniversityPress, 2001.
8. R. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.
9. L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis,Elsevier Academic Press, 2005.
10. I.L. Finar, Organic chemistry, Vol-I, 6th Edition, Pearson, 2002.
11. Organic Chemistry -Natural products,O.P.Agarwal, Vol –I,40th ed. and Vol.II, 38th ed.,2010

Course Code: MSCC-202

Title of the Course: Heterocyclic Chemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Understand the structures of classes of heterocyclic aromatic organic compounds.

CO2: Classify simple heterocyclic aromatic compounds as electron deficient or electron rich and explain their reactivity based on these properties.

CO3: Apply organometallic reactions that applied in heterocyclic chemistry.

CO4: Explain on a mechanistic level, reactions and synthesis

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	M	S	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	M	W	W

Unit	Course Outline	Hour(s)
I	**Nomenclature of Heterocycles** Replacement and systematic nomenclature (HantzschWidman system) for monocyclic, fused and bridged heterocycles. **Aromatic Heterocycles** General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond length, ring current and chemical shifts in 1H NMR-spectra, empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltation). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.	9
II	**Non Aromatic Heterocycles** Strain bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3diaxial interaction. Stereo-electronic effects – anomeric and related effects. Attractive interactions – hydrogen bonding and intermolecular nucleophilic – electrophilic interactions. **Heterocyclic Synthesis** Principles of heterocyclic synthesis involving cyclization	9

	reactions and cycloaddition reactions.	
III	**Small Ring Heterocycles** Three membered and four membered heterocycles- synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes. **Benzo-Fused Five-Membered Heterocycles** Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans, and benzothiophenes.	**9**
IV	**Meso-Ionic Heterocycles** General classification, chemistry, chemistry of some important meso-ionic heterocycles of type-A and B and their applications. **Six-Membered Heterocycles with One Heteroatom** Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium&thiopyrylium salts and pyridones. Synthesis & reactions of quinolizinium and benzopyreliumsals, coumarins and chromones.	**9**

Total: 36

Text Books:

1. R.R. Gupta, M. Kumar and V. Gupta, 'Heterocyclic Chemistry: Principles, Three- and Four-Membered Heterocycles, Vol. 1', Springer Berlin Heidelberg, **1998.**
2. R.R. Gupta, M. Kumar and V. Gupta, 'Heterocyclic Chemistry: Five-Membered Heterocycles, Vol. 2', Springer Berlin Heidelberg, **1999.**
3. T. Eicher and S. Hauptmann, 'The Chemistry of Heterocycles', Georg Thieme, Stuttgart, **1995**
4. R.M. Acheson, 'An Introduction to the Heterocyclic Compounds', John Wiley &SonsLtd., New York, London, **1976.**
5. https://onlinelibrary.wiley.com/toc/19435193/current
6. https://www.digimat.in/nptel/courses/video/104105034/L01.html

Course Code: MSCC -203

Title of the Course: Statistical Thermodynamics & Photochemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Apply fundamental concepts of thermodynamics to engineering applications

CO2: Study about orbital electron capture

CO3: Understands different electron capture detectors

CO4: Estimate thermodynamic properties of substances in solid, gas and liquid states

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	M	W	M	S	S	S	S
CO2	M	M	S	S	M	S	M	W	S	S	M	M
CO3	S	M	M	M	W	W	S	M	M	W	S	W
CO4	S	S	S	S	S	S	M	S	S	W	W	M

Unit	Course Outline	Hour(s)
I	**Quantum Statistics** Recapitulation of classical statistics and partition function, comparison between Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, thermodynamic probability, statistics of monatomic ideal gas, principle of equipartition of energy, barometric equation, theory of paramagnetism, statistics of photon and electron gases, velocity, speed and energy distribution functions, thermionic emission.	**9**
II	**Gaseous State** Classical and quantum mechanical treatments of specific heats of ideal diatomic gases, vibrational, rotational and electronic contributions to the specific heats of diatomic gases, fine correction due to rotation-vibration coupling for diatomic gases, ortho and parahydrogens, polyatomic gases, gas mixture and entropy of mixing, non ideal gases, equation of state of nonideal gases, Lennard-Jones potential energy equation compressed gases.	**9**

III	**Solid State** Classical treatment of specific heat of solids, Einstein and Debye theories of specific heats, Debye's T3 law, entropy of solids, equation of state of solids, order and disorder and the melting point. **Chemical Systems** Law of mass action, chemical equilibrium, dissociation, equilibrium constants and their computation.	**9**
IV	**Fluctuations** Means distribution, mean square deviation, fluctuations in energy in a canonical ensemble, density fluctuation in a gas. Theory of Brownian motion and Brownian motion of galvanometer. **Irreversible Processes** Introduction, entropy production, coupled phenomena, transport parameters, thermoelectric phenomena, The Seebeck effect, Peltier effect and Thomson effect.	**9**

Total: 36

Text Books:

1. Statistical Thermodynamics by J.F. Lee, F. W. Sears and D.L. Turcotte.
2. Introduction to Statistical Thermodynamics by F.L. Hill.
3. Statistical Thermodynamics by M.C. Gupta.
4. https://www.nptel.ac.in/courses/104/105/104105084/
5. https://www.pdfdrive.com/physical-chemistry-in-brief-e4440232.html

Course Code: MSCC-204

Title of the Course: Advanced Chemistry Lab I

L	T	P	Credits
0	0	2	1

Course Outcomes:

At the end of the course, the student will be able to

CO1: To provide a basic knowledge and understanding of essential chemical and physical principles for analytical chemistry.

CO2: To introduce basic analytical techniques and practical aspects of classical chemical analysis

CO3: To solve problems related to chemical analysis and interpret analytical results.

CO/PO mapping
(S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak

CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	S	M	M	M	S	W	M	S	W	M

SECTION-A

1. To determine the percentage purity of given sample of $ZnSO_4.7H_2O$ by complexo-metric titration.
2. Determine the percentage purity of the given sample of $NiSO_4.7H_2O$ by complexometric titration using Eriochrome black-T.
3. To determine the composition of Calcium and Magnesium in the mixture of the given solution.
4. To find the strength of ascorbic acid in the given solution of Vitamin C tablet by titrating against (I) Standard I_2 solution (II) Standard Sodium thiosulphate solution.
5. To determine the percentage purity of sample of KBr using adsorption indicator.
6. To determine the amount of H_2O_2 in the given solution by titrating against. (I) Standard $KMnO_4$ (II) Standard Sodium thiosulphate solution.
7. To find out the percentage purity of KI by titrating it against standard KIO_3 solution.

SECTION-B

1. To determine the strength of HCl and acetic acid solution by titrating it against NaOHpH-metrically.
2. To determine the composition of the mixture of HCl& CH_2COOH by titrating it against NaOH pH^- metrically.
3. Determine the strength of HCl& CH_3COOH solution by titrating it against

NaOHconductometrically.

4. To determine the composition ofthe mixture of HCl& CH_3COOH by titrating it against NaOHconductometerically.
5. Determine the strength of $FeSO_4.7H_2O$ solution by titrating it against $KMnO_4$potentiometrically.
6. Determine the strength of $CuSO_4.7H_2O$ Colorimetrically.
7. Determine the strength of $K_2Cr_2O_7$ solution Colorimetrically.
8. Determine the strength of Titanium Colorimctcrically.

Course Code: MSCC -205

Title of the Course: Environmental Chemistry and Eco-Toxicology

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: To provide a basic knowledge and understanding of chemistry and composition of environment.

CO2: To introduce basic chemistry of componentsand Applications of chemistry of components.

CO3: To provide a basic knowledge and understandingthe Concept of routesandkineticsof toxicantuptake.

CO4: To provide basic knowledge of Antidotal procedureintoxicology, Bioassays &its application

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	M	W	M	S	S	S	S
CO2	M	M	S	S	M	S	M	W	S	S	M	M
CO3	S	M	M	M	W	W	S	M	M	W	S	W
CO4	S	S	S	S	S	S	M	S	S	W	W	M

Unit	Course Outline	Hour(s)
I	**CONCEPT, CHEMISTRY AND COMPOSITION OF ENVIRONMENT** 1.1 ConceptandscopeofEnvironmentalChemistry-Pollutant,Contaminant,Receptor, Sink,Pathways ofapollutant,Speciation,Thresholdlimitvalue,Stoichiometry,Gibb'sEnergy. 1.2 Compositionofatmosphereandatmospherestructure. 1.3 Cyclingofprimarygaseous pollutants andchemistryofmethanecycle. 1.4 Chemicalandphotochemicalreactionsinatmosphere. 1.5 ChemistryofozoneandalternativesforCFC's.	9
II	**CHEMISTRY OF COMPONENTS** 2.1 Chemistryofwater:Acidbaseequilibria,pHandbuffers, oxidation-reduction,redoxpotential,ionization. 2.2 ConceptofDO,BOD,COD, Sedimentation,Coagulation,filtration. 2.3 Inorganicandorganiccomponentsofsoil. 2.4 IntroductiontoRadiochemistry-αβ	9

	γradiation,nomenclatureandclassificationofnuclides. 2.5 Applications ofradioisotopesinagricultureandindustry.	
III	**ROUTESANDKINETICSOF TOXICANTUPTAKE** 3.1 ToxicoKinetics -Absorption,distributionandeliminationoftoxicants. 3.2 Routeoftoxicantuptake-skin,lungs,GIT, gills,toxicantuptakeinplants. 3.3 BiochemicaleffectsofMercury,Lead,Chromium,Cadmium,Arsenicandtheirrela tiontotoxicity. 3.4 ToxicchemicalsintheEnvironment.	**8**
IV	**COMPLEXISSUES** 4.1 Antidotal procedureintoxicology. 4.2 Bioassays &its application 4.3 Biologicalindicatoroftoxicants. 4.4 Environmentaltoxicologyoffertilizers. 4.5 Concept of major, Trace & Rare Earth Elements 4.6 Classification & mobility of trace elements	**10**

Total: 36

Text Books:

1. Baird,C(2000). EnvironmentalChemistry.W.H. FreemanandCompany,USA.
2. De,A.K.(2003). EnvironmentalChemistry.NewAgeInternationalLtd.,NewDelhi.
3. Eisenbund,M.andGesell,T.(1997). EnvironmentalRadioactivity-fromnatural,industrialandmilitarysources.Acad.Press,USA.
4. Mido,Y. andSatake, M. (1995). Chemicalsintheenvironment.DiscoveryPub.House,NewDelhi.
5. Harrison,R.M.andMora, S. J.De. (1996). IntroductorychemistryfortheEnvironmentalChemistry. CambridgeUniversity,Press.
6. Girard,J. E. (2005).Principals ofEnvironmentalChemistry.JonesandBartlettPublishers,Inc.
7. Sodhi,G.S. (2006).Fundamentalconceptsofenvironmentalchemistry.NarosaPublishingHouse,NewDelhi.
8. Sharma,B.K.(2001). EnvironmentalChemistry.KrishnaPrakashanMediaPvt.Ltd.Meerut.
9. Wright,D.A.&P. Welbowin(2002)-EnvironmentalToxicology,CambridgeUniv.Press,U.K.
10. Banerjii,S.K.(2001). EnvironmentalChemistry2001.PrenticeHallofIndiaPvt.Ltd.,New Delhi.
11. De, A.K.(2003)EnvironmentalChemistry,NewAgeInt.Lts. N. Delhi.

Course Code: MSCC-206

Title of the Course: Fundamentals and Atmospheric Photochemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Explain photocatalytic systems using a theoretical framework, and describe typical photocatalytical reactions

CO2: Explain theory and application of photocatalysis and explain the environmental impact of atmospheric photochemistry

CO3: Describe the structure and function of photosynthetic reaction centra, and apply theoretical analyses to explain the function of antenna systems

CO/PO mapping
(S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak

CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	S	M	M	M	S	S	M	S
CO2	S	S	S	W	M	M	S	W	M	S	W	S
CO3	S	M	S	M	M	M	S	M	M	S	M	M

Unit	Course Outline	Hour(s)
I	**Photochemical Reactions** Interaction of electromagnetic radiations with matter, types of excitations, Distinction of photoreactions from thermally initiated reactions and from high energy radiation reactions, Basic laws of photochemistry; Grothus& Draper law, law of photo chemical equivalence and law of absorption (Lambert Beer's law) and its limitations, Quantum yield and its determination by ferrioxalateactinometer. **Photochemistry of Atoms** Term symbols, RusselSaunder's coupling, selection rules, Excited states of Hg atoms ($^1P_1$, $^3P_1$ and metastable state, $^3p_0$) Photosensitized reactions. Sensitized fluorescence, spin conservation rule and its application for energy transfer, Photo physical processes (fluorescence, phosphorescence etc.), and photochemical degradation of excited states of Hg atoms, Hg sensitized photoreactions of simple alkanes and alkenes. **Photochemistry of Simple Molecules** Different kinds of spectra; banded, continuous and diffuse spectra, Pre-dissociation, Photophysical processes of simple molecules like sulphur, halogens and oxygen.	**9**

II	**Photochemistry of Polyatomic Molecules** Different types of molecular orbitals and electronic states, Jablonskii diagram showing various photophysical processes like fluorescence, phosphorescence, ISC, IC etc. Intensities and selection rules for spectral transitions, types of electronic transitions in organic molecules, Charge transfer transitions. **Electronically Excited Singlet and Triplet States** Fluorescence and its measurement, excimer and exciplex formation, non-radiative intermolecular and intramolecular energy transfers, Kinetic analysis and quantum yield of triplet state, Triplet singlet energy transfer, Difference in the behaviour of 'n' and □ states. **Photochemical Oxidation and Reductions** Mechanistic features of photoreduction of benzophenone by alcohols, Photosensitized incorporations of molecular oxygen into organic compounds, Type I and II photoxygenation reactions.	**9**
III	Structure of the atmosphere, structure in terms of temperature, diffusion and ionization, characteristics and chemical composition. Solar radiation, solar spectral distribution outside the earth's atmosphere, absorption by N_2, O_2, O_3 and distribution of solar energy on earth. Chemistry of the upper atmosphere, features of odd oxygen and singlet oxygen, NO_2 and HO_2 species and other species like N_2O, NH_3, HNO_3 etc., in the atmosphere.	**9**
IV	Meaning of Pollutant, different ways to express concentration of Pollutants (mass concentration, volume concentration, mass volume concentration & ppm) various pollutants like CO and CO_2,hydrocarbons, oxides of nitrogen, oxidants, halogenated, compounds, sulphur containing compounds and particulate matter monitoring and control of these pollutants. Photochemical smog, Production of smog, hydrocarbon reactivities, conversion of NO to NO_2 oxidant dosage, reactions of O_3 and singlet O_2. SO_2 Chemistry, Photolysis of SO_2, Photo-oxidation, free radical reactions.	**9**

Total: 36

Text Books

1. Gilbert &Cundel :Photochemistry.
2. Calvert &Pits :Photochemistry.
3. Atmoshperic Chemistry, J. Heicklen, Academic Press, New York.
4. Environmental Pollution Control Engineering, C.S. Rao, New Age International (P) Limited Publishers.

Course Code: DBES-101
Title of the Course: EVS

L	T	P	Credits
3	0	2	4

Course Outcomes:
After undergoing this course student will be able to:
CO1: Articulate the interdisciplinary context of environmental issues.
CO2: Identify and justify key stakeholders in humanities and social sciences that need to be a part of sustainable solutions.
CO3: Formulate an action plan for sustainable alternatives that integrate science, humanist, and social perspectives.
CO4: Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	W	S	S	W	W	S	M	S	M
CO2	S	S	M	M	S	M	M	W	W	S	M	S
CO3	S	M	S	M	S	W	S	M	S	W	S	S
CO4	S	S	M	W	S	S	W	W	S	M	S	M

Unit	Course Outline	Hour(s)
I	**The Multidisciplinary Nature of Environmental Studies** Definition, scope and importance Need for public awareness. **Natural Resources** Renewable and Non-renewable Resources: • Natural resources and associated problems. (a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. (b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. (c) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. (d) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources.	**10**

	• Equitable use of resources for sustainable lifestyles.	
II	**Ecosystems** • Concept of an ecosystem. • Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow in the ecosystem. • Ecological succession. • Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the ecosystem **Biodiversity and Its Conservation** • Introduction, definition: genetic, species and ecosystem diversity. • Biodiversity at global, National and local levels.	**10**
III	**Environmental Pollution** • Definition • Causes, effects and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards • Solid waste management: Causes, effects and control measures of urban and industrial wastes. • Role of an individual in prevention of pollution. **Social Issues and the Environment** • From unsustainable to sustainable development. • Water conservation, rain water harvesting, watershed management. • Environmental ethics: Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Consumerism and waste products. • Environment Protection Act. • Air (Prevention and Control of Pollution) Act. • Water (Prevention and Control of Pollution) Act. • Wildlife Protection Act. • Forest Conservation Act.	**10**
IV	**Human Population and the Environment** • Population growth, variation among nations. • Population explosion—Family Welfare Programme. • Environment and human health. • Human rights. • Value education. • HIV/AIDS. • Women and Child Welfare. • Role of Information Technology in environment and human	**15**

	health. • Case Studies. **Field Work** • Visit to a local area to document environmental assets—river/forest/grassland/hill/mountain. • Visit to a local polluted site—Urban/Rural/Industrial/Agricultural. • Study of common plants, insects, birds. • Study of simple ecosystems—pond, river, hill slopes, etc. • (Field work equal to 5 lecture hours	

Total- 45

Reference Books –

1. "Environmental Science" by Miller T G.
2. "Introduction to Environmental Engineering and Science" by Gilbert M Masters.
3. "The Biodiversity of India" by BharuchaErach.
4. "Essentials of Ecology" by Townsend C and Michael Begon.
5. https://nptel.ac.in/courses/122102006/
6. https://swayam.gov.in/nd2_cec19_bt03/preview
7. https://www.pdfdrive.com/environmental-science-e12033451.html

(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Semester III

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1.	MSCC-301	Analytical Chemistry	CC	40	60	100	3	0	0	3
2.	MSCC-302	Advanced Chemistry Lab II	CC	40	60	100	0	0	2	1
3.	MSCC-303	Seminar	CC	40	60	100	0	0	4	2
Department Elective Courses (Select Any One)										
4.	MSCC-304	Medicinal Chemistry	DE	40	60	100	3	0	0	3
5.	MSCC-305	Molecules of Life	DE	40	60	100	3	0	0	3
6.	MSCC-306	Quantum Chemistry	DE	40	60	100	3	0	0	3
Life Skill Courses										
7.	DBEI-301 (SDN)	Employability Skills Intermediate	LSC	40	60	100	1	0	4	3
Total				200	300	500	7	0	10	12

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

Course Code: MSCC-301

Title of the Course: Analytical Chemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Describe the basic concept of analytical chemistry. Qualitative and quantitative analysis.

CO2: Apply the basic statistical treatment of the analytical data for getting a correct result.

CO3: Describe the different separation techniques such as distillation, Solvent and Solid Phase extraction.

CO4: Explain the basic of chromatography

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	M	W	M	S	S	S	S
CO2	S	M	S	S	M	S	M	W	S	S	M	M
CO3	S	M	M	M	W	W	S	M	M	W	S	W
CO4	S	S	S	S	S	S	M	S	S	W	W	M

Unit	Course Outline	Hour(s)
I	**Elementaryconcepts** Qualitative and quantitative analysis, Concepts important to quantitative analysis, Classification of methods for quantitative analysis, Choice of method for analysis, Sampling, Preparation of samples for analysis, Calibration standards, Solution concentration in terms of various conventions, Simple equilibrium calculations, Calibration of analytical weights and glass wares, Significance of calibration. **Gravimetric MethodsofAnalysis** Precipitationgravimetry,Propertiesofprecipitatesandprecipitatingagents,particlesize,Colloidal and crystalline precipitates, Precipitation from homogeneous solutions, Washing and filtration of precipitates, Drying and ignition of precipitates, Inorganic and organic precipitating agents, Applications of gravimetricmethods.	9
II	**Volumetric (Titrimetric) MethodsofAnalysis** Terms used in volumetric analysis, Precipitation titrimetry, Neutralization titrations and its applications,Complexationtitrations,Redoxtitrationsandredoxindicators,standardreducingand oxidizingagent.	9

III	**Thermo analytical orThermometricMethods** Thermogravimetric analysis (TGA): Principle and method, automatic analysis, factors affecting results.DerivativeThermogravimetricanalysis(DTG),applications.Differentialthermalanalysis (DTA): Principle and working, theory, simultaneous DTA-TGA curves,applications.	**9**
IV	**Chromatography** Introduction, terminology and basic principle, Gas chromatography (GC): Instrumentation for Gas-Liquid chromatography, columns, stationary phases, applications, Gas-Solid chromatography. High-Performance Liquid Chromatography (HPLC), instrumentation, partition chromatography,Ion-Exchangechromatography,Size-Exclusionchromatography,Comparisonof HPLC andGC.	**9**

Text Books:

1. Christian G.D.Analytical Chemistry, John Wiley, 6th edition,1994.
2. SkoogD.A.,West,D.M.,Holler,F.J.andCrouch,S.R.FundamentalsofAnalyticalchemistry, Brooks/Cole, 2004.
3. SkoogD.A.PrinciplesofInstrumentalAnalysis,Holt-SaundersInternationaledition,3rd edition, 1985.
4. Bassett, J., Denney, R.C., Jeffery, G.H. and Mendham, J.Vogel's Textbook of Quantitative Inorganic Analysis (revised), Orient Longman, 4th edition,1978.
5. Willard H.H., Merritt L.L. Jr, Dean J.A. and Settle F.A. Jr.Instrumental Methods of Analysis,California: Wadsworth Publishing Company, 7th edition,19

6.www.scribd.com/document/354206072/Analytical-Techniques-and-Methods-for-Biomass

7 https://www.. nptel.ac.in/courses/104/105/104105084/

8. https://www.pdfdrive.com/fundamentals-of-analytical-chemistry-e4247428.html

9Analytical Chemistry –Gary D. Christian, JhonWilys& Sons, INC, V Edition, 2001.

10. Statistics for Analystical Chemistry – J.C. Miller and J.N. Miller, Ellis Harwood. Chichester, 1984.

11. Instrumental Analysis – Gary D. Christian & James, E. O'Reilly, Allyn& Bacon Ino, II Edition, 1986.

Course Code: MSCC-302

Title of the Course: Advanced Chemistry Lab II

L	T	P	Credits
0	0	2	1

Course Outcomes:

At the end of the course, the student will be able to

CO1: To demonstrate the techniques involved in organic binary mixture separation

CO2: To use the technique of separation, crystallization derivatization and function group detection

CO3: To perform the methods for the preparation of useful compounds using named reaction

CO/PO mapping
(S/M/W indicates strength of correlation)S- Strong , M-Medium , W- Weak

CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	S	M	M	M	S	S	M	S
CO2	S	S	S	W	M	M	S	W	M	S	W	S
CO3	S	M	S	M	M	M	S	M	M	S	M	M

1. To determine the Molecular weight of given polymer by viscosity method.
2. To find out the value of coefficient of expansion for the given liquid with the help of Pyknometer.
3. To determine the atomic Parachors of C, H & O.
4. To compare the cleansing powers of two samples of detergents by surface tension method.
5. To determine the interfacial tension between two immiscible solvents.
6. To find out the equilibrium constant for the reaction,
   $KI + I_2 \rightleftharpoons KI_3$ by partition method.
7. To determine the rate constant of the hydrolysis of ethyl acetate catalysed by an acid and also find out the half life period of the reaction.
8. To determine the order of saponification of ethylacetate with sodium hydroxide.
9. To find out the molar refractivities of homologous series of alcohols & also find out the atomic refractivities of C & H.
10. To find out the molar refractivity of the given solid.
11. To study the adsorption of acetic acid on activated charcoal & prove the validity of Freundlich Adsorption Isotherm.
12. To find out the molecular weight of benzoic acid in bezenecryoscopically& hence find out its degree of association.
13. To find out the degree of hydrolysis of sodium acetate cryoscopically.
14. To determine the density of given liquids with the help of Pyknometer.

Course Code: MSCC-303
Title of the Course: Seminar

L	T	P	Credits
0	0	4	2

Course Outcomes:
At the end of the course, the student will be able to
CO1: Collect useful information from the literature on the particular topic chosen by student

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	W	M	W	S	M	S	M	S

Course Code: MSCC-304

Title of the Course: Medicinal Chemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Design a chemical synthesis.

CO2: Describe the sources of drug compounds.

CO3: Describe methods of drug development including design and discovery.

CO4: Explain the relationship between drug's chemical structure and its therapeutic properties.

CO/PO mapping
(S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak

CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	W	M	W	S	M	S	M	S
CO2	M	S	S	S	M	M	S	W	M	S	W	M
CO3	S	M	M	M	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	W	W	M

Unit	Course Outline	Hour(s)
I	**Antibacterial and Antiviral Agents** History of antibacterial drugs, types, classifications, structural activity relationship, fluoroquinolones. Mechanism of action of antibacterial, ß-lactams, bacterial resistance against antibacterial drugs. Target for anti HIV drugs, anti HIV agents, HIV-protease inhibitors, amprenavir, foseprenavir, alazanavir etc., anti-HIV nucleosides: lamivudine, retrovir, videx, hivid, zlarit, viread, carbovir, delavirdine, ziduvidine, etavirenz, calanolide, capravine, nevirapine. DNA polymerase inhibitors: acyclovir, ganciclovir, penciclovir, famicilovir, valaciclovir, valomaciclovir, codofvir.	9
II	**Anti-malarials** Cinchona alkaloids, 4-aminoquinolines, 8-aminoquinolines, pyramidines and sulfones, 9-aminoacridines, biguanides, mefloquine, sulfonamides. **Commercial Synthetic Routes to** Chloroquine, pamaquine, primaquine, proguanil, amodiaquine, mefloquine, pyremethamine, sontoquine.	9

III	**CNS Active Drugs**: **CNS depressants: Hypnotics and Sedatives** Barbiturates, non-barbiturates, amides and imides, glutethimide, benzodiazepines, aldehydes and derivatives, methaqualone and other miscellaneous agents. **Anticonvulsants** Barbiturates, hydanatoins, oxazolidinediones, succinimides, bezodiazepines, thenacemide, glutethimide. **CNS-Stimulants & Psychoactive Drugs** Analeptics, purines, psychomotor stimulants, sympathomimetics, monamine oxidase inhibitors, tricyclic antidepressants, miscellaneous psychomotor stimulants. Hallucinogens (psychedelics, psychometrics): Indolethylamines, R-phenylethylamines, butyrophenones and other miscellaneous drugs. **Commercial Synthetic Routes to** Thioridazine, haloperidol, chloropromazine, phenytoin, Phenobarital, Carbamazipinevalproic acid, methaquolane, nitrazepam, oxazepam, diazepam, cholridazepoxide.	**9**
IV	**Diuretics** Osmotic agents, acidifying salts, mercurials, purines and related heterocycles, sulfonamides, benzothiadiazene and related compounds, chlorothiazides and analogs, sulfamoylebenzoic acid and analogs, endocrine antagonists, miscellaneous diuretics. **Commercial Synthetic Routesto** Furosemide, methalthiazidemethylchlothlazide: Chlorothiazide, triameterene, hydrochlothiazide, ameloride, chlorthalidone.	**9**

Total: 36

Text Books:

1. Wilson and Gisvolds, 'Textbook of Organic Medicinal and Pharmaceuticals Chemistry',8thEdn., edited by R.F. Deorge, J.B. Lippincott Company, Philadelphia, **1982**.
2. B.G. Reuben and H.A. Wittcoff, 'Pharmaceutical Chemicals in Perspective'**,** John Wiley & Sons, New York, **1989**.
3. W.O. Foye, T.L. Lamke, D.A. Williams, 'Principles of Medicinal Chemistry'**,** 5thEdn. Lippencott Williams and Wilkins, **2002**
4. http://www.lmdc.edu.pk/downloads/MedicinalChemistry/BurgersMedicinalChemistryandDrugDiscoveryVolumeoneSixthEditionEditedbyDonaldJAbraham.
5. https://www.nptel.ac.in/content/syllabus_pdf/104106106.
6. Drug Discovery and Evaluation, Pharmacological assays, H.GerhardVogel,ndedition, Springer publications.
7. Quality Control of Herbaldrugs, An approach to evaluation of botaniocals, by PulokMukherjee, Business Horizon Publications.
8. Pharmacognosy and Pharmacobiotechnology, by AshutoshKar, New age Internationalpublications.
9. Role of Biotechnology in Medicinal and Aromatic plants, Vol-XIII, UkaazPublications,Hyderabad.
10. Supplement to cultivation and utilization of medicinal plants, S.S.Handa and M.K.Kaul,RRL Jammu.

Course Code: MSCC-305

Title of the course: Molecules of Life

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Learns basis of green chemistry

CO2: Understands principles of green chemistry

CO3: Appreciates the importance of solvent free synthesis

CO4: Gains knowledge about molecular designing

CO5: Validates the adverse effect of chemicals on environment

CO/PO mapping												
(S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	M	W	S	S	S	M	S
CO2	S	S	S	S	M	S	S	W	S	S	W	M
CO3	S	M	M	M	W	W	S	M	M	W	S	W
CO4	S	S	S	S	S	S	M	S	S	W	W	M
CO5	S	M	M	M	W	W	S	M	M	W	S	W

Unit	Course Outline	Hour(s)
I	**Carbohydrates** Classificationofcarbohydrates,reducingandnon-reducingsugars,GeneralPropertiesofGlucose and Fructose, their open chain structures. Epimers, mutarotation and anomers. Determination of configurationofGlucose(Fischerproof).Cyclicstructureofglucose.Haworthprojections.Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structureelucidation.	**9**
II	Amino Acids, Peptidesand Proteins Classification of Amino Acids, Zwitter ion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides,determinationofN-terminalaminoacid(byDNFBandEdmanmethod)andC–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phasesynthesisEnzymes and correlation with drug	**9**

	actionMechanismofenzymeaction,factorsaffectingenzymeaction,Coenzyme sandcofactorsandtheir role in biological reactions, Specificity of enzyme action (Including stereo specificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition.	
III	**NucleicAcids** Components of Nucleic acids: Adenine, guanine ,thymine and Cytosine(Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation. Lipids Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).	**9**
IV	**Concept of Energy inBiosystems** Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of food (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.	**9**

Total: 36

Text Books:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Pearson Education, 6thedition, 1992.
2. Finar, I. L. Organic Chemistry (Volume 1), Pearson Education, 6thedition,1973.
3. Finar, I. L. Organic Chemistry (Volume 2), Pearson Education, 6thedition,1973.

Course Code: MSCC -306

Title of the Course: Quantum Chemistry

L	T	P	Credits
3	0	0	3

Course Outcomes:

At the end of the course, the student will be able to

CO1: Have a deep understanding of the Importance of Quantum Mechanics in Chemistry

CO2: Understand the concept of Angular momentum

CO3: Understand its applications on some model systems

CO4: To have understanding of various theories in Quantum Chemistry.

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	M	M	M	M	M	M	M	M
CO2	M	S	S	S	M	M	S	W	M	S	W	M
CO3	S	M	M	M	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	W	W	M

Unit	Course Outline	Hour(s)
I	Origin of the quantum theory. Postulates of quantum mechanics and Schrödinger equation; its application on some model systems viz., free-particle and particle in a box, tunneling, the harmonic oscillator, the rigid rotator, and the hydrogen atom.	**8**
II	The variation theorem; linear variation principle; perturbation theory; applications of variational methods and perturbation theory to the helium atom. Ordinary angular momentum, generalized angular momentum, eigenfunctions, and eigenvalues of angular momentum operator, Ladder operator, addition of angular momenta. Spin, antisymmetry, Pauli exclusion principle, Slatterdeterminantal wave functions.	**12**
III	Term symbol (RS and jj coupling) and spectroscopic states, term separation energies of pn and dn configurations, magnetic effects: spin-orbit coupling and Zeeman splitting.	**8**
IV	Born-Oppenheimer approximation, VB and MO theory, H2 +, H2 molecule problem, Hückel molecular orbital theory and its application to ethylene, butadiene and benzene. Hybridisation and valence MOs of H2O, NH3 and CH4.	**8**

Total: 36

Text Books:

1. Statistical Thermodynamics by J.F. Lee, F. W. Sears and D.L. Turcotte.
2. Introduction to Statistical Thermodynamics by F.L. Hill.
3. Statistical Thermodynamics by M.C. Gupta0
4. https://www.nptel.ac.in/courses/104/105/104105084/
5. https://www.pdfdrive.com/physical-chemistry-in-brief-e4440232.html

Course Code: DBEI-301 (SDN)
Title of the Course: Employability Skills Intermediate

L	T	P	Credits
1	0	4	3

The course is designed to achieve superior outcomes of placement, retention and progression of students through 21' century employability skills' training and assessment.

Skills development network shall provide Vocational curricula and e-content for high quality employability and work skills training through an online learning platform

(U/S 2(f) and 12B of the UGC Act1956, NAAC Accredited)

DESH BHAGAT UNIVERSITY, MANDI GOBINDGARH

Faculty of Engineering and Applied Sciences

Department of Applied Sciences

Program: M. Sc (Chemistry)

Semester IV

S. No.	Course Code	Course Name	Category	Internal	External	Total	L	T	P	C
1	MSCC-401	Research Methodology	CC	40	60	100	2	0	0	2
2	MSCC-402	Major Project	CC	100	200	300	0	0	48	24
Life Skill Courses										
3	HVP-201C*	Human Value and Professional	LSC	40	60	100	2	0	0	2
Total				180	320	500	4	0	48	28

L- Lecture , T- Tutorial , P- Practical , C- Credit , CC- Core Course , DE- Department Elective, LSC- Life Skill Course

Course Code: MSCC-401

Title of the Course: Research Methodology

L	T	P	Credits
2	0	0	2

Course Outcomes:

At the end of the course, the student will be able to

CO1: Organize and conduct research (advanced project) in a more appropriate manner.

CO2: Write a research report and thesis.

CO3: Write a research proposal (grants).

CO4: Prepare a project proposal (to undertake a project).

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	M	S	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	M	W	W

Unit	Course Outline	Hour(s)
I	Foundations of Research: Meaning, Objectives. Concept of theory, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable.ResearchProcess Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic&Importance	**9**
II	Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent &Dependentvariables. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.	**9**

III	Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of thesample Practical considerations in sampling andsamplesize. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	**9**
IV	Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, PlagiarismandSelf-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detectionofPlagiarism	**9**

Total- 36

Books Recommended:-

1. BusinessResearchMethods–DonaldCooper&PamelaSchindler,TMGH,9thedition
2. Business Research Methods – Alan Bryman& Emma Bell, Oxford UniversityPress.
3. Research Methodology –C.R.Kothari
4. Select references from theInternet

Links:

1. https://swayam.gov.in/nd2_cec20_hs17/preview#:~:text=The%20present%20course%20intends%20to,sociology%2C%20social%20work%2C%20etc.
2. https://swayam.gov.in/nd1_noc19_ge21/preview

Course Code: MSCC-402
Title of the Course: Major Project

L	T	P	Credits
0	0	48	24

Course Outcomes:
On completion of this course, the students will be able to:
CO1: Understand project characteristics and various stages of a project.
CO2: Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

CO/PO Mapping (S-Strong Correlation, M- Medium Correlation, W-Weak Correlation)												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M

Course Code: HVP-201C*
Title of the Course: Human Value and Professional Ethics

L	T	P	Credits
2	0	0	2

Course Outcomes:
On completion of this course, the students will be able to:
CO1: Become sensitive towards human values.
CO2: Understand commitment and responsibility.
CO3: Gain the ability to bring harmony to the society they live
CO4: Progress from discrimination to commitment
CO5: Develop the ability to face difficult situations in life boldly and resolve them confidently

CO/PO mapping (S/M/W indicates strength of correlation) S- Strong , M-Medium , W- Weak												
CO's	Program Outcome (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	S	M	S	M	M	M	W	S	S	M	S
CO2	M	S	S	W	M	M	S	W	M	S	W	M
CO3	S	M	M	S	M	W	S	M	M	W	S	W
CO4	S	S	S	S	M	S	M	S	M	M	W	W
CO5	M	S	S	W	M	M	S	W	M	S	W	M

Unit	Course Outline	Hour(s)
I	**Introduction - Need, Basic Guidelines and Content:**Understanding the need, basic guidelines, content and process for Value Education. Self Exploration–what is it? - Its content and process; „Natural Acceptance" and Experiential Validation- as the mechanism for selfexploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations	**10**
II	**Process for Value Education**: Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living inHarmony at various levels **Understanding Harmony in the Human Being -** Understanding human being as a co-existence of the sentient „I" and the material „Body" Understanding the needs of Self („I") and „Body" - Sukh and Suvidha Understanding the Body as an instrument of „I" (I	**10**

	being the doer, seer and enjoyer)	
III	**Harmony in Myself! :** Understanding the characteristics and activities of „I" and harmony in „I" . Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya- practice exercises and case studies will be taken up in practice sessions. **Understanding Harmony in the Family and Society**- Harmony in Human-Human Relationship Understanding harmony in the Family- the basic unit of human interaction. Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship	**10**

Total- 30

Recommended Books

1. Engineering Ethics (Includes Human Values)" by Govindarajan M.
2. "Professional Ethics and Human Values" by Govindarajan M.
3. "Human Values" by A N Tripathi.
4. "Human Values and Professional Ethics" by Jayshree Suresh and B S Raghavan.