Faculty of Physical Sciences

Ordinance, Curriculum & Syllabus

Bachelor of Science (Non-Medical)

(2018-19)

Shree Guru Gobind Singh Tricentenary University, Gurugram (Haryana)-122505, India

BACHELOR OF SCIENCE [B.Sc.]

COURSE ORDINANCE

FINAL

1. PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.
Faculty of Physical Sciences, Shree Guru Gobind Singh Tercentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guide lines as such in UG courses.

The grading system is considered to be better than the conventional marks system and in order to facilitate student mobility across institutions with in India and across countries the community grade point average (CGPA) has been introduced in the UG courses. The guidelines as follows,

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   i. **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The

University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

d. **Open Elective Course:** In order to adopt the inter disciplinary approach open elective course introduced, there exist a university basket having papers from the discipline other than Faculty of Physical Sciences.

e. Student has to opt four papers each of two credits of his/her choice from the basket. He/She has to pass at least two papers of four credits.

2. GOAL

i. Employment prospects for under graduates are very good. The scientific knowledge and mathematical and analytic skills acquired help to place across a wide range of industries including aerospace, pharmaceutical, dyes, fabrics, electronics, semiconductors, petroleum, communications, computing, education, commerce, civil services and many more.

ii. The course will build a rich knowledge base to provide a foundation for the continued study of science.

iii. The theoretical and experimental skills necessary to analyze and solve a range of advances problems, providing an excellent foundation for leadership.

3. OBJECTIVES

The undergraduate training should enable the student to:

i. Practice efficiently various investigative procedures backed by scientific knowledge including basic sciences and skills.

ii. Get expertise in his/her field of interest

iii. Play the assigned role in the implementation of required practical skills.

iv. Be a motivated 'teacher' - defined as one keen to share knowledge and skills with a colleague or a junior or any learner continue to evince keen interest in continuing education irrespective of whether he/she is in a teaching institution or is practicing and use appropriate learning resources.

v. Exercise empathy and a caring attitude and maintain professional integrity, honesty and high ethical standards.

vi. The student is expected to know his subject in depth; however, emphasis should be on the analytical techniques. Knowledge of recent advances and basic sciences as applicable to his/her specialty should get high priority.

vii. Competence in skills commensurate with the specialty (actual hands-on training) must be ensured.

4. Duration and Nomenclature of the Course:

The duration of B.Sc. (Non-Medical/ Forensic Science (H)) course shall be of three academic years consisting of six (6) semesters (15-17 weeks) under Credit Based System (CBS). On successful completion of all the six semesters, the student will be awarded B. Sc. Degree in the concerned course. The student shall complete the course within a maximum period of five (5) years from the date of admission to the first semester, failing which he/she will be disqualified from the course.

5. Admission to the Course:

i. Eligibility for Admission:

The candidate seeking admission to B.Sc.(Non-medical) course must have passed Senior Secondary Examination (10+2) of the Board of School Education Bhiwani Haryana or any other examination recognized by SGT University as equivalent thereto, with at least 45 % marks (40% marks in case of SC/ST candidates of Haryana State only) in Physics, Chemistry and Math taken together both in qualifying and/or competitive examinations and must have passed in the subjects of Physics, Chemistry, Math and English individually in the qualifying examination.

The candidate seeking admission to B.Sc.(H) Forensic Sciences course must have passed Senior Secondary Examination (10+2) of the Board of School Education Bhiwani Haryana or any other examination recognized by SGT University as equivalent thereto, with at least 50 % marks (45% marks in case of SC/ST candidates of Haryana State only) in Physics, Chemistry and Biology taken together both in qualifying and/or competitive examinations and must have passed in the subjects of Physics, Chemistry, Biology and English individually in the qualifying examination.

ii. Schedule of admission and payment of fees:

The admission schedule, along with last date for the submission of admission forms and Payment of fees shall be fixed by the Vice-Chancellor from time to time.

6. Mode of Selection of Candidates for Admission:

The candidates shall be selected for admission to the above course on the basis of their academic merit to be determined on the basis of marks obtained either in Entrance Examination conducted by SGT University, or in the qualifying examination as decided by the University from time to time.

7. Syllabus:

The syllabus recommended by University Grants Commission (UGC) has been adopted as such. It is based on Choice Based Credit System (CBCS) and is recommended by Board of Studies and approved by Academic Council from time to time.

8. Scheme of Examination, distribution of marks, credit systemand Syllabus:

The Scheme of examination, distribution of marks in various papers along with the credit system and the syllabus of the course shall be as approved by Board of Studies/Academic Council from time to time.

9. Medium of Instruction and Examination:

The medium of the instruction and the examination shall be English only.

10. Attendance Requirements/Eligibility to Appear in Examination:

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examinations:

i. He/sheshould bear a good moral character.

ii. He/she should be on the rolls of theDept./Faculty of the University during the semester.

iii. He/she should have 75% of the attendance during the respective semester. Twenty five per cent (25%) of attendance relaxation shall account for illness and contingencies of serious and unavoidable nature.

iv. The Dean of the Faculty of his own or on the recommendation of the HoD shall have the power to give relaxation upto 5% on genuine grounds over the minimum 75% attendance.

v. Further, the Vice Chancellor of his own or on the recommendation of the Dean shall have the power to give further relaxation upto 5% on genuine grounds over the above mentioned minimum attendance.

vi. He/she should not be a defaulter in payment of any dues of the SGT University and no disciplinary action is pending against the student.

11. Exemption from Attendance / Shortage of attendance to be condoned:

The shortage of lecture to the maximum limit as under can be condoned by the competent authority:

Sr. No	Exemptable No. of Lecture	Ground of Exemption	Competent Authority
1	All periods of the days of blood donation	Voluntarily blood donation to the Blood Bank.	Dean of the Faculty
2	All periods of the day of Examination	For appearing in the supplementary examinations(Theory /Practical/Viva-voce)	-do-
3	10 days attendance during a semester	For participation in University or Inter-Collegiate Sports Tournaments/ Youth Festivals, NCC/NSS Camps/University Educational Excursions/ Mountaineering Courses	-do-
4	15days attendance during a semester	For participation in Inter-University Sports Tournaments/ Youth Festivals	-do-

Provided:

i. that he/she has obtained prior approval of the Dean, Faculty of Physical Sciences;

ii. that credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

12. Attendance Shortage Warning:

Attendance shortage warning will be displayed on the Faculty's Notice Board and University Website by 10th day of every month.

13. Detained students

A student,who does not fulfill the criteria prescribed in Clauses10-11, will not be eligible for appearing in the End Term Semester Examination in that particular paper and will be deemed as detained in that paper.Such student will repeat the course/paper alongwith the regular students of the subsequent batchto fulfill the prescribed conditions to appear in the "End Term" examination of the course/ paper.

14. Submission of Examination Forms and Payment of Examination Fee:

The Dean, Faculty of Physical Sciences shall submit the examination admission forms of thosestudents who satisfy the eligibility criteria to appear in the examinations to the Controller of Examinations as per schedule of examination circulated by him from time to time.

15. University Examinations:

i. **End Term Semester Examinations:**

The examination for the 1st,3rdand 5thsemesters (Odd Semesters) shall ordinarily be held in the month of December and of the 2nd,4thand 6th semesters (Even Semesters) in the month of May/June. The examination dates are fixed by the controller of examination with the approval of Vice Chancellor.

ii. **Fail/ Reappear candidates:**

Fail / re-appear candidate of the odd semesters (1st,3rd& 5th) will take re-appear exams as an ex-student in the subsequent exams of the odd semesters(1st, 3rd& 5th). Similarly, for the even semesters (2nd, 4th&6th), he/she will take re-appear examsin the subsequent exams of the even semesters (2nd, 4th&6th). However, a candidate appearing in the 6thsemester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of previous semesters. The examination dates are fixed by the controller of examination with the approval of Vice Chancellor.

16. Improvement Examination:

The student may be permitted to improve his/her result subject to the following conditions:

i. The student will be permitted to appear in improvement examination as an ex-student with regular batches.

ii. The student will be permitted to improve his/her CGPA in one or all papers in which he/she has obtained CGPA less than 'First Division' in aggregate.

iii. Only one chance per paper will be given. The chance must be availed of within a year of initially passing of the every semester examination.

iv. The candidate will be required to apply and allowed to appear only for theory examinations.

v. If the status/nature of the student's result does not improve by five (05) or more per cent, his/her improvement result will be declared "PRS" (Previous Result Stands).

vi. The candidate shall be allowed to appear in the improvement examination(s) along with regular candidates as and when the course is offered. No separate examination will be held for improvement of result. In case of change of syllabi, the student shall have to appear for improvement in accordance with the changed syllabi of the concerned course applicable to the regular students of that exam.

17. Setting of Question Papers:

i. The Head of the Department/Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

ii. An examiner shall be allowed to set not more than two papers in a semester examination.

iii. The examiner(s) will set the question papers as per criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council of the University.

18. Evaluation Process – Theory and Practical:

Evaluation of Answer Books:

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examiners with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

Re-evaluation of Answer Books:

Re-evaluation/ rechecking of any paper is allowed. The students can apply for Re-evaluation/ Re-checking of any paper to the Controller of Examinations through the HoD/Dean of the Faculty within 10 days of the declaration of result by paying prescribed fee.

Practical Examinations - Appointment of Examiner:

a. The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners.

Marks Distribution:

The distribution of marks in examination of the practical paper will be as per the criteria given below:

a. Experimental performance = 60% marks
b. Viva-Voce = 30% marks
c. Laboratory work report = 10% marks

19. External Assessment (Summative Assessment):

Sixty per cent marks shall be assigned to each theory and practical paper as Summative Assessment. The distribution of marks in theory as well as practical papers will be in accordance to IQAC guidelines.

20. Internal Assessment(Formative Assessment):

i. **Theory Paper:**

Forty per cent marks shall be assigned to each theory paper as Internal Assessment which shall be awarded as per the criteria given below:

Theory paper:

a. Attendance = 10 %

b. Mid-term Class Test = 20 %

c. Assignment/Quiz/Seminar etc. = 10 %

ii. **Practical paper:**

Forty per cent marks shall be assigned to each practical paper as Internal Assessment which shall be awarded as per the criteria given below:

i. Attendance = 10 %

ii. Regular experimental performance = 10 %

iii. Mid-term Internal Viva = 10 %

iv. Laboratory work report = 10 %

iii. In case of ex-students, those appearing for re-appear / improvement examination in any semester, their previous Internal Assessment marks will be counted.If there is any change in Scheme of Examination, then Internal Assessment marks will be modified accordingly.

iv. The concerned teacher shall preserve records on the basis of which the Internal Assessment has been awarded and shall make the same available to the Controller of Examinations whenever required.

v. The Head of the Department/ Dean of the Faculty shall ensure:

a. That the internal assessment marks are displayed for information of the students at least seven (07) days before the commencement of the examinations of each semester

b. That the internal assessment marks are submitted to the Controller of Examinations at least seven (07) days before the commencement of the examinations of each semester.

21.Criteria for Promotion to Higher Semester:

All the students will be automatically promoted to 2nd, 4th and 6th semester without any condition of passing minimum number of papers. For promotion from 2nd to 3rd semester, the student shall have to clear at least 50% papers of 1st semester; for promotion from 4th to 5th semester, the student shall have to clear at least 50% papers of 1st, 2nd and 3rd semesters taken together.

22. Credit Based Grading System:

i. Key Definitions:

Programme	An educational programme leading to award of a Degree, Diploma or Certificate.
Course	Usually referred to as 'paper' is a component of a programme. All courses need not carry the same weight.
Credit	A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for practical work/field work per week. A Research Based Paper /Project is equal to 5 credits.
Credit Point	It is the product of grade point and number of credits for a course i.e. Credit Point = No. of credits in a course X "grade value" of the grade obtained in the course.
Grade Point Average (GPA)	There are two types of GPAs as given hereunder: Semester Grade Point Average (SGPA) Cumulative Grade Point Average (CGPA) Every student earns a distinct SGPA and a distinct CGPA at the end of each specified semester.
SGPA	SGPA is a measure for performance of student in a Semester. It is the Point Average ratio of sum of the product of number of credits with the grade points scored by the student in all the courses taken by him/her and the sum of the number of credits of all the Courses undergone by the student i.e. $SGPA\ (Si) = \sum (CixGi) / \sum Ci$
CGPA	CGPA is a measure of performance up to any Grade Grade specified semester Point Average beginning from the first Semester. It is also calculated in the same (CGPA) manner as SPGA taking into account all the courses undergone by a student over all the semesters of programme i.e. $CGPA = \sum (Cix\ Si) / \sum Ci$
Grade Point	Itis a numerical weight allotted to each letter grade on a 10-point scale.
Letter Grades	It is an index of the performance of a student in a said course. The Grades are denoted by letters O, A+, A, B+, B, C, P, F and Ab.

ii. Credits, Semesters, Courses and total Credit Points:

S. No	Course	Semesters	Theory Credits	Practical credits	Project/ Industrial Training Credits	Open Elective	Total Credits
1	B.Sc.(Non Medical)	6	94	24	0	8	126
2	B.Sc.(H) Forensic Science	6	136	42	0	8	186

Grading Table

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8< 9	Excellent
70&above but less than 80	A (Very Good)	8	7< 8	1st Div with Distinction
60& above but less than 70	B+ (Good)	7	6< 7	1st Division
50 & above but less than 60	B (Above Average)	6	5<6	2nd Division
Above 40% but less than 50%	C (Pass Average)	5	Above 4 <5	3rd Division
40%	P (Pass)	4	4	Pass
Less than 40	F (Fail)	0	-	Fail

Formula for Calculating percentage of marks:

CGPA × 10. e.g.6.53× 10 = 65.3
Formula for calculating Grade Point:
G= (marks obtained in paper/total marks of paper) x 10
Formula for Computation SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grad points scored by a student in all the courses taken by a students and the sum of the number of credits of all the courses taken by the students ; i.e

SGPA (Si) = $\sum(Ci \times Gi) / \sum Ci$ where Ci is the no of credits of the ith course and Gi is the grad point Scored by the student in the ith course

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by the students over all the students over all the semesters of a programme , i.e

CGPA = $\sum(Ci \times Si) / \sum Ci$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA Shall be rounded up to 2 decimal points and reported in the transcripts. Result–Cum-Detailed Marks Card/ Transcript: Based on the above recommendations on letter grades, grade points and SGPA and CGPA, the DMC/ Transcript for each semester and a consolidated transcript in dictating the performance in all semester may be issued

1. Illustration of Computation of SGPA and CGPA and Format for Transcripts

Course	Credit	Grade Letter	Grade Point	Credit Points (Credit × *Grad*)
Course 1	3	A	8	3×8 = 24
Course 2	4	B +	7	4×7 = 28
Course 3	3	B	6	3×6 = 18
Course 4	3	O	10	3×10 = 30
Course 5	3	C	5	3×5 = 15
Course 6	4	B	6	4×6 = 24
	20			**139**

Thus SGPA = 139/20 = 6.95

Similarly, Suppose the SGPA for 2nd , 3rd and 4th semester are 7.85 , 5.6, and 6.0 with credits 22, 24 and 22, respectively, then for a two-year PG Programme, the CGPA will be computed as followed

CGPA = (20× 6.95 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.57

Course	Credits	Grade Letter	Grad Point Block	Range of Grad Points(Actual Grade Value as per marks obtained	Earned Credit Point(Credit × Actual *Grade Value*)
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=27.6
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				135.9

Thus SGPA= 135.9/20 = 6.79

Similarly suppose SGPA for 2nd , 3rd , and 4th semester are 7.85, 5.6 and 6.0 with credits 22, 24, and 22 respectively

CGPA = (20× 6.79 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.53

Calculating percentage of marks

CGPA× 10 E.G.6.53× 10 = 65.3

23. Pass criteria:

The minimum percentage of marks to pass the examination in each subject/paper will be 40% each in theory paper, practical /field work/Research Project etc. examination & internal assessment. The student has to pass in summative and formative (Internal) assessment separately.

24. Declaration of Results:

i. The Controller of Examinations shall declare the results as early as possible after the conclusion of each examination, but before the start of teaching for the next academic session.

ii. Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

iii. The student whose result is declared late without any fault on his/her part may attend classes for the next higher semester provisionally at his /her own risk and responsibility, subject to his /her passing the concerned semester examination. In case, the student fails to pass the concerned semester examination, his/her attendance/internal assessment in the next higher semester in which he / she was allowed to attend classes provisionally will stand cancelled.

25. Other Provisions:

i. Nothing in the Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.

ii. Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.

iii. In case of any dispute, the Vice-Chancellor will be competent authority to interpret the rules and his interpretation shall be final.

B.Sc. (Non-Medical)

Course Structure under Choice Based Credit System (CBCS): 2018-19

Semester	Course Opted	Course Name	L	T	P	Contact Hours/ Week	Credit	Max. Marks	Formative Assessment	Summative Assessment
I	Ability Enhancement Compulsory Course-I	English Communications	2	0	0	2	2	50	20	30
	Core course-I	Mechanics	4	0	0	4	4	100	40	60
	Core Course-I Practical	Mechanics Lab	0	0	4	4	2	50	20	30
	Core course-II	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	4	0	0	4	4	100	40	60
	Core Course-II Practical	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	0	0	4	4	2	50	20	30
	Core Course-III	Differential Calculus	4	0	0	4	4	100	40	60
	Open Elective Course-I	University Open Elective	2	0	0	2	2	50	20	30
Total			**16**	**0**	**8**	**24**	**18**	**500**	**200**	**300**
II	AbilityEnhancement Compulsory Course-II	Environmental Science	2	0	0	2	2	50	20	30
	Core course-IV	Electricity, Magnetism and EMT	4	0	0	4	4	100	40	60
	Core Course-IV Practical	Electricity, Magnetism and EMT Lab	0	0	4	4	2	50	20	30
	Core course-V	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I	4	0	0	4	4	100	40	60
	Core Course-V Practical	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab	0	0	4	4	2	50	20	30
	Core Course-VI	Differential Equations	4	0	0	4	4	100	40	60
	Open Elective Course-II	University Open Elective	2	0	0	2	2	50	20	30
Total			**16**	**0**	**8**	**24**	**18**	**500**	**200**	**300**
III	Core course-VII	Thermal Physics and Statistical Mechanics	4	0	0	4	4	100	40	60
	Core Course-VII Practical	Thermal Physics and Statistical Mechanics Lab	0	0	4	4	2	50	20	30
	Core course-VIII	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	4	0	0	4	4	100	40	60
	Core Course-VIII Practical	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab	0	0	4	4	2	50	20	30
	Core Course-IX	Real Analysis	4	0	0	4	4	100	40	60
	Open Elective Course-III	University Open Elective	2	0	0	2	2	50	20	30
Total			**15**	**1**	**8**	**24**	**20**	**500**	**200**	**300**
IV	Core course-X	Waves and Optics	4	0	0	4	4	100	40	60
	Course-X Practical	Waves and Optics Lab	0	0	4	4	2	50	20	30
	Core course-XI	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics	4	0	0	4	4	100	40	60
	Course-XI Practical	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics Lab	0	0	4	4	2	50	20	30
	Core course-XII	Algebra	4	0	0	4	4	100	40	60

	Skill Enhancement Course -1	SEC-1	2	0	0	2	2	50	20	30
	Open Elective Course-IV	University Open Elective	2	0	0	2	2	50	20	30
Total			**16**	**0**	**8**	**24**	**18**	**500**	**200**	**300**
V	Discipline Specific Elective -1	DSE-1A	4	0	0	4	4	100	40	60
	Discipline Specific Elective -1 Practical	DSE-1A Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective -2	DSE-2A	4	0	0	4	4	100	40	60
	Discipline Specific Elective -2 Practical	DSE-2A Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective -3	DSE-3A	4	0	0	4	4	100	40	60
	Skill Enhancement Course -2	SEC-2	2	0	0	2	2	50	20	30
Total			**14**	**0**	**8**	**22**	**18**	**450**	**180**	**270**
VI	Discipline Specific Elective -4	DSE-1B	4	0	0	4	4	100	40	60
	Discipline Specific Elective -4 Practical	DSE-1B Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective -5	DSE-2B	4	0	0	4	4	100	40	60
	Discipline Specific Elective -5 Practical	DSE-2B Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective-6	DSE-3B	4	0	0	4	4	100	40	60
	Skill Enhancement Course -3	SEC-3	2	0	0	2	2	50	20	30
Total			**14**	**0**	**8**	**22**	**18**	**450**	**200**	**300**
Grand Total			**90**	**0**	**48**	**138**	**106**	**2850**	**1140**	**1710**

Scheme of Studies B.Sc. (Non-Medical): 2018-19

Category	Credits
Core Course	64
Discipline Specific Elective Course	32
Skill Enhancement Course	6
Ability Enhancement Compulsory Course (AECC)	4
Open Elective Course	8
Total	114

20/4/2018

1. Core Course

Semester	Course Code	Course Name
I	09010113	Mechanics
	09010114	Mechanics Lab
	09010115	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
	09010116	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab
	09010117	Differential Calculus
II	09010212	Electricity, Magnetism and EMT
	09010213	Electricity, Magnetism and EMT Lab
	09010214	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I
	09010215	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab
	09010216	Differential Equations
III	09010312	Thermal Physics and Statistical Mechanics
	09010313	Thermal Physics and Statistical Mechanics Lab
	09010314	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II
	09010315	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab
	09010316	Real Analysis
IV	09010410	Waves and Optics
	09010411	Waves and Optics Lab
	09010412	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics
	09010413	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics Lab
	09010414	Algebra

2. Discipline Specific Elective Course (DSE) [Choose one paper from each discipline of choice]

Semester	Subject		Course Code	Course Name
V	Physics	DSE-1A	09010511	Solid State Physics
			09010512	Solid State Physics Lab
			09010513	Atomic Molecular and Laser Physics
			09010514	Atomic Molecular and Laser Physics Lab
			09010515	History and Philosophy of science
			09010516	History and Philosophy of science Lab
			09010532	Digital and Analog Electronics Circuit and Instrumentation
			09010533	Digital and Analog Electronics Circuit and Instrumentation Lab
	Chemistry	DSE-2A	09010517	Analytical Methods in Chemistry
			09010518	Analytical Methods in Chemistry Lab
			09010519	Molecules of Life
			09010520	Molecules of Life Lab
			09010521	Quantum Chemistry, Spectroscopy and Photochemistry
			09010522	Quantum Chemistry, Spectroscopy and Photochemistry Lab
	Mathematics	DSE-3A	09010523	Matrices
			09010524	Calculus Without Limits
			09010525	Probability and Statistics
VI	Physics	DSE-1B	09010611	Elements of Modern Physics
			09010612	Elements of Modern Physics Lab
			09010613	Quantum Mechanics
			09010614	Quantum Mechanics Lab
			09010615	Nuclear and Particle Physics
			09010616	Nuclear and Particle Physics Lab
	Chemistry	DSE-2B	09010617	Polymer Chemistry
			09010618	Polymer Chemistry Lab
			09010619	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UVIR Spectroscopy
			09010620	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UVIR Spectroscopy Lab
			09010621	Chemistry of Main Group Elements, Theories of Acids and Bases
			09010622	Chemistry of Main Group Elements, Theories of Acids and Bases Lab
	Mathematics	DSE-3B	09010623	Numerical Methods
			09010624	Integral Calculus
			09010625	Elementary Inference

3. Skill Enhancement Course (SEC) [Choose one paper]

Semester	Subject		Course Code	Course Name
IV	Physics	SEC-1	09010415	Computational Physics Skills
			09010416	Applied Optics
			09010417	Mobile Communications
			09010418	Renewable Energy and Energy Harvesting
			09010419	Physics Workshop Skills
			09010420	Basic Instrumentation Skills
V	Chemistry	SEC-2	09010526	Basic Analytical Chemistry
			09010527	Fuel Chemistry
			09010528	Chemical Technology and Society
			09010529	Pharmaceutical Chemistry
			09010530	Chemistry of Cosmetics & Perfumes
			09010531	Pesticide Chemistry
VI	Mathematics	SEC-3	09010626	Special Functions & Integral Transform
			09010602	Linear Algebra
			09010627	Vector Calculus
			09010628	Operations Research
			09010629	Complex Analysis
			09010630	Computer Fundamentals

4. Ability Enhancement Compulsory Course (AECC)

Semester	Course Code	Course Name
I	09010112	English Communications
II	09010211	Environmental Science

This is the updated course structure for batch 2018-19 as approved by BOS.

20/4/2021

DEAN
Faculty of Science
SGT University
Budhera, Gurugram

Date: 07/06/2019

B.Sc. (Non-Medical)

Course Structure under Choice Based Credit System (CBCS): 2018-19

The following changes have been made in the curriculum of B.Sc. (Non-Medical) 2018-2019.

The credit for the Mathematics papers has been revised.

Semester	CourseOpted	CourseName	L	T	P	Contact Hours/ Week	Credit	Max. Marks	Formative Assessment	Summative Assessment
I	AbilityEnhancement CompulsoryCourse-I	English Communications	2	0	0	2	2	50	20	30
	Corecourse-I	Mechanics	4	0	0	4	4	100	40	60
	CoreCourse-I Practical	Mechanics Lab	0	0	4	4	2	50	20	30
	Corecourse-II	AtomicStructure,Bonding,GeneralOrganicChemistry&AliphaticHydrocarbons	4	0	0	4	4	100	40	60
	CoreCourse-II Practical	AtomicStructure,Bonding,GeneralOrganicChemistry&AliphaticHydrocarbons Lab	0	0	4	4	2	50	20	30
	CoreCourse-III	DifferentialCalculus	4	0	0	4	4	100	40	60
	Open Elective Course-I	University Open Elective	2	0	0	2	0	50	20	30
Total			16	0	8	24	18	500	200	300
II	AbilityEnhancementCompulsoryCourse-II	EnvironmentalScience	2	0	0	2	2	50	20	30
	Corecourse-IV	Electricity,MagnetismandEMT	4	0	0	4	4	100	40	60
	CoreCourse-IV Practical	Electricity,MagnetismandEMT Lab	0	0	4	4	2	50	20	30
	Corecourse-V	ChemicalEnergetics, Equilibria&FunctionalGroup OrganicChemistry-I	4	0	0	4	4	100	40	60
	CoreCourse-V Practical	ChemicalEnergetics, Equilibria&FunctionalGroup OrganicChemistry-I Lab	0	0	4	4	2	50	20	30
	CoreCourse-VI	DifferentialEquations	4	0	0	4	4	100	40	60
	Open Elective Course-II	University Open Elective	2	0	0	2	0	50	20	30
Total			16	0	8	24	18	500	200	300
III	Corecourse-VII	ThermalPhysicsandStatisticalMechanics	4	0	0	4	4	100	40	60
	CoreCourse-VII Practical	ThermalPhysicsandStatisticalMechanics Lab	0	0	4	4	2	50	20	30
	Corecourse-VIII	Solutions,PhaseEquilibria,Conductance,Electrochemistry&FunctionalGroupOrganic Chemistry-II	4	0	0	4	4	100	40	60
	CoreCourse-VIII Practical	Solutions,PhaseEquilibria,Conductance,Electrochemistry&FunctionalGroupOrganic Chemistry-II Lab	0	0	4	4	2	50	20	30
	CoreCourse-IX	RealAnalysis	4	0	0	4	4	100	40	60
	Open Elective Course-III	University Open Elective	2	0	0	2	0	50	20	30

20/7/2020

07/06/19

18/07/2019

Total			**14**	**0**	**8**	**22**	**16**	**450**	**180**	**270**
IV	Corecourse-X	WavesandOptics	4	0	0	4	4	100	40	60
	Course-XPractical	WavesandOptics Lab	0	0	4	4	2	50	20	30
	Corecourse-XI	TransitionMetal&CoordinationChemistry,Statesofmatter&Chemicalkinetics	4	0	0	4	4	100	40	60
	Course-XIPractical	TransitionMetal&CoordinationChemistry,Statesofmatter&Chemicalkinetics Lab	0	0	4	4	2	50	20	30
	Corecourse-XII	Algebra	4	0	0	4	4	100	40	60
	SkillEnhancement Course-1	SEC-1	2	0	0	2	2	50	20	30
	Open Elective Course-IV	University Open Elective	2	0	0	2	0	50	20	30
Total			**16**	**0**	**8**	**24**	**18**	**500**	**200**	**300**
V	DisciplineSpecificElective-1	DSE-1A	4	0	0	4	4	100	40	60
	DisciplineSpecificElective-1 Practical	DSE-1A Lab	0	0	4	4	2	50	20	30
	DisciplineSpecificElective-2	DSE-2A	4	0	0	4	4	100	40	60
	DisciplineSpecificElective-2 Practical	DSE-2A Lab	0	0	4	4	2	50	20	30
	DisciplineSpecificElective-3	DSE-3A	4	0	0	4	4	100	40	60
	SkillEnhancement Course-2	SEC-2	2	0	0	2	2	50	20	30
Total			**14**	**0**	**8**	**22**	**18**	**450**	**180**	**270**
VI	DisciplineSpecificElective-4	DSE-1B	4	0	0	4	4	100	40	60
	DisciplineSpecificElective-4 Practical	DSE-1B Lab	0	0	4	4	2	50	20	30
	DisciplineSpecificElective-5	DSE-2B	4	0	0	4	4	100	40	60
	DisciplineSpecificElective-5 Practical	DSE-2B Lab	0	0	4	4	2	50	20	30
	DisciplineSpecificElective-6	DSE-3B	4	0	0	4	4	100	40	60
	SkillEnhancementCourse-3	SEC-3	2	0	0	2	2	50	20	30
Total			**14**	**0**	**8**	**22**	**18**	**450**	**180**	**270**
Grand Total			**90**	**0**	**48**	**138**	**106**	**2850**	**1140**	**1710**

Scheme of Studies B.Sc. (Non-Medical): 2018-19

Category	Credits
Core Course	64
Discipline Specific Elective Course	32
Skill Enhancement Course	6
Ability Enhancement Compulsory Course (AECC)	4
Total	106

open elective Course 08

114

07/06/19.

19/07/2019

B.Sc. (Non-Medical)

Course Structure under Choice Based Credit System (CBCS): 2018-19

Semester	Course Opted	Course Name	L	T	P	Credits	Hours	Max Marks	Formative Assessment	Summative Assessment
I	Ability Enhancement Compulsory Course-I	English Communications	2	0	0	2	2	50	20	30
	Core course-I	Mechanics	4	0	0	4	4	100	40	60
	Core Course-I Practical	Mechanics Lab	0	0	4	4	2	50	20	30
	Core course-II	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	4	0	0	4	4	100	40	60
	Core Course-II Practical	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	0	0	4	4	2	50	20	30
	Core Course-III	Differential Calculus	5/4	1	0	6	6	150	60	90
	Open Elective Course-I	University Open Elective	2	0	0	2	2	50	20	30
Total			**17**	**1**	**8**	**26**	**22**	**550**	**220**	**330**
II	AbilityEnhancement Compulsory Course-II	Environmental Science	2	0	0	2	2	50	20	30
	Core course-IV	Electricity, Magnetism and EMT	4	0	0	4	4	100	40	60
	Core Course-IV Practical	Electricity, Magnetism and EMT Lab	0	0	4	4	2	50	20	30
	Core course-V	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I	4	0	0	4	4	100	40	60
	Core Course-V Practical	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab	0	0	4	4	2	50	20	30
	Core Course-VI	Differential Equations	5	1	0	6	6	150	60	90
	Open Elective Course-II	University Open Elective	2	0	0	2	2	50	20	30
Total			**17**	**1**	**8**	**26**	**22**	**550**	**220**	**330**
III	Core course-VII	Thermal Physics and Statistical Mechanics	4	0	0	4	4	100	40	60
	Core Course-VII Practical	Thermal Physics and Statistical Mechanics Lab	0	0	4	4	2	50	20	30
	Core course-VIII	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	4	0	0	4	4	100	40	60
	Core Course-VIII Practical	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab	0	0	4	4	2	50	20	30
	Core Course-IX	Real Analysis	5	1	0	6	6	150	60	90
	Open Elective Course-III	University Open Elective	2	0	0	2	2	50	20	30
Total			**15**	**1**	**8**	**24**	**20**	**500**	**200**	**300**
IV	Core course-X	Waves and Optics	4	0	0	4	4	100	40	60
	Course-X Practical	Waves and Optics Lab	0	0	4	4	2	50	20	30
	Core course-XI	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics	4	0	0	4	4	100	40	60
	Course-XI Practical	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics Lab	0	0	4	4	2	50	20	30

Pl. add. electronics at some stage

Digital, Communication, Networks, Semiconductor devices.

4/6/18

4/6/18

	Core course-XII	Algebra	5	1	0	6	6	150	60	90
	Skill Enhancement Course -1	SEC-1	2	0	0	2	2	50	20	30
	Open Elective Course-IV	University Open Elective	2	0	0	2	2	50	20	30
Total			**17**	**1**	**8**	**26**	**22**	**550**	**220**	**330**
V	Discipline Specific Elective -1	DSE-1A	4	0	0	4	4	100	40	60
	Discipline Specific Elective -1 Practical	DSE-1A Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective -2	DSE-2A	4	0	0	4	4	100	40	60
	Discipline Specific Elective -2 Practical	DSE-2A Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective -3	DSE-3A	5	1	0	6	6	150	60	90
	Skill Enhancement Course -2	SEC-2	2	0	0	2	2	50	20	30
Total			**15**	**1**	**8**	**24**	**20**	**500**	**200**	**300**
VI	Discipline Specific Elective -4	DSE-1B	4	0	0	4	4	100	40	60
	Discipline Specific Elective -4 Practical	DSE-1B Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective -5	DSE-2B	4	0	0	4	4	100	40	60
	Discipline Specific Elective -5 Practical	DSE-2B Lab	0	0	4	4	2	50	20	30
	Discipline Specific Elective-6	DSE-3B	5	1	0	6	6	150	60	90
	Skill Enhancement Course -3	SEC-3	2	0	0	2	2	50	20	30
Total			**15**	**1**	**8**	**24**	**20**	**500**	**200**	**300**
Grand Total			**96**	**6**	**48**	**150**	**126**	**3150**	**1260**	**1890**

Scheme of Studies B.Sc. (Non-Medical): 2018-19

Category	Credits
Core Course	72
Discipline Specific Elective Course	36
Skill Enhancement Course	6
Ability Enhancement Compulsory Course (AECC)	4
Open Elective Course	8
Total	126

1. Core Course

Semester	Course Code	Course Name
I	09010113	Mechanics
	09010114	Mechanics Lab
	09010115	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
	09010116	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab
	09010117	Differential Calculus
II	09010212	Electricity, Magnetism and EMT
	09010213	Electricity, Magnetism and EMT Lab
	09010214	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I
	09010215	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab
	09010216	Differential Equations
III	09010312	Thermal Physics and Statistical Mechanics
	09010313	Thermal Physics and Statistical Mechanics Lab
	09010314	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II
	09010315	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab
	09010316	Real Analysis
IV	09010410	Waves and Optics
	09010411	Waves and Optics Lab
	09010412	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics
	09010413	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics Lab
	09010414	Algebra

Babu Ram

Open Elective Courses Code

Sem - I Open Elective Course - I - 09010118 Positive Psychology & Mindfulness.

Sem - II Open Elective Coures - II -

Sem - III Open Elective Course - III -

Sem - IV Open Elective Course - IV. -

2. Discipline Specific Elective Course (DSE) [Choose one paper from each discipline of choice]

Semester	Subject		Course Code	Course Name
V	Physics	DSE-1A	09010511	Solid State Physics
			09010512	Solid State Physics Lab
			09010513	Atomic Molecular and Laser Physics
			09010514	Atomic Molecular and Laser Physics Lab
			09010515	History and Philosophy of science
			09010516	History and Philosophy of science Lab
	Chemistry	DSE-2A	09010517	Analytical Methods in Chemistry
			09010518	Analytical Methods in Chemistry Lab
			09010519	Molecules of Life
			09010520	Molecules of Life Lab
			09010521	Quantum Chemistry, Spectroscopy and Photochemistry
			09010522	Quantum Chemistry, Spectroscopy and Photochemistry Lab
	Mathematics	DSE-3A	09010523	Matrices
			09010524	Calculus Without Limits
			09010525	Probability and Statistics
VI	Physics	DSE-1B	09010611	Elements of Modern Physics
			09010612	Elements of Modern Physics Lab
			09010613	Quantum Mechanics
			09010614	Quantum Mechanics Lab
			09010615	Nuclear and Particle Physics
			09010616	Nuclear and Particle Physics Lab
	Chemistry	DSE-2B	09010617	Polymer Chemistry
			09010618	Polymer Chemistry Lab
			09010619	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UVIR Spectroscopy
			09010620	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UVIR Spectroscopy Lab
			09010621	Chemistry of Main Group Elements, Theories of Acids and Bases
			09010622	Chemistry of Main Group Elements, Theories of Acids and Bases Lab
	Mathematics	DSE-3B	09010623	Numerical Methods
			09010624	Integral Calculus
			09010625	Elementary Inference

3. Skill Enhancement Course (SEC) [Choose one paper]

Semester	Subject		Course Code	Course Name
IV	Physics	SEC-1	09010415	Computational Physics Skills
			09010416	Applied Optics
			09010417	Mobile Communications
			09010418	Renewable Energy and Energy Harvesting
			09010419	Physics Workshop Skills
			09010420	Basic Instrumentation Skills
V	Chemistry	SEC-2	09010526	Basic Analytical Chemistry
			09010527	Fuel Chemistry
			09010528	Chemical Technology and Society
			09010529	Pharmaceutical Chemistry
			09010530	Chemistry of Cosmetics & Perfumes
			09010531	Pesticide Chemistry
VI	Mathematics	SEC-3	09010626	Special Functions & Integral Transform
			09010602	Linear Algebra
			09010627	Vector Calculus
			09010628	Operations Research
			09010629	Complex Analysis
			09010630	Computer Fundamentals

4. Ability Enhancement Compulsory Course (AECC)

Semester	Course Code	Course Name
I	09010112	English Communications
II	09010211	Environmental Science

5. Open Elective Course (OEC) [Choose one paper]

Semester	Name of Faculty	Course Code	Open Elective Course
III	Faculty of Indian Medical System	IMS-1	Ayurvedic Dietetics
		IMS-2	AyurvedMateriaMedica
	Faculty of Commerce & Management	CM-1	Management Concepts
		CM-2	Entrepreneurship Development
	Faculty of Hotel Management	HM-1	Life and Service Skills
		HM-2	Food – Etiquettes and Nutrition
	Faculty of Physical Sciences	PS-1	Radiation Physics
		PS-2	Green Technology
	Faculty of Engineering & Technology	FET-1	Cyber Security
		FET-2	Solid Waste Management
	College of Pharmacy	PH-1	Dosage Form Design
		PH-2	Cosmetic Science
	Faculty of Physiotherapy	PHY-1	Basics of Yoga Therapy
		PHY-2	Physical Fitness
	Faculty of Education	ED-1	Education System in Contemporary India
	Faculty of Allied Sciences	ASC-1	Healthy lifestyle and Nutrition
		ASC-2	Anthropology and Personal Identification
	Faculty of Fashion Design	FD-1	Design Development Techniques
		FD-2	Fashion Sketching
	Faculty of Law	LW-1	Business Law
		LW-2	Law of Constitution
	Mass Communication & Media Technology	MCM-1	Basics of Photography
		MCM-2	Basics of Film and Television Products
	Faculty of Behavioral Sciences	FBS-1	Anxiety and Stress Management
		FBS-2	Understanding Social Behavior
	Faculty of Agriculture Sciences	ASC-1	Hi-tech Horticulture
		ASC-2	Sustainable Approaches in Agriculture
	Faculty of Nursing	NRS-1	First Aid
		NRS-2	Gerontology
	Centre for Languages and Communication	CLC-1	Elementary German Language
		CLC-2	Elementary French Language

Department of Physics

Core papers

1. Mechanics
2. Mechanics Lab
3. Electricity and Magnetism
4. Electricity and Magnetism Lab
5. Thermal Physics and Statistical Mechanics
6. Thermal Physics and Statistical Mechanics Lab
7. Waves and Optics
8. Waves and Optics Lab

Discipline Specific Elective Course

1. Solid State Physics
2. Solid State Physics Lab
3. Atomic molecular and laser physics
4. Atomic molecular and laser physics Lab
5. History and Philosophy of sciences
6. History and Philosophy of sciences Lab
7. Elements of Modern Physics
8. Elements of Modern Physics Lab
9. Quantum Mechanics
10. Quantum Mechanics Lab
11. Nuclear and Particle Physics
12. Nuclear and Particle Physics Lab

Skill Enhancement Course

1. Computational Physics Skills
2. Applied Optics
3. Mobile communications
4. Renewable Energy and Energy harvesting
5. Physics Workshop Skills
6. Basic Instrumentation Skills

1. Name of the Department: Physics						
2. Course Name	Mechanics	**L**	**T**		**P**	
3. Course Code	09010113	4	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will teach about the fundamental concept of mechanics and their subsequent development in applications in various field like oscillations and waves, elastic properties of materials, rest in motion and relative motion etc.

9. Course Objectives:

The aim of this course is to understand the basic concepts for the development of mechanics such as mathematical concept in physics, oscillations and waves, elastics properties of materials, rest in motion and relative motion etc.

10. Course Outcomes (COs):

After going through this course the student will be able to implement, the elastic properties of the materials in everyday life, understand the mechanism of satellite motion, latest developments in theory of relativity.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Vectors**

Vectors: Vector algebra, Scalar and vector products, Derivatives of a vector with respect to a parameter,

Ordinary Differential Equations: 1st order homogeneous differential equations, 2nd order homogeneous differential equations with constant coefficients.

Oscillations: Simple harmonic motion, Differential equation of SHM and its solutions, Kinetic and Potential Energy, Total Energy and their time averages, Damped oscillations.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Laws of Motion**

Laws of Motion: Frames of reference, Newton's Laws of motion, Dynamics of a system of particles, Centre of Mass.

Momentum and Energy: Conservation of momentum, Work and energy, Conservation of energy, Motion of rockets.

Rotational Motion: Angular velocity and angular momentum, Torque, Conservation of angular momentum,

Gravitation: Newton's Law of Gravitation, Kepler's Laws (statement only), Satellite in circular orbit and applications, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS),

Unit - 3	**Number of lectures = 13**	**Title of the unit: Elasticity**

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder

Unit - 4	**Number of lectures = 13**	**Title of the unit: Special Theory of Relativity**

Special Theory of Relativity: Constancy of speed of light, Postulates of Special Theory of Relativity, Length contraction, Time dilation, Relativistic addition of velocities.

12. Books Recommended
1. University Physics, FW Sears, MW Zemansky and HD Young13/e, 1986, Addison-Wesley
2. Mechanics Berkeley Physics course,v,1: Charles Kittel, et, Al, 2007, Tata McGraw-Hill,
3. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn,, 2015, Oxford University Press
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole,

1. Name of the Department: Physics						
2. Course Name	Mechanics Lab	**L**	**T**		**P**	
3. Course Code	09010114	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 40**			

8. Course Description:

The experiment has been designed in such a way the student can measure distance upto micrometer scale, can determine elastic constant of different materials and calculate moment of inertia of regular and irregular bodies.

9. Course Objectives:

The aim of this paper is that the student performs the experiment based on the description and calculates the results. Compare the result with the standard value wherever applicable and know how to calculate different type of errors also he/she understand how the theoretical concepts are verified experimentally.

10. Course Outcomes (COs):

After successful completion of the course, students will be able to verify

1. The theoretical formulas by performing experiment
2. Demonstrate the practical application of properties of materials etc. in actual practice

11. List of Experiments

1. Moment of Inertia of a fly-wheel.
2. M.I. of an irregular body using a torsion pendulum.
3. Surface Tension by Jeager's method.
4. Young modulus by bending of beam.
5. Modulus of rigidity by Maxwell's needle.
6. Elastic constants by Searle's method.
7. Viscosity of water by its flow through a uniform capillary tube.
8. Thermal conductivity of a good conductor by Searle's method.
9. Mechanical equivalent of Heat by Callender's and Barne's method.
10. 'g' by Bar pendulum.

12. Book Recommended

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

1. Name of the Department: Physics						
2. Course Name	Electricity and magnetism	**L**	**T**		**P**	
3. Course Code	09010212	4	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will teach about the vector analysis of electric field and magnetic field , integral and differential form of Maxwell equations and electromagnetic wave propagation.

9. Course Objectives:

To impart knowledge about electrostatics, magnetism, and Maxwell's equations and their practical applications.

10. Course Outcomes (COs):

After successful completion of this course, students will have understanding of

1. basic principle of electricity and magnetism, and their everyday life applications
2. propagation of electromagnetic radiation in different medium like vacuum, isotropic dielectric medium etc.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Vector Analysis**

Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only)

Unit - 2	**Number of lectures = 13**	**Title of the unit: Electrostatics**

Electrostatic Field, electric flux, Gauss's theorem of electrostatics, Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor, Electric potential as line integral of electric field, Energy per unit volume in electrostatic field, Dielectric medium, Polarisation, Displacement vector, Gauss's theorem in dielectrics, Parallel plate capacitor completely filled with dielectric,

Unit - 3	**Number of lectures = 13**	**Title of the unit: Magnetism**

Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current, Divergence and curl of magnetic field, Magnetic vector potential, Ampere's circuital law, Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, Brief introduction of dia-, para-and ferro-magnetic materials,

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils, Energy stored in magnetic field.

Unit - 4	**Number of lectures = 13**	**Title of the unit: Maxwell`s equations and Electromagnetic wave propagation**

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

12. Book Recommended:

1. Electricity and Magnetism, Edward M, Purcell, 1986, McGraw-Hill Education
2. Electricity and Magnetism, J,H, Fewkes & J, Yarwood, Vol, I, 1991, Oxford Univ, Press
3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole
5. D,J, Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings

1. Name of the Department: Physics						
2. Course Name	Electricity and magnetism Lab	**L**	**T**		**P**	
3. Course Code	09010213	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 40**		

8. Course Description:

Experiments include the fundamental characteristics of DC power supply, RC coupled amplifier, Melde's experiment, electronic voltmeter, compound pendulum etc.

9. Course Objectives:

To understand the working principles of different types of transistors and diodes like JFET, MOSFET, LED and Photo diodes and implement them into practically working equipment which are helpful in our daily life.

10. Course Outcomes (COs):

After successful completion of the course, students will be able to:

1. Apply the concepts of basic electronic devices to design various electronic circuits.
2. Understand operation of diodes, transistors in order to design basic circuits.
3. Measure the oscillations of a mass under different combination of springs.

11. List of Experiments

1. To draw common base and common emitter characteristics of a transistor and calculate transistor and calculate transistor characteristics parameters.
2. To study the ripple factor in a D.C. power supply.
3. To draw frequency response curve of transistorised R.C. coupled amplifier.
4. To find out the frequency of a tuning fork by Melde's experiment.
5. Study of series and parallel resonance circuits.
6. Electronic Voltmeter measurement of peak, average & R .M.S. values of signal.
7. Study of voltage doubler and trippler circuits.
8. Study of a compound pendulum.
9. Study of oscillations of a mass under different combinations of springs.
10. Study of oscillations under a bifilar suspension.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

1. Name of the Department: Physics						
2. Course Name	Thermal Physics and Statistical Mechanics	**L**	**T**		**P**	
3. Course Code	09010312	4	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will deepen your understanding of basics of thermodynamic principles, thermodynamic potentials, and the kinetic theory of gases.

9. Course Objectives:

To study the different laws of thermodynamics and their practical applications, basics of law of equipartition of energy and its applications to specific heat of gases such as monoatomic and diatomic gases.

10. Course Outcomes (COs):

After completion of this course, students will have understanding of

1. different laws of thermodynamics and their practical applications
2. Maxwell's law of distribution of velocities, conduction and diffusion phenomenon etc.
3. Fermi-Dirac distribution law, electron gas, Bose-Einstein distribution law, photon gas and comparison of their statistics

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Thermodynamic Description of system**

Zeroth Law of thermodynamics and temperature, First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: Work Done during Isothermal and Adiabatic Processes, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Thermodynamic Potentials**

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V, TdS equations.

Unit - 3	**Number of lectures = 13**	**Title of the unit: Kinetic Theory of Gases**

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Unit - 4	**Number of lectures = 13**	**Title of the unit: Statistical Mechanics**

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

12. Books Recommended:

1. Thermal Physics, S, Garg, R, Bansal and C, Ghosh, 1993, Tata McGraw-Hill,
2. A Treatise on Heat, Meghnad Saha, and B,N, Srivastava, 1969, Indian Press,
3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications,
4. Heat and Thermodynamics, M,W,Zemasky and R, Dittman, 1981, McGraw Hill
5. Thermodynamics, Kinetic theory & Statistical thermodynamics, F,W,Sears & G,L,Salinger, 1988
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole,
7. Thermal Physics, A, Kumar and S,P, Taneja, 2014, R, chand Publications

1. Name of the Department: Physics						
2. Course Name	Thermal Physics and Statistical Mechanics Lab	**L**	**T**		**P**	
3. Course Code	09010313	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 40**		

8. Course Description:

The experiment has been designed in such a way the student can learn about thermo-electric effect, conduction of heat through metals and use of potentio meter fore calibration etc.

9. Course Objectives:

To understand the working principles of thermocouples and various effects associated with thermocouple. Also they will learn about the various processes of transmission heat and basic principle of thermodynamics

10. Course Outcomes (COs):

After successful completion of the course, students will be able to

1. Apply the concepts of basic thermodynamic principle to design the different type's thermocouples for daily life applications such as a refrigerator, cooling etc.
2. Understand the mechanism of flow of heat through different medium.

11. List of Experiments

1. To study the variation of thermo emf across two junction of a thermo couple with temperature.
2. To determine the coefficient of thermal conductivity of copper by Searl's apparatus.
3. To determine mechanical equivalent of heat by Callender and Barne's constant flow method.
4. Determination of wave length of Na light and the number of lines per centimeter using a diffraction grating.
5. Calibration of a thermocouple by potential meter
6. Wavelength by Newton's Rings.
7. Resolving power of telescope.
8. Comparison of Illuminating Powers by a Photometer.
9. Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
10. Ordinary and extra ordinary refractive indices for calcite or quartz.

12.Book Recommended

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

1. Name of the Department: Physics						
2. Course Name	Waves and Optics	**L**	**T**		**P**	
3. Course Code	09010410	4	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

The course will teach about different types of simple harmonic motion and their superposition, flow of fluids, free forced and resonant oscillation and the phenomenon of interference, diffraction and polarization.

9. Course Objectives:

To impart knowledge about harmonic oscillations, and their superposition, various fluids phenomenon, propagation of sound, and different optical phenomenon.

10. Course Outcomes (COs):

After completion of this course, students will have understanding of

lissajous figures, phenomenon of viscosity, surface tension, musical notes, acoustics of buildings, interference diffraction and polarization.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Harmonic oscillations**

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle, (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats),

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures with equal an unequal frequency and their uses.

Waves Motion- General: Transverse waves on a string, Travelling and standing waves on a string, Normal Modes of a string, Group velocity, Phase velocity, Plane waves, Spherical waves, Wave intensity,

Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale, Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Fluids**

Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method, Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication, Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage.

Unit - 3	**Number of lectures = 13**	**Title of the unit: Wave Optics**

Wave Optics: Electromagnetic nature of light, Definition and Properties of wave front, Huygens Principle

Interference: Interference: Division of amplitude and division of wavefront, Young's Double Slit experiment, Lloyd's Mirror and Fresnel's Biprism, Phase change on reflection: Stokes' treatment, Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes), Newton's Rings: measurement of wavelength and refractive index,

Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes.

Unit - 4	Number of lectures = 13	Title of the unit: Diffraction and Polarization

Diffraction: Fresnel Diffraction, Fraunhofer diffraction: Single slit, double Slit Multiple slits & Diffractiongrating, Resolving and Dispersive Power of grating.

Polarization: Transverse nature of light waves, Plane polarized light – production and analysis, Circular and elliptical polarization

12. Books Recommended

1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
2. Principles of Optics, B,K, Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H,R, Gulati and D,R, Khanna, 1991, R, Chand Publication
4. University Physics, FW Sears, MW Zemansky and HD Young 13/e, 1986, Addison-Wesley.

1. Name of the Department: Physics						
2. Course Name	Waves and Optics Lab	**L**	**T**		**P**	
3. Course Code	09010411	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 40**		

8. Course Description:

In this paper the experiments based on a theoretical concepts of light has been introduced such as determination of wavelength by Biprism, Newton's ring and gratings.

9. Course Objectives:

To understand the working principles of various instruments such as spectrometer, telescope, laser and their use in determination of physical quantities like wavelength, refractive index and resolving power.

10. Course Outcomes (COs):

After performing these experiment, students will be able to implement and demonstrate the use of optical instruments , indetermination of various physical quantities related to light and materials

11. List of Experiments

1. Wave length of Sodium light by Fresnel's biprism.
2. Velocity of ultrasonic waves by grating formation in CC14.
3. Diameter of Lycopodium powder particles by Carona rings.
4. To study double slit interference by He-Ne laser.
5. Diameter of a thin wire by diffraction method (using He-Ne Laser).
6. Young's modulus by Newton's Rings method.
7. Resolving power of a prism.
8. Thickness of a thin plate using air wedge.
9. Resolving Power of plane transmission grating.
10. Rydberg constant by Hydrogen gas spectrum.

12. Book Recommended:

1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
4. University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986, Addison-Wesley

1. Name of the Department: Physics						
2. Course Name	Solid State Physics	**L**	**T**		**P**	
3. Course Code	09010511	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course will deepen your understanding of the different types of crystal structures and that will help you to analyse the electrical, mechanical, optical, and magnetic properties of the solids.

9. Course Objectives:

1. To study the basics of crystallography
2. To study the basic of origin of band gap in different types of solids
3. To analyse the electrical and thermal properties of metals
4. To understand the diamagnetic, paramagnetic and ferromagnetic properties of the materials
5. To get familiar with superconducting phenomenon and its applications.

10. Course Outcomes (COs):

After successful completion of the course, students will

1. have a basic knowledge of crystal systems and spatial symmetries
2. understand the concept of reciprocal space and be able to use it as a tool to know the significance of Brillouin zones
3. be able to calculate thermal and electrical properties in the free-electron model
4. know the fundamental principles of semiconductors, including pn-junctions, and be able to estimate the charge carrier mobility and density
5. know basic models of magnetism
6. be able to outline the importance of solid state physics in the modern society

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Crystal Structure**

Crystal Structure: Solids: Amorphous and Crystalline Materials, Lattice Translation Vectors, Lattice with a Basis – Central and Non-Central Elements, Unit Cell, Miller Indices, Reciprocal Lattice, Types of Lattices, Brillouin Zones, Diffraction of X-rays by Crystals, Bragg's Law.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains, Acoustical and Optical Phonons, Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids, T^3 law

Unit - 2	**Number of lectures = 13**	**Title of the unit: Magnetic Properties of Matter**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials, Classical Langevin Theory of dia – and Paramagnetic Domains, Quantum Mechanical Treatment of Paramagnetism, Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains, Discussion of B-H Curve, Hysteresis and Energy Loss.

Unit - 3	**Number of lectures = 13**	**Title of the unit: Dielectric Properties of Materials**

Dielectric Properties of Materials: Polarization, Local Electric Field at an Atom, Depolarization Field, Electric Susceptibility, Polarizability, Clausius Mosotti Equation, Classical Theory of ElectricPolarizability, Normal and Anomalous Dispersion.

Unit - 4	Number of lectures = 13	Title of the unit: Elementary band theory and superconductivity

Elementary band theory: Kronig Penny model, Band Gaps, Conductors, Semiconductors and insulators, P and N type Semiconductors, Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient,

Superconductivity: Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's Equation and Penetration Depth, Isotope effect.

12. Books Recommended

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed,, 2004, Wiley India Pvt, Ltd,
2. Elements of Solid State Physics, J,P, Srivastava, 2nd Ed,, 2006, Prentice-Hall of India
3. Introduction to Solids, Leonid V, Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, Neil W, Ashcroft and N, David Mermin, 1976, Cengage Learning
5. Solid State Physics, Rita John, 2014, McGraw Hill
6. Solid-state Physics, H, Ibach and H Luth, 2009, Springer
7. Elementary Solid State Physics, 1/e M, Ali Omar, 1999, Pearson India
8. Solid State Physics, M,A, Wahab, 2011, Narosa Publications

1. Name of the Department: Physics						
2. Course Name	Solid State Physics Lab	**L**	**T**		**P**	
3. Course Code	09010512	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 40**			

8. Course Description:

Experiments include the fundamental of materials used in making solar cell, semiconductor diodes, laser diode etc.

Course Objectives:

To understand the working of solar cell, semiconductor diode laser diode etc. and application of their characteristics in making solid state devices.

10. Course Outcomes (COs):

After performing the experiment, the student will be able to convert solar energy into electrical energy using solar cell, laser diode and design circuits rectifier, amplifier etc.

11. List of Experiments

1. Verification of inverse square law by photo-cell.
2. To study the characteristics of a solar cell.
3. To draw forward and reversed bias characteristics of a semiconductor diode.
4. Zener Diode voltage regulation characteristics.
5. E.C.E. of hydrogen using Ammeter.
6. Low resistance by Carey Foster's Bridge with calibration.
7. Frequency of A.C. mains and capacity by electrical vibrator.
8. Frequency of A.C. mains by sonometer using an electromagnet.
9. Measurement of angle dip by earth Inductor.
10. High resistance by substitution method.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal, New Delhi
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

1. Name of the Department: Physics						
2. Course Name	Atomic, Molecular and Laser Physics	**L**	**T**		**P**	
3. Course Code	09010513	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Atom and molecule are the fundamental unit for all matters in universe. Matter, whatever the states, is made of atoms. The properties of all matters are governed by the electronic structure of atom and molecule. They have individual properties like electronic, magnetic and optical properties, which are quite different from the collective properties of matter made of atoms and molecules. This course will enlighten the knowledge of atoms and molecules and build up the pre-requisite knowledge for all science and engineering field.

9. Course Objectives:

1. Comparing between atomic emission spectroscopy and atomic absorption spectroscopy; Optical spectroscopy, Atomic spectrum.
2. Molecular spectroscopy.
3. Theory of magnetic energy, Anomalous Zeeman's effect and Landue splitting. factor.
4. Working principle of different types of laser and its applications.

10. Course Outcomes (COs):

1. State and explain the key properties of many electron atoms and the importance of the Pauli exclusion principle
2. Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields
3. State and justify the selection rules for various optical spectroscopies in terms of the symmetries of molecular vibrations

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Atomic spectroscopy**

Basic concept of atom model and need of vector atom model, Vector atom model, Quantum numbers associated with vector atom model, Penetrating & non- penetrating orbits, Alkali spectra (Description), Spectral lines in different series of alkali spectra, Spin orbit interaction and doublet term separation, LS coupling and jj coupling description, Expression for interaction energy in LS coupling, Expression for interaction energy in jj coupling.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Molecular Spectroscopy**

Normal Zeeman effect, Anomalous Zeeman Effect, Zeeman pattern of D_1 and D_2 lines of Na atom, Paschen Back effect of a single valance electron system, Weak field Stark effect of H-atom, Discrete set of electronic energies of molecules, Quantization of vibrational energies, Quantization of rotational energies, Raman effect (Quantitative Description), Stokes and Anti-stokes lines.

Unit - 3	**Number of lectures = 13**	**Title of the unit: Basics of lasers**

Main features of Laser (Directionality and Intensity), Main features of Laser (Monochromaticity and Coherence), Einstein coefficients and possibility of amplification, Momentum transfer & life time of a level absorption, Kinetics of optical, Laser pumping.

Unit - 4	Number of lectures = 13	Title of the unit: Working of lasers

RUBY Laser (Principle, construction & working), He-Ne Laser (Principle, construction & working), CO_2 Laser (Principle, construction & working), Semiconductor Laser (Principle, construction & working), Application of Laser in the field of medicine and industry.

12. Books Recommended

1. Jain, V,K, Introduction to Atomic and Molecular Spectroscopy, New Delhi: Narosa,
2. White, H,B, Introduction to Atomic Spectra,
3. Herzberg, G, Atomic Spectra,
4. Herzberg, G, Molecular Spectra and Molecular Structure,
5. Banwell, Colin N, and Elaine M, McCash, Fundamentals of Molecular Spectroscopy,
6. Thiagrajan and Ajay Ghatak, Lasers, Theory and Applications, 2nd ed,
7. Laud, B,B, Laser and Nonlinear Optics, 2nd ed,
8. Pedrotti, Frank L, and Lens S, Pedrotti, Introduction to Optics, New York: Prentice-Hall, 1987

1. Name of the Department: Physics						
2. Course Name	Atomic, Molecular and Laser Physics Lab	**L**	**T**		**P**	
3. Course Code	09010514	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 40**		

8. Course Description:

Experiments based on atomic and molecular physics and related topics such as determination of e/m ratio by Thamson method, basic characteristics of G.M counter etc.

9. Course Objectives:

To learn by performing experiment based on G.M. Counter, cathode ray oscilloscope, spectrometer etc..

10. Course Outcomes (COs):

After performing these experiment students will be able to demonstrate the experiment and their practical applications.

11. List of Experiments

1. e/m by Thomson method.
2. To draw the Plateau of G.M. Counter
3. To determine the Mass attenuation coefficient by G.M. Counter.
4. Transistor as voltage Amplifier in C-B configuration.
5. Transistor as voltage Amplifier in C-E configuration.
6. Study of B-H Curve by C.R.O.
7. Study of Hartley Oscillator (Calibration of Gang Condenser).
8. Measurement of Energy Gap of Four Probe Method.
9. Characteristics of PNP transistor.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal, New Delhi
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

1. Name of the Department: Physics						
2. Course Name	History and Philosophy of Science	**L**	**T**		**P**	
3. Course Code	09010515	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The course will teach about historical development of science and associated philosophical concepts.

9. Course Objectives:

To understand about the views of different philosopher about the science and its development

10. Course Outcomes (COs):

After completing this course Students will able to know the names of different philosopher and scienctis who contributed in the development of science and also they will understand the conceptual development of science by criticism and hypothetical consideration

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Development of science**

The history of the development of science can affect our view of science and the philosophy of science, Present-day histories of knowledge and science describe the origins of science as exclusively Western, Critiques of such histories are available, Adequate histories of science in China, India, Africa, South American (Maya), Iran, Arabia, Korea, etc,, are now readily available, These accounts suggest major original scientific activity in several of these countries and continents.

These scientific contributions will be discussed through specific instances, ideas or

techniques originating from different parts of the world:

a) Gun powder and Chinese science

b) The printing press and Korea

c) Arithmetic, algebra, trigonometry, calculus and probability from India

d) The calendar from Mayan civilization

e) Geometry from Egypt

f) The House of Wisdom (Baghdad)

g) The Hospital (Jandishapur/Iran)

h) The Alkashi Observatory from Samarkhand and its influence

The discussions will examine origins and transmissions of key scientific ideas and inventions across continents including geometry and emphasizing the Indian achievements in science, especially achievements in mathematics, astronomy, and medicine.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Primary, secondary and tertiary sources**

Primary, secondary and tertiary sources, What kind of source is Wikipedia? Can one easily correct Wikipedia? Examination of the history of science in school texts and evidence for it, Is the claim of Greek origins of mathematics and science sustainable? Primary evidence for Euclid, Claudius Ptolemy, Archimedes, Eratosthenes, Aristotle, Case of "Pythagorean" proposition in Egypt, Iraq, and India, Greek

and Roman arithmetic and its defects, How they are reflected in defects of the Greek and Roman calendars, How could the Greeks have done science without knowledge of arithmetic? How history was churchified during the Crusades, Transmission of knowledge and its appropriation, Case of Toledo and the beginning of Western universities, The appropriation of Arabic knowledge the example of Copernicus, Appropriation of Indian knowledge, the case of Ptolemy, and trigonometric values, The navigation problem as the biggest scientific problem in Europe,The case of calculus, Later cases, vaccination vs inoculation, Recent cases of appropriation.

Unit - 3	Number of lectures = 13	Title of the unit: Basic concepts of science-working

Basic concepts of science-working including testability, Popper's criterion and experimental methods, Examples of experimental methods and challenges to superstition in Indian tradition, Payasi, Lalla, Vateshwar with examples from various traditions will be discussed including various strategies and tricks relied upon by scientists to avoid testing or to resist testability, This discussion will enable the students to understand the difference between science and non-science,Why is mathematics metaphysics? Indian ganita vs Western mathematics, Plato's religious philosophy of mathematics as a means of arousing the soul, The rejection of the empirical in the church theology of reason and its relation to the rejection of the empirical in present-day philosophy of formal mathematics, Does this add to the practical value of mathematics? The practical philosophy of math in sulba sutra and Aryabhata, Zeroism.

Examples of testability in science: the round earth versus flat earth theory and measurement of the earth's size, Students will experiment to measure the circumference of the earth, Summarise the discussion on moving earth, including Galileo.

Example for discussion of science as inference: Length of the day, Summarise the discussion.

Unit - 4	Number of lectures = 13	Title of the unit: General popular discussion

As a general popular discussion in terms of its relevance to their own lives, the ethics of science will enable students to voice their opinions on the remaking of the world according to science and its negative impacts on the environment as well.

12. Books Recommended

1. Kuhn, T, S, 1957/2003, The Copernican Revolution: Planetary Astronomy in the Development of Western Thought, Cambridge: Harvard University Press,
2. Nasr, Seyyed Hossein, 1968, Science and Civilization in Islam, Cambridge: Harvard University Press
3. Needham, J,1981, The Shorter Science and Civilization in China, Vol, 2 (Abridgement by C,A, Ronan), Cambridge University Press,
4. Raju, C, K, 2009, Is Science Western in Origin? Penang: Multiversity and Citizen's International,Also, Daanish Books, Delhi,
5. Raju C,K, 2012, Euclid and Jesus, India, Other India Press,
6. Raju C, K, 2007 Cultural Foundation of Mathematics, Pearson Longman, 2007
7. Alvares, Claude, 1991, Decolonising History: Technology and Culture in India, China and the West 1492 to the Present Day, Goa: The Other India Press, India,
8. Selin, Helaine (Ed,), 2016, Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures, Dordrecht: Springer,
9. Dharampal, Indian Science and Technology in the 18th Century, OIP, India
10. Dharampal, The Beautiful Tree, Indigenous Indian Education in the Eighteenth Century
11. Broad W, and Wade, N,, Betrayers of the Truth: Fraud and Deceit in the Halls of Science, Simon and Schuster, 1982,
12. James George, Stolen Legacy: Greek Philosophy is Stolen Egyptian Philosophy, 1952, reprint Classic House Books, New York, 2009, 2016,
13. Salim T,S, Al-Hassani, (2011), ed, 1001 Inventions: Muslim Heritage in Our World (2nd ed,), London:Foundation for Science Technology and Civilization,

1. Name of the Department: Physics						
2. Course Name	Elements of modern physics	**L**	**T**		**P**	
3. Course Code	09010611	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will includes the planck quantum concepts of particle and wave natures, atomic models, uncertainty principle, operators, radio activity and nuclear reactions.

9. Course Objectives:

The aim of this course is to understand the quantum mechanical view of particle and wave nature, uncertainty in measurements, certainty and probability in measurements, source of nuclear energy and related devices.

10. Course Outcomes (COs):

After completing this course Students will be able to explain the quantum mechanical view of particle and wave nature, uncertainty in measurements, certainty and probability in measurements, source of nuclear energy and related devices.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit:**

Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering, De Broglie wavelength and matter waves; Davisson-Germer experiment, Position measurement- gamma ray microscope thought experiment, Wave particle-duality, and Heisenberg uncertainty principle impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.

Unit - 2	**Number of lectures = 13**	**Title of the unit:**

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension.

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.

Unit - 3	**Number of lectures = 13**	**Title of the unit:**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle, Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

Unit - 4	**Number of lectures = 13**	**Title of the unit:**

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α-decay; β-decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission, Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons, Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.

1. Name of the Department: Physics						
2. Course Name	History and Philosophy of Science Lab	**L**	**T**		**P**	
3. Course Code	09010516	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 0	**Tutorials = 0**	**Practical = 40**

8. Course Description:

Experiments include the Basic concepts of science-working including testability, Popper's criterion and experimental methods.

9. Course Objectives:

To understand the Basic concepts of science-working including testability, Popper's criterion and experimental methods etc.

10. Course Outcomes (COs):

After successful completion of the course, students will be able to implement the basic concepts of science-working including testability, Popper's criterion and experimental methods in practical life.

11. List of Experiments

Basic concepts of science-working including testability, Popper's criterion and experimental methods, Examples of experimental methods and challenges to superstition in Indian tradition, Payasi, Lalla, Vateshwar with examples from various traditions will be discussed including various strategies and tricks relied upon by scientists to avoid testing or to resist testability, This discussion will enable the students to understand the difference between science and non-science. And other experiments related to history and philosophy of science.

12. Book Recommended:

1. Kuhn, T, S, 1957/2003, The Copernican Revolution: Planetary Astronomy in the Development of Western Thought, Cambridge: Harvard University Press,
2. Nasr, Seyyed Hossein, 1968, Science and Civilization in Islam, Cambridge: Harvard University Press,
3. Needham, J,1981, The Shorter Science and Civilization in China, Vol, 2 (Abridgement by C,A, Ronan), Cambridge University Press,
4. Raju, C, K, 2009, Is Science Western in Origin? Penang: Multiversity and Citizen's International,Also Daanish Books, Delhi,
5. Raju C,K, 2012, Euclid and Jesus, India, Other India Press,
6. Raju C, K, 2007 Cultural Foundation of Mathematics, Pearson Longman, 2007
7. Alvares, Claude, 1991, Decolonising History: Technology and Culture in India, China and the West, 1492 to the Present Day, Goa: The Other India Press, India,

12. Books Recommended

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, John R, Taylor, Chris D, Zafiratos, Michael A,Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A, Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics Course Vol,4, E,H, Wichman, 2008, Tata McGraw-Hill Co,
5. Modern Physics, R,A, Serway, C,J, Moses, and C,A,Moyer, 2005, Cengage Learning
6. Modern Physics, G, Kaur and G,R, Pickrell, 2014, McGraw Hill.

1. Name of the Department: Physics						
2. Course Name	Elements of modern physics Lab	**L**	**T**		**P**	
3. Course Code	09010612	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 0	**Tutorials = 0**	**Practical = 40**

8. Course Description:

Experiments include the Basic concepts of measurement of Planck's constant using LEDs, measurement of ionization potential of mercury, work function, hall coefficient etc.

9. Course Objectives:

To understand the working principles of measurement of Planck's constant using LEDs, measurement of ionization potential of mercury, work function, hall coefficient etc.

10. Course Outcomes (COs):

After performing these experiments, students will be able to implement and demonstrate the photoelectric effect that is how radiation can be converted into electric energy, effect of stress on materials to develop potential difference etc.

11. List of Experiments

1. To determine value of Planck's constant using LEDs of at least 4 different colours
2. To determine value of Boltzmann constant using V-I characteristic of PN diode.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the ionization potential of mercury.
5. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light.
6. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
7. To study Hall effect.
8. To determine I-V characteristics of PNP transistors.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

1. Name of the Department: Physics						
2. Course Name	Quantum Mechanics	**L**	**T**		**P**	
3. Course Code	09010613	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will includes the planck quantum concepts of particle and wave natures, atomic models, uncertainty principle, operators, Schrodinger wave equation and its applications.

9. Course Objectives:

The aim of this course is to understand the quantum mechanical view of particle and wave nature, uncertainty in measurements, certainty and probability in measurements, time dependent and time independent Schrodinger wave equations and its solution for hydrogen atom and many electron atoms.

10. Course Outcomes (COs):

After completing this course Students will be able to explain the quantum mechanical view of particle and wave nature, uncertainty in measurements, certainty and probability in measurements, time dependent and time independent Schrodinger wave equations and its solution for hydrogen atom and many electron atoms

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Time dependent Schrodinger equation**

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function, Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions, Normalization, Linearity and Superposition Principles, Eigenvalues and Eigen functions, Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum, Wave Function of a Free Particle,

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states.

Unit - 2	**Number of lectures = 13**	**Title of the unit: General discussion of bound states in an arbitrary potential**

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions,

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (idea only).

Unit - 3	**Number of lectures = 13**	**Title of the unit: Atoms in Electric and Magnetic Fields**

Atoms in Electric and Magnetic Fields: - Electron Angular Momentum, Space Quantization, Electron Spin and Spin Angular Momentum, Larmor's Theorem, Spin Magnetic Moment, Stern-Gerlach Experiment, **Atoms in External Magnetic Fields**:- Normal and Anomalous Zeeman Effect.

Unit - 4	Number of lectures = 13	Title of the unit: Many electron atoms

Many electron atoms:- Pauli's Exclusion Principle, Symmetric and Antisymmetric Wave Functions, Periodic table, Fine structure, Spin orbit coupling, Spectral Notations for Atomic States, Total Angular Momentum, Vector Model, Spin-orbit coupling in atoms-L-S and J-J couplings.

12. Books Recommended

1. A Text book of Quantum Mechanics, P,M, Mathews & K, Venkatesan, 2nd Ed,, 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn,, 2002, Wiley,
3. Quantum Mechanics, Leonard I, Schiff, 3rdEdn, 2010, Tata McGraw Hill,
4. Quantum Mechanics, G, Aruldhas, 2ndEdn, 2002, PHI Learning of India,
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning,

1. Name of the Department: Physics						
2. Course Name	Quantum mechanics Lab	**L**	**T**		**P**	
3. Course Code	09010614	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 0	**Tutorials = 0**	**Practical = 40**

8. Course Description:

Experiments include the basic concepts of measurement of Planck's constant using LEDs, measurement of ionization potential of mercury, work function, hall coefficient etc.

9. Course Objectives:

To understand the working principles of measurement of Planck's constant using LEDs, tunnelling current in backward diode or tunnel diode, work function, hall coefficient etc.

10. Course Outcomes (COs):

After performing these experiments, students will be able to implement and demonstrate the photoelectric effect that is how radiation can be converted into electric energy, effect of magnetic field to develop potential difference etc.

11. List of Experiments

1. To determine value of Planck's constant using LEDs of at least 4 different colours
2. To determine I-V characteristics of PNP transistors.
3. To study Hall effect.
4. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
5. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
6. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.
7. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
8. To determine value of Boltzmann constant using V-I characteristic of PN diode.
9. To determine work function of material of filament of directly heated vacuum diode.

12. Books Recommended:

1. Scilab Image Processing: Lambert M. Surhone. 2010Betascript Publishing ISBN: 978-6133459274A
2. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
3. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
4. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

1. Name of the Department: Physics						
2. Course Name	Nuclear and particle physics	**L**	**T**		**P**	
3. Course Code	09010615	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The syllabus is divided into four units i.e. general properties of nuclei and nuclear models, radioactive decay and nuclear reactions, interaction of nuclear radiation with matter, and particle accelerator.

9. Course Objectives:

In this course students will learn about the phenomenon involve in the interaction of nuclear radiation with matters, working principles and characteristics of different types of nuclear detectors, radioactive decay processes and basics of high energy physics

10. Course Outcomes (COs):

After the successful completion of the course, students would be able to

1. Understand the science involved with interaction of nuclear radiations with matter.
2. Explain the characteristics of GM counter, gamma ray spectroscopy and high purity germanium detectors.
3. Explain the basic concepts of isospin, nuclear forces, Coulomb excitation, nuclear kinematics etc
4. Describe the basic features involved in high energy physics.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: General Properties of Nuclei and Nuclear Models**

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability, Two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Radioactivity decay and Nuclear reaction**

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis, (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit - 3	**Number of lectures = 13**	**Title of the unit: Interaction of Nuclear Radiation with matter**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula),

energy loss of electrons, Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter,

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter, Basic principle of Scintillation, Detectors and construction of photo-multiplier tube (PMT), Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility).

Unit - 4	Number of lectures = 13	Title of the unit: Particle Accelerators

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons,

Particle physics: Particle interactions; basic features, types of particles and its families, Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons,

12. Books Recommended

1. Introductory nuclear Physics by Kenneth S, Krane (Wiley India Pvt, Ltd,, 2008),
2. Concepts of nuclear physics by Bernard L, Cohen, (Tata Mcgraw Hill, 1998),
3. Introduction to the physics of nuclei & particles, R,A, Dunlap, (Thomson Asia, 2004)
4. Introduction to Elementary Particles, D, Griffith, John Wiley & Sons
5. Quarks and Leptons, F, Halzen and A,D, Martin, Wiley India, New Delhi
6. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K, Heyde (IOP- Institute of Physics Publishing, 2004),
7. Radiation detection and measurement, G,F, Knoll (John Wiley & Sons, 2000),
8. Theoretical Nuclear Physics, J,M, Blatt & V,F,Weisskopf (Dover Pub,Inc,, 1991)

1. Name of the Department: Physics						
2. Course Name	Nuclear and particle physics Lab	**L**	**T**		**P**	
3. Course Code	09010616	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 0	**Tutorials = 0**	**Practical = 40**

8. Course Description:

Experiments based on atomic and molecular physics and related topics such as determination of e/m ratio by Thamson method, basic characteristics of G.M counter etc

9. Course Objectives:

To learn by performing experiment based on G.M. Counter, cathode ray oscilloscope, spectrometer etc..

10. Course Outcomes (COs):

After performing these experiment students will be able to demonstrate the experiment and their practical applications.

11. List of Experiments

1. e/m by Thomson method.
2. Study of B-H Curve by C.R.O.
3. Study of Hartley Oscillator (Calibration of Gang Condenser).
4. Measurement of Energy Gap of Four Probe Method.
5. To draw the Plateau of G.M. Counter.
6. To determine the Mass Attention Coefficient by G.M. Counter.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal, New Delhi
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

1. Name of the Department: Physics						
2. Course Name	Computational Physics Skills	**L**	**T**		**P**	
3. Course Code	09010415	4	0		0	
4. Type of Course (use tick mark)		Core ()	DSE ()	AEC ()	SEC (√)	OE ()
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics,

9. Course Objectives:

To impart knowledge about various computer programming method to solve problems in physics.

10. Course Outcomes (COs):

After completion of this course, students will have understanding of

1. the use of computational methods to solve physical problems
2. Use of computer language as a tool in solving physics problems (applications)
3. Course will consist of hands on training on the Problem solving on Computers,

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Introduction**

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution, Usage of linux as an Editor, **Algorithms and Flowcharts:** Algorithm: Definition, properties and development, Flowchart: Concept of flowchart, symbols, guidelines, types, Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin (x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal,

Unit - 2	**Number of lectures = 8**	**Title of the unit: Scientific Programming**

Scientific Programming: Some fundamental Linux Commands (Internal and External commands), Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program, Operators: Arithmetic, Relational, Logical and Assignment Operators, Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions, Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic, Examples from physics problems

Unit - 3	**Number of lectures = 8**	**Title of the unit: Control Statements**

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file, Examples from physics problems,

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN,
3. To print out all natural even/ odd numbers between given limits,
4. To find maximum, minimum and range of a given set of numbers,
5. Calculating Euler number using exp(x) series evaluate d at x=1

Unit - 4	Number of lectures = 8	Title of the unit: Scientific word processing

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages, **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors,

Visualization: Introduction to graphical analysis and its limitations, Introduction to Gnuplot, importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc,
2. To evaluate sum of finite series and the area under a curve,
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series,
5. To write program to open a file and generate data for plotting using Gnuplot,
6. Plotting trajectory of a projectile projected horizontally,
7. Plotting trajectory of a projectile projected making an angle with the horizontally,
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen, Saving it as an eps file and as a pdf file,
9. To find the roots of a quadratic equation,
10. Motion of a projectile using simulation and plot the output for visualization,
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization,
12. Motion of particle in a central force field and plot the output for visualization

12. Books Recommended

1. Introduction to Numerical Analysis, S,S, Sastry, 5th Edn,, 2012, PHI Learning Pvt, Ltd,
2. Computer Programming in Fortran 77", V, Rajaraman (Publisher:PHI),
3. LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994),
4. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co,

6. Computational Physics: An Introduction, R, C, Verma, et al, New Age International Publishers, New Delhi(1999)
7. A first course in Numerical Methods, U,M, Ascher and C, Greif, 2012, PHI Learning
8. Elementary Numerical Analysis, K,E, Atkinson, 3rd Edn ,, 2007, Wiley India Edition,

1. Name of the Department: Physics						
2. Course Name	Renewable energy and energy harvesting	**L**	**T**		**P**	
3. Course Code	09010418	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will focus on the physical principles underlying energy processes. The application of these principles for harvesting energy from various sources will also be discussed.

9. Course Objectives:

To teach students the fundamental laws and physical processes that governs the sources, extraction, storage, and uses of energy.

10. Course Outcomes (COs):

Students will have enhanced their abilities to:

1. Understand how physical principles influence energy use.

2. Understand how to solve the problem of energy demand using various alternatives.

11. Unit wise detailed content

Unit-1	**Number of lectures = 7**	**Title of the unit: Fossil fuels and Alternate Sources of energy**

Fossil fuels and Alternate Sources of energy: Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources, An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit - 2	**Number of lectures = 8**	**Title of the unit: Solar energy and Wind Energy harvesting**

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning, Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Ocean Energy, Geothermal Energy and Hydro Energy**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy. Osmotic Power, Ocean Bio-mass,

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Unit - 4	Number of lectures = 14	Title of the unit: Piezoelectric Energy harvesting and Electromagnetic Energy Harvesting

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models.

12. Books Recommended

1. Non-conventional energy sources - G,D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co, Ltd,
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd,
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University,
5. Dr. P Jaya kumar, Solar Energy: Resource Assesment Handbook, 2009
6. J,Balfour, M,Shaw and S, Jarosek, Photovoltaics, Lawrence J Goodrich (USA),
7. http://en,wikipedia,org/wiki/Renewable_energy

1. Name of the Department: Physics						
2. Course Name	Applied Optics	**L**	**T**		**P**	
3. Course Code	09010416	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The course will teach about different types of light source and detectors, fourier transform spectroscopy, holography and the phenomenon of interference, diffraction and polarization.

9. Course Objectives:

To impart knowledge about different types of light source and detectors, fourier transform spectroscopy, holography and the phenomenon of interference, diffraction and polarization.

10. Course Outcomes (COs):

Students will have understanding of

1. different types of light sources and detectors
2. how to use fourier transform spectroscopy for analyzing various physical phenomenon related to light

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Sources and Detectors**

Sources and Detectors

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers,

Experiments on Lasers:

Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser,

To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser,

To find the polarization angle of laser light using polarizer and analyzer

Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

V-I characteristics of LED

Study the characteristics of solid state laser

Study the characteristics of LDR

Photovoltaic Cell

Characteristics of IR sensor

Unit - 2	**Number of lectures = 8**	**Title of the unit: Fourier Optics**

Fourier Optics

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

Experiments on Fourier Optics:

Fourier optic and image processing

Optical image addition/subtraction

Optical image differentiation

Fourier optical filtering

Construction of an optical 4f system

Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science,

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer, The resulting interferogram is the Fourier transform of the power spectrum of the source, Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters, Computer simulation can also be done,

Unit - 3	Number of lectures = 6	Title of the unit: Holography

Holography

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

Experiments on Holography and interferometry:

Recording and reconstructing holograms

Constructing a Michelson interferometer or a Fabry Perot interferometer

Measuring the refractive index of air

Constructing a Sagnac interferometer

Constructing a Mach-Zehnder interferometer

White light Hologram

Unit - 4	Number of lectures = 8	Title of the unit: Photonics: Fibre Optics

Photonics: Fibre Optics

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics

To measure the numerical aperture of an optical fibre

To study the variation of the bending loss in a multimode fibre

To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern

To measure the near field intensity profile of a fibre and study its refractive index profile

To determine the power loss at a splice between two multimode fibre

12. Books Recommended

1. Fundamental of optics, F, A, Jenkins & H, E, White, 1981, Tata McGraw hill,
2. LASERS: Fundamentals & applications, K,Thyagrajan & A,K,Ghatak, 2010, Tata McGraw Hill
3. Fibre optics through experiments,M,R,Shenoy, S,K,Khijwania, et,al, 2009, Viva Books
4. Nonlinear Optics, Robert W, Boyd, (Chapter-I), 2008, Elsevier,
5. Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer,
6. Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt, Ltd,
7. Optoelectronic Devices and Systems, S,C, Gupta, 2005, PHI Learning Pvt, Ltd,
8. Optical Physics, A,Lipson, S,G,Lipson, H,Lipson, 4th Edn,, 1996, Cambridge Univ, Press

1. Name of the Department: Physics						
2. Course Name	Mobile Communications	**L**	**T**		**P**	
3. Course Code	09010417	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 30		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
This course discusses basics of cellular mobile system, frequency management & channel assignment, modulation and access techniques, and digital, wireless systems.						
9. Course Objectives:						
This course would provide an introduction to the fundamental principles involved in mobile communications, the handset and various wireless technologies involved.						
10. Course Outcomes (COs):						
1. Familiarity with fundamental principles of mobile communications 2. Familiarity with components of a mobile handset and wireless communications						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 6**	**Title of the unit: Basics of Cellular Mobile System**				
Basics of Cellular Mobile Systems: A basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, overview of generations of cellular systems. Cellular Radio Systems Design and Interference: General description of the problem, concept of frequency reuse channels, co-channel interference reduction factor, desired C/I from a normal case in an omni directional antenna system, cell splitting, consideration of the components of cellular systems, Introduction to co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Basics of Frequency Management & Channel Assignment**				
Signal & Antenna Structures: introduction, obtaining the mobile point-to-point mode, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point-to-point prediction model – characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation, Characteristics of basic antenna structures, antenna at cell site, mobile antennas. Frequency Management & Channel Assignment, Hand Off & Dropped Calls: Frequency Management, fixed channel assignment, non-fixed channel assignment, traffic & channel assignment, hand-off, types of hand-off and their characteristics, dropped call rates & their evaluation.						
Unit - 3	**Number of lectures = 9**	**Title of the unit: Modulation and Access Techniques**				
Methods of Modulation, coding for error detection and correction: Introduction to Digital modulation techniques, modulation methods in cellular wireless systems, OFDM, Block Coding, convolution coding and Turbo coding. Access techniques: FDMA, TDMA, CDMA: Time-division multiple access (TDMA), code division multiple access (CDMA), CDMA capacity, probability of bit error considerations, CDMA compared with TDMA.						
Unit - 4	**Number of lectures = 5**	**Title of the unit: Digital, Wireless systems**				
GSM, D-AMPS, IS-95, basics of 4G, mobile management, voice signal processing and coding.						

12. Books Recommended

1. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, UK, 2005.
2. William, C. Y. Lee, "Mobile Cellular Telecommunications", 2nd Edition, McGraw Hill, 1990.
3. "Mobile Communication Hand Books", 2nd Edition, IEEE Press.
4. Theodore S Rappaport, "Wireless Communication Principles and Practice", 2nd Edition, Pearson Education, 2002.
5. Kaveh Pahlavan and Prashant Krishnamurthy", Principles of Wireless Networks", PHI, 2001.
6. Lawrence Harte, "3G Wireless Demystified", McGraw Hill Publications, 2001.

1. Name of the Department: Physics						
2. Course Name	Physical Workshop Skills	**L**	**T**		**P**	
3. Course Code	09010419	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will teach about the practical uses of mechanical, electrical and magnetic equipment which has been beneficial for the our everyday life.

9. Course Objectives:

To impart knowledge about various mechanical, electrical and magnetic equipment such as lathe, shaper, drilling, milling and surface machines, Cutting tools, Multimeter, Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB etc.

10. Course Outcomes (COs):

After performing these experiment students will be able to demonstrate the experiment and their practical applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Introduction**

Introduction: Measuring units, conversion to SI and CGS, Familiarization with meter scale, Vernier calliper, Screw gauge and their utility, Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc, Use of Sextant to measure height of buildings, mountains, etc Characteristics of IR sensor

Unit - 2	**Number of lectures = 8**	**Title of the unit: Mechanical Skill**

Mechanical Skill: Concept of workshop practice, Overview of manufacturing methods: casting, foundry, machining, forming and welding, Types of welding joints and welding defects, Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood, Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines, Cutting tools, lubricating oils, Cutting of a metal sheet using blade, Smoothening of cutting edge of sheet using file, Drilling of holes of different diameter in metal sheet and wooden block, Use of bench vice and tools for fitting, Make funnel using metal sheet,

Unit - 3	**Number of lectures = 8**	**Title of the unit: Electrical and Electronic Skill**

Electrical and Electronic Skill: Use of Multimeter, Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB, Operation of oscilloscope, Making regulated power supply, Timer circuit, Electronic switch using transistor and relay,

Unit - 4	**Number of lectures = 8**	**Title of the unit: Introduction to prime movers**

Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axel, Lever mechanism, Lifting of heavy weight using lever, braking systems, pulleys, working principle of power generation systems, Demonstration of pulley experiment.

12. Books Recommended

1. A text book in Electrical Technology - B L Theraja – S, Chand and Company,

2. Performance and design of AC machines – M,G, Say, ELBS Edn,
3. Mechanical workshop practice, K,C, John, 2010, PHI Learning Pvt, Ltd,
4. Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn,, Editor Newnes
5. New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland

1. Name of the Department: Physics						
2. Course Name	Basic Instrumentation Skills	**L**	**T**		**P**	
3. Course Code	09010420	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course will teach about the practical uses of mechanical, electrical and magnetic equipment which has been beneficial for our everyday life.

9. Course Objectives:

To impart knowledge about various mechanical, electrical and magnetic equipment such , multimeter, AC millivoltmeter, cathode ray oscilloscope, signal generator and analysis of related instruments etc.

10. Course Outcomes (COs):

After performing these experiment students will be able to demonstrate the experiment and their practical applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Basic of Measurement**

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Unit - 2	**Number of lectures = 8**	**Title of the unit: Electronic Voltmeter**

Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance

Unit - 3	**Number of lectures = 8**	**Title of the unit: Cathode Ray Oscilloscope**

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Signal Generators and Analysis Instruments**

Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis,

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

12. Books Recommended

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.

3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Department of Chemistry

Core papers:

1. Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
2. Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab
3. Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I
4. Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I Lab
5. Conductance, Electrochemistry & Functional Group Organic Chemistry-II
6. Conductance, Electrochemistry & Functional Group Organic Chemistry-II Lab
7. Transition Metal & Coordination Chemistry, States of Matter and Chemical Kinetics
8. Transition Metal & Coordination Chemistry, States of Matter and Chemical Kinetics Lab

Discipline Specific Elective papers

1. Analytical Methods in Chemistry
2. Analytical Methods in Chemistry Lab
3. Molecules of Life
4. Molecules of Life Lab
5. Quantum Chemistry, Spectroscopy & Photochemistry
6. Quantum Chemistry, Spectroscopy & Photochemistry Lab
7. Polymer Chemistry
8. Polymer Chemistry Lab
9. Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy
10. Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy Lab
11. Chemistry of Main Group Elements, Theories of Acids and Bases
12. Chemistry of Main Group Elements, Theories of Acids and Bases Lab

Skill Enhancement Courses:

1. Basic Analytical Chemistry
2. Fuel Chemistry
3. Chemical Technology & Society
4. Pharmaceutical Chemistry
5. Chemistry of Cosmetics & Perfumes
6. Pesticide Chemistry

1. Name of the Department: Chemistry						
2. Course Name	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	**L**	**T**	**P**		
3. Course Code	09010115	4	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Chemistry is essential to the understanding of the world around us. This core paper in Chemistry will help Science students understand and rationalize bonding in compounds, basic shapes and structures of molecules and even predict properties, which may have potential applications as materials, nanostructured materials and devices.

The course highlights the uses and limitations of the Schrodinger wave equation and explains the concept of quantization of energy followed by an explanation of the rules governing the filling up of electrons in various orbitals and the electronic configuration of the atoms and ions. Atomic properties give rise to three models of chemical bonding- ionic, covalent, and metallic.

Energetics behind the formation of ionic bonds (Born Landè Equation), the forces of interaction operating in covalent molecules (bond energy) and the band theory of metals will be explained in detail.

Organic chemistry is probably the most active and important field of chemistry, due to its diverse applications in life and industry. Organic Chemistry involves basic principles governing life and applications of these principles. The course highlights the fundamentals of these carbon containing compounds with emphasis on inductive effect, hyper-conjugation, resonance and how they affect the properties of these compounds. Nucleophilic and electrophilic behavior of organic compounds and the intermediates formed during reactions; carbocations; carbanions; and free radicals will be exaplined along with along with studying the effects of functional groups on reactions.

Stereochemistry of organic compounds, which involves the study of the relative spatial arrangement of atoms that form the structure of molecules and their manipulation along with the applications, will be discussed at length. Many important reactions and their mechanisms would also be discussed.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to Schrödinger wave equation, quantization of energy and electronic configuration of atoms and ions.
2. Explain three types of chemical bonding- ionic, covalent and metallic- and understand energetics of bond formation.
3. Introduce properties of organic compounds with special emphasis on inductive effect, hyperconjugation and resonance.
4. Understand electrophilicity and nucleophilicity and impact of functional groups on reactions
5. Understand stereochemistry of compounds
6. Explain important reactions and mechanisms

10. Course Outcomes (COs):

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

1. Understand and quantization of energy and determine electronic configurations of atoms and ions
2. Explain chemical bonding in atoms and molecules
3. Explain electronic displacements in organic molecules with special emphasis on inductive, resonance, electromeric effects and hyperconjugation

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4. Explain nucleophilic and electrophilic behavior of organic species
5. Explain spatial arrangement of atoms on organic molecules
6. Identify important properties and reactions of aliphatic hydrocarbons (alkanes, alkenes and alkynes)

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Atomic Structure**

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and $\psi 2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit – 2	**Number of lectures = 14**	**Title of the unit: Chemical Bonding and Molecular structure**

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Unit – 3	**Number of lectures = 16**	**Title of the unit: Fundamentals of Organic Chemistry and Stereochemistry**

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms).

Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit – 4	Number of lectures = 10	Title of the unit: Aliphatic Hydrocarbons

Aliphatic Hydrocarbons : Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

13. Books Recommended

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
9. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
11. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

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1. Name of the Department: Chemistry						
2. Course Name	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab		**L**	**T**		**P**
3. Course Code	09010116		0	0		4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

The lab work emphasizes learning of basic skills helpful not only to chemistry students but all those who want to pursue any experimental science. It includes volumetric analysis of compounds, crystallization of compounds, determining the purity, melting and boiling point of compounds and simple chromatographic techniques.

9. Course Objectives:

The objectives of this course are to:

1. Estimate various components in a mixture
2. Estimate oxalic acid, water of crystallization in Mohr's salt, Fe(II) ions and Cu(II) ions by volumetric analysis
3. Detect various elements in organic compounds
4. Separate mixture by various types of chromatography

10. Course Outcomes (COs):

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

1. Separate mixtures of Sodium carbonate and Sodium hydrogen carbonate
2. Determine strengths of solutions of oxalic acid and water of crystallization in Mohr's salt with $KMnO_4$.
3. Determine strengths of Fe(II) solutions with $K_2Cr_2O_7$
4. Determine strengths of Cu(II) solutions iodometrically with $Na_2S_2O_3$
5. Detect heteroatoms (N, S, Cl, Br, I) in organic compounds
6. Separate amino acids with paper chromatography
7. Separate sugars with paper chromatography

11. List of Experiments (Student has to perform ten experiments – at least two from each section)

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
3. Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
4. Identify and separate the sugars present in the given mixture by paper chromatography.

12. Books Recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,
4. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
5. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960.

1. Name of the Department: Chemistry									
2. Course Name	Chemical Energetics, Equilibria, Functional Organic Chemistry		**L**		**T**		**P**		
3. Course Code	09010214		4		0		0		
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**AEC ()**		**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**		Even (✓)		Odd ()		Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals									
Lectures = 52		**Tutorials = 0**				**Practical = 0**			

8. Course Description:

This course aims to explain the physical world around us by describing important principles and definitions of thermochemistry. Through Laws of thermodynamics, energetics of reactions will be explained. Calculation of bond energy, bond dissociation energy, resonance energy, entropies and enthalpies will be demonstrated. In addition, concepts related to chemical equilibrium (Gibb's Free Energy, Le Chatlier's Principle) will be discussed.

Equilibria in term of ions will also be explained. Important concepts include strong, moderate and weak electrolytes; ionization of water; ionization of weak acids and bases; common ion effect; pH scale; buffer solutions; and solubility of sparingly soluble salts.

In Organic Chemistry, preparation and reactions of aromatic hydrocarbons; alkyl and aryl halides; alcohols, phenols and ethers will be discussed. Important reactions and their mechanisms will be explained.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to energetics of chemical reactions through Laws of Thermodynamics
2. Demonstrate calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.
3. Explain thermodynamic derivation of the law of chemical equilibrium (be able to distinguish between ΔG and ΔG^0, Le Chatlier's Principle)
4. Understand the difference between strong, moderate and weak electrolytes; degree of ionization and ionic product of water
5. Understand ionization of weak acids and bases and related concepts
6. Understand reactions and preparations of aromatic hydrocarbons; aryl and alkyl halides; alcohols, phenols and ethers; aldehydes and ketones.

10. Course Outcomes (COs):

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

1. Explain energetics of chemical reactions through important principles and definitions of thermo chemistry
2. Understand free energy change in a chemical reaction
3. Explain degree of ionization and the differences between strong, moderate and weak electrolytes
4. Explain important concepts associated with the ionization of weak acids and bases
5. Explain preparation and reactions of aromatic hydrocarbons; aryl and alkyl halides; alcohols, phenols and ethers; aldehydes and ketones.

11. Unit wise detailed content

Section A: Physical Chemistry (26 Lectures)

Unit-1	**Number of lectures = 8**	**Title of the unit: Chemical Energetics**

Review of thermodynamics and the Laws of thermodynamics

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation and bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature- Kirchoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit – 2	**Number of lectures = 18**	**Title of the unit: Chemical Equilibrium and Ionic Equilibria**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^0, Le Chatlier's Principle.

Relationships between K_p, K_c and K_x for reactions involving ideal gases.

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts- applications of solubility product principle.

Section B: Organic Chemistry (26 Lectures)

Unit – 3	**Number of lectures = 14**	**Title of the unit: Aromatic Hydrocarbons; Alkyl and aryl halides**

Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Aromatic Hydrocarbons

Preparation : (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and aryl halides (Common)

Alkyl halides (upto 5 carbons) Types of Nucleophiles (S_N1, S_N2 and S_Ni) reactions.

Preparation: From alkenes and alcohols

Reactions: Hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation, Williamson's ether synthesis: Eliminations vs. substitution.

Aryl Halides

Preparation : (Chloro, bromo and iodo benzene case): from phenol, Sanmeyer & Gattermann reactions.

Reactions: (Chlorobenzene): Aromatic nucleophilic substitution (replacement by -OH group) and effect of nitro substituent. Benzyne mechanism: KNH_2/NH_2 (or $NaNH_2/NH_3$).

Reactivity and relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit 4	**No. of Lectures = 12**	**Title of the unit: Alcohols, Phenols and ethers (Up to 5 Carbons)**

Alcohols:

Preparation: Preparation of 1°, 2° and 3° alcohols using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acids and esters.

Reactions: With Sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation

Diols: (Upto 6 Carbons), oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case)

Preparation: Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten-Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and nitriles

Reactions: Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol condensation, Canizzaro's reaction, Wittig reaction, Benzoin condensation.

Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

13. Books Recommended

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I and II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

1. Name of the Department: Chemistry						
2. Course Name	Chemical Energetics, Equilibria, Functional Organic Chemistry Lab		L	T		P
3. Course Code	09010215		0	0		4
4. Type of Course (use tick mark)		Core (✓)	DSE ()	AEC ()	SEC ()	OE ()
5. Pre-requisite (if any)	NA	6. Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0	Tutorials = 0		Practical = 52			

8. Course Description:

The lab work emphasizes learning of basic skills helpful not only to chemistry students but all those who want to pursue any experimental science. It includes using instruments to determine physical parameters, *e.g.*, heat capacity, enthalpy, solubility and pH; crystallization of compounds, determining the purity, melting and boiling point of compounds and simple chromatographic techniques. Syntheses of selected organic compounds will also be performed and their mechanisms will be discussed.

9. Course Objectives:

1. Determination of heat capacity of calorimeter
2. Determination of enthalpy of selected reactions
3. Studying the solubility of benzoic acid in water
4. Determination of pH of various solutions, for instance, aerated drinks, fruit juices, shampoos and soaps.
5. Preparation of buffer solutions and determination of their pH
6. Purification of organic compounds by crystallization and distillation
7. Preparation of selected organic compounds and discussion about their mechanism.

10. Course Outcomes (COs):

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

1. Determine heat capacity of calorimeter for different volumes.
2. Determine enthalpy of
   a. Neutralization of hydrochloric acid with sodium hydroxide
   b. Ionization of acetic acid
   c. Solution of salts (KNO_3, NH_4Cl)
   d. Hydration of Copper Sulphate
3. Study solubility of benzoic acid in water
4. Measure pH of different solutions, for instance, aerated drinks, fruit juices, shampoos and soaps
5. Prepare buffer solutions (one acidic and basic each) and determine their pH
6. Purify organic compounds by crystallization and distillation and determine their purity with melting and boiling points
7. Conduct the following syntheses and determine their mechanisms
   a. Bromination of Phenol/Aniline
   b. Benzoylation of amines/phenols
   c. Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

11. List of Experiments(Student has to perform ten experiments – at least two from each section)

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of *H*.

Ionic equilibria

1. pH measurements
2. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
3. Preparation of buffer solutions:
4. Sodium acetate-acetic acid
5. Ammonium chloride-ammonium hydroxide
6. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
4. Bromination of Phenol/Aniline
5. Benzoylation of amines/phenols
6. Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

12. Books Recommended

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,
2. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960.
4. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

1. Name of the Department: Chemistry						
2. Course Name	Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Organic Chemistry-II		**L**		**T**	**P**
3. Course Code	09010314		4		0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = 52	**Tutorials = 0**		**Practical = 0**			

8. Course Description:

This course will delve deeper into the thermodynamics of solutions- ideal and non-ideal. Raoult's Law which governs the behavior of ideal solutions will be explained. In addition, miscibility of liquids (partial and immiscibility) will be discussed. Principles of steam distillation, Nernst distribution law and its application, and solvent extraction will be highlighted.

This course will also explain equilibrium between phases. Phases, components and degrees of freedom of a system will be explained. In addition, phase diagrams of one-component systems (water and Sulphur) and selected two-component systems involving eutectics, congruent and incongruent melting points will be discussed.

Conductivity, transference number and ionic mobility will be explained as a foundation for electrochemistry. Important concepts in electrochemistry include measuring EMF of a cell; Nernst equation; standard electrode potential and the electrochemical series; concentration cells; pH determination; and potentiometric titrations.

In organic chemistry, preparation and reactions of carboxylic acids and their derivatives (acid chlorides, esters, amides, anhydrides); amines and Diazonium salts; amino acids, peptides and proteins; and carbohydrates will be discussed.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to thermodynamics of ideal solutions and Raoult's law
2. Familiarize students with principles governing miscibility of liquids
3. Explain phase diagrams of one component system (water and Sulphur) and two component systems (Pb-Ag, $FeCl_3$-H_2O and Na-K) involving eutectics, congruent and incongruent melting points
4. Explain molar conductivity, transference number and ionic mobility
5. Understand how to measure EMF of a cell
6. Understand how to determine pH using Hydrogen electrode
7. Explain preparation and reactions of Carboxylic acids and derivatives; amines and diazonium salts; amino acids, peptides and proteins; and carbohydrates.

10. Course Outcomes (COs):

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

1. Understand the behavior of ideal solutions and Raoult's law and deviations from Raoult's law
2. Explain phase diagrams for selected one component and two component systems
3. Explain migration of ions

4. Determine degree of ionization of weak electrolytes; solubility products of sparingly soluble salts; ionic product of water; and hydrolysis constant of a salt
5. Determine EMF of a cell and from the EMF data, □G, □H and □S.
6. Explain preparation and reactions of Carboxylic acids and derivatives; amines and diazonium salts; amino acids, peptides and proteins; and carbohydrates.

11. Unit wise detailed content

Section A: Physical Chemistry II (26 Lectures)

Unit-1	**Number of lectures = 14**	**Title of the unit: Solutions and Phase Equilibrium**

Thermodynamics of ideal solutions: Ideal solutions and Raoult's Law, deviations from Raoult's law- non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

Partial miscibility of liquids: Critical solution temperature, effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation, Nernst distribution law and its application, solvent extraction.

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius-Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and Sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only)

Unit – 2	**Number of lectures = 12**	**Title of the unit: Conductance and Electrochemistry**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Application of conductance measurements, determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes, Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: □G, □H and □S from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

pH determination using hydrogen electrode and quinhydrone electrode.

Potentiometric titrations- qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry -II (26 Lectures)

Unit – 3	**Number of lectures = 10**	**Title of the unit: Carboxylic Acids and their derivatives; Amines and Diazonium Salts**

Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic)

Preparation: Acidic and Alkaline hydrolysis of esters

Reactions: Hell-Vollhard-Zelinsky Reaction

Carboxylic acid derivatives (Upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic) (Upto 5 Carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test with HNO2, Schotten-Baumann Reaction, Electrophilic substitution (case aniline), nitration, bromination, sulphonation.

Diazonium salts

Preparation: from aromatic amines

Reactions: conversion to benzene, phenol, dyes.

Unit 4	**No. of Lectures = 16**	**Title of the unit: Amino acids, peptides and proteins; Carbohydrates**

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of amino acids: ester of -COOH group, actylation of -NH2 group, complexation with Cu2+ ions, ninhydrin test

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins

Determination of primary structure of peptides by degradation. Edmann degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme).

Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) and C-activating groups and Merrifield solid-phase synthesis.

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellulose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

13. Books Recommended

1. Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007)
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004)
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New Delhi (1985).
6. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
7. Finar, I.L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
8. Finar, I.L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
9. Nelson, D.L. & Cox, M.M. Lehninger's Principles of Biochemistry 7th Ed., W.H. Freeman.
10. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.

1. Name of the Department: Chemistry							
2. Course Name	Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Organic Chemistry-II Lab		**L**		**T**		**P**
3. Course Code	09010315		0		0		4
4. Type of Course (use tick mark)			**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite(if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()		Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.							
Lectures = 0		**Tutorials = 0**			**Practical = 52**		

8. Course Description:

The lab work emphasizes learning of basic skills helpful not only to chemistry students but all those who want to pursue any experimental science. It includes studying equilibria by distribution methods; construction of the phase diagram of a binary system and determining its critical temperature and composition; determination of cell constant, conductance and degree of dissociation; perform conductometric titrations; perform potentiometric titrations; qualitative analysis of organic compounds; simple chromatographic techniques; and miscellaneous experiments in organic chemistry, *e.g.*, titration of glycine and determination of its concentration, studying the action of salivary amylase on starch, and differentiating between a reducing and nonreducing sugar.

9. Course Objectives:

1. Studying the equilibrium of selected reactions by distribution method
2. Construction of phase diagram of a binary system (simple eutectic) using cooling curves and determination of critical temperatures and composition.
3. Determination of a cell constant, conductance and degree of dissociation of a weak acid
4. Perform conductometric and potentiometric titrations
5. Perform qualitative analyses of selected organic compounds possessing monofunctional groups
6. Separation of amino acids by paper chromatography
7. Titration of glycine and determination of its concentration
8. Studying the action of salivary amylase on starch
9. Differentiation between a reducing and a nonreducing sugar

10. Course Outcomes (COs):

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

1. Explain the equilibrium of selected reactions by distribution method
2. Construct phase diagrams of binary systems (simple eutectic) with cooling curves and determine critical parameters
3. Determine cell constant, conductance and degree of dissociation of an acid
4. Perform conductometric and potentiometric titrations
5. Perform qualitative analyses of selected organic compounds possessing monofunctional groups
6. Separation of amino acids by paper chromatography
7. Titrate glycine and determine its concentration

8. Study the action of salivary amylase on starch
9. Differentiate between a reducing and a nonreducing sugar

11. List of Experiments(Student has to perform ten experiments – at least two from each section)

Section A: Physical Chemistry

Distribution

1. Study of the equilibrium of one of the following reactions by the distribution method:

$$I_2(aq) + I^-(aq) \longrightarrow I_3^-(aq)$$

$$Cu^{2+}(aq) + xNH_2(aq) \longrightarrow [Cu(NH_3)_x]^{2+}$$

Phase equilibria

1. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
2. Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
3. Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance

1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and
3. dissociation constant of a weak acid.
4. Perform the following conductometric titrations:
5. Strong acid vs. strong base
6. Weak acid vs. strong base

Potentiometry

1. Perform the following potentiometric titrations:
2. Strong acid vs. strong base
3. Weak acid vs. strong base
4. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

1. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.
2. Separation of amino acids by paper chromatography
3. Determination of the concentration of glycine solution by formylation method.
4. Titration curve of glycine
5. Action of salivary amylase on starch
6. Effect of temperature on the action of salivary amylase on starch.
7. Differentiation between a reducing and a nonreducing sugar

12. Books Recommended

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

1. Name of the Department : Chemistry						
2. Course Name	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics	**L**	**T**		**P**	
3. Course Code	09010412	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course will give an excellent opportunity to study and use the knowledge of Transition Elements, coordination chemistry, Gaseous State, Liquid State, Solid State and Chemical Kinetics.

9. Course Objectives:

The objectives of this course are to:

1. Study the properties of transisition elements.
2. Understand the key features of coordination compounds
3. Discuss the various properties of solids, liquids and gases.
4. Study the reaction rates, theories of reaction rates and different order reactions.

10. Course Outcomes (COs):

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

1. Identify the behavior of transition elements
2. Recognize the types of isomers and nomenclature and applications of coordination compounds.
3. Become familiar with the various applications of molecules in different states..
4. Describe how the rate of a chemical reaction changes as a function of time.

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Transition Elements (3d series)**

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Unit – 2	**Number of lectures = 11**	**Title of the unit: Coordination Chemistry**

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. Crystal Field Theory, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Unit – 3	**Number of lectures = 15**	**Title of the unit: Gaseous Sate and Liquid State**

Gaseous State: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation

of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews's isotherms of CO_2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions.

Liquid State: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Unit – 4	Number of lectures = 15	Title of the unit: Solid State and Chemical Kinetics

Solid State: Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

12. Books Recommended

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley.
7. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
8. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
9. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.

1. Name of the Department : Chemistry						
2. Course Name	Transition Metal & Coordination Chemistry, States of matter & Chemical kinetics Lab			**L**	**T**	**P**
3. Course Code	09010413			0	0	4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

This course provides practical training in inorganic qualitative analysis, surface tension and viscosity measurements and kinetics of chemical reactions which enable students to solve the technical problems during the separation of mixtures.

9. Course Objectives:

The objectives of this course are to:

1. Identify different cataions and anions in an inorganic mixture.
2. Perform experiment on surface tension and viscosity
3. Study the kinetics of chemical reactions.

10. Course Outcomes (COs):

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

1. Separate the components in an inorganic mixture
2. Identify quality of any chemical and any formulation.
3. Apply Arrhenius equation to study different chemical reactions.

11. List of Experiments(Student has to perform ten experiments – at least two from each section)

Inorganic Chemistry :

I. Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of the following:

Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2}+, Cd^{2}+, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2}+, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+

Anions : CO_3^{2-}, S^{2-}, SO_2^-, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_{43-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-

(Spot tests should be carried out wherever feasible)

II. Estimations

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Estimation of (i) Mg+ or (ii) Zn+ by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.

Physical Chemistry:

I. Surface tension measurement (use of organic solvents excluded)

a. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b. Study of the variation of surface tension of a detergent solution with concentration.

II. Viscosity measurement (use of organic solvents excluded).

a. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

b. Study of the variation of viscosity of an aqueous solution with concentration of solute.

III. Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.
   c. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis

12. Books recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

1. Name of the Department : Chemistry						
2. Course Name	Analytical Methods in Chemistry		**L**		**T**	**P**
3. Course Code	09010517		4		0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This course provides an excellent opportunity to learn about Sampling, evaluation of analytical data, analyzing and identifying samples using different spectroscopic techniques like Infra-red, UV, Visible, flame absorption spectrometry. This course also emphasizes on applications of thermogravimetry, electrochemistry and separation methods like chromatography.

9. Course Objectives:

The objectives of this course are to:

1. Learn the basic principles of different instrumentation.
2. Introduce Origin of spectra, fundamental laws of spectroscopy and selection rules.
3. Theory of thermogravimetry (TG) and its application.
4. Understand the mechanism and efficiency of separation techniques like solvent extraction, chromatography.
5. Introduce electro analytical methods to study different types of titrations.
6. Learn the basic principle of flame photometry and techniques of atomization and sample introduction.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify choice of source, monochromator and detector for single and double beam instrument in spectrometry.
2. Apply and verify Lambert Beer's Law.
3. Use Flame photometers for the quantitative estimation of trace level of metal ions from water samples
4. Explain mechanism of extraction: extraction by solvation and chelation. Technique of extraction:
5. Calculate Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents.
6. Understand the advantage of determining the equivalence point by performing conductometric and potentiometric titrations over volumetric titration.
7. Determine pKa values using pH meter.

11. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Qualitative and quantitative aspects of analysis**

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit – 2	Number of lectures = 20	Title of the unit: Optical methods of analysis

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

Basic principles of quantitative analysis: Estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit – 3	Number of lectures = 10	Title of the unit: Thermal methods of analysis and Electroanalytical methods

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Classification of electro analytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit – 4	Number of lectures = 14	Title of the unit: Separation Techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique,Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC,

GLC, GPC, TLC and HPLC. Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess

12. Books Recommended

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
7. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

1. Name of the Department: Chemistry						
2. Course Name	Analytical Methods in Chemistry Lab		**L**	**T**		**P**
3. Course Code	09010518		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals.

Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

Practical work has had a central and distinct role in chemistry education (from school to university) for more than a century. The aim of chemistry is to increase our understanding of the composition, properties and change of matter. Claims and explanations in chemistry should be supported by observational data.

The module designed here for students is to understand the basic principles and learn the experimental techniques of classical titrimetric and gravimetric methods of analysis. The student will also be introduced to common instrumental techniques including chromatography, spectrophotometry, ion exchange resins and electro-analytical methods.

9. Course Objectives:

The objectives of this course are to:

1. Understand the basic principles and learn the experimental techniques of classical titrimetric methods of analysis,
2. Understand the theory behind the instrumental techniques of chromatography, spectrophotometry ,ion exchange and electro-analytical methods
3. Perform experiments with samples of water to determine BOD and COD and dissolved oxygen.
4. Determine the acidity and alkalinity in soil samples.
5. Study and apply the principle of complexometry for detecting metals in samples at the ppm level.
6. Use flame photometry method for detecting alkali metals in sample as they give characteristic colors in flame.

10. Course Outcomes (COs):

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

1. Refer to the chemical theory behind the use of modern instrumental techniques for quantitative chemical analysis.
2. Identify and estimate traces of metals using the theory of complexation with EDTA
3. Analyze soil for its pH and total soluble salt content.
4. Determine Na, Ca and Li In fruit juices and cola drinks by applying flame photometric technique.
5. Use chromatography to separate mixtures of metal ions, dyes, sugars, amino acids and various other samples and calculate their Rf values.

11.List of Experiments(Student has to perform ten experiments – at least two from each section)

I. Chromatography

1. Paper chromatographic separation of Fe3+, Al3+, and Cr3+.
2. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.
3. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.
4. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

1. To separate a mixture of Ni2+ & Fe2+ by complexation with DMG and extracting the Ni2+-DMG complex in chloroform, and determine its concentration by spectrophotometry.
2. Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.
3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
5. Analysis of soil:

Ion exchange:

I. Determination of exchange capacity of cation exchange resins and anion exchange resins.

II. Separation of metal ions from their binary mixture.

III. Separation of amino acids from organic acids by ion exchange chromatography.

III. Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen, (COD) and (BOD).in water.
4. Determine the composition of the ferric-salicylate/ ferric-thiocyanate complex by Job's method.

12. Books Recommended

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
7. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

1. Name of the Department: Chemistry						
2. Course Name	Molecules of Life	**L**	**T**		**P**	
3. Course Code	09010519	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

The complexity of even the simplest of life forms, the single cell cannot be overstated. From a chemical perspective, cellular components can be segregated into macromolecules (DNA, RNA, proteins etc.) and relatively simpler molecules (amino acids, monosaccharaides and lipids). This course highlights the classification, synthesis, structure and properties of these molecules of life. This course also includes the chemistry of these biomolecules and their roles in metabolism.

9. Course Objectives:

The objectives of this course are to:

1. Study the classification and general properties of carbohydrates, proteins, amino acids, enzymes and lipids.
2. Understand the difference between monosaccharaides, disaccharides' and polysaccharides.
3. Determine primary structure of peptides and synthesize simple peptides.
4. Explain about enzymes and their mode of action
5. Understand how DNA carries genetic information, and how it is put into action by cells and organisms,
6. Study the concept of energy and conversion of food into energy.
7. Understand the interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify the different biomolecules and elucidate their structure.
2. Explain Specificity of enzyme action, Enzyme inhibitors and their importance.
3. Differentiate between oil and fats; calculate saponification value and iodine number.
4. Get detail knowledge about Nucleic acids, and DNA in particular, which are key macromolecules for the continuity of life. DNA bears the hereditary information that's passed on from parents to children
5. Describe the Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs cycle, and other biomolecules.

11. Unit wise detailed content

Unit-1	**Number of lectures = 20**	**Title of the unit: Carbohydrates and Proteins**

Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharaides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch

and cellulose) excluding their structure elucidation.

Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–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 phase synthesis.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Enzymes and correlation with drug action**

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition(Competitive and Non- competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH2 group, double bond and aromatic ring,

Unit – 3	**Number of lectures = 10**	**Title of the unit: Nucleic Acids and lipids**

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. 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).

Unit – 4	**Number of lectures = 10**	**Title of the unit: Concept of Energy in Biosystems**

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (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.

12. Books Recommended

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 98
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.,W. H. Freeman.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.

1. Name of the Department: Chemistry						
2. Course Name	Molecules of Life Lab	**L**	**T**		**P**	
3. Course Code	09010520	0	0		4	
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

Practical work has had a central and distinct role in chemistry education (from school to university) for more than a century. The aim of chemistry is to increase our understanding of the composition, properties and change of matter. Claims and explanations in chemistry should be supported by observational data.
This course provides practical training to the students to use various methods to estimate, separate, detect or analyze samples containing biomolecules. Different techniques like chromatography , extraction method , acid base titrations ,organic synthesis are introduced.

9. Course Objectives:

The objectives of this course are to:

1. independently carry out organic synthesis
2. Enable students to prepare their own solutions for experiment having complete knowledge about normality, molality, molarity, mole fraction, as measures of concentration.
3. plan and carry out acid-base titrations; justify choice of indicator and interpret titration curve
4. to differentiate the reducing and non reducing sugar.

10. Course Outcomes (COs):

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

1. Prepare Biochemical reagent for various solutions with respect to different Normality, Molarity, % Solutions (W/V), (V/V) & Numericals.
2. Perform titrations with suitable indicators to detect the sharp end point and quantitatively estimate the desired samples.
3. Use chromatographic methods to separate mixture of amino acids.
4. Prepare chromatogram, separate pigments from extracts of leaves and flowers/ink mixtures and determine of Rf value
5. Determine iodine value and saponification value of fat/oil.

11. List of Experiments

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/ nonreducing sugar.
9. Extraction of DNA from onion/cauliflower
10. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

12. Books Recommended

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

1. Name of the Department: Chemistry						
2. Course Name	Quantum Chemistry, Spectroscopy & Photochemistry		**L**	**T**		**P**
3. Course Code	09010521		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The course is divided into three different sections,

The first unit deals with the introduction to the quantum mechanical model of the atom:Thinking about electrons as probabilistic matter waves using the de Broglie wavelength, the Schrödinger equation, and the Heisenberg's Uncertainty Principle.

The second part focuses on the five key spectroscopic methods used by chemists and biochemists to analyse the molecular and electronic structure of atoms and molecules. These are Vibrationional, Rotational, Electronic, Raman and Nuclear Magnetic Resonance (NMR) spectroscopies for understanding the molecular structure and nature of chemical bonding. This course provides a thorough knowledge of the methods of Quantum mechanics and the different types of spectroscopic techniques.

In nature, photochemistry is of immense importance as it is the basis of photosynthesis, vision, and the formation of vitamin D with sunlight. Photochemical reactions proceed differently than temperature-driven reactions. This course also highlights the basic laws of photochemistry, energy levels, quantum yield and examples of photochemical reactions.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to Schrödinger wave equation, quantization of energy and electronic configuration of atoms and ions.
2. Discuss chemical bonding using valence bond and molecular orbital approaches and apply them to various hydrogen like atoms.
3. Learn the basic principles of molecular spectroscopy.
4. Understand the theory of electromagnetic radiation and concepts of absorption and emission spectra.
5. Study the origin of selection rules that governs the transitions to occur between two Eigen states.
6. Understand the Role of photochemical reactions in biochemical processes, photostationary states, and chemiluminescence.
7. Study the principles and laws of photochemistry and apply them in field of chemistry, biology, biochemistry, biomedicine etc.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. understand and explain the differences between classical and quantum mechanics
2. understand the idea of wave function
3. understand the uncertainty relations

4. solve Schrödinger equation for simple potentials
5. Define Bonding and antibonding orbitals and apply LCAO-MO treatment to homonuclear and heteronuclear diatomic molecules (HF, LiH).
6. Identify the unknown molecules and measure their bond length from the values of their rotational constants.
7. Determine the Force constant associated with the chemical bonds.
8. Qualitatively order the molecular energy levels into electronic, vibrational, rotational and other energy levels.
9. Calculate the relative population of these energy levels. Identify the regions of the electromagnetic spectrum corresponding to different molecular transitions.
10. Calculate larmor frequency, chemical shift and shielding constant in NMR
11. Differentiate between NMR and ESR.
12. Determine whether the molecular vibrations of a triatomic molecule are Raman active and explain the difference between Stokes and anti-Stokes lines in a Raman spectrum.
13. Distinguish between the energy levels of a rigid and a non-rigid rotor.
14. Distinguish between harmonic and anharmonic vibrations.
15. Apply the laws of photochemistry, Lambert-Beer's law, define terms like photosensitization, quenching, chemiluminescence etc.

11. Unit wise detailed content

Unit-1	**Number of lectures = 16**	**Title of the unit: Quantum Chemistry**

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, and quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Unit-2	**Number of lectures = 10**	**Title of the unit: Chemical Bonding.**

Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Unit 3	Number of lectures = 20	Title of the unit: Molecular Spectroscopy

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

Unit – 4	Number of lectures =6	Title of the unit: Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

12. Books Recommended

1. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006)
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004)
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
5. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).

1. Name of the Department: Chemistry						
2. Course Name	Quantum Chemistry, Spectroscopy & Photochemistry Lab		**L**	**T**		**P**
3. Course Code	09010522		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite .	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

A spectrophotometer is a photometer that can measure the intensity of light as a function of its wavelength. Single beam and double beam are the two major classes of spectrophotometers This course provides practical training to handle UV spectrophotometer and study absorbance spectra of various samples in the visible range. Solutions of transition metal ions can be colored (i.e., absorb visible light) because d electrons within the metal atoms can be excited from one electronic state to another. The colour of metal ion solutions is strongly affected by the presence of other species, such as certain anions or ligands. For instance, the colour of a dilute solution of copper sulfate is a very light blue; adding ammonia intensifies the colour and changes the wavelength of maximum absorption (λ_{max}).

Organic compounds, especially those with a high degree of conjugation, also absorb light in the UV or visible regions of the electromagnetic spectrum. (Organic solvents may have significant UV absorption; not all solvents are suitable for use in UV spectroscopy. Ethanol absorbs very weakly at most wavelengths.) Solvent polarity and pH can affect the absorption spectrum of an organic compounds.

9. Course Objectives:

The objectives of this course are to:

1. To measure the absorbance of the sample at different wavelengths.
2. To find out the unknown concentration of the sample.
3. Verification of Beer-Lambert's Law.

10. Course Outcomes (COs):

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

1. Record the spectra of different organic compounds.
2. Determine the concentration of KMnO4 and K2Cr2O7 in a mixture.
3. Study the effect of pH on spectra of compounds.
4. to determine the kinetics or rate constant of a chemical reaction

11. List of Experiments

I. UV/Visible spectroscopy

1. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1, cm-1, eV).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

II. Colourimetry

1. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration
2. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.
3. Study the kinetics of iodination of propanone in acidic medium.
4. Determine the amount of iron present in a sample using 1,10-phenathroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
7. Analyse the given vibration-rotation spectrum of HCl(g)

12. Books Recommended

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

1. Name of the Department : Chemistry						
2. Course Name	Polymer Chemistry	**L**	**T**		**P**	
3. Course Code	09010617	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Introduction and history of polymeric materials , Classification, Functionality and its importance, Kinetics of Polymerization, Crystallization and crystallinity, Nature and structure of polymers, Determination of molecular weight of polymers, Glass transition temperature (Tg) and determination of Tg, Polymer Solution and properties of the polymers.

9. Course Objectives:

1. To gain the basic knowledge of polymer science
2. To develop synthetic skills of polymeric product

10. Course Outcomes (COs):

The students will achieve

1. basic knowledge of Polymer science
2. The skills for the synthesis of polymeric products with different techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Introduction and Functionality of polymeric materials**

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of polymers. Nature and structure of polymers-Structure Property relationships. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Kinetics of Polymerization and crystallinity**

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Molecular weight, Glass transition temperature (Tg) and determination of Tg, Polymer Solution**

Determination of molecular weight of polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance.

Polydispersity index. Glass transition temperature (Tg) and determination of Tg: Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Unit – 4	**Number of lectures = 14**	**Title of the unit: Properties of Polymers**

Properties of Polymers (Physical, thermal, flow & mechanical properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

12. Books Recommended

1. Seymour, R.B. & Carraher, C.E. Polymer Chemistry: An Introduction, Marcel
2. Dekker, Inc. New York, 1981.
3. Odian, G. Principles of Polymerization, 4th Ed. Wiley, 2004.
4. Billmeyer, F.W. Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971.
5. Ghosh, P. Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
6. Lenz, R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.

1. Name of the Department: Chemistry						
2. Course Name	Polymer Chemistry Lab		**L**	**T**		**P**
3. Course Code	09010618		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 0	**Tutorials = 0**	**Practical = 52**

8. Course Description:

Experiments in this class are broadly aimed at acquainting students with the range of properties of polymers, methods of synthesis, purification and characterization including instrumental techniques such as IR, DSC, etc. Some examples of laboratory work include solution polymerization of styrene (St), Interfacial polymerization: polyester preparation, Redox polymerization of acrylamide, Precipitation polymerization of acrylonitrile, Determination of molecular weight by viscometry, Testing of mechanical properties of polymers.

9. Course Objectives:

1. To gain the basic knowledge of polymer synthesis
2. To develop synthetic skills of purification and characterization of polymers.

10. Course Outcomes (COs):

Students will be able

1. To synthesize polymeric compounds
2. To characterize polymeric compounds by using different methods.

11. List of Experiments: (Student has to perform ten experiments)

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) Acrylic acid (AA).
   a. Purification of monomer
   b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bisisobutylonitrile (AIBN)
2. Preparation of nylon 6,6
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resold resin.
7. Determination of molecular weight by viscometry:
   a. Polyacrylamide-aq.$NaNO_2$ solution
   b. (Poly vinyl proplylidine (PVP) in water
8. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
9. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
10. Determination of hydroxyl number of a polymer using colorimetric method.

11. Estimation of the amount of HCHO in the given solution by sodium sulphite method.
12. Preparation of polyacrylamide and its electrophoresis
12. Books Recommended
1. M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1999.
2. H.R. Allcock, F.W. Lampe & J.E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
3. F.W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
4. J.R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
5. P. Munk & T.M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
7. M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford University Press (2005).
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

1. Name of the Department: Chemistry						
2. Course Name	Organometallics,bioinorganic chemistry, polynuclear hydrocarbons and UV, IR spectroscopy		**L**	**T**	**P**	
3. Course Code	09010619		4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Chemistry of 3d metals, Organometallic Compounds, Bio-Inorganic Chemistry, Polynuclear and heteronuclear aromatic compounds, Active methylene compounds, Application of Spectroscopy to Simple Organic Molecule.

9. Course Objectives:

The objectives of this course are to:

1. Introduce the knowledge of organic and inorganic chemistry
2. Introduce the knowledge of spectroscopic applications.

10. Course Outcomes (COs):

The students will acquire knowledge of

1. Applications of Inorganic and organic chemistry including spectroscopic techniques.
2. Applications organometallics,chemistry of 3d metals and bio inorganic chemistry.

11. Unit wise detailed content

Unit-1	**Number of lectures = 14**	**Title of the unit: Chemistry of 3d metals and Organometallic Compounds**

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, K2Cr2O7, KMnO4, K4[Fe(CN)6], sodium nitroprusside, [Co(NH3)6]Cl3, Na3[Co(NO2)6].

Definition and Classification with appropriate examples based on nature of metalcarbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

Unit – 2	**Number of lectures = 12**	**Title of the unit: Bio-Inorganic Chemistry**

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na+, K+ and Mg2+ ions: Na/K pump; Role of Mg2+ ions in energy production and chlorophyll. Role of Ca2+ in blood clotting, stabilization of protein structures and structural role (bones).

Unit – 3	**Number of lectures = 12**	**Title of the unit: Polynuclear, heteronuclear aromatic compounds, and Active methylene compounds**

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole, Thiophene, and Pyridine.

Preparation: Claisen ester condensation. Keto-enol tautomerism.

Reactions: Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).

Unit – 4	Number of lectures = 14	Title of the unit: Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α,β – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

12. Books Recommended

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
4. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.
5. R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall.
6. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
7. dvanced Organic Chemistry, S. Chand.

1. Name of the Department: Chemistry						
2. Course Name	Organometallics, bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR spectroscopy Lab		**L**	**T**	**P**	
3. Course Code	09010620		0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

This course provides students with practical experience of the techniques used in basic inorganic and organic chemistry. Some examples of the experiment are Separation of mixtures by paper chromatography, Preparation of the complexes and measurement of their conductivity, Qualitative Organic Analysis of Organic Compounds.

9. Course Objectives:

To develop the qualitative technique skills in students including preparation of the metal complexes, chromatographic separation.

10. Course Outcomes (COs):

The students will acquire knowledge of

1. preparation and purification of metal complexes by using chromatographic separation techniques
2. Qualitative Organic Analysis of Organic Compounds

11. List of Experiments: (Student has to perform any ten experiments)

1. Separation of mixtures by chromatography: Measure the *Rf* value in each case. (Combination of two ions to be given)
   a. Paper chromatographic separation of Fe3+, A13+ and Cr3+ or
   b. Paper chromatographic separation of Ni2+, Co2+, Mn2+ and Zn2+
2. Preparation of any two of the following complexes and measurement of their conductivity:
   a. tetraamminecarbonatocobalt (III) nitrate
   b. tetraamminecopper (II) sulphate
   c. potassium trioxalatoferrate (III) trihydrate
3. Compare the conductance of the complexes with that of M/1000 solution of NaCl,MgCl2 and LiCl3.
4. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

12. Books Recommended

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960.

1. Name of the Department: Chemistry						
2. Course Name	Chemistry of main group elements, theories of acids and bases		**L**	**T**		**P**
3. Course Code	09010621		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 52	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course provides students the knowledge of Acids and Bases, General Principles of Metallurgy, *s*- and *p*-Block Elements, Noble gases, inorganic polymers, etc.

9. Course Objectives:

The objectives of this course are to:

1. Introduce the knowledge of acids, bases and Metallurgy
2. Introduce the knowledge of *s*- and *p*-Block Elements, Noble gases and inorganic polymers.

10. Course Outcomes (COs):

Students will gain an understanding of:

1. Acids, bases, *s*- and *p*-Block Elements, Noble gases and inorganic polymers
2. General Principles of Metallurgy and their applications

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Acids, Bases and General Principles of Metallurgy**

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept),applications of HSAB process.

Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents. Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, van Arkel-de Boer process, Parting Process, Mond's process and Kroll Process.

Unit - 2	**Number of lectures = 13**	**Title of the unit: *s*- and *p*-Block Elements**

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electro negativity (Pauling scale). General characteristics of *s*-block metals like density, melting and boiling points, flame colour and reducing nature. Oxidation states of *s*- and *p*-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S. Complex forming tendency of *s* block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals. Solutions of alkali metals in liquid ammonia and their properties. Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of *s*-block metals.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Structure, bonding ,properties and Applications**

Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever

applicable: Diborane and concept of multicentre bonding, hydrides of Groups 13 (BH_3), 14, 15, 16 and 17.

Oxides of N and P, Oxoacids of P, S and Cl. Halides and oxohalides of P and S (PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2) .Interhalogen compounds. A brief idea of pseudohalides

Unit – 4	**Number of lectures = 14**	**Title of the unit: Noble gases and Inorganic Polymers**

Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF_2, XeF_4 and XeF_6 ,bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory. Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in $(NPCl_2)_3$.

12. Books Recommended

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
6. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
7. Atkin, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

1. Name of the Department: Chemistry						
2. Course Name	Chemistry of main group elements, theories of acids and bases Lab		**L**	**T**		**P**
3. Course Code	09010622		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

This course provides students with practical experience of the techniques of analysis of quantitative data. It is addressed to students who have little or no experience of using quantitative data and it aims to enable students to develop an understanding of basic and intermediate quantitative chemical analysis methods and the ability to use these methods. This course includes iodimetric and gravimetric titrations by considering the example of date to date life.

9. Course Objectives:

To develop quantitative technique skills in students.

10. Course Outcomes (COs):

Students will gain an understanding of:

1. the application of analytical methods based on titrations such iodometric, gravimetric, and isolation, separations methods, etc
2. solving most important problems of quantitative analysis
3. Applications of the quantitative analysis in daily life.

11. List of experiments

1. Iodometric estimation of potassium dichromate and copper sulphate
2. Iodimetric estimation of antimony in tartaremetic
3. Estimation of amount of available chlorine in bleaching powder and household bleaches
4. Estimation of iodine in iodized salts.
5. Iodimetric estimation of ascorbic acid in fruit juices.
6. Estimation of dissolved oxygen in water samples.
7. Gravimetric estimation of sulphate as barium sulphate.
8. Gravimetric estimation of aluminium as oximato complex
9. Preparation of the following: potash alum, chrome alum, tetraamminecopper(II) sulphate monohydrate, potassium trioxalatoferrate(III) any two, including one double salt and one complex).

12. Books Recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

1. Name of the Department : Chemistry						
2. Course Name	Basic Analytical Chemistry	**L**		**T**	**P**	
3. Course Code	09010526	2		0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 26	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course provides students with practical experience of analytical chemistry. Some of the examples of the experiments are soil, water, food product, and cosmetic analysis. Chromatographic and instrumental techniques will also be practiced.

9. Course Objectives:

1. To develop analytical and chromatographic skills
2. To develop instrumental technique skills in students.

10. Course Outcomes (COs):

1. The students will gain an understanding of application of analytical methods in day to day life such soil, water, food product and cosmetic analysis.
2. The students will gain hands-on practices on chromatographic and instrumental techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Introduction to Analytical Chemistry**

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures. Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

b. Analysis of preservatives and colouring matter.

c. Analysis of cosmetics: Major and minor constituents and their function

Unit – 2	**Number of lectures = 13**	**Title of the unit: Analysis of water and food products**

1. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
2. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide,
3. Zinc oxide and Calcium carbonate by complexometric titration.
4. To study the use of phenolphthalein in trap cases.
5. To analyze arson accelerants.
6. To carry out analysis of gasoline.

7. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry
8. Determination of pH, acidity and alkalinity of a water sample.
9. Determination of dissolved oxygen (DO) of a water sample.
10. Determination of pH of soil samples.
11. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

12. Books Recommended

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
3. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
4. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
5. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
6. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

1. Name of the Department : Chemistry						
2. Course Name	Fuel Chemistry	**L**	**T**		**P**	
3. Course Code	09010527	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 26		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course includes study of energy sources (renewable and nonrenewable) which includes fuels, coal, gasification and liquefaction techniques, Petroleum and its applications in industries, and lubricants.

9. Course Objectives:

Objectives of this course are to:

1. Make the students aware of the renewable and non-renewable energy sources.
2. To build up knowledge of the concepts and theories of fuel chemistry.
3. To be familiar with the fundamental physical and chemical principles regarding formation and control of air pollutants in industrial and technological processes.
4. Give students an awareness of the Petroleum and Petrochemical Industry applications.

10. Course Outcomes (COs):

At the end of the course, students should be able to:

1. Identify and characterize various renewable and non-renewable energy sources.
2. Develop an understanding of the Petrochemical Industry applications.
3. Use techniques such as coal liquefaction, solvent refining and gasification, etc.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Fuels and Coal**

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses.Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Petroleum and Lubricants**

Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. Classification of lubricants, lubricating oils (conducting and nonconducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

12. Books Recommended

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

1. Name of the Department: Chemistry						
2. Course Name	Chemical Technology & Society		**L**		**T**	**P**
3. Course Code	09010528		2		0	0
Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = 26	**Tutorials = 0**		**Practical = 0**			

8. Course Description:

This course will introduce students to basic principles of chemical technology. Important processes and equipment employed will be described. Students will also be familiarized with how processes finalized in the Research and Development Laboratories are scaled up in pilot plants and plants.

Scientific literacy will be inculcated in order to gain a better understanding of complex environmental issues that face the modern world, *e.g.*, air and water pollution, energy from natural sources, impact of nuclear fission, impact of genetic engineering and manufacture of drugs.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to basic principles of chemical technology
2. Explain important processes employed in chemical technology, *e.g.*, distillation, solvent extraction, solid-liquid leaching etc.
3. Familiarize students with special equipment needed in chemical technology, *e.g.*, reactors, distillation columns, pumps etc.
4. Familiarize students with principles of clean technology
5. Discuss societal and technological issues from a chemical perspective
6. Induce scientific literacy to understand interdisciplinary issues, *e.g.*, are and water pollution, energy from natural sources, drugs manufacture and genetic engineering etc.

10. Course Outcomes (COs):

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

1. Explain basic principles of chemical technology
2. Explain key processes used in chemical technology
3. Identify key equipment employed in chemical technology
4. Understand clean technology
5. Attain understanding of complex societal and technological issues from a scientific viewpoint

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Chemical Technology**

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Society**

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels

and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.
13. Books Recommended
1. John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed.

1. Name of the Department: Department of Chemistry						
2. Course Name	Pharmaceutical Chemistry	**L**	**T**		**P**	
3. Course Code	09010529	2	0		0	
Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals.		
Lectures = 26	**Tutorials = 0**	**Practical = 0**

8. Course Description:

The search for new drugs to treat serious diseases such as cancer, heart disease and bacterial and viral infections remains at the forefront of cutting edge medical research. There is a demand in the pharmaceutical industry graduates with a strong background in organic chemistry, mixed with a broad understanding of pharmacology and related biochemical areas. This course offers the opportunity to study subjects allied to medical and pharmaceutical industries.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to drug discovery, design and development
2. Introduce students to basic retrosynthetic approach
3. Familiarize students with synthesis of representative drugs of classes, *e.g.*, analgesic agents, antipyretic agents, anti-inflammatory agents, antibiotics etc.
4. Explain aerobic and anaerobic fermentation and its use in production of selected products.
5. To provide hands-on experience in synthesis if aspirin and antacid.

10. Course Outcomes (COs):

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

1. Understand drug discovery, design and development
2. Recognize representative classes of drugs, *e.g.*, analgesic agents, antipyretic agents, antibiotics etc.
3. Explain the production of selected drugs and Vitamins *via* the fermentation process.

11. Unit wise detailed content

Unit-1	**Number of lectures = 20**	**Title of the unit: Drugs & Pharmaceuticals**

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Aerobic and anaerobic fermentation. Production of Ethyl alcohol and citric acid, Antibiotics: Penicillin, Cephalosporin, Chloromycetin and Streptomycin, Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C

12. List of Experiments	**Number of lectures = 06**

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

13. Books Recommended

1. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK.
2. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L.,Lemke , David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi

1. Name of the Department : Chemistry						
2. Course Name	Chemistry of Cosmetics & Perfumes		**L**	**T**		**P**
3. Course Code	09010530		2	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 26		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course provides training in chemistry with applications in perfumery and cosmetic science. You will have an integrated learning experience where you will build a strong chemistry foundation and apply your knowledge in specific applications using your senses.

9. Course Objectives:

The objectives of this course are to:

1. Understand the science behind Perfumes and Cosmetics.
2. To understand the various safety testing methods to evaluate the quality of the products.
3. To understand the preparation methods of various Perfumes and Cosmetics.

10. Course Outcomes (COs):

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

1. To discover social and scientific concepts of human beauty
2. To deliver the safety of cosmetics and perfumes.
3. To deliver the history and science of cosmetics and perfumes.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit:** Chemistry of Cosmetics & Perfumes

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

12. List of experiments | **Number of lectures = 11**

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

13. Books Recommended

1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House,Meerut (1996).

1. Name of the Department : Department of Chemistry						
2. Course Name	Pesticide Chemistry	**L**	**T**		**P**	
3. Course Code	09010531	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = 26		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course provides training in chemistry with applications in perfumery and cosmetic science. You will have an integrated learning experience where you will build a strong chemistry foundation and apply your knowledge in specific applications using your senses.

9. Course Objectives:

The objectives of this course are to:

1. Understand the science behind pesticides.
2. Understand the classification of pesticides.
3. Understand the preparation methods of various pesticides.

10. Course Outcomes (COs):

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

1. To deliver the usage of pesticides.
2. To deliver the importance of pesticides.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit:** Pesticide Chemistry

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

12. List of experiments	**Number of lectures = 11**

1. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates

13. Books Recommended

1. Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.
2. Ohkawa.H, Miyagawa.H and Lee.P.W. Pesticide chemistry,Wiley-VCH verlag Gmbh & Co.2007.

Department of Mathematics

Core Courses:

1. Differential Calculus
2. Differential Equations
3. Real Analysis
4. Algebra

Discipline Specific Elective Courses

1. Matrices
2. Calculus Without Limits
3. Probability & Statistics
4. Numerical Methods
5. Integral Calculus
6. Elementary Inference

Skill Enhancement Courses:

1. Special Function & Integral Transform
2. Linear Algebra
3. Vector Calculus
4. Operations Research
5. Complex Analysis
6. Computer Fundamentals

1. Name of the Department: Mathematics						
2. Course Name	Differential Calculus	**L**	**T**		**P**	
3. Course Code	09010117	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course is designed to develop the topics of differential calculus. Emphasis is placed on limits, continuity, derivatives. Upon completion, students should be able to select and use appropriate models and techniques for finding solutions to derivative-related problems with and without technology.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. Learn to find and use limits of functions,
2. Apply the Mean Value Theorem.
3. Find intervals of concavity and points of inflection of elementary algebraic functions and trigonometric functions.
4. Find Curvature and Asymptotes.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to evaluate various limi& continuity problem, Curvature, Mean value theorems and applications of Partial Differential equations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Continuity and Differentiation**

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, nth differentiation of functions, Leibnitz's theorem.

Unit – 2	**Number of lectures = 9**	**Title of the unit: Asymptote and Curve Tracing**

Asymptotes in Cartesian coordinates, Asymptotes in polar coordinates, Oblique Asymptotes, Concavity, Convexity & Points of Inflexion, Tangents and normal Curvature, Singular points, Tracing of curves in Cartesian, Parametric and polar co-ordinates

Unit – 3	**Number of lectures = 9**	**Title of the unit: Mean Value Theorems**

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, e^x , log(1+x), $(1+x)^m$, Maxima and Minima, Indeterminate forms.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Curvature**

Curvature, radius of curvature for Cartesian Curves, Parametric curves, polar curves, Newton's method. Radius of Curvature for pedal curves. Tangential polar equation, Center of curvature. Circle of curvature. Chord of curvature, Evolutes.

Unit – 5	**Number of lectures = 8**	**Title of the unit: Partial Differentiation**

Partial differentiation, Euler's theorem on homogeneous functions, Differentiability of functions of two variables, Change of variables, Taylors theorem for two variables, Composite functions and Implicit & explicit functions, Total differentials.

12. Books Recommended

1. Shanti Narayan: Differential and Integral Calculus.
2. Murray R.Speigel: Theory and Problems of Advanced Calculus, Schaum's Outline series, Schaum Publishing Co., New York.
3. N. Piskunov: Differential and Integral Calculus, Peace Publishers, Moscow.
4. Gorakh Prasad: Differential Calculus, Pothishasla Pvt. Ltd. Allahabad.
5. Gorakh Prasad: Integral Calculus, Pothishasla Pvt. Ltd. Allahabad

1. Name of the Department: Mathematics						
2. Course Name	Differential Equations	**L**	**T**		**P**	
3. Course Code	09010216	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**		**Practical = 0**		

8. Course Description:

Differential equations and their solutions. Linear Differential equation. Homogeneous Differential Equations. Second order linear differential equations. Total differential equations.

9. Course Objectives:

To introduce the basic concept of Differential equations and their solutions. Strength of these concepts in engineering and real world problems will be highlighted.

10. Course Outcomes (COs):

1. Differential Equations are used in many models to determine how the state of model is changing regarding time or any other variable.
2. Its application is inevitably based on mathematical theories of reality

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the Unit: Introduction to Differential Equations**

Order and degree of a differential equation, Linear & Non-Linear Differential equation, Homogeneous equations, Geometrical meaning of DE, Exact DE, Integrating factors, First order higher degree equations solvable for x,y,p, Lagrange's equation, Clairaut's equations, Equations reducible to Clairaut's form, Singular solutions

Unit - 2	**Number of lectures = 8**	**Title of the unit: Orthogonal Trajectories and Homogeneous DE**

Orthogonal trajectories in Cartesian coordinates and polar coordinates, Self orthogonal family of curves, Linear DE with constant coefficients, Homogeneous linear ODE, Equations reducible to homogeneous

Unit - 3	**Number of lectures = 8**	**Title of the unit: Linear DE and Non-homogeneous DE**

Linear DE of second order: Reduction to normal form, Transformation of the equation by changing the dependent variable/independent variable, Solution by operators of non-homogeneous linear DE, Reduction of order of a DE

Unit - 4	**Number of lectures = 9**	**Title of the unit: Named Methods to solve DE and Solutions of Simultaneous DE**

Method of variations of parameters, Method of undetermined coefficients, Ordinary simultaneous DE, Solution of simultaneous DE involving operators x (d/dx) or t (d/dt) etc, Simultaneous equation of the form dx/P=dy/Q=dz/R .

Unit - 5	**Number of lectures = 8**	**Title of the unit: Total DE and their methods to solve**

Total DE, Condition for Pdx+Qdy=Rdz=0 to be exact, General method of solving Pdx+Qdy+Rdz=0 by taking one variable constant, Method of auxiliary equations

12. Books Recommended

1. D.A. Murray: Introductory Course in Differential Equations. Orient Longaman (India), 1967
2. A.R.Forsyth: A Treatise on Differential Equations, Machmillan and Co. Ltd. London
3. E.A. Codington: Introduction to Differential Equations.
4. S.L.Ross: Differential Equations, John Wiley & Sons
5. B.Rai and D.P. Chaudhary: Ordinary Differential Equations; Narosa, Publishing House Pvt. Ltd

1. Name of the Department: Mathematics						
2. Course Name	Real Analysis	**L**	**T**		**P**	
3. Course Code	09010316	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**			**Practicals: 0**	

8. Course Description:

Real analysis is a large field of mathematics based on the properties of the real numbers and the ideas of sets, functions, and limits. Topics covered are: Countable and uncountable sets, the real numbers and their properties, least upper bounds, the Archimedean property and completeness, sequences of real numbers, convergence, subsequences, and Cauchy sequences. Bolzanno-Weierstrass property and compactness, Limit, Continuous functions and their properties, the Riemann integral and its properties, the fundamental theorem of calculus, convergence of sequences and series of functions etc.

9. Course Objectives:

The objective of this course are:

1. Define the real numbers, least upper bounds,
2. Define Bolzano –Weirstrass theorem and Cauchy criteria.
3. Define functions between sets; equivalent sets; finite, countable and uncountable sets. Recognize convergent, divergent, bounded, Cauchy and monotone sequences.
4. Calculate the limit superior, limit inferior, and the limit of a sequence.
5. Recognize alternating, convergent, conditionally and absolutely convergent series.
6. Apply the ratio, root and limit comparison tests.
7. Define metric and metric space, subsets of a metric space are open, closed, connected, bounded.
8. Determine if a function on a metric space is discontinuous, continuous, or uniformly continuous.

10. Course Outcomes (COs):

On successful completion of this course, students will be able to:

1. describe fundamental properties of the real numbers that lead to the formal development of real analysis.
2. define convergence of series using the Cauchy criterion and use the comparison, ratio, and root tests to show convergence of series.
3. define continuity; state, prove, and use properties of limits of continuous functions, including the fact that continuous functions attain extreme values on compact sets.
4. demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
5. construct rigorous mathematical proofs of basic results in real analysis.
6. state the Fundamental Theorem of Calculus and use it in proofs.
7. construct the Riemann Integral and state its properties.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Real Number System**

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, completeness property of R, Archimedean property of R, intervals, Boundedness of the set of Real

numbers, Least upper bound and Greatest lower bound of a set, Neighborhoods, interior points and isolated points, Limit points, open sets, closed sets, Interior of a set, Closure of a set in Real numbers and their properties, Bolzano-Weierstrass theorem.

Unit - 2	Number of lectures = 8	Title of the unit: Sequences

Sequences: Real sequences and their convergence, Subsequences, Theorem on limits of sequences, Divergent sequence, Bounded sequence, Monotonic sequence, Monotone convergence theorem, Cauchy's sequence, Cauchy general principle of convergence.

Unit - 3	Number of lectures = 8	Title of the unit: Infinite Series

Infinite series: Convergence and divergence of infinite series, Comparison tests of positive term infinite series, Cauchy's general principle of convergence of series, Convergence and divergence of geometric series, Auxiliary series or p-series, D-Alembert's ratio test, Rabbe's Test, Logarithmic Test, De Morgan and Bertrand's Test, Cauchy n^{th} Root Test, Gauss Test, Cauchy Integral test, Cauchy's condensation test, Alternating series: Leibnitz's Test, absolute and conditional convergence, Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test.

Unit – 4	Number of lectures = 8	Title of the unit: Metric Spaces

Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle.

Unit-5	Number of lectures = 8	Title of the unit: Riemann integral

Riemann integral, Integrabililty of continuous and monotonic functions, The Fundamental theorem of integral calculus, Mean value theorems of integral calculus.

12. Books Recommended

1. P.K. Jain and Khalil Ahmed: Metric spaces, 2nd Ed., Narosa, 2004
2. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
3. R.R. Goldberg: Real Analysis Oxford & IBH publishing Co., New Delhi, 1970
4. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
5. R.R. Goldberg: Real Analysis Oxford & IBH publishing Co., New Delhi, 1970
6. D. Somasundaram and B. Choudhary: A First Course in Mathematical Analysis, Narosa Publishing House,New Delhi, 1997

1. Name of the Department: Mathematics						
2. Course Name	Algebra	**L**	**T**		**P**	
3. Course Code	09010414	5	1		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course covers properties of groups, permutation groups, cyclic groups, Lagrange's Theorem, subgroups, normal subgroups, quotient groups, external direct product of groups, homomorphism and isomorphism of groups, and introduction to rings and fields.

9. Course Objectives:

This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups, rings, fields and some related structures. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

10. Course Outcomes (COs):

Upon completion of the course, students will be able to:

1. Demonstrate knowledge and understanding of groups, subgroups, and order of an element in finite groups.
2. Demonstrate knowledge and understanding of the concept of cosets of a subgroup of a group, normal subgroups, symmetric groups, cyclic groups and their properties.
3. Demonstrate knowledge and understanding of direct product of groups, quotient groups, group homomorphism and isomorphism.
4. Demonstrate knowledge and understanding of rings, subrings, integral domains, fields, Euclidean ring and unique factorization domain.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Groups, Subgroups and Cyclic groups**

Definition of a group with example and simple properties of groups, Subgroups and Subgroup criteria, Generation of groups, cyclic groups

Unit – 2	**Number of lectures = 8**	**Title of the unit: Cosets and Normal Subgroups**

Cosets, Left and right cosets, Index of a sub-group Coset decomposition, Largrage's theorem and its consequences, Normal subgroups, Quotient groups

Unit – 3	**Number of lectures = 8**	**Title of the unit: Homomorphism and Automorphism**

Homomorphisms, isomophisms, automorphisms and inner automorphisms of a group. Automorphisms of cyclic groups

Unit – 4	**Number of lectures = 8**	**Title of the unit: Permutations and Alternating groups**

Permutations groups. Even and odd permutations. Alternating groups, Cayley's theorem, Center of a group and derived group of a group.

Unit – 5	**Number of lectures = 10**	**Title of the unit: Rings, Integral Domain & Fields**

Introduction to rings, subrings, integral domains and fields, Characteristics of a ring. Ring homomorphisms, ideals (principle, prime and Maximal) and Quotient rings, Field of quotients of an

integral domain. Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion, Polynomial rings over commutative rings, Unique factorization domain, R unique factorization domain implies so is R[X1 , X2……Xn]

12. Books Recommended

1. N Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. Joseph A. Gallian, Contemporary Abstract Algebra, 4th, Narosa Publishing House, 1999.
3. B. Bhattacharya, S.K. Jain and S.R. Nagpal : Basic Abstract Algebra (2nd edition)
4. A Text Book of Modern Abstract Algebra, Shanti Narayan
5. S.Luther and I.B.S. Passi : Algebra, Vol. II, Narosa Publishing House.
6. John B. Fraleigh, A First course in Abstract Algebra, 7th, Pearson, 2002.

1. Name of the Department : Mathematics						
2. Course Name	Matrices	**L**	**T**		**P**	
3. Course Code	09010523	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**		**Practical = 0**		

8. Course Description:

The course covers the concepts of matrices. This course covers the types of matrices and Rank of matrices. This course also covers the some basic concepts and examples(R, R^2, R^3 as vector spaces over R)of vector spaces.

9. Course Objectives:

The objective of this course is to make the students able to understand matrices and properties of matrices. It also makes the students able to solve system of linear equations (Both Homogeneous and Non Homogeneous).

10. Course Outcomes (COs):

1. Students in this course will demonstrate ability to work with matrices.
2. Students in this course will demonstrate ability to solve system of linear equations.
3. Students in this course will come to know about some basic examples of vector spaces.
4. Students in this course will demonstrate ability to work with Bilinear and quadratics forms of matrices.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Vector Spaces**

R, R^2, R^3 as vector spaces over R, Standard basis for each of them, Concepts of Linear Independence and examples of different bases, Subspaces of R^2 and R^3

Unit – 2	**Number of lectures = 8**	**Title of the unit: Basic Geometric Transformations**

Translation, Dilation, Rotation, Reflection in a point, line and plane, Matrix form of basic geometric transformations, Interpretation of Eigen values and Eigen vectors for such transformations and Eigen spaces as invariant subspaces.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Matrices**

Algebra of matrices, Types of matrices e.g. Symmetric & Skew- Symmetric matrices, Hermitian ,Skew-Hermitian matrices, Unitary and orthogonal matrices, Nilpotent and Involutary matrices, Eigen values, eigenvectors of matrices, Characteristic Equation of a matrix, Minimal polynomial of a matrix, Cayley Hamilton Theorem and its use in finding inverse of a matrix.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Rank of Matrices**

Elementary operations on matrices, Rank of matrices ,inverse of matrices, Linear dependence and Linear independence of rows and columns, Homogeneous and non Homogeneous system of linear equations, Application of matrices to a system of linear equations with number of variables & equation upto 4, Theorems on consistency of a system of linear equation

Unit – 5	Number of lectures = 8	Title of the unit: Normal form, Quadratic and Bilinear form of matrices
Reduction to normal form of a matrix, Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3, Bilinear and Quadratic forms of matrices		

12. Books Recommended

1. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984
2. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989

1. Name of the Department Mathematics						
2. Course Name	Calculus Without Limit	**L**	**T**		**P**	
3. Course Code	09010524	**5**	**1**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course is designed to develop the topics of Differential and Integral Calculus. Emphasis is placed on limit, Continuity, Derivative and integral of algebraic and Transcendental function.

9. Course Objectives:

The current Standard for the Calculus Curriculum is failure in many aspect .We try to present it with modern standard of Mathematical rigor.

10. Course Outcomes (COs):

After Completion of the Course the Student will be able to interpret a function from an Algebraic, Numeric. Graphical. Also we expects Students to have a reasonable mastery.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Brief History of Background and Geometric Numeric**

How and Why Europeans misunderstood Indian Airthemetic, Fibonacci and Florentine law, Zero, Surd, Fractions Misunderstanding of Trigonometry and Conceptual confusion, Measurement of an angles through arcsin radians ,Trigonometric values: past and present: progress or regress ?,Finite differences vs derivatives : chord vs tangent .,Error and myth of perfection. ,Zeroism.

Unit - 2	**Number of lectures = 8**	**Title of the unit: Differential Equations Basics**

Relation between values and differences, The fundamental theorem of calculus, Proportionality relation between sine and cosine ,.Differential equations vs difference equations. Using calcode , Aryabhatta - Euler method

Unit - 3	**Number of lectures = 8**	**Title of the unit: Application of Ordinary Differential Equation**

Problems of Newtonian Physics , Example problems: The amplitude dependence of the time period of the Simple pendulum , Jacobian Elliptic Functions , Solving 2-body problem of Newtonian Gravitation, Trajectory problems , Examples of chaotic motion and few more

Unit - 4	**Number of lectures = 10**	**Title of the unit: Symbolic Manipulation and Number System with Limit**

Introducing Maxima and using it for symbolic manipulation, Evaluating symbolic derivatives, integrals and elliptic integrals. Origin of formal real numbers, Dedekind cuts ,Problem of Cantorian and naïve set theory Russell paradox ,Limits and Cauchy sequences ,Archimedean ordered field ,Obtaining limits by discarding infintesimals Computers and floating point numbers ,Extended precision

Unit - 5	**Number of lectures = 6**	**Title of the unit: Higher Order Polynomial interpolation**

Brahma Gupta, Vateshwar - Stirling Formula and quadratic interpolation Runga kutta and higher order polynomial interpolation, Accelerating convergence.

12. Books Recommended

1. C.K. Raju, 'Cultural foundations of mathematics: the nature of mathematical proof and the transmission of calculus from India to Europe in the 16thCentury, CE, Pearson Longman, 2007.
2. C.K. Raju 'Eternity and infinity: The western understanding of Indian mathematics and its consequences for science today', American Philosophical Association Newsletter on Asian and Asian American Philosophers and Philosophies, 14(2), 27-33, 2015.
3. H. Flanders, R. Korfhage, J. Price, 'Calculus', Academic Press, New York, 1970.
4. D.V. Widder, 'Advanced Calculus', 2nd Ed., Prentice Hall, New Delhi, 1999.
5. W. Rudin, 'Principles of mathematical analysis', Mc Graw Hill, 1964.
6. L. Mendelson, 'Introduction to mathematical logic', van Nostrand Reinhold, New York, 1964.
7. P.R. Halmos, 'Naïve Set Theory', East – West Press, New Delhi, 1972.
8. C.K. Raju, 'Éuclid and Jesus: how and why the church changed mathematics and christanity across two religious wars', Multiversity, Penang, 2012.
9. C.K. Raju, 'Computers, mathematics education, and the alternative epistemology of the calculus in Yuktibhasa', Philosophy east and west, 51(3), pp. 325-361, 2001.
10. C.K. Raju, 'Logic', Encyclopaedia of Non-Western Science, Technology and Medicine, Springer, 2016, pp 2564-2569, 2008.
11. C.K. Raju, 'The religious roots of Mathematics', Theory, Culture and Society, 23(1-2), pp. 95-97, 2006.
12. C.K. Raju, 'Cultural Foundation of Mathematics', Pearson, Longman, 2007.
13. C.K. Raju, 'Zeroism', article in Encyclopedia of Non-western Science, Technology and Medicine, ed. Helaine Celin, Springer, Dordrecht, pp. 4604-4610, 2016.
14. GhadarJari Hai, 2(1), pp. 26-29, 2007.
15. C.K. Raju, 'Teaching Mathematics with a different philosophy, Part 1: Formal mathematics as blased metaphysics', Science and Culture, 77(7-8), pp. 274-279, 2011.
16. C.K. Raju, Calculus without Limits, paper for 2nd people's congress of education, Homi Bhabha Center, Mumbai.

1. Name of the Department: Mathematics						
2. Course Name	Probability & Statistics	**L**	**T**		**P**	
3. Course Code	09010525	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

This course provides a solid undergraduate foundation in both probability theory and mathematical statistics. Topics include: Basics in probability theory, random variables, expectation and variance, special probability distributions.

9. Course Objectives:

1. To develop the skills of the students in the area of Probability and Statistics
2. To expose the students to the basics of probability distributions and application of family of random variables in real life situations
3. Students should understand basic concepts in probability theory and mathematical statistics learn commonly used probability distributions.

10. Course Outcomes (COs):

After successfully completing of this course, students will be able to:

1. Apply the knowledge gained in Probability theory in Medical Sciences, Life Sciences and Engineering fields.
2. Translate real world problems into Probability models

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Probability and Random Variables**

Introduction, random experiment, trial, sample space, events, Definitions of probability, random variables (discrete and continuous type), probability mass function (p.m.f.), probability density function (p.d.f.) and cumulative distribution function (c.d.f.)

Unit - 2	**Number of lectures = 9**	**Title of the unit: Two dimensional Random Variable**

Two dimensional random variables (discrete and continuous type), joint and marginal p.m.f, p.d.f., c.d.f., conditional distributions and independent random variables.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Expectation and generating Function**

Expectation of single and bivariate random variables, moments and moment generating function along with their properties, Conditional expectations.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Discrete Probability Distributions**

Bernoulli, Binomial, Poisson along with their properties.

Unit - 5	**Number of lectures = 8**	**Title of the unit: Continuous Probability Distributions**

Uniform, normal, exponential along with their properties.

12. Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
3. Gupta, S.C. and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2008.

1. Name of the Department: Mathematics						
2. Course Name	Numerical Method	**L**	**T**		**P**	
3. Course Code	09010623	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**		**Practical = 0**		

8. Course Description:

This course analyzed the basic techniques (direct and iterative methods) for the efficient numerical solution of problems in science and engineering. Topics s covered are: Number representation and errors, Polynomials, Locating roots of equations, Solution of nonlinear equations, Interpolation and approximation, Numerical differentiation, Numerical integration, Systems of linear equations, Solution of differential equations

9. Course Objectives:

Many applications in engineering, physics, geology and other specifications containing complicated problems that will require one of the numerical methods to be solved. In this course students will learn the classification of many complicated problems and the suitable numerical methods for obtaining an approximated solution to these problems with desired accuracy.

10. Course Outcomes (COs):

On completion of this course, the students will learn

1. Practical and theoretical knowledge of a range of iterative techniques for solving linear and nonlinear systems of equations
2. Practical and theoretical knowledge of polynomial interpolation,
3. Practical and theoretical knowledge of schemes for numerical integration
4. Practical and theoretical knowledge of schemes for solving differential equations

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Errors & Solution of transcendental and algebraic equations**

Representations of numbers: Roundoff error, truncation error, significant error, error in numerical computations. Bisection, secant, Regula Falsi, fixed-point, Newton-Raphson, Graffe's methods.

Unit-2	**Number of lectures = 8**	**Title of the unit: Interpolation & Approximation**

Difference schemes, interpolation formulas using differences. Lagrange and Newton interpolation. Hermite interpolation. Divided differences, Different types of approximation, least square polynomial approximation.

Unit-3	**Number of lectures = 9**	**Title of the unit: Numerical differentiation & Numerical integration**

Numerical differentiation, Methods based on interpolations, Methods based on finite differences, Numerical integration: Trapezoidal, Simpson's, and Weddle's rules. Gauss Quadrature Formulas

Unit- 4	**Number of lectures = 8**	**Title of the unit: Solution of linear equations**

Direct methods - Gauss elimination, Gauss-Jordan elimination, LU decomposition. Iterative methods - Jacobi, Gauss-Siedel; The algebraic eigenvalue problem: Jacobi's method, Power method.

Unit – 5	Number of lectures = 8	Title of the unit: Numerical Solution of IVP (ODEs)
Ordinary differential equations (ODEs): Euler's method, Single-step methods, Runge Kutta's method, multi-step methods		

12. Books Recommended

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis, Brookes Cole 2004.
2. M.K. Jain, S.R.K. Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age international Publishers, New Delhi, India, 2003.
3. Chapra, S. and R. Canale, Numerical Methods for Engineers. New York: McGraw Hill 1998.
4. BabuRam, Numerical Methods, Pearson Education, 2010

1. Name of the Department						
2. Course Name	Integral Calculus	**L**	**T**		**P**	
3. Course Code	09010624	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 42	**Tutorials = 10**	**Practical = 0**

8. Course Description:

Concept of integration and its application to physical problems such as evaluation of areas, volumes of revolution, force, and work; fundamental formulas and various techniques of integration applied to both single variable and multi-variable functions; tracing of functions of two variable. It is an introduction to the theory and applications of integral calculus of functions of one variable. It includes most of the basic topics of integration on functions of a single real variable: the fundamental theorem of calculus, applications of integrations, and techniques of integration, sequences, and infinite series. The emphasis in this course is on problem solving, not on the presentation of theoretical considerations

9. Course Objectives:

1. Understand the meaning of differentiation and integration.
2. Apply the various methods of calculating derivative of a function.
3. Apply techniques of indefinite and definite integration.

10. Course Outcomes (COs):

1. Calculus is a primary gateway to an engineering and engineering technology
2. Properly carry out integration through the use of the fundamental formulae and/or the various techniques of integration for both single and multiple integral.
3. Correctly apply the concept of integration in solving problems involving evaluation of arc lengths, areas, volumes, work, and force

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Integration Concept/ Formula**

Anti-Differentiation. The Definite Integral, Simple Power Formula, Simple trigonometric Functions, Logarithmic and exponential Functions, Inverse trigonometric Functions, Hyperbolic Functions, General Power Formula, Constant of Integration, Definite Integral

Unit - 2	**Number of lectures = 9**	**Title of the unit: Integration Techniques**

Integration by Parts, Trigonometric Integrals, Trigonometric Substitution, Rational Functions, Rationalizing Substitution, Definite Integrals, Wallis' Formula, Partial fractions

Unit - 3	**Number of lectures = 8**	**Title of the unit: Applications**

Improper Integrals, Plane Area, Arc Length, Areas Between Curves, Centroids, Moments of Inertia, Volumes, Work, Hydrostatics Pressure and Force.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Surface Multiple Integral as Volume**

Surface Tracing: Planes, Spheres, Cylinders, Quadratic Surfaces, Double Integrals, Triple Integral

Unit - 5	**Number of lectures = 8**	**Title of the unit: Application**

Integral as limit of a sum. Fundamental Theorem of Calculus. Properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.
12. Books Recommended
1. Yuri A. Brychkov (Ю. А. Брычков), Handbook of Special Functions: Derivatives, Integrals, Series and Other Formulas. Russian edition, Fiziko-Matematicheskaya Literatura, 2006. English edition, Chapman & Hall/CRC Press, 2008 2. Richard Courant: Differential And Integral Calculus, Vol. 2 3. Martin Braun : Differential Equations and Their Applications 4th Ed.

1. Name of the Department: Mathematics						
2. Course Name	Elementary Inference	**L**	**T**		**P**	
3. Course Code	09010625	5	1		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 10**	**Practical = 0**			

8. Course Description:

This course introduces students to the basic theory behind the development and assessment of statistical analysis techniques in the areas of point and interval estimation, as well as hypothesis testing.

Topic includes: Point estimation and interval methods, including method of moments and maximum likelihood, unbiasedness, consistency, efficiency and sufficiency, hypothesis testing methods and related confidence interval.

9. Course Objectives:

The objective of the course are to:

1. Familiar the students about method of maximum likelihood and the properties of good estimators.
2. Familiar the students with the concept of statistical inference, point and interval estimation, hypothesis testing under a large variety of discrete and continuous probability models.
3. Familiar the students about ANOVA

10. Course Outcomes (COs):

Upon successful completion of this course the students are able to perform the following:

1. How to apply discrete and continuous probability distributions to various business problems.
2. Perform Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases.
3. Learn non-parametric test such as the Chi-Square test for Independence as well as Goodness of Fit.
4. Perform ANOVA and F-test

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Estimator and their properties**

Parameter and statistic, sampling distribution and standard error of estimate. Point and interval estimation, Unbiasedness, Efficiency, Consistency and Sufficiency.

Unit - 2	**Number of lectures = 9**	**Title of the unit: Basic of Hypothesis and Method of Estmation**

Method of maximum likelihood estimation. Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Types of errors, Neyman- Pearson Lemma.

Unit - 3	**Number of lectures = 8**	**Title of the unit: Large Sample Test**

Testing and interval estimation of a single mean, single proportion, difference between two means and two proportions.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Small Sample Test**

Definition of Chi-square statistic, Chi-square tests for goodness of fit and independence of attributes.

Definition of Student's't' and Snedcor's F-statistics. Testing for the mean and variance of univariate normal distributions, Testing of equality of two means and two variances of two univariate normal distributions. Related confidence intervals.

Unit - 5	Number of lectures = 8	Title of the unit: ANOVA

Analysis of variance (ANOVA) for one-way and two-way classified data.

12. Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Gupta, S.C. and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2008.
3. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the theory of Statistics, McGraw Hill, 1974.
4. A.M. Goon, M.K. Gupta, and B. Das Gupta, Fundamentals of Statistics, Vol-II.
5. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics.

1. Name of the Department: Mathematics						
2. Course Name	Special Function and Integral Transform	**L**	**T**		**P**	
3. Course Code	09010626	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practicals: 0**

8. Course Description:

Integral transforms and special functions belong to the basic subjects of mathematical analysis, the theory of differential and integral equations and to many other areas of mathematics.

9. Course Objectives:

These subjects are under intense development, for use in pure and applied mathematics, engineering and computer science.

The main use of Integral Transforms and Special Functions is to further growth by providing a means for the publication of important research.

10. Course Outcomes (COs):

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

1. To solve Linear Differential Equations using Power-Series Methods
2. To learn Special functions like Legendre, Bessel, Chebyshev functions.
3. To know how root finding techniques can be used to solve practical engineering problems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Beta and Gamma function**

Series solution of Des-Power series method, Definitions of Beta and Gamma functions, Bessel equation and its solution.

Unit – 2	**Number of lectures = 7**	**Title of the unit: Bessel function**

Bessel functions and their properties, Relations and generating functions, Orthogonality of Bessel functions.

Unit – 3	**Number of lectures =10**	**Title of the unit: Recurrence relations and generating functions**

Legendre and Hermite DEs and their solutions ,Legendre and Hermite functions and their properties, Recurrence relations and generating functions, Orthogonality of Legendre and Hermite polynomials, Rodrigues' formula for Legendre and Hermite polynomials, Lapalace integral representation of Legendre polynomial.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Laplace transforms and Application**

Laplace transforms, Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting theorems, Convolution theorem, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Inverse Laplace transforms, Solution of ODEs using Laplace transform.

Unit – 5	**Number of lectures = 7**	**Title of the unit: Fourier transforms**

Fourier transforms-Linearity property, Shifting, Modulation, Convolution Theorem, Fourier transform of derivatives, Relations between Fourier transform and Laplace transform, Parseval's Identity for Fourier transforms, Solution of DEs using Fourier Transforms.
12. Books Recommended
1. Advanced Engineering Mathematics: R.K. Jain and S.R.K. Iyengar Narosa Publishing House 2. Advanced Engineering Mathematics: Erwin Kreyszig- Wiley Publications 3. Higher Engineering Mathematics: B.S. Grewal-Khanna Publications

1. Name of the Department: Mathematics						
2. Course Name	Linear Algebra	**L**	**T**		**P**	
3. Course Code	09010602	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course covers the basic concepts of Linear Algebra. This course covers the concept of Vector spaces, Basis and Dimension of vector spaces, Quotient spaces etc. It also covers Linear Transformations and algebra of linear transformations. This course also covers the concepts of Inner product spaces.

9. Course Objectives:

The Objective of this course is to present the basic concepts of Vector Spaces and Linear Transformations. The course also presents basic concepts of Inner product Spaces.

10. Course Outcomes (COs):

1. Students in this course will demonstrate ability to work within vector spaces.
2. Students in this course will demonstrate ability to distill vector space properties.
3. Students in this course will demonstrate ability to manipulate linear transformations.
4. Students in this course will demonstrate ability to work within Inner product spaces.

11. Unit wise detailed content

Unit-1	**Number of lectures = 5**	**Title of the unit: Vector Spaces**

Definition and examples of vector spaces, Subspaces. Sum and direct sum of subspaces, Linear span, Linear dependence and independence and their basic properties.

Unit – 2	**Number of lectures = 7**	**Title of the unit: Finite Dimensional vector spaces**

Basis of a vector space, Finite dimensional Vector spaces, Existence theorem for bases, Invariance of the number of elements of a basis set, Quotient spaces. Dimensions of quotient spaces.

Unit – 3	**Number of lectures = 6**	**Title of the unit: Linear Transformations**

Linear transformations, Null space, Range space of a linear transformation, Rank & Nullity of linear transformation, Matrix of a linear transformation and Change of basis

Unit – 4	**Number of lectures = 6**	**Title of the unit: Algebra of Linear Transformations**

Algebra of linear transformations, Singular and Non –Singular linear transformation, Eigen values and Eigen vector of linear transformations, Minimal polynomial of linear transformation, Dual spaces, Bidual spaces

Unit – 5	**Number of lectures = 6**	**Title of the unit: Inner Product Space**

Inner product spaces, Cauchy Schwarz inequality, Orthogonal vectors, orthogonal complements, Orthogonal sets and basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt Orthogonalization process

12. Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007
3. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
4. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007

1. Name of the Department: Mathematics						
2. Course Name	Vector Calculus	**L**	**T**		**P**	
3. Course Code	09010627	2	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Course in multivariable Calculus. Topics include scalar and vector product, gradient divergence and curl; line and surface integrals; and the theorems of Green, Stokes, and Gauss.

9. Course Objectives:

Students will be able to understand:

1. Scalar and vector quantities. Types of vector, Directional vector, Evaluate vector integration of Surface & Volume, Theorems of Gauss, Green and Stokes and problem based on these theorems.
2. To make students familiar with Curl, Divergence, Gradient and its properties. Laplacian operator, spherical and curvilinear coordinates etc.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to Compute dot product, cross product, length of vectors. Compute partial derivatives, derivatives of vector-valued functions, gradient functions. Evaluate integrals of functions or vector-related quantities over curves, surfaces, and domains in two- and three-dimensional space.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Scalar and Vector Product**

Scalar and vector product of three vectors and four vectors, Reciprocal vectors, Vector differentiation, Scalar valued point function and vector valued point function, Derivative along curve, Directional derivatives.

Unit – 2	**Number of lectures = 6**	**Title of the unit: Gradient, Divergence and Curl**

Gradient of scalar point function, Divergence and curl of a vector point function, Characters of Div f and curl f of a vector point function, Vector identities , Gradient, Divergence and curl of sums and product and their related vector identities.

Unit – 3	**Number of lectures = 6**	**Title of the unit: Gradient, Divergence and Curl in orthogonal curvilinear coordinates**

Gradient, Divergence, Curl and Laplacian operator in terms of orthogonal curvilinear coordinates, Cylindrical coordinates and Spherical coordinates.

Unit – 4	**Number of lectures = 6**	**Title of the unit: Vector Integration**

Vector integration; line integration, Surface integration, Volume integration

Unit – 5	**Number of lectures = 6**	**Title of the unit: Applications of theorems**

Statements and applications of Green's theorem, Gauss divergence theorem and Stokes theorem

12. Books Recommended

1. Murrary R. spiegal: Theory end Problems of Advanced Calculus, Schaum Publishing Comp., New York.
2. Shanti Narayana: A Text Book of Vector Calculus. S. Chand & Co., New Delhi
3. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
4. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.
5. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.

Unit - 2	Number of lectures = 6	Title of the unit: Conversation Skills
Greetings and Introducing oneself, Framing questions and answers, Role play, Buying: asking details etc, Word formation strategies, Vocabulary building: Antonyms, Synonyms, Affixation, Suffixation, One word substitution		
Unit - 3	**Number of lectures = 6**	**Title of the unit: Reading Comprehension**
Simple narration and Stories, Newspaper and articles clippings, Sentence types, Note Making, Paragraph Writing, Comprehension, Report Writing: types, characteristics		
Unit - 4	**Number of lectures = 6**	**Title of the unit: Pronunciation**
Pronunciation, Syllable and Stress, Intonation and Modulation		
Unit - 5	**Number of lectures = 6**	**Title of the unit: Writing Comprehension**
Letters: types, format, style, Précis Writing, Paragraph: Order, Topic sentence, consistency, coherence, Report and Proposal, Project Writing: Features, Structure		

12. Books Recommended

1. Fluency in English-II, Department of English, Delhi University, Oxford University Press
2. Murphy's English Grammar with CD, Murphy, Cambridge University Press
3. English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP
4. Learning Spoken English by Lynn Lundquist-ASIN: B0094XNOPW
5. Essential English Grammar: A Self-Study Reference and Practice Book for Elementary

1. Name of the Department: Allied Health Science				
2. Course Name	Environmental Sciences	L	T	P
3. Course Code	09010211	2	0	0

4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC (✓)**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 30	**Tutorials = 0**	**Practical = 0**

8. Course Description:

Environmental Science subject focuses on the scientific principles, concepts, and methodologies required to understand the functions of global environment. This course will give you the skills necessary to address the environmental issues we are facing today, to analyze the relative risks associated with these problems and explores possibilities for alleviating and preventing these problems. In this course students can survey some major environmental problems of society at an introductory level and ultimately considering the sustainability of human activities on the planet.

9. Course Objectives:

1. Create awareness among students about the environmental problems.
2. Motivate students by concern for welfare of the many human and non-human communities.
3. To nurture respect and love for the natural system.
4. Acquire basic knowledge and skills to identify and solve the environmental problems.
5. Strive to attain harmony with nature.

10. Course Outcomes (COs):

1. Students will develop a sense of responsibility by becoming aware of environmental issues.
2. Students will able to analyze the local and global environmental problems; looking at the science behind them.
3. Students will able to learn different scientific approaches to solve the local environmental problems.
4. Understand key concepts for sustainable development.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Introduction to environment and natural resources.**

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. **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems. **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies. **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit - 2	**Number of lectures = 6**	**Title of the unit: Ecology and Bio-diversity**

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. **Biodiversity and its conservation:** Hot-spots of biodiversity **Threats to biodiversity:** habitat loss, poaching of wildlife, man-wildlife conflicts. **Conservation of biodiversity:**

In-situ and Ex-situ conservation of biodiversity.		
Unit - 3	**Number of lectures = 6**	**Title of the unit: Environmental Pollution**
Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. **Solid waste Management:** Causes, effects and control measures of urban and industrial wastes, Fireworks, their impacts and hazards. Pollution case studies. **Disaster management:** floods, earthquake, cyclone and landslides.		
Unit - 4	**Number of lectures = 6**	**Title of the unit: Social issues and Environment**
Social Issues and the Environment From: Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case studies. **Environmental ethics:** Issues and possible solutions, Consumerism and waste products, Environmental Legislation (Acts and Laws), Issues involved in enforcement of environmental legislation **Human Population and the Environment:** Population growth, variation among nations with case studies, Population explosion – Family Welfare Programmes and Family Planning Programmes, Human Rights, Value Education, Women and Child Welfare.		
12. Books Recommended		
1. A.K. De, Environmental Chemistry, Wiley Eastern Ltd. 2. P.D. Sharma, Ecology and Environment, Rastogi Publications. 3. Y. K. Singh, Environmental Science, New Age International Pvt., Publisher Banglore. 4. Kaushik and Kaushik, Respective in Environmental Studies. 5. Bharucha Erach, The Biodiversity of India, Mapin Pu Publishing Pyt. Ltd., Ahmedabad. 6. Agarwal K.C., 2001, Environmental Biology, Nidi Publishing Ltd. Bikaner.		