GNA UNIVERSITY
SRI HARGOBINDGARH, PHAGWARA – HOSHIARPUR ROAD,
PHAGWARA 144401, PUNJAB

ORDINANCE

FOR

BACHELOR OF PHYSICAL SCIENCES

GNA UNIVERSITY

Inspiring Innovation.....

(THIS ORDINANCE HAS BEEN APPROVED IN THE MEETING OF BOARD OF STUDIES HELD ON DATED 31st May, 2022)

APPLICABLE W.E.F. ACADEMIC SESSION 2022-2023

SRI HARGOBINDGARH, PHAGWARA – HOSHIARPUR ROAD,PHAGWARA 144401, PUNJAB

ORDINANCE FOR B.SC. PHYSICS SCIENCES

SHORT TITLE AND COMMENCEMENT

I. This Ordinance shall be called the Ordinance for the B.Sc. Physical Sciences Program of GNA University, Phagwara.

II. This Ordinance shall come into force with effect from academic session 2020 - 21

1. Name of Program: B.Sc. Physical Sciences

2. Name of Faculty: Faculty of Natural Sciences.

3. Vision of the department: To Produce highly qualified students and professionals in the field of Mathematical Science, Chemistry & Physics accepting globally for catering the need of the society.

4. Mission of the department:

M1: To prepare students with technical aspects of Physics, Chemistry & Mathematics, which they are ready to take the new real-world challenges.

M2: Establish an industry-academia relationship to enhance the technical skills of students to work prominently in industrial environments.

M3: Provide exposure to students of state-of-the-art tools and technology in the field of chemistry

M4: Each Faculty member motivates students to become problem-solving individuals, researcher, a good academician in the field of chemistry.

5. Program Educational Outcomes (PEO):

PEO1: To excel in academic development skills coveted in the Mathematical industry.

PEO2: To evolve student as globally competent professionals possessing leadership skills for developing innovative solutions in multidisciplinary domains.

PEO3: To involve student in lifelong learning to adapt the technological advancements in the emerging areas of applications of physics, chemistry & mathematics.

PEO4: To provide student with an academic environment that fosters excellence, transparency, leadership and promote awareness of life-long learning.

PEO5: To Work as teams to solve problem solving of different field using different mathematical concepts.

6. Program Specific Outcomes

PSO1: Professional Skills: Attain the ability to handle various mathematical problems and applying different methods to solve them mathematically.

PSO2: Successful Career and Entrepreneurship: Explore technical knowledge in diverse areas of mathematics and experience an environment conducive in cultivating skills for successful career, entrepreneurship, and higher studies.

PSO3: Problem Solving: Ability to use knowledge gained for solving complex reactions using various methods & technology.

7. Program Specific Outcomes:

PO1: Basic knowledge: An ability to apply knowledge of basic mathematics in different field.

Po2: Discipline knowledge: An ability to apply discipline specific knowledge to solve core and/or applied sciences (Physics, chemistry & Mathematics).

PO3: Modern Tool Usage: Use current techniques, skills, and tools necessary to carry out various analytical methods for problem solving.

PO4: Ethics: Recognize the social and ethical responsibilities of a professional working in the discipline.

PO5: Computing Skills: Analyze a problem and identify and define the computing requirements appropriate to its solution.

PO6: Profession and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional practice.

PO7: Environment and sustainability: Understand the impact of the professional solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9: Social Contribution: Follow professional mathematician by applying contextual knowledge to assess societal and legal issues.

PO10: Communication: Communicate effectively on complex activities and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the management principles and apply these to one's own work, as a member and leader in a team.

PO12: Lifelong Learning: Work as teams to work on different projects using programming and different mathematical problem-solving techniques.

8. General Regulations for Faculty of Natural Sciences:

8.1 The University may introduce programs under Faculty of Natural Sciences which are specified under the UGC Act 1956. The Governing Body may approve the introduction, suspending or phasing out a program on the recommendation of the Academic Council either on its own or on the initiative of faculty.

8.2 The admissions to a Faculty of Natural Sciences programs shall be generally governed by the rules of the UGC or any other competent authority of the MHRD or as approved by Governing Body of University and shall be as notified in the admission notification of the respective academic year.

8.3 The minimum entry qualification for admission to the students of Faculty of Natural Sciences shall be such as may be laid down in the regulations or specified by the Governing Body like Minimum qualification for admission to the first year program of Faculty of Natural Sciences shall be the Senior Secondary School Certificate (10+2) examination. While deciding the admission procedure, the University may lay down compulsory subjects in qualifying examination for admission for various programs in the admission policy.

8.4 A student shall be required to earn a minimum number of credits through various academic components of a curriculum, as provided for in the regulations.

8.5 A student shall be required to complete all the requirements for the award of the degree within such period as may be specified in the regulations.

8.6 A student may be granted such scholarship as may be specified in accordance with the directions of the Governing Body from time to time or regulations laid down for the same.

8.7 A student admitted to the programs shall be governed by the rules, regulations and procedures framed and implemented by the University from time to time.

8.8 The students shall abide by the regulations mentioned in student handbook issued by the University. These standing regulations shall deal with the discipline of the students in the Hostels, Faculty, and University premises or outside. The standing orders may also deal with such other matters as are considered necessary for the general conduct of the students' co-curricular and extra-curricular activities.

8.9 In exceptional circumstances the chairman of Academic Council may, on behalf of the Council, approve amendments, modifications, Insertions or deletions of an Ordinance(s) which in his/her opinion is necessary or expedient for the smooth running of the program provided all such changes are reported approved to the Council in its next meeting.

9. General Regulations for the Bachelor of Science - Physical Sciences

9.1 Short Title and Commencement: These regulations shall be called regulations for the PG programs in Faculty of Natural Sciences of the University and shall come into force on such a date as the Academic Council may approve.

9.2 Duration: The duration of the PG programs leading to degrees of B.Sc. Physical Sciences shall be minimum two years and each year will comprise of two semesters. However, the duration may be extended up-to five years from the registered batch. The maximum duration of the programs excludes the period of withdrawal, due to medical reasons. However, it shall include the period of rustication or any other reason of discipline /academics e.g. detention, willful absence by the student, not getting promotion to the next class due to poor academic performance etc. Under detention, the student shall attend the University for an additional semester or more time, as equated to period of absence/suspension.

9.3 Starting or Phasing out of Program: A program may be phased out on recommendations of the Academic Council and approval of the Governing Body, on account of continuous low registration in the program or any other justifiable reason like becoming obsolete etc. Similarly, the Academic Council may approve starting of a new program or modifying the existing one on the recommendations of the Academic Council.

9.4 Admissions: The centralized admission cell shall make selection for admission to the program. Admission to this program shall be made as per procedure to be approved by the Academic Council, and further by Board of Management and Governing Body and may be reviewed periodically as required. Eligibility criteria for the program, meriting and selection policy, fee structure, refund policy, total number of seats etc. shall be defined in the admission policy.

9.5 Eligibility for Admission: 10+2 standard with 50% marks in aggregate in Non – Medical (45 % for SC/ST/OBC).

9.6 Semester System: The Bachelor of Science - Physical Sciences academic programs in the University shall be based on Semester System, namely, Even (Jan to June) and Odd (July to Dec) Semesters, in an academic year. The courses whether offered in regular semester shall be evaluated as per the policy and procedure laid down.

9.7 Semester Duration: Total duration of the Program shall be of three years and each year will comprise of two semesters. In addition, each semester shall normally have teaching for the 90 working days.

10. Curriculum: The three years curriculum has been divided into six semesters and shall include lectures, tutorials, practical, and projects along with the industrial visits and educational tours etc. The curriculum will also include other curricular, co-curricular and extra-curricular activities as may be prescribed by the University from time to time.

11. Choice Based Credit System:

The University has adapted Choice Based Credit System (CBCS) which provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The choice based credit system provides a "flexible" approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. Following are the types of courses and structure for the program:

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

11.2 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.

iii. Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. In B.Sc () Physics, the bucket of Elective subjects contains Mathematics & Chemistry also so that student will be eligible to pursue Bachelors of Education.

Note: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

11.3 Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; i. Environmental Science and ii. English/MIL Communication. These are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

i. Ability Enhancement Compulsory Courses (AECC): Environmental Science, English Communication/MIL Communication.

ii. Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

11.4 Introducing Research Component in Under-Graduate Courses

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analysing /exploring a real-life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

12. Medium of Instructions:

12.1 The medium of instruction for B.Sc. Physical Sciences will be English.

12.2 Question Papers of all examinations will be set and answered in English.

12.3 Practical work/Project Work / Project Report / Dissertation / Field Work Report / Training Report etc., if any, should be presented in English.

13. Mode: The program is offered on 'Full Time' mode of study only.

14. Attendance Requirement to be Eligible to Appear in End Semester Examination:

14.1 Every student is required to attend at least 75% of the lectures delivered squaring tutorials, practical and other prescribed curricular and co-curricular activities.

14.2 Dean of Faculty may give a further relaxation of attendance up to 10% to a student provided that he/she has been absent with prior permission of the Dean of the Faculty for the reasons acceptable to him/her.

14.3 Further, relaxation up to 5% may be given by the Vice Chancellor to make a student eligible under special circumstances only.

14.4 No student will be allowed to appear in the end semester examination if he/she does not satisfy the attendance requirements. Further, the attendance shall be counted from the date of admission in the University or commencement of academic session whichever is later.

14.5 Attendance of N.C.C/N.S.S. Camps or Inter-Collegiate or Inter-University or Inter-State or International matches or debates or Educational Excursion or such other Inter-University activities as approved by the authorities involving journeys outside the city in which the college is situated will not be counted as an absence. However, such absence shall not exceed four weeks per semester of the total period of instructions. Such type of facility should not be availed twice during the study.

15. Credit: Each course, except a few special audit courses, has a certain number of credits assigned to it depending upon its lecture, tutorial and/or laboratory contact hours in a week.

A letter grade, corresponding to a specified number of grade points, is awarded in each course for which a student is registered. On obtaining a passing grade, the student accumulates the course credits as earned credits. A student's performance is measured by the number of credits that he/she has earned and by the weighted grade point average. A minimum number of credits should be acquired to qualify for the programs.

Earned Credits (EC): The credits assigned to a course in which a student has obtained 'D' (a minimum passing grade) or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained F, or W or "I" grade will not be counted towards his/her earned credits.

A unit by which the course is measured. It determines the number of hours of instruction required per week.

Contact Hours per Week	Credit Assigned
1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
2 Hours Practical (Lab) per week	1 credit

16. Program Structure: As per GNA University

Details of Courses under B.Sc. Physical Sciences

Course	**Credits***	
	Theory + Practical	Theory + Practical
I. Core Course (12 papers) 04 Courses from each of the 03 disciplines of choice	12 X 4 = 48	12 X 5 = 60
Core Course Practical / Tutorial* **(12 Practical/ Tutorials*)** 04 Courses from each of the 03 Disciplines of choice	12 X 2 = 24	18 X 1 = 18
II. Elective Course (6 Papers)	6 X 4 = 24	6 X 5 = 30
Two papers from each discipline of choice Including paper of interdisciplinary nature. Elective Course Practical/ Tutorial* (6 Practical/ Tutorials*)	6 X 2 = 12	6 X 1 = 06
Optional Dissertation or project work in place of one Discipline elective paper (3 credits) in 6th Semester		
III. Ability Enhancement Courses Ability Enhancement Courses (2 Papers of 2 credits each) Environmental Studies/ English Communication	2 X 2 = 04	2 X 2 = 4
VI. Skill Enhancement Course (Skill Based) (4 Papers of 2 credits each)	4 X 2 = 08	4 X 2 = 08
	Total credit= 120	Total credit= 120

COURSE STRUCTURE (BACHELOR OF PHYSICAL SCIENCES)

COURSE SCHEME

Semester	Core Course (CC) 14	Ability Enhancement Compulsory Course (AECC) (02)	Skill Enhancement Elective Course (SEC) (02) Skill Based	Discipline Specific Elective (DSE) (04)
I	CC	AECC - 1		
	CC			
	CC			
II	CC	AECC - 2		
	CC			
	CC			
III	CC		SEC - 1	
	CC			
	CC			
IV	CC		SEC - 2	
	CC			
	CC			
V			SEC - 3	DSE-1-A
				DSE-2 A
				DSE-3 A
VI			SEC - 4	DSE-1-B
				DSE-2 B
				DSE-3 B

B.Sc. Physical Science Semester I (First year)

Sr. No	Category	Course Code	Course Title	Teaching Scheme L	T	P	credits	Hours	Examination Scheme Internal	External	Total
1	CC - 1	BMT101	Calculus	4	0	0	4	4	40	60	100
		BMT121	Calculus Lab	0	0	4	2	4	30	20	50
2	CC - 2	BPH102	Mechanics	4	0	0	4	4	40	60	100
		BPH122	Mechanics Lab	2	0	0	2	4	30	20	50
3	CC – 3	BCH101	Inorganic Chemistry I: Atomic Structure & Chemical Bonding	4	0	0	4	4	40	60	100
		BCH121	Inorganic Chemistry I: Atomic Structure & Chemical Bonding Lab	0	0	4	2	4	30	20	50
4	AECC – 1		Ability Enhance Compulsory Course – 1	2	0	0	2	2	40	60	100

B.Sc. Physical Science Semester II (First year)

Sr. No	Category	Course Code	Course Title	Teaching Scheme L	T	P	credits	Hours	Examination Scheme Internal	External	Total
1	CC - 4	BMT202	Differential Equations	4	0	0	4	4	40	60	100
		BMT222	Lab: Differential Equations	0	0	4	2	4	30	20	50
2	CC - 5	BPH201	Electricity and Magnetism	4	0	0	4	4	40	60	100
		BPH221	Electricity and Magnetism Lab	0	0	4	2	4	30	20	50
3	CC – 3	BCH201	Organic Chemistry I: Basics and Hydrocarbons	4	0	0	4	4	40	60	100
		BCH221	Organic Chemistry I: Basics and Hydrocarbons LAB	0	0	4	2	4	30	20	50
4	AECC – 2		Ability Enhance Compulsory Course – 2	2	0	0	2	2	40	60	100

B.Sc. Physical Science Semester III (Second year)

Sr. No	Category	Course Code	Course Title	Teaching Scheme L	T	P	credits	Hours	Examination Scheme Internal	External	Total
1	CC - 7	BMT301	Real Analysis	5	1	0	6	6	40	60	100
2	CC - 8	BPH302	Thermal Physics	4	0	0	4	4	40	60	100
		BPH322	Thermal Physics Lab	0	0	4	2	4	30	20	50
3	CC – 9	BCH303	Physical Chemistry III: Phase Equilibria and Chemical Kinetics	4	0	0	4	4	40	60	100
		BCH323	Physical Chemistry III: Phase Equilibria and Chemical Kinetics LAB	0	0	4	2	4	30	20	50
4	SEC – 1		Skill Enhancement Elective – 1				2				

B.Sc. Physical Science Semester IV (SECOND YEAR)

Sr. No	Category	Course Code	Course Title	Teaching Scheme			credits	Hours	Examination Scheme		Total
				L	T	P			Internal	External	
1	CC – 10	BMT401	Numerical Methods	4	0	0	4	4	40	60	100
		BMT421	Lab: Numerical Methods	0	0	4	2	4	30	20	50
2	CC – 11	BPH404	Waves & Optics	4	0	0	4	4	40	60	100
		BPH424	Waves & Optics Lab	0	0	4	2	4	30	20	50
3	CC – 12	BCH401	Inorganic Chemistry III: Coordination Chemistry	4	0	0	4	4	40	60	100
		BCH421	Inorganic Chemistry III: Coordination Chemistry Lab	0	0	4	2	4	30	20	50
4	SEC – 2		Skill Enhancement Elective – 2				2				

B.Sc. Physical Science Semester V (THIRD YEAR)

Sr. No	Category	Course Code	Course Title	Teaching Scheme			credits	Hours	Examination Scheme		Total
				L	T	P			Internal	External	
1	DSE – 1A		Discipline Specific Mathematics Elective – 1A	4	0	0	4	4	40	60	100
			Discipline Specific Mathematics Elective Lab – 1A	0	0	4	2	4	30	20	50
2	DSE – 2A		Discipline Specific Physics Elective – 2A	4	0	0	4	4	40	60	100
			Discipline Specific Physics Elective Lab – 2A	0	0	4	2	4	30	20	50
3	DSE – 3A		Discipline Specific Chemistry Elective – 3A	4	0	0	4	4	40	60	100
			Discipline Specific Chemistry Elective Lab– 3A	0	0	4	2	4	30	20	50
4	SEC – 3		Skill Enhancement Elective – 3				2				

B.Sc. Physical Science Semester VI (THIRD YEAR)

Sr. No	Category	Course Code	Course Title	Teaching Scheme			credits	Hours	Examination Scheme		Total
				L	T	P			Internal	External	
1	DSE – 1B		Discipline Specific Mathematics Elective – 1B	4	0	0	4	4	40	60	100
			Discipline Specific Mathematics Elective Lab – 1B	0	0	4	2	4	30	20	50
2	DSE – 2B		Discipline Specific Physics Elective – 2B	4	0	0	4	4	40	60	100
			Discipline Specific Physics Elective Lab – 2B	0	0	4	2	4	30	20	50
3	DSE – 3B		Discipline Specific Chemistry Elective – 3B	4	0	0	4	4	40	60	100
			Discipline Specific Chemistry Elective Lab– 3B	0	0	4	2	4	30	20	50
4	SEC – 4		Skill Enhancement Elective – 4				2				

Core Course Bucket

Sr. No	Course Code	Course Name	L	T	P
1.	BMT101	Calculus	4	0	0
	BMT121	Calculus – Lab	0	0	4
2.	BPH102	Mechanics	4	0	0
	BPH122	Mechanics Lab	0	0	4
3.	BCH101	Inorganic Chemistry: Atomic Structure & Chemical Bonding	4	0	0
	BCH121	Inorganic Chemistry: Atomic Structure & Chemical Bonding Lab	0	0	4
4.	BMT202	Differential Equations	4	0	0
	BMT222	Differential Equations LAB	0	0	4
5.	BPH201	Electricity and Magnetism	4	0	0
	BPH221	Electricity and Magnetism Lab	0	0	4
6.	BCH201	Organic Chemistry: Basics and Hydrocarbons	4	0	0
	BCH201	Organic Chemistry: Basics and Hydrocarbons LAB	0	0	4
7.	BMT301	Real Analysis	5	1	0
8.	BPH302	Thermal Physics	4	0	0
	BPH322	Thermal Physics Lab	0	0	4
9.	BCH303	Physical Chemistry: Phase Equilibria and Chemical Kinetics	4	0	0
	BCH323	Physical Chemistry: Phase Equilibria and Chemical Kinetics Lab	0	0	4
10.	BMT401	Numerical Methods	4	0	0
	BMT421	Numerical Methods LAB	0	0	4
11.	BPH404	Waves and Optics	4	0	0
	BPH424	Waves and Optics Lab	0	0	4
12.	BCH401	Inorganic Chemistry: Coordination Chemistry	4	0	0
	BCH421	Inorganic Chemistry: Coordination Chemistry LAB	0	0	4

Ability Enhancement Compulsory Courses (02 Credits)

Sr. No	Course Code	Course Name	L	T	P
1.	ENS001	Environmental Studies	2	0	0
2.	COM101	English Communication	2	0	0
3.	GWE001	Gender Equality & Women Empowerment	2	0	0

Discipline Specific Electives (DSE) – Mathematics

Sr. No	Sr. No	Course Name	L	T	T
1.	BMT503	Number Theory	5	1	0
2.	BMT504	Theory of equations	5	1	0
3.	BMT505	Probability and Statistics	5	1	0
4.	BMT506	Mechanics	5	1	0
5.	BMT507	Portfolio Optimization	5	1	0
6.	BMT508	Boolean Algebra and Automata Theory	5	1	0
7.	BMT509	Linear Programming	5	1	0
8.	BMT510	Differential Geometry	5	1	0
9.	BMT511	Mathematical Modelling	5	1	0

Discipline-Specific Electives (DSE) – Physics

Sr. No	Sr. No	Course Name	L	T	T
1.	BPH503	Experimental Techniques	4	0	0
	BPH523	Experimental Techniques Laboratory	0	0	4
2.	BPH504	Embedded systems- Introduction to Microcontroller	4	0	0
	BPH524	Embedded systems- Introduction to Microcontroller Laboratory	0	0	4
3.	BPH505	Physics of Devices and Communication	4	0	0
	BPH525	Physics of Devices and Communication Laboratory	0	0	4
4.	BPH506	Advanced Mathematical Physics	4	0	0
	BPH526	Advanced Mathematical Physics Laboratory	0	0	4
5.	BPH507	Classical Dynamics	5	1	0
6.	BPH508	Applied Dynamics	4	0	0
	BPH528	Applied Dynamics Laboratory	0	0	4
7.	BPH509	Communication Systems	4	0	0
	BPH529	Communication Systems Laboratory	0	0	4
8.	BPH510	Nuclear and Particle Physics	5	1	0
9.	BPH603	Astronomy and Astrophysics	5	1	0
10.	BPH604	Atmospheric Physics	4	0	0
	BPH624	Atmospheric Physics Laboratory	0	0	4
11.	BPH605	Nano Materials and Applications	4	0	0
	BPH625	Nano Materials and Applications Laboratory	0	0	4
12.	BPH606	Physics of the Earth	5	1	0
13.	BPH607	Digital Signal Processing	4	0	0
	BPH627	Digital Signal Processing Laboratory	0	0	4
14.	BPH608	Medical Physics	4	0	0
	BPH628	Medical Physics Laboratory	0	0	4
15.	BPH609	Biological Physics	5	1	0
16.	BPH610	Dissertation	0	0	12

Discipline Specific Elective Papers: Chemistry (Credit: 06 each)

Sr. No	Sr. No	Course Name	L	T	T
1.	BCH503	Applications of Computers in Chemistry	4	0	0
	BCH523	Applications of Computers in Chemistry Lab	0	0	4
2.	BCH504	Analytical Methods in Chemistry	4	0	0
	BCH524	Analytical Methods in Chemistry LAB	0	0	4
3.	BCH505	Molecular Modelling & Drug Design	4	0	0
	BCH525	Molecular Modelling & Drug Design LAB	0	0	4
4.	BCH506	Novel Inorganic Solids	4	0	0
	BCH526	Novel Inorganic Solids LAB	0	0	0
5.	BCH507	Molecular spectroscopy	4	0	0
	BCH527	Molecular spectroscopy LAB	0	0	4
6.	BCH508	Research Methodology for Chemistry	5	1	0
7.	BCH509	Green Chemistry	4	0	0
	BCH529	Green Chemistry LAB	0	0	4
8.	BCH603	Industrial Chemicals & Environment	4	0	0
	BCH623	Industrial Chemicals & Environment LAB	0	0	4
9.	BCH604	Inorganic Materials of Industrial Importance	4	0	0
	BCH624	Inorganic Materials of Industrial Importance LAB	0	0	4
10.	BCH605	Instrumental Methods of Analysis	4	0	0
	BCH625	Instrumental Methods of Analysis LAB	0	0	4
11.	BCH606	Dissertation	0	0	8

Skill Enhancement Course (SEC)

Sr. No	Sr. No	Course Name	L	T	T
1.	BMT306	PYTHON PROGRAMMING LAB	0	0	4
2.	BMT307	MATLAB PROGRAMMING LAB	0	0	4
3.	BMT308	LATEX LAB	0	0	4
4.	BMT309	OPERATING SYSTEMS: LINUX	1	0	2
5.	BPH304	Applied Optics	2	0	0
6.	BPH305	Physics Workshop Skills	2	0	0
7.	BPH306	Electrical circuits and Network Skills	2	0	0
8.	BPH307	Basic Instrumentation Skills	2	0	0
9.	BPH308	Renewable Energy and Energy harvesting	2	0	0
10.	BPH309	Radiation Safety	2	0	0
11.	BPH310	Weather Forecasting	2	0	0
12.	BCH304	IT Skills for Chemists	2	0	0
13.	BCH305	Basic Analytical Chemistry	2	0	0
14.	BCH306	Chemical Technology & Society	2	0	0
15.	BCH307	Chemoinformatics	2	0	0
16.	BCH308	Business Skills for Chemists	2	0	0
17.	BCH404	Intellectual Property Rights	2	0	0
18.	BCH405	Analytical Clinical Biochemistry	2	0	0
19.	BCH406	Green Methods in Chemistry	2	0	0
20.	BCH407	Pharmaceutical Chemistry	2	0	0
21.	BCH408	Chemistry of Cosmetics & Perfumes	2	0	0
22.	BCH409	Pesticide Chemistry	2	0	0

17. Examination/ Evaluation System:

17.1 Internal Assessment, which includes attendance, mid semester examination and other components (Project 1, Project 2, Mid Term Exam, Attendance, Class Test) carrying a weightage of 40%. This is applicable for all theory courses.

17.2 Practical Courses: The examination/evaluation criteria of the practical courses shall be decided by the respective faculty member and wherever required on the availability of the external experts/visiting faculty. Faculty may set/design the practical exercises out of any marks but the overall weightage shall be in pre-defined percentage, which the concerned faculty/course coordinator shall announce in the first class of the semester and upload on the GU-Academia. Methodology for evaluation of Lab component may include day to day work, lab records, quantity/quality of work and Viva/Seminar/Practical as may be decided.

17.3 External Assessment i.e. End Semester Examination, carrying a weightage of 60%.

a) End Semester Examination: These examinations shall be conducted by Controller of Examination. The examination dates and schedule shall be released by the University.

b) Similar division of marks may be created for special courses like Major Projects, seminars, term papers, internship etc. by respective faculty but same shall also be predefined.

c) Every student has to score at least 25% marks each in Continuous Assessment and End Semester examination. The minimum pass percentage is 40% in aggregate. In case a student scores more than 25% each in Continuous Assessment and End Semester Examination, but overall percentage in the concerned subject remains less than 40%, then student has to repeat End Semester Examination in that subject.

17.4 Failing to meet Attendance Requirement:

a) A student is required to attend all the classes.

b) If the attendance profile of a student is unsatisfactory, he/she will be debarred. Any student, who has been debarred due to attendance shortage, shall not be allowed to take the supplementary Examination. The student shall have to register for the course in the regular semester when offered.

17.5 Makeup Examinations for Mid Semester Examination: A student may apply for a makeup examination where he/she is not able to attend the examination schedule due to reasons of personal medical condition or compassionate reason like death of a very close relative. No other contingencies are acceptable. Except in case of medical emergency, a student needs to seek advance approval from appropriate authority before missing the Examination.

Theory Courses:

- A student missing Mid Term Examination only shall be required to take a make-up Examination.
- The students must put-up the request for make-up Examination along with the medical documents to prove the genuineness of the case (for having missed the Examination) within 5 days of last date of Examination.
- The genuineness shall be reviewed and approved by the Vice Chancellor, whose decision shall be final.
- In case a student misses the make-up Examination also, then no further chance will be

provided.

- The duration of Examination shall be as decided by the Faculty member.
- Genuine approved cases shall be notified by the Controller of Examination based on the requests received and only such students shall be allowed to take make-up Examination in the subjects where approval has been granted.
- The date sheet need not be taken out as the makeup examination shall be conducted under arrangement concerned faculty, who after evaluation and sharing the evaluated answer sheet with student shall submit marks to the Controller of Examination.

17.6 Makeup of End Semester Examination: It is mandatory to appear the end semester major examination to obtain any grade for a course. A student who misses the end semester major examination shall follow a similar procedure as outlined above, to obtain approval of the Vice Chancellor to prove genuineness of the case. The student whose case is approved as genuine shall be awarded "I" Grade in the semester results in the given subject. The student shall be allowed to appear in the supplementary examination of the said subject. However, the grades shall be worked out by computing the marks obtained by students in Mid Term Exams, TA, Lab and supplementary examination (equated to the weightage of end semester examination). The total marks shall be compared with the marks of the class as in the regular semester for award of grade.

17.7 Makeup of End Semester Viva of Projects: It is mandatory to appear in the final Viva examination to obtain any grade for a project course. In case of student missing the same for genuine reasons; similar method as given for written examination of theory courses shall be followed.

17.8 Procedure to be adopted by students in case of missing any of the specified Examination(s): Following procedure shall be adopted for establishing genuineness of the case.

a. Action by the student (Medical Cases)

I. They should report absence from the Examination(s) by fastest possible means to the Controller of Examination. It could be email or written communication by speed post or sent by hand through any means. In case of Hosteller's, if a student falls sick while residing in the hostel, he/she should seek advice of the available qualified doctor.

II. The said report should preferably be sent prior to the Examination, but not later than 5 days after the last date of the said Examination.

III. The student should on rejoining:

a. Report to the Controller of Examination with complete medical documents to include referral/Prescription slip of the doctor specifically indicating the disease and medicine prescribed, investigation/Lab reports and discharge slip in case of admission should be provided.

b.Submit the Documents to the Controller of Examination, not later than 5 days after the last date of Examination.

IV. In case delay beyond 5 days is anticipated the student should arrange for the medical documents to be sent to the University Medical Officer by hand through a friend / relative etc. and get the said genuineness deposit with the Controller of Examination.

V. No request later than 5 days after the last date of Examination shall be accepted for reasons of ignorance or any other reasons.

b. **Action by students (any other reaso**n)

In case the student must miss Examination due to genuine reason other than medical, prior written sanction of Vice Chancellor and in his absence Dean is mandatory. No post facto requests shall be accepted in any case. The approval should be deposited with the Controller of Examination before the examination.

18. Supplementary Examination:

18.1 The supplementary examinations shall be held for each commiserating semester in December for Odd semester and May/June for Even semester, respectively. For the final semester students, there is privilege to appear in the supplementary exams of all previous semester.

18.2 Eligibility: Student with 'F' grade is eligible to appear in the Supplementary Examination.

18.3 Re-appear: Student with backlog of one semester will be carried forward to next semester. Re-appear examinations will be conducted twice in a year after ESE of every semester.

18.4 Supplementary for Projects: There shall be no supplementary examinations for the projects, except makeup examination for missing the final viva as per rules outlined above.

19. Grading System: University follows eight letter grading system (A+, A, B+, B, C+, C, D, and F) that have grade points with values distributed on a 10-point scale for evaluating the performance of student. The letter grades and the corresponding grade points on the 10-point scale are as given in the table below. If number of passing students in any subject is less than or equal to 30 then Absolute Grading System will be followed otherwise Relative Grading System will be followed for evaluation.

Academic Performance	Range of Marks	Grades	Grades Points	Remarks
Outstanding	≥90	A+	10	
Excellent	≥80 & <90	A	9	
Very Good	≥70 & <80	B+	8	
Good	≥60 & <70	B	7	
Fair	≥50 & <60	C+	6	
Average	≥40 & <50	C	5	
Minimally Acceptable	40	D	4	
Fail	<40	F	0	
Incomplete		I	-	
Withdrawal		W	-	
Grade Awaited		GA	-	
Minor Project		**S/US**		**S-Satisfactory US-Unsatisfactory**

19.1 Description of Grades:

A. **D Grade:** The D grade stands for marginal performance, i.e. it is the minimum passing grade in any course. D grade shall not be awarded below 30% marks, though each teacher may set higher marks for the same.

B. F Grade: The 'F' grade denotes a very poor performance, i.e. failing a course. A student has to repeat all courses in which she/he obtains 'F' grade until a passing grade is obtained. In the case of 'F', no Grade points are awarded. However, the credits of such courses shall be used as the denominator for calculation of GPA or CGPA.

C. W Grade: The 'W' grade is awarded to a student if he/she is allowed to withdraw for an entire Semester from the University on medical grounds for a period exceeding five weeks.

D. "I" Grade: The 'I' grade is awarded when the student is allowed additional opportunity like makeup Examination etc. based on which the grade is to be decided along with other components of the evaluation during the semester 24 An incomplete grade of 'I' may be given when an unforeseen emergency prevents a student from completing the work in a course. The 'I' must be converted to a performance grade (A to F) within 90 days after the first day of classes in the subsequent regular semester.

E. X Grade: It is equivalent to Fail grade but awarded due to a student falling below the laid down attendance requirement. Students having X grade shall be required to re-register for the course, when offered next.

19.2 Cumulative Grade Point Average (CGPA), it is a measure of the overall cumulative performance of a student for all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimals places.

NB: The CGPA can be converted to percentage by using the given formula:

CGPA x 10 = %

e.g. 7.8 x 10 = 78%

19.3 Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (Course title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

20. General Rules: Examinations:

a) Showing the Answer Scripts: The answer scripts of all written Examinations i.e. Mid Term or end semester examination or any other written work conducted by a teacher shall be shown to the students. Students desirous of seeing the marked answer scripts of End Semester Examination has to ensure their presence before results are declared, as per dates notified by the Controller of Examination.

b) Marks/Answer Sheets of all other tests shall also be shared with the students and thus, there shall be no scrutiny of grades. However, before the grades are forwarded to Registrar/Controller of Examination, they should be displayed on GU-Academia and time are given to students, to discuss the same with respective faculty.

c) No appeal shall be accepted for scrutiny of grades.

d) Examination Fee for Supplementary. A fee of Rs.1000/- per course or as decided by the Management from time to time will be charged from the students.

21. Improvement of overall Score: A candidate having CGPA < 5.5 and wishes to improve his/her overall score may do so within two academic years immediately after passing the degree program by reappearing into maximum four course(s)/subject(s). The improvement would be considered if and only if the CGPA becomes > 5.5.

22. Program qualifying criteria: For qualifying the Program every student is required to earn prescribed credits (i.e. 120) If any student fails to earn prescribed credits for the program then he/she will get a chance to complete his/her Program in two more years than the actual duration of degree.

23.Revision of Regulations, Curriculum and Syllabi: The University may revise, amend, change or update the Regulations, Curriculum, Syllabus and Scheme of examinations through the Board of Studies and the Academic Council as and when required.

24. Conditions for Award of a Degree: Should complete the requirements of the Degree in maximum duration specified for the program. Semester withdrawals due to medical reasons are not counted in six years. However, forced withdrawal of students e.g. rustication or expulsion or nonattendance by student due to any other reasons, shall count in the maximum period of six years and minimum period of four years.

GNA UNIVERSITY

Inspiring Innovation.....

Syllabus

BACHELOR OF PHYSICAL SCIENCE

BMT101: CALCULUS

Credit : 04

LTP 400

Course Description:

This course provides the students with a broad understanding of higher-order derivatives and their applications, Curve Tracing and sketching of conics, and Vector functions and their applications.

Course learning outcomes: Students will have an understanding of:

CO1: Compute limits and derivatives of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions

CO2: Compute definite and indefinite integrals of algebraic, trigonometric, and logarithmic functions.

CO3: Learn the techniques to trace different types of curves which are highly applicable in different fields of study.

Co4: Identify and sketch symmetries from graphs of conic section for given constraints

Course content:

Unit I

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule.

Unit II

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx\, dx$, $\int \cos nx\, dx$, $\int \tan nx\, dx$, $\int \sec nx\, dx$, $\int (\log x)^n\, dx$, $\int \sin^n x \sin^m x\, dx$, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Unit III

Techniques of sketching conics, reflection properties of conics, rotation of axes and second-degree equations, classification into conics using the discriminant, polar equations of conics..

Unit IV

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, Kepler's second law.

Books Recommended

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
5. Liefhold, L 1997, Calculus and Analytic Geometry, 6th edn, Harper & Row.

Web Links:

1. https://nptel.ac.in/courses/111/104/111104085/
2. https://nptel.ac.in/courses/122/104/122104017/
3. https://nptel.ac.in/courses/111/103/111103021/
4. https://nptel.ac.in/content/storage2/courses/122101003/downloads/Lecture-9.pdf

BMT121: CALCULUS LAB

Credits : 02

LTP 004

Course Description: This course provides the students with a broad understanding of higher-order derivatives and their applications, Curve Tracing and sketching of conics, and Vector functions and their applications.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Plot the graph for the trigonometric, exponential, and logarithmic functions.

CO2: Sketch the various types of parametric curves.

CO3: Computing the program for the solution of matrices.

List of Experiments:

1) Plotting of graphs of function e^{ax+b}, log (ax + b), 1/ (ax + b), sin (ax + b), cos (ax + b), |ax + b| and to illustrate the effect of a and b on the graph.
2) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3) Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
4) Obtaining surface of revolution of curves.
5) Tracing of conics in Cartesian coordinates/ polar coordinates.
6) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates.
7) Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus,* 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd.,Singapore, 2002.
4. R. Courant and F. John, I*ntroduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
5. Liefhold, L 1997, *Calculus and Analytic Geometry,* 6th edn, Harper & Row.

BPH102: MECHANICS

Credits : 04

LTP 400

Course Description: This course is offered to the students as a fundamental course. The topics included in the course provide the students with broad understanding of motion of macroscopic objects.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Relative motion, Inertial and non-inertial reference frames.

CO2: Parameters defining the motion of mechanical systems

CO3: Study of the interaction of forces between solids in mechanical systems.

CO4: Centre of mass of mechanical systems.

Unit I

Fundamentals of Dynamics: Reference frames, Inertial frames; Review of Newton's Laws of Motion, Galilean transformations; Galilean invariance, Momentum of variable mass system: motion of rocket, Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass, Principle of conservation of momentum, Impulse.

Work and Energy: Work and Kinetic Energy Theorem, Conservative and non-conservative forces, Potential Energy, Energy diagram, Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Work done by non-conservative forces, Law of conservation of Energy.

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit II

Rotational Dynamics: Angular momentum of a particle and system of particles, Torque, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation.

Elasticity: Relation between Elastic constants, Twisting torque on a Cylinder or Wire.

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit III

Gravitation and Central Force Motion: Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram, Kepler's Laws, Satellite in circular orbit and applications, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS).

Oscillations: SHM: Simple Harmonic Oscillations, Differential equation of SHM and its solution, Kinetic energy, potential energy, total energy, and their time-average values, Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

Unit IV

Non-Inertial Systems: Non-inertial frames and fictitious forces, uniformly rotating frame, Laws of Physics in rotating coordinate systems, Centrifugal force, Coriolis force and its applications, Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events, Lorentz contraction, Time dilation, Relativistic transformation of velocity, frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics, Transformation of Energy and Momentum.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

BPH122: MECHANICS LABORATORY

Credits : 02

LTP 004

Course Description: This course is offered to the students as a fundamental course. The topics included in the course provide the students with practical understanding of motion of macroscopic objects.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Laws of motion and conservation principles.

CO2: Parameters defining the motion of mechanical systems.

CO3: Study of the interaction of forces between solids in mechanical systems.

CO4: Centre of mass of mechanical systems.

List of Experiments:

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a)Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books

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

BCH101: INORGANIC CHEMISTRY-I

Credits : 04

LTP 400

Course Description: This course aims to provide a detailed description about the nature of compounds. It aims to understand the Periodic Table and Chemical Periodicity.

Course learning outcomes: After completion of this course, students will be able to:

CO1: understand the periodic table and how the compound is formed.

CO2: have a complete understanding about basic concept of inorganic Chemistry.

CO3: Students will have knowledge of chemical bonding.

CO4: understand oxidation-reduction reactions**.**

Course content:

Unit I

Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s, p, d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit II

Periodicity of Elements:

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

I. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

ii. Atomic radii (van der Waals)

iii. Ionic and crystal radii.

iv. Covalent radii (octahedral and tetrahedral)

v. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

vi. Electron gain enthalpy, trends of electron gain enthalpy.

vii. Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

Unit III

Chemical Bonding:

(I) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing one pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(iii) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Unit IV

Oxidation-Reduction:

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

Books recommended:

• Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
• Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
• Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
• Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.11

BCH 121: Inorganic Chemistry I LAB

Atomic Structure & Chemical Bonding LAB

Credits : 02

LTP 004

Course Description: This course aims to provide a detailed description about different types of titrations.

Course learning outcomes: After completion of this course, students will be able to:

CO1: understand acid-base Titration.

CO2: understand oxidation-reduction Titration.

(A) Titrimetric Analysis

(I) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(I) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(I) Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe (II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Books recommended:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

Web Links:

http://nptel.ac.in/courses.php?disciplineId=104

http://www.slideshare.net/bherren/periodic-table-ppt

BMT202: DIFFERENTIAL EQUATIONS

Credits : 04

LTP 400

Course Description: The objective of this course is to introduce the students to the theory of differential equations, to give competence in solving differential equations by using analytical methods.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Identity& apply the concepts to solve first-order differential equations.

CO2: Solve the differential equations of higher-order derivatives.

CO3: Identify & apply the concepts to solve linear Ordinary differential equations of second & higher order.

CO4: Solve the problems involving applications of ordinary differential equations occurring in various technical fields.

Content:

Unit I

Ordinary Differential equations of First Order: Formation of Differential Equations of First Order and First degree, Variable Separable form, Differential equations of the form dy/dx = f (ax + by + c) Homogeneous Differential equations and its Solution, Equations reducible to Homogeneous form, Exact differential equations and integrating factors, equations reducible to this form.

Unit II

Differential Equations of First Order and Higher Degree, Equations Solvable for p, y, and x. Clairaut's Equation, the Solution of Leibnitz's linear differential equation, and Bernoulli's equations.

Unit III

Linear Ordinary Differential equations of Second and Higher Order: Definitions, the operator D, Auxiliary Equations (A.E.), Rules for finding the Complementary Function, The Inverse Operator, Rules for finding the Particular Integral, and Working Rule to solve the equations. Method of variation of parameters, Operator method, Cauchy's homogeneous Linear equation, Legendre's Linear equation. Simultaneous linear equations with constant coefficients.

Unit IV

Applications of Ordinary Differential Equations: Simple Harmonic Motion (S.H.M.); Application of Differential Equations to Electric circuits, Kirchhoff's Law; Differential equations of an electric circuit in series containing R – L circuit; Differential equation of an electric Oscillatory circuit containing Inductance and Capacitance with negligible resistance; Differential Equation of an L-C circuit with E.M.F. as *k cosnt;* Differential equation of electrical circuit containing L-C-R with negligible E.M.F.; Differential equation of electric circuit containing LCR circuit with E.M.F. as *k cosnt;* Simple pendulum; Gain or Loss of Beats; Conduction of Heat; Newton's Law of Cooling; Rate of Growth or Decay; Chemical Reactions.

Reference Books:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and MATLAB*, 2nd Ed., Taylor and Francis Group, London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value Problems Computing and Modeling*, Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

4. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

Web Links:

1. http://tutorial.math.lamar.edu/Classes/DE/DE.aspx
2. https://www.khanacademy.org/math/differential-equations
3. http://www.sosmath.com/diffeq/diffeq.html
4. https://nptel.ac.in/courses/111/106/111106100/
5. https://www.youtube.com/watch?v=Ty1sy-Mda_w
6. https://www.youtube.com/watch?v=TV4IHvDAg2A&list=PLhmzl7rZy2Ew4op7Fdpzxowx6ExZHIyvH&index=78

BMT222: DIFFERENTIAL EQUATIONS LAB

Credits : 02

LTP 004

Course Description: The objective of this course is to introduce the students to the theory of differential equations, to give competence in solving differential equations by using analytical methods.

Course learning outcomes: After completion of this course, students will be able to:

CO1: The topics included in the course provide the students with broad understanding and capability to solve different types of Differential equations.

CO2: The practicals involved give in depth knowledge of plotting differential equations.

CO3: The practicals help students to use differential equations in different games algorithms.

List of Practicals (using any software)

1. Plotting of second-order solution family of the differential equation.
2. Plotting of third-order solution family of the differential equation.
3. Predatory-prey model (basic Volterra model, with density dependence, the effect of DDT, two prey one predator).
4. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
5. Battle model (basic battle model, jungle warfare, long-range weapons).

Books Recommended

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and MATLAB,* 2nd Ed., Taylor and Francis Group, London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value Problems Computing and Modeling*, Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

BPH201: ELECTRICITY AND MAGNETISM

Credits : 04

LTP 400

Course Description: This course is offered to the students of physics as a fundamental course. The topics included in the course provide the students with broad understanding of basic principles of electricity and magnetism.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Identify the presence of static electric charges and fields due to static charges.

CO2: Possess adequate knowledge to analyze electrical capacitor.

CO3: Understand the phenomena of Seeback effect and apply the concept of thermo emf wherever suitable.

CO4: Distinguish between different types of magnetic materials and different kinds of magnetism manifested in materials.

CO5: Analyze magnetic properties of a ferromagnetic solid by analyzing or recording its hysteresis behaviour.

Unit I

Electric Field and Electric Potential

Electric field: Electric field lines, Electric flux, Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field, Electrostatic Potential, Laplace's and Poisson equations, The Uniqueness Theorem, Potential and Electric Field of a dipole, Force and Torque on a dipole, Electrostatic energy of system of charges.

Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor, Capacitance of a system of charged conductors, Parallel-plate capacitor. Capacitance of an isolated conductor, Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Unit II

Dielectric Properties of Matter: Electric Field in matter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric, Displacement vector **D**, Relations between **E, P** and **D.** Gauss' Law in dielectrics.

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop, Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole), Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B:** curl and divergence, Vector Potential, Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements, Torque on a current loop in a uniform Magnetic Field.

Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Ferromagnetism, B-H curve and hysteresis.

Unit III

Electromagnetic Induction: Faraday's Law, Lenz's Law, Self-Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations, Charge Conservation and Displacement current.

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits, Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width, Parallel LCR Circuit.

Unit IV

Network theorems: Ideal Constant-voltage and Constant-current Sources, Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to dc circuits.

Ballistic Galvanometer: Torque on a current Loop, Ballistic Galvanometer: Current and Charge Sensitivity, Electromagnetic damping, Logarithmic damping, CDR.

Reference Books:

1. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
2. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
3. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edition, 1998, Benjamin Cummings.
4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J.H.Fewkes & J.Yarwood Vol. I, 1991, Oxford Univ. Press.

BPH221: ELECTRICITY AND MAGNETISM LABORATORY

Credits : 02

LTP 004

Course Description: This course is offered to the students of physics as a fundamental course. The topics included in the course provide the students with broad understanding of basic principles and hands-on practice of electricity and magnetism.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Identify the presence of static electric charges and fields due to static charges

CO2: Possess adequate knowledge to analyze electrical circuits using Kirchoff's laws.

CO3: Analyze the Impedance at resonance and Quality factor Q using LCR circuit.

CO4: Identify the self-inductance of a coil by Rayleigh's method.

List of experiments:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using DeSauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self-inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
5. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Publications.

BCH201: ORGANIC CHEMISTRY I:

Basics and Hydrocarbons

Credits : 04

LTP 400

Course Description:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry.

Course learning outcomes: After completion of this course, students will be able to:

CO1: students will have knowledge of the basics of organic chemistry

CO2: understand the topic of stereochemistry of compounds

CO3: will have knowledge of aliphatic hydrocarbon

CO4: will have knowledge of alkene and alkyne pi bonding

Course Contents:

Unit I

1. Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. *Electronic Displacements:* Inductive, electrometric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit II

2. Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations

Unit III

3. Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. *Reactions of alkenes:* Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2-and 1, 4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. *Reactions of alkynes:* Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit IV

C. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

4. Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Books recommended:

• Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

• Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

• Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
• Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

BCH221: ORGANIC CHEMISTRY II LAB:

Basics and Hydrocarbons

Credits : 02

LTP 004

Course Description: This course deals with calibration of thermometer, purification of organic compounds, melting and boiling point determination and separation of a mixture using paper and thin layer chromatography.

Course learning outcomes: After completion of this course, students will be able to:
CO1: use a thermometer.
CO2: purify organic compounds using solvents.
CO3: determine melting and boiling points.
CO4: separate a mixture using chromatography.

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
a. Water
b. Alcohol
c. Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitro phenol or o-and p-aminophenol by thin layer Chromatography (TLC).

Books recommended:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

Web links:

http://nptel.ac.in/courses/1152455

BMT301: REAL ANALYSIS

Credits : 06

LTP 510

Course Description: This course will develop a deeper and more rigorous understanding of Calculus including defining terms and proving theorems about bounded/unbounded sets and sequences, Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion, Infinite series, Uniform convergence, and continuity.

Course learning outcomes: After completion of this course, students will be able to:

CO1: understand the concepts of bounded & unbounded sets, infima & suprema of a set.

CO2: understand the fundamental properties of the real numbers that underpin the formal development of real analysis.

CO3: recognizes convergent, divergent, bounded, Cauchy, and monotone sequences.

CO4: understand the theory of sequences and series, convergence and divergence of infinite series, and various tests for convergence.

Course Contents:

Unit I

Review of Algebraic and Order Properties of *R*, δ-neighborhood of a point in *R,* Idea of countable sets, uncountable sets and uncountability of *R.* Bounded above sets, bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

Unit II

The Completeness Property of *R,* The Archimedean Property, Density of Rational (and Irrational) numbers in *R*, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Unit III

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences.

Cauchy sequence, Cauchy's Convergence Criterion.

Unit IV

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Reference Books:

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, *An Introduction to Analysis,* 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis,* Prentice Hall, 2001.
4. S.K. Berberian, *A First Course in Real Analysis,* Springer Verlag, New York, 1994.
5. Apostol, TM 2002, *Mathematical Analysis*, 2nd edn, Narosa Publishing House, New Delhi.
6. Malik, SC & Savita, A 2010, *Mathematical Analysis,* New Age International Publishers.
7. Goldberg, RR 1976, *Real Analysis*, 2nd edn, Oxford & IBH Publishing Co, New Delhi.
8. Lang, S 2005, *Undergraduate Analysis*, 2nd edn., Springer-Verlag, New York.

Web Links:

1. https://en.wikipedia.org/wiki/List_of_real_analysis_topics
2. http://www.math.louisville.edu/~lee/RealAnalysis/
3.https://nptel.ac.in/courses/111/106/111106053/
4. https://nptel.ac.in/courses/111/101/111101134/

BPH302: THERMAL PHYSICS

Credits : 04

LTP 400

Course Description:

This course aims to give students a deep understanding of the fundamental principles of thermal physics. Thermal Physics forms one of the core foundations of modern natural science and plays a significant role in cutting edge research in a variety of fields ranging from condensed matter physics and materials science and engineering to molecular biology and biophysics to chemical structure and dynamics and even to high energy physics and astrophysics.

This course aims to introduce students to state-of-the art theoretical techniques and to communicate the excitement of cutting-edge research in a variety of fields where thermal physics plays a critical role.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Know the basics of thermal physics.

CO2: Make use of different problem by solving techniques in the field of thermodynamics.

CO3: Understand the kinetic theory of gases: Maxwell –Boltzmann distribution law, Brownian motion etc.

CO4: Understand the behavior of real gases in Thermal Physics.

Course Contents:

Unit I

Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Second Law of Thermodynamics: Reversible and Irreversible process with examples, Conversion of Work into Heat and Heat into Work, Heat Engines, Carnot's Cycle, Carnot engine & efficiency, Refrigerator & coefficient of performance, 2ND Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence, Carnot's Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale

Unit II

Entropy: Concept of Entropy, Clausius Theorem, Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of Increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Universe, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Temperature–Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability of Absolute Zero.

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, Their Definitions, Properties and Applications, Surface Films and Variation of Surface Tension with Temperature, Magnetic Work, Cooling due to adiabatic demagnetization, First and second order phase transitions with examples, clausius, clapeyron equation and Ehrenfest equations.

Unit III

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (No proof required), Specific heats of Gases.

Unit IV

Molecular Collisions: Mean Free Path, Collision Probability, Estimates of Mean Free Path, Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion, Brownian Motion and its Significance.

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrew's Experiments on CO_2 Gas, Critical Constants, Continuity of Liquid and Gaseous State, Vapor and Gas, Boyle Temperature, Van der Waal's Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule-Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule- Thomson Cooling.

Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press

3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill

4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

BPH322: THERMAL PHYSICS LABORATORY

Credits : 02

LTP 004

Course Description: This course aims to give students a deep understanding of the fundamental principles of thermal physics. This course aims to introduce students to state-of-the art practical techniques and to communicate the excitement of cutting-edge research in a variety of fields where thermal physics plays a critical role.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Know the basics knowledge of thermal physics.

CO2: Make use of different problem-solving techniques in the field.

CO3: Understand the concept of experiments and acquired to analyse the problem in real time applications.

CO4: Understand the behavior of thermal conductivity, using conducting and non-conducting materials for real gas.

LIST OF EXPERIMENTS

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.ol or o-and p-aminophenol by thin layer Chromatography (TLC).

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani

BCH303: PHYSICAL CHEMISTRY
PHASE EQUILIBRIA AND CHEMICAL KINETICS
Credits : 04
LTP 400

Course Description: To enable the students to understand phase equilibrium, chemical kinetic, catalysis and surface chemistry.

Course learning outcomes: After completion of this course, students will be able to:
CO1: have knowledge about concept of phases and its components.
CO2: have knowledge about phase equilibrium, colligative properties and chemical kinetics.
CO3: have knowledge about Chemical kinetics.
CO4: have knowledge about three component system
Course Contents:

Unit I

1. Phase Equilibria:

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Unit II

2. Three component systems, water-chloroform-acetic acid system, triangular plots. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit III

3. Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit IV

4. Catalysis:

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

Reference Books:

• Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed*., Oxford University Press (2010).
• Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
• Mc Quarrie, D. A. & Simon, J. D., *Molecular Thermodynamics,* Viva Books Pvt. Ltd.: New Delhi (2004).
• Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
• Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics*. CRC Press: NY (2011).
• Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
• Ball, D. W. *Physical Chemistry* Cengage India (2012).
• Mortimer, R. G. P*hysical Chemistry 3rd Ed*., Elsevier: NOIDA, UP (2009).
• Levine, I. N. *Physical Chemistry 6th Ed.*, Tata McGraw-Hill (2011).
• Metz, C. R. *Physical Chemistry 2nd Ed*., Tata McGraw-Hill (2009).

BCH323: PHYSICAL CHEMISTRY
PHASE EQUILIBRIA AND CHEMICAL KINETICS LAB
Credits : 02
LTP 004

Course Description: To enable the students to understand phase equilibrium, chemical kinetic, catalysis and surface chemistry.

Course learning outcomes: After completion of this course, students will be able to:

CO1: to test physical parameters and study phase equilibrium.

CO2: have knowledge about kinetics and adsorption isotherms.

Content:

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and

b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(a) I_2 (aq) + I^- $\rightarrow$ I_3^- (aq)

(b) Cu^{2+}(aq) + n NH_3 $\rightarrow$ Cu $(NH_3)n$

V. Study the kinetics of the following reactions.

a) Initial rate method: Iodide-persulphate reaction

b) Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

c) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate.

VI. Adsorption: Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid **on** activated charcoal.

Books recommended:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; Mc Graw-Hill: New York (2003).
- Halpern, A. M. & Mc Bane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

Web Links:

(a) www.youtube.com/watch?v=zumZL9lWKGM

(b) www.youtube.com/watch?v=zumZL9lWKGM

BMT401: NUMERICAL METHODS

Credits : 04

LTP 400

Course Description: The primary objective is to provide students with knowledge of numerical methods including root-finding, elementary numerical linear algebra, solving systems of linear equations and numerical solution to ordinary differential equations.

Course learning outcomes: After completion of this course, students will be able to:

CO1: evaluate errors arising in different calculations.

CO2: solve linear algebraic equations using Gaussian Elimination, Gauss Jordan, Gauss Jacobi, and Gauss-Seidel methods.

CO3: apply interpolation methods to find the approximate values using Lagrange's& Newton's approximations and backward as well as forward interpolation methods in engineering and science.

CO4: apply the concept of integration to find the values of different functions with given boundary conditions.

Course Contents: **(Use of Scientific Calculator is allowed.)**

Unit I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.

Unit II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss-Seidel method, and their convergence analysis.

Unit III

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Unit IV

Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule. Ordinary Differential Equations: The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method. Euler's method. Runge-Kutta methods of orders two and four.

Books Recommended

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and EngineeringComputation,* 6th Ed., New age International Publisher, India, 2007.

3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.

4. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods,* 7th Ed., PHI Learning Private Limited, 2013.

5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

Web Links:

1. https://en.wikipedia.org/wiki/Numerical_methods_for_ordinary_differential_equations
2. http://mathfaculty.fullerton.edu/mathews/numerical.html
3. http://www.codewithc.com/category/numerical-methods/
4. http://www.codeproject.com/Articles/17998/Some-simple-numerical-methods-in-C

BMT421: NUMERICAL METHODS LAB

Credits : 02

LTP 004

Course Description: The primary objective is to provide students with knowledge of numerical methods including root-finding, elementary numerical linear algebra, solving systems of linear equations and numerical solution to ordinary differential equations.

Course learning outcomes:

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

CO1: calculate the basic mathematical calculations using different software.

CO2: apply mathematical algorithms using different software's to solve linear equations and find roots of the given equations using Bisection Method, Newton Rapson Method.

CO3: calculate the approximate values of the given data using interpolation methods by algorithms.

CO4: Calculate the numerical integration between the bounded intervals using software.

List of Practicals (using any software)

(I) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.

(ii) To find the absolute value of an integer.

(iii) Enter 100 integers into an array and sort them in ascending order.

(iv) Bisection Method.

(v) Newton Raphson Method.

(vi) Secant Method.

(vii) Regula Falsi Method.

(viii) LU decomposition Method.

(ix) Gauss-Jacobi Method.

(x) SOR Method or Gauss-Siedel Method.

(xi) Lagrange Interpolation or Newton Interpolation.

(xii) Simpson's rule.

Books Recommended

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis,* Pearson Education, India, 2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 6th Ed., New age International Publisher, India, 2007.

3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.

4. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.

5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using* MATLAB, 4th Ed., PHI Learning Private Limited, 2012.

BPH404: WAVES AND OPTICS

Credits : 04

LTP 400

Course Description:

This course is offered to the students of physics as a fundamental course. The topics included in the course provide the students with broad understanding of waves and optics principles.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Understand the role of the wave equation and appreciate the universal nature of wave motion.

CO2: Understand superposition of harmonic waves.

CO3: Understand interference and diffraction (Fraunhofer and Fresnel diffraction)

CO4: Understand optical phenomena such as polarization.

Course Contents:

Unit I

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle, Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats), Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses

Unit II

Wave Motion: Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Travelling) Waves, Wave Equation, Particle and Wave Velocities, Differential Equation, Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave, Water Waves: Ripple and Gravity Waves.

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction.

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends, Analytical Treatment, Phase and Group Velocities, Changes with respect to Position and Time, Energy of Vibrating String, Transfer of Energy, Normal Modes of Stretched Strings, Plucked and Struck Strings, Melde's Experiment, Longitudinal Standing Waves and Normal Modes, Open and Closed Pipes, Superposition of N Harmonic Waves.

Unit III

Wave Optics: Electromagnetic nature of light, Definition and properties of wave front, Huygens Principle, Temporal and Spatial Coherence.

Interference: Division of amplitude and 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.

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes, Fabry-Perot interferometer.

Unit IV

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only)

Fraunhofer diffraction: Single slit, Circular aperture, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating.

Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Holography: Principle of Holography, Recording and Reconstruction Method, Theory of Holography as Interference between two Plane Waves, Point source holograms.

Reference Books

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

BPH424: WAVES AND OPTICS LABORATORY

Credits : 02

LTP 004

Course Description:

This course is offered to the students of physics as a fundamental course. The topics included in the course provide the students with practical understanding of waves and optics principles.

Course learning outcomes: After completion of this course, students will be able to:

CO1: Understand superposition of harmonic waves.

CO2: To know the interference and diffraction of Michelson's interferometer.

CO3: Understand optical phenomena by using the different sources such as sodium lamp.

CO4: Understand the principles of measurement and error analysis and develop skills in experimental design.

List of Experiments:

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

BCH401: INORGANIC CHEMISTRY-III

COORDINATION CHEMISTRY

Credits : 04

LTP 400

Course Description: The course deals with coordination chemistry, study of transition element and f–block element and bioinorganic chemistry.

Course learning outcomes: After completion of this course, students will be able to:

CO1: coordination chemistry and its importance,

CO2: various phenomena associated with coordination chemistry and bioinorganic chemistry.

CO3: properties of d and f-block element.

CO4: have knowledge about lanthanides and actinides.

Course Contents:

Unit I

Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electro neutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry, Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes

Unit II

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

Unit III

Lanthanoids and Actinoids:

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit IV

Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Reference Books:

- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
- Huheey, J.E., Inorganic Chemistry, Prentice Hall, 193.
- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley &Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997.

BCH421: INORGANIC CHEMISTRY III LAB

COORDINATION CHEMISTRY LAB

Credits : 04

LTP 004

Course Description: The course deals with the estimation of metal ions in a complex and prepare complexes along with metal ion separation.

Course learning outcomes: After completion of this course, students will be able to:

CO1: coordination chemistry and its importance

CO2: various phenomena associated with coordination chemistry.

CO3: Chromatography

1. Gravimetric Analysis:

I. Estimation of nickel (II) using Dimethylglyoxime (DMG).

ii. Estimation of copper as CuSCN

iii. Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3.

iv. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

2. Inorganic Preparations:

I. Tetra ammine copper (II) sulphate, [Cu(NH3)4]SO4.H2O

ii. Cis and trans K[Cr(C2O4)2. (H2O)2] Potassium dioxalato diaqua chromate (III)

iii. Tetra ammine carbonate cobalt (III) ion

iv. Potassium tris(oxalate)ferrate (III)

3. Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)

ii. Fe (III) and Al (III)

Books recommended:

- Vogel, A.I. A textbook of Quantitative Analysis, ELBS 1986.

Web links:

- www.youtube.com/gatechemistry/coordinationchemistry
- www.youtube.com/chemistry/coordinationchemistry

BCH503: APPLICATIONS OF COMPUTERS IN CHEMISTRY

Credits : 04

LTP 400

Course Description: This course deals with Basics, Strings and graphics, Numerical methods, Roots of equations, Simultaneous equations.

Course learning outcomes: After reading this course student will be able to have knowledge of

CO1: Strings and graphics,

CO2: Numerical methods,

CO3: Roots of equations,

CO4: Simultaneous equations

Unit I

Basics:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators.

Unit II

Strings and graphics:

Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Unit III

Numerical methods:

Roots of equations: Numerical methods for roots of equations: Quadratic formula, Iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

:

Unit IV

Simultaneous equations:

Matrix manipulation: addition, multiplication. Gauss-Siedal method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.

Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Reference Books:

- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, how to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
- Venit, S.M. Programming in BASIC: Problem solving with structure andstyle. Jaico Publishing House: Delhi (1996).

BCH523: APPLICATIONS OF COMPUTERS IN CHEMISTRY PRACTICAL

Credits : 02

LTP 004

Course Description: This course deals with Basics, Strings and graphics, Numerical methods, Roots of equations, Simultaneous equations.

Course learning outcomes: After reading this course student will be able to have knowledge of

CO1: Numerical differentiation and integration

CO2: Numerical methods,

CO3: matrices

CO4: molecular visualization software

Computer programs based on numerical methods for

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a Vander Waals gas, potentiometric titrations).
3. Numerical integration (e.g. entropy/ enthalpy changes from heat capacity data), probability distributions (gas kinetic theory) and mean values.
4. Matrix operations. Application of Gauss-Siedel method in colorimetry.
5. Simple exercises using molecular visualization software.

Reference Books:

- McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008).
- Mortimer, R. *Mathematics for Physical Chemistry.* 3rd Ed. Elsevier (2005).
- Steiner, E. *The Chemical Math's Book* Oxford University Press (1996).
- Yates, P. *Chemical Calculations.* 2nd Ed. CRC Press (2007).
- Harris, D. C. *Quantitative Chemical Analysis.* 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis,* Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical Chemistry on a Microcomputer.* Little Brown &Co. (1985).
- Venit, S.M. Programming in BASIC: *Problem solving with structure andstyle.* Jaico Publishing House: Delhi (1996).

BCH504: ANALYTICAL METHODS IN CHEMISTRY

Credits : 04

LTP 400

Course Description:

This course deals with Qualitative and quantitative aspects of analysis, Optical methods of analysis, Infrared Spectrometry, Flame Atomic Absorption and Emission Spectrometry, Thermal methods of analysis, Electroanalytical methods, Separation techniques, Chromatography, Stereo isomeric separation and analysis.

Course Learning Outcomes: After reading this course student will be able to have knowledge of

CO1: Qualitative and quantitative aspects of analysis,

CO2: Optical methods of analysis, Infrared Spectrometry,

CO3: Flame Atomic Absorption and Emission Spectrometry,

CO4: Thermal methods of analysis, Electroanalytical methods,

CO5: Separation techniques, Chromatography, Stereo isomeric separation and analysis.

Unit I

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.

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator, and detector) for single and double beam instrument.

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

Unit II

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, and 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 III

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

Classification of electroanalytical 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.

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 non-aqueous media.

Unit IV

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.

Stereo isomeric separation and analysis:

Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.

Reference Books:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis,* John Wiley & Sons, 1989.
- 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.
- Christian, G.D; *Analytical Chemistry,* 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D. C. *Exploring Chemical Analysis,* Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry.* New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis,* Cengage Learning India Ed.
- Mikes, O. L*aboratory Hand Book of Chromatographic & Allied Methods,* Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

BCH524: ANALYTICAL METHODS IN CHEMISTRY LAB

Credits : 02

LTP 004

Course Description: This course is about chromatography, solvent extractions, pH, flame photometry, ion exchangers, estimation of salts and spectrophotometry.

Course Learning Outcomes: Students will be able to

CO1: separate mixtures using chromatography.

CO2: use solvent based extractions and flame photometry.

CO3: measure pH, estimate cations and anions.

CO4: perform spectrophotometric analysis and use ion exchangers.

I. Separation Techniques

1. Chromatography:

(a) Separation of mixtures

I. Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

ii. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.

II. Solvent Extractions:

(I) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} - DMG complex in chloroform and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

1. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

2. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

3. Analysis of soil:

(I) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

4. 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 in water.
4. Determination of Chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis,* John Wiley & Sons, 1989.
- 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.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis,* Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods,* Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. A*nalytical Chemistry; Methods of Separation,* van Nostrand, 1974.

BCH505: MOLECULAR MODELLING & DRUG DESIGN

Credits : 04

LTP : 400

Course Description: This course deals with Introduction to Molecular Modelling, Force Fields, Energy Minimization and Computer Simulation, Molecular Dynamics & Monte Carlo Simulation, Structure Prediction and Drug Design

Course learning outcomes:

After reading this course student will be able to have knowledge of

CO1: Introduction to Molecular Modelling, Force Fields,

CO2: Energy Minimization and Computer Simulation,

CO3: Molecular Dynamics & Monte Carlo Simulation,

CO4: Structure Prediction and Drug Design.

Unit I

Introduction to Molecular Modelling:

Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to non-bonded interactions. Electrostatic interactions. Vander Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

Unit II

Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods.Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

Unit III

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models.

Molecular Dynamics with continuous potentials. Molecular Dynamics at constanttemperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

Unit IV

Structure Prediction and Drug Design:

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by Threading, Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemo-informatics – QSAR.

Books recommended:

- Leach, A.R. *Molecular Modelling Principles and Application*, Longman,2001.
- Haile, J.M. *Molecular Dynamics Simulation Elementary Methods,* John Wiley and Sons, 1997.
- Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

BCH525: MOLECULAR MODELLING & DRUG DESIGN LAB

Credits : 02

LTP : 004

Course Description: This course deals with study of molecular modeling and designing of drugs using it.

Course learning outcomes: Students will be able to:

CO1: perform modeling of different compounds and find conformations.

CO2: comparison of structures on the basis of different parameters.

(I) Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.

(ii) (a) Perform a conformational analysis of butane.

(b) Determine the enthalpy of isomerization of cis and trans 2-butene.

(iii) Visualize the electron density and electrostatic potential maps for LiH, HF, N2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.

(iv) (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character.

(b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.

(V) (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule.

(b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).

(vi) Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound:

(a) Alkyl halide

(b) aldehyde

(c) ketone
(d) amine
(e) ether
(f) nitrile
(g) thiol
(h) carboxylic acid
(i) ester
(j) amide.
(vii) (a) Determine the heat of hydration of ethylene.
(b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
(viii) Arrange 1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2, 3-dimethyl-2-butene in order of increasing stability.
(ix) (a) Compare the optimized bond angles H_2O, H_2S, H_2Se.
(b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.
Note: Software: Chem Sketch, Argus Lab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), Web Lab Viewer, Hyperchem, or any similar software.

Reference Books:

- Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
- Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
- Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

BCH506: NOVEL INORGANIC SOLIDS

Credits : 04

LTP 400

Course Description: This course deals with synthesis and modification of inorganic solids, Inorganic solids of technological importance, Nanomaterials, engineering materials for mechanical construction, Composite materials, and Specialty polymers.

Course Learning Outcomes:

After reading this course student will be able to have knowledge of

CO1: Synthesis and modification of inorganic solids,
CO2: Inorganic solids of technological importance,
CO3: Nanomaterials,
CO4: Engineering materials for mechanical construction, Composite materials, Specialty polymers.

Unit I

Synthesis and modification of inorganic solids:
Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, hydrothermal method, Ion-exchange and Intercalation methods.
Inorganic solids of technological importance:
Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments. Molecular material and fullerides, molecular materials & chemistry – one dimensional metals, molecular magnets, inorganic liquid crystals.

Unit II

Nanomaterials:
Overview of nanostructures and nanomaterials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled Nanostructures control of nano architecture-one dimensional control. Carbon nanotubes and inorganic Nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bio Nano composites.

Unit III

Introduction to engineering materials for mechanical construction:

Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

Composite materials:

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fiber-reinforced composites, environmental effects on composites, applications of composites.

Unit II

Specialty polymers:

Conducting polymers - Introduction, conduction mechanism, polyacetylene,

Poly Para phenylene and polypyrrole, applications of conducting polymers, Ion exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

Reference Books:

- Shriver & Atkins. *Inorganic Chemistry,* Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
- Adam, D.M. Inorganic Solids: *An introduction to concepts in solid-state structural chemistry.* John Wiley & Sons, 1974.
- Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley &Sons, 2003.
- Rodger, G.E. *Inorganic and Solid State Chemistry,* Cengage Learning India Edition, 2002.

BCH526: NOVEL INORGANIC SOLIDS LAB

Credits : 02

LTP 004

Course Description: To understand use of ion exchangers, total difference, hydrogel synthesis and nanoparticles synthesis.

Course learning outcomes: Students will be able to

CO1: use ion exchangers

CO2: synthesize hydrogel and nanoparticles.

1. Determination of cation exchange capacity
2. Determination of total difference of solids.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of silver and gold metal nanoparticles.

Reference Book:

- Fahlman, B.D. *Materials Chemistry,* Springer, 2004.

BCH507: MOLECULAR SPECTROSCOPY

Credits : 04

LTP 400

Course Description: This course deals with concept of spectroscopy (MW, IR, NMR, UV-VISIBLE)

Course Learning Outcomes: After reading this course student will be able to

CO1: have knowledge of concept and applications of general spectroscopy

CO2: rotational, vibrational and Infrared spectroscopy

CO3: Raman spectroscopy

CO4: UV-visible spectroscopy.

Unit I

1. General features of Spectroscopy:

Units and conversion factors, Introduction to spectroscopy, Nature of radiation, Energies corresponding to various kinds of radiation, Intensities of spectral lines, selection rules and transition moments, Line widths, Broadening (Book 1)

2. Pure Rotational Spectra:

Classification of molecules according to their moment of inertia. Rotational energy levels of hydrogen chloride. Determination of molecular geometry by rotational spectrum, isotopic substitution effects. Stark effect, Estimation of molecular dipole moments, Selection rules, Rotational Raman Spectra, anisotropic polarizability, specific selection rule in Raman Spectra, Stokes and anti – Stokes lines.

Unit II

3. Vibrational Spectra:

Diatomic molecules, Force constants, Fundamental vibration frequencies, anharmonicity of molecular vibrations and its effect on vibrational frequencies, Frequencies of the vibrational transitions of HCl. Vibrational rotation spectra of CO, P,Q and R branches.

Unit III

4. Infrared and Raman Spectra:

Vibrations of polyatomic molecules. Examples of CO2, H2O. Mechanics of measurement of infrared and Raman spectra, absorption of common functional groups, their dependence on chemical environment (bond order, conjugation, H – bonding), Use of group theory to determine the number of active infrared and Raman active lines. Fermi resonance, combination bands and overtones, complications due to interactions of vibrations of similar frequency. Application of IR in structure elucidation of organic compounds – Carbonyls and effect of substituents on it, C-H, N-H, O-H vibrations and H-bonding – unsubstituted, mono and di-substitute aromatic compounds – Far IR region, Metal ligand vibrations, Group frequencies of complex ligands –CN stretching and effect of co-ordination on it. Nitro-nitrito- and C=O ligands and the effect of their co-ordination with metal ions and IR spectra.

Unit IV

5. UV and Visible Spectroscopy of organic molecules:

Measurement technique, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Frank Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra.Chromophores, auxochromes, electronic spectra of polyatomic molecules, Woodward rules for conjugated dienes and α, β- unsaturated carbonyl groups, extended conjugated and aromatic sterically hindered systems, red shift, blue shift, hypo and hyperchromic effect.

References:

- R.S. Drago, "Physical Methods in Chemistry".
- R.M. Silverstein, G.C. Bassler, T.C. Morrill, "Spectrometric Identification of Organic Compounds.
- W. Kemp, "Organic Spectroscopy".
- D.H. Williams, I. Pleming, "Spectroscopic Methods in Organic Chemistry".
- J.R.Dyer, "Application of Absorption Spectroscopy of Organic Compounds".
- D. H. Williams, I. Fleming, "Spectroscopic Problems in Organic Chemistry" 1967.
- R.C. Banks, E.R. Matjeka, G. Mercer, "Introductory Problems in Spectroscopy" 1980.
- G.M. Barrow "Introduction to Molecular Spectroscopy".
- C.N. Banwell "Fundamentals of Molecular Spectroscopy".
- D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy" Hartcourt College Publishers, 2001

BCH527: Molecular Spectroscopy LAB

Credits : 02

LTP 004

Course Description: To know about applications of UV-visible spectroscopy and Colourimetry.

Course learning outcomes: Students will be able to:

CO1: perform UV-visible analysis.

CO2: find parameters using Colourimeter.

UV/Visible spectroscopy

I.Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ max values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).

II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.

III. 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.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration

II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1, 10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

VII. Analysis of the given vibration-rotation spectrum of HCl (g).

Reference Books

• Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

• Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in *Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

• Halpern, A. M. &Mc Bane, G. C. *Experimental Physical Chemistry 3rd Ed*.; W.H. Freeman & Co.: New York (2003).

BCH508: RESEARCH METHODOLOGY FOR CHEMISTRY

Credits : 06

LTP 510

Course Description: This course deals with Literature Survey, Print, Digital, Information Technology and Library Resources, Methods of Scientific Research and Writing Scientific Papers, Chemical Safety and Ethical Handling of Chemicals, Data Analysis, Electronics.

Course Learning Outcomes: After reading this course student will be able to

CO1: have knowledge about basics of journals and their resources.

CO2: learn how to write scientific papers.

CO3: have knowledge about safe handling of Chemicals and instruments.

CO4: knowledge about Data analysis.

Unit I

Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC info net, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, Chem Industry, Wiki- Databases, Chem Spider, Science Direct, Sci Finder, Scopus.

Unit II

Information Technology and Library Resources:

Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

Unit III

Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Unit IV

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry.* 2nd Ed. Prentice-Hall, Harlow.
- Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry.* Oxford University Press.
- Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.
- Harris, D. C. *Quantitative chemical analysis.* 6th Ed., Freeman (2007) Chapters 3-5.

- Levie, R. de, *how to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge Univ. Press (2001) 487 pages.
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
- OSU safety manual 1.01.

BCH509: GREEN CHEMISTRY

Credits : 04

LTP 400

Course Description: This course deals with Introduction to Green Chemistry, Principles of Green Chemistry and Designing a Chemical synthesis, Examples of Green Synthesis/ Reactions and some real-world cases, Future Trends in Green Chemistry.

Course Learning Outcomes: After reading this course student will be able to

CO1: have knowledge of principles as well as scope of green chemistry and Green methods of synthesis.

CO2: learn daily routine experiments and future scope of green chemistry.

CO3: examples of green reactions

CO4: future aspects in green chemistry.

Unit I

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

1. Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

2. Prevention/ minimization of hazardous/ toxic products reducing toxicity risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

3. Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.

Unit II

4. Energy requirements for reactions – alternative sources of energy: use of microwaves and

ultrasonic energy.

5. Selection of starting materials; avoidance of unnecessary derivatization–careful use of blocking/protecting groups.

6. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

7. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

8. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit III

Examples of Green Synthesis/ Reactions and some real-world cases

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium imino diacetate (alternative to Strecker synthesis)

2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions inorganic solvents Diels-Alder reaction and Decarboxylation reaction

3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)

4. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.

5. Designing of Environmentally safe marine antifoulant.

Unit IV

6. Right fit pigment: synthetic azo pigments to replace toxic organic and inorganic pigments.

7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

8. Healthier fats and oil by Green Chemistry: Enzymatic inter esterification for production of no Trans-Fats and Oils

9. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting**.**

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

Reference Books:

- Ahluwalia, V.K. & Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).
- Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
- Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
- Ryan, M.A. & Tinnes and, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
- Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.

BCH529: GREEN CHEMISTRY LAB

Credits : 02

LTP 004

Course Description: This course deals with importance of green chemistry in our daily life.

Course learning outcomes: Students will learn about:

CO1: green resources and how to apply green chemistry principles.

CO2: Usage of enzymes as catalysts.

1. Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources

Preparation of biodiesel from vegetable/ waste cooking oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH- → propene + trimethyl propene + water

(II) 1-propanol H_2SO_4/propene + water

Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice. Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy

Solvent free, microwave assisted one pot synthesis of phthalocyanine complexof copper (II).

Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

- Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment.* American Chemical Society, Washington DC (2002).
- Ryan, M.A. *Introduction to Green Chemistry,* Tinnes and; (Ed), American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green *Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi.* Bangalore CISBN 978-93-81141-55-7 (2013).
- Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry,* American Chemical Society (2008).
- Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
- Lancaster, M. Green Chemistry: *An Introductory Text* RSC Publishing, 2nd Edition, 2010.
- Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. I*ntroduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach*, W.B. Saunders, 1995.

BCH603: INDUSTRIAL CHEMICALS AND ENVIRONMENT

Credits : 04

LTP 400

Course Description: This course deals with Industrial Gases and Inorganic Chemicals, Industrial Metallurgy, Environment and its segments, Water Pollution, Energy & Environment, Biocatalysis.

Course Learning Outcomes:

After reading this course student will be able to have knowledge of

CO1: Industrial Gases and Inorganic Chemicals,

CO2: Industrial Metallurgy,

CO3: Environment and its segments,

CO4: Water Pollution,

CO5: Energy & Environment,

CO6: Biocatalysis

Unit I

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Unit II

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO_2, CO_2, CO, NOx, H_2S and other foul-smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Unit III

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

Unit IV

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

Introduction to Biocatalysis: Importance in “Green Chemistry” and Chemical Industry.

Reference Books:

- E. Stocchi: *Industrial Chemistry,* Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes,* Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry,* CBS Publishers, New Delhi.
- S. S. Dara: A T*extbook of Engineering Chemistry,* S. Chand & Company Ltd. New Delhi.

- K. De, *Environmental Chemistry:* New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis:* Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry,* CRC Press (2005).
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- Mishra, *Environmental Studies.* Selective and Scientific Books, New Delhi (2005).

BCH623: INDUSTRIAL CHEMICALS & ENVIRONMENT LAB

Credits : 02

LTP 004

Course Description:

To understand how to determine the amount of pollutants in water and air.

Course learning outcomes: Students will be able to

CO1: find COD, BOD, chlorine, DO, salinity and alkalinity of water samples.

CO2: learn about bioindicators, SPM and preparation of borax.

Content

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples ($CO3^{2}$-, HCO_3-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

E. Stocchi: *Industrial Chemistry,* Vol-I, Ellis Horwood Ltd. UK.

R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.

J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

S. S. Dara: *A Textbook of Engineering Chemistry,* S. Chand & Company Ltd. New Delhi.

K. De, *Environmental Chemistry:* New Age International Pvt. Ltd, New Delhi.

S. M. Khopkar, *Environmental Pollution Analysis:* Wiley Eastern Ltd, New Delhi.

BCH604: DSE: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

Credits : 04

LTP 400

Course Description: This course deals with Silicate Industries, Fertilizers, Surface Coatings, Batteries, Alloys, Catalysis, Chemical explosives.

Course Learning Outcomes: After reading this course student will be able to

Co1: have knowledge about properties of glasses, ceramics and cements.

CO2: learn applications of fertilizers, coatings and usage of batteries.

CO3: learn about alloys and catalysts .

CO4: learn about chemical explosives.

Unit I

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armored glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit II

Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fireretardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Unit III

Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolytebattery. Fuel cells, Solar cell and polymer cell.

Alloys: Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorization) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Unit IV

Catalysis: General principles and properties of catalysts, homogenous catalysis (catalytic stepsand examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellant.

Reference Books:

- E. Stocchi: *Industrial Chemistry,* Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*,Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry,* CBS Publishers, New Delhi.
- P. C. Jain & M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
- B. K. Sharma: *Engineering Chemistry,* Goel Publishing House, Meerut.

BCH624: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE LAB

Credits : 02

LTP : 004

Course Description: To determine fertilizer parameters, composition of dolomite, using electroless metallic coatings and analysis of metal ions.

Course learning outcomes: Students will be able to:

CO1: estimate acidity in fertilizer and its composition.

CO2: carry out electroless coating.

CO3: do analysis of copper, nickel and zinc and prepare zinc oxide.

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of calcium in calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes,* Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry,* CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).

BCH605: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Credits : 04

LTP 400

Course Description: This course deals with Introduction to spectroscopic methods of analysis, Molecular spectroscopy, Separation techniques, Elemental analysis, NMR spectroscopy, Electroanalytical Methods, Radiochemical Methods.

Course Learning Outcomes: After reading this course student will be able to

CO1: find use of infrared and UV-visible spectroscopy.

CO2: learn about different chromatographic techniques.

CO3: have knowledge of Mass Spectrometry, potentiometry, voltametry and radiochemical methods.

CO4: learn about NMR spectroscopy.

Unit I

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Unit II

Molecular spectroscopy:

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/Near IR – emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).

Unit III

Separation techniques

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

Unit IV

Elemental analysis:

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

NMR spectroscopy: Instrumentation,

Electroanalytical Methods: Potentiometry & Voltammetry

Radiochemical Methods

Reference books:

- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis,* Cengage Learning India Ed.
- 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.
- P.W. Atkins: Physical Chemistry.
- G.W. Castellan: Physical Chemistry.
- C.N. Banwell: Fundamentals of Molecular Spectroscopy.
- Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
- W.J. Moore: Physical Chemistry.

BCH625: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LAB

Credits : 02

LTP : 004

Course Description: To understand different methods of analysis.

Course learning outcomes: Students will be able to:

CO1: use different equipment such as UV-visible spectrophotometer, GC and HPLC.

Co2: perform different chemical analyses.

Content:

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do "presumptive tests" to identify blood or other body fluids.
16. Use of "presumptive tests" for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fiber analysis

At least 10 experiments to be performed.

- **Reference Books:**

- Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
- 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.

BMT503: NUMBER THEORY

Credits : 06

LTP : 510

Course Description: The aim of this module is to introduce students to some of the basic ideas of number theory, and to use this as a context in which to discuss the development of mathematics through examples, conjectures, theorems, proofs and applications

Course learning outcomes: Students will be able to:

CO1: To interpret the concept of divisibility, prime number, congruence & related theorems.

CO2: To understand the logic and methods behind the major proofs in number theory.

CO3: Add and subtract integers modulo n, multiply integers and calculate powers.

CO4: To study & apply concepts of primitive roots & quadratic reciprocity.

Course content:

Unit I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear Congruences.

Unit II

Complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function.

Unit III

Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion,

Unit IV

Primitive root & indices, quadratic residue, the Legendre symbol and its properties, Euler's criterion, Gauss lemma, Jacobi symbol & its properties, quadratic reciprocity, Fermat's Last theorem. files in MS-Access, Switching between applications.

Books Recommended

1. David M. Burton, *Elementary Number Theory,* 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.

2. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

BMT504: THEORY OF EQUATIONS

Credits : 06

LTP : 510

Course Description: In this course, students will learn about polynomial functions as wll as symmetric functions and various methods to find out the roots of these type of equations.

Course learning outcomes: Students will be able to:

CO1: Different methods to construct and solve the polynomial functions

Co2: How to identify symmetric functions as well as solution methods of symmetric equations

CO3: Various methods to solve polynomial equations.

Course content:

Unit I

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum value of polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

Unit II

Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

Unit III

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, and limits of the roots of equations.

Unit IV

Separation of the roots of equations, Strum theorem, Applications of Strum's theorem, Conditions for the reality of the roots of an equation, and biquadratic. Solution of numerical equations.

Recommended Books / Suggested Readings:

1. W.S. Burnside and A.W. Panton, *The Theory of Equations,* Dublin University Press, 1954.

2. C. C. MacDuffee, *Theory of Equations,* John Wiley & Sons Inc., 1954.

BMT505: PROBABILITY AND STATISTICS

Credits : 06

LTP : 510

Course Description: The course will lay the foundation for the probability theory and Statistical modeling of outcomes of random experiments through standard distributions. The focus will be on Statistical Techniques used for the summarization and analysis of data.

Course learning outcomes: Students will be able to:

Co1: explain the concept of a random variable and the probability distributions.

CO2: define the concept of discrete and continuous distributions of random variables and solve the problems about these distributions.

CO3: formulate joint moment generating functions, covariance, and linear regression of two variables.

CO4: to understand the concept of random variables as well as statistical techniques used for summarization and analysis of data.

Course content:

Unit I

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function,

Unit II

discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations,

Unit III

independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Unit IV

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.*

2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications,* 7th Ed., Pearson Education, Asia, 2006.

3. Sheldon Ross, *Introduction to Probability Models,* 9th Ed., Academic Press, Indian Reprint,2007.

4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

BMT506: MECHANICS

Credits : 06

LTP : 510

Course Description:

1. This course is offered to the students as a foundation course.
2. This course is designed to enhance the understanding of basic phenomena of physics.

Course learning outcomes:

At the end of this course, students will be able:

CO1: concept & applications of moments

CO2: concept & applications of friction,

CO3: concept & applications of energy,

CO4: concept & applications of different types of references for a particle.

Course content:

Unit I

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections.

Unit II

General equations of equilibrium, two-point equivalent loading, problems arising from structures, static indeterminacy. Laws of Coulomb friction, application to simple and complex surface contact friction problems, the transmission of power through belts, screw jack, wedge, the first moment of an area and the centroid, other centers.

Unit III

Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes. Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass.

Unit IV

Moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies, Chasles' theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references.

Books Recommended

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics,* 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

BMT507: PORTFOLIO OPTIMIZATION

Credits : 06

LTP : 510

Course Description:

In this course, students will gain an understanding of the theory underlying optimal portfolio construction, the different ways portfolios are actually built-in practice, and how to measure and manage the risk of such portfolios.

Course learning outcomes:

At the end of this course, students will be able:

CO1: identify different types of risks in the financial sector.

CO2: understand portfolio optimization.

CO3: understand Capital market theory.

CO4: understand Portfolio performance evaluation measures

Course content:

Unit I

Financial markets. Investment objectives. Measures of return and risk. Types of risks. Risk free assets. Mutual funds. Portfolio of assets

Unit II

Expected risk and return of the portfolio. Diversification. Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem,

Unit III

Risk-free assets and one fund theorem, efficient frontier. Portfolios with short sales. Capital market theory

Unit IV

Capital assets pricing model- the capital market line, beta of an asset, beta of a portfolio, security market line. Index tracking optimization models. Portfolio performance evaluation measures.

Books Recommended

1. F. K. Reilly, Keith C. Brown, *Investment Analysis and Portfolio Management,* 10th Ed., South-Western Publishers, 2011.

2. H.M. Markowitz, Mean-V*ariance Analysis in Portfolio Choice and Capital Markets,* Blackwell, New York, 1987.

3. M.J. Best, Portfolio *Optimization,* Chapman and Hall, CRC Press, 2010.

4.D.G. Luenberger, *Investment Science,* 2nd Ed., Oxford University Press, 2013.

BMT508: BOOLEAN ALGEBRA AND AUTOMATA THEORY

Credits : 06

LTP : 510

Course Description:

The aim of this course is to enable students to understand about lattices, Boolean algebra, finite automata, turning machines and un-decidability.

Course learning outcomes:

At the end of this course, students will be able:

CO1: to understand in detail about Posets and lattices.

CO2: apply the principles of number system, binary codes and Boolean algebra to minimize logic expressions.

CO3: analyze the fundamentals of theory of computation and design an infinite language in finite ways through deterministic finite automata, regular languages.

CO4: formulate different abstract models like PDA, CFGs and non-deterministic PDA, pumping Lemma.

CO5: discuss turning machine as a computational model and define whether a problem is decidable and undecidable.

Course content:

Unit I

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sub-lattices, products and homomorphisms.

Unit II

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Unit III

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

Unit IV

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.

Un-decidability: Recursively enumerable and recursive languages, un-decidable problems about Turing machines: halting problem, Post Correspondence Problem, and un-decidability problems About CFGs.

Books Recommended

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order,* Cambridge University Press, Cambridge, 1990.

2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore)* P.Ltd., Indian Reprint 2003.

3. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

4. J. E. Hopcroft, R. Motwani and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation,* 2nd Ed., Addison-Wesley, 2001.

5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, *Elements of the Theory of Computation*, 2nd Ed., Prentice-Hall, NJ, 1997.

6. J.A. Anderson, *Automata Theory with Modern Applications,* Cambridge University Press,2006.

BMT509: LINEAR PROGRAMMING

Credits : 6

LTP : 510

Course Description: This is an introductory course on formulating mathematical models and developing solution methods for real-life optimal decision problems. Students will study how to obtain the best decisions in allocating scarce resources.

Course learning outcomes: Students will be able to:

CO1: Formulate a given simplified description of a suitable real-world problem as a linear programming model in general, standard and canonical forms.

CO2: Describe quantitative methods used in decision making.

CO3: Explain transportation model solution methods.

CO4: Develops and solve assignment models.

CO5: Identify strategic situations and represent them as games.

Course content:

Unit I

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Unit II

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Unit III

Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit IV

Game theory: formulation of two-person zero sum games, solving two-person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

BMT510: DIFFERENTIAL GEOMETRY

Credits : 06

LTP : 510

Course Description: The objective is to provide a basic understanding of the geometry of two and three dimensions.

Course learning outcomes:

At the end of this course, students will be able to

CO1: understand about theory of space curves,

CO2: understand about theory of surfaces,

CO3: understand about geodesics.

CO4: understand about tensors in detail**.**

Contents:

Unit I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Fernet formulae. Osculating circles, Osculating circles and spheres. The existence of space curves. Evolutes and involutes of curves.

Unit II

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula, Conjugate and Asymptotic lines. Developable: Developable associated with space curves and curves on surfaces, Minimal surfaces.

Unit III

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem. Surfaces of constant curvature. Conformal mapping. Geodesic mapping. Tissot's theorem.

Unit IV

Tensors: Summation convention and indicial notation, Coordinate transformation and Jacobian, Contra-variant and Covariant vectors, Tensors of different type, Algebra of tensors and contraction, Metric tensor and 3-index Christoffel symbols, Parallel propagation of vectors, Covariant and intrinsic derivatives, Curvature tensor and its properties, Curl, Divergence and Laplacian operators in tensor form, Physical components.

Books Recommended

1. T.J. Willmore, *An Introduction to Differential Geometry,* Dover Publications, 2012.
2. B. O'Neill, *Elementary Differential Geometry,* 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, *Differential Geometry of Three Dimension*s, Cambridge University Press 2003.
4. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.
5. S. Lang, *Fundamentals of Differential Geometry,* Springer, 1999.
6. B. Spain, *Tensor Calculus: A Concise Course,* Dover Publications, 2003.

BMT511: MATHEMATICAL MODELING

Credits : 06

LTP : 510

Course Description: The aim of this course is to enable students to build mathematical models of real-world systems, analyze them and make predictions about the behavior of these systems.

Course learning outcomes: Students will be able to:

Co1: understand & will be able to solve differential equations using the power series method.

CO2: understand application to initial value problem up to second order.

CO3: Assess and articulate what type of modeling techniques are appropriate for a given physical system, construct a mathematical model of a given physical system and analyze it, and make predictions of the behavior of a given physical system based on the analysis of its mathematical model.

Course content:

Unit I

Power series solution of a differential equation about an ordinary point, solution about a regular singular point.

Unit II

Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.

Unit III

Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence,

Unit IV

Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis

List of Practicals (using any software)

(I) Plotting of Legendre polynomial for n = 1 to 5 in the interval [0,1]. Verifying graphically that all the roots of Pn (x) lie in the interval [0,1].

(ii) Automatic computation of coefficients in the series solution near ordinary points.

(iii) Plotting of the Bessel's function of the first kind of order 0 to 3.

(iv) Automating the Frobenius Series Method.

(v) Random number generation and then use it for one of the following (a) Simulate area under a curve (b) Simulate volume under a surface.

(vi) Programming of either one of the queuing models (a) Single server queue (e.g. Harbor system) (b) Multiple server queue (e.g. Rush hour).

(vii) Programming of the Simplex method for 2/3 variables.

Books Recommended

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equation for Scientists and Engineers,* Springer, Indian reprint, 2006.

2. Frank R. Giordano, Maurice D. Weir and William P. Fox, *A First Course in Mathematical Modeling,* Thomson Learning, London and New York, 2003.

BPH503: EXPERIMENTAL TECHNIQUES

Credits : 04

LTP : 400

Course Description: This course provides a detailed account of some common experimental techniques in physics research. It introduces the basic working principles, the operational know-how and the strength and limitations of the techniques.

Course learning outcomes:

Students will be able to:

CO1: Identify the assumptions underlying any experimental measurement made in the physics laboratory.

CO2: Identify and explain the limitations of the hypothesis behind your planned (and completed) experimental measurements.

CO3: Acquire the knowledge and analyzed the concept of Digital Millimeter.

CO4: Identify the limitations of proposed and planned experimental measurements

Course Contents:

Unit I

Measurements: Accuracy and precision, Significant figures, Error and uncertainty analysis, Types of errors: Gross error, systematic error, random error, Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting, Gaussian Distribution.

Signals and Systems: Periodic and aperiodic signals, Impulse response, transfer function and frequency response of first and second order systems, Fluctuations and Noise in measurement system. S/N ratio and Noise figure, Noise in frequency domain, Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.

Unit II

Shielding and Grounding: Methods of safety grounding, Energy coupling, Grounding, Shielding: Electrostatic shielding, Electromagnetic Interference.

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems, Generalized performance of systems, Zero order first order, second order and higher order systems, Electrical, Thermal and Mechanical systems, Calibration, Transducers and sensors, Characteristics of Transducers, Transducers as electrical element and their signal conditioning, Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

Unit III

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement**.**

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge, Q-meter and its working operation, Digital LCR bridge.

Unit IV

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path, Application of vacuum, Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

Reference Books:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
4. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
5. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sharma, V.S.V. Mani, Tata McGraw Hill
6. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
7. Electronic circuits: Handbook of design & applications, U. Tietze, Ch. Schenk, Springer

BPH523: EXPERIMENTAL TECHNIQUES LABORATORY

Credits : 02

LTP : 004

Course Description: This course provides a detailed account of some common experimental techniques in physics research. It introduces the basic working principles, the operational knowhow and the strength and limitations of the techniques.

Course learning outcomes:

Students will be able to:

CO1: Identify the assumptions underlying any experimental measurement made in the physics laboratory.

CO2: Identify and explain the limitations of the hypothesis behind your planned (and completed) experimental measurements.

CO3: Explain the hypothesis of junctions' diode.

CO4: Understand and explain the various characteristics of circuit.

List of Experiments:

1. Determine output characteristics of an LVDT & measure displacement using LVDT.
2. Measurement of Strain using Strain Gauge.
3. Measurement of the level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode.
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter.

Reference Books:

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, McGraw Hill
3. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

BPH504: EMBEDDED SYSTEM: INTRODUCTION TO MICROCONTROLLERS

Credits : 04

LTP : 400

Course Description: The main objective of this course is to provide the student with the basic understanding of embedded systems design. This includes system requirements specifications, architectural and detailed design, and implementation, focusing on real-time applications.

Course learning outcomes:

Completion of this course will enable the students to:

CO1: Have knowledge about the basic working of a microcontroller system and its programming in assembly language.

CO2: To provide experience to integrate hardware and software for microcontroller applications systems.

CO3: various addressing modes, assembly language

CO4: To acquire the knowledge of Interfacing 8051 microcontroller to peripherals.

Course Contents:

Unit I

Embedded system introduction: Introduction to embedded systems and general-purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems, operational and non-operational quality attributes of embedded systems, elemental description of embedded processors and microcontrollers.

Review of microprocessors: Organization of Microprocessor based system, 8085μp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts

Unit II

8051 microcontrollers: Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

8051 I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions, I/O port programming in 8051 (using assembly language), I/O programming: Bit manipulation.

Unit III

Programming: 8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic and logic instructions, 8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations, for ASCII and BCD conversions.

Timer and counter programming: Programming 8051 timers, counter programming.

Serial port programming with and without interrupt: Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupts, interrupt priority in the 8051.

Unit IV

Interfacing 8051 microcontrollers to peripherals: Parallel and serial ADC, DAC interfacing, LCD interfacing.

Programming Embedded Systems: Structure of embedded program, infinite loop, compiling, linking, and locating, downloading and debugging.

Embedded system design and development: Embedded system development environment, file types generated after cross-compilation, disassembler/decompiler, simulator, emulator and debugging, embedded product development life cycle, trends in the embedded industry.

Introduction to Arduino: Pin diagram and description of Arduino UNO. Basic programming.

Reference Books:

1. Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.

3. Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole
4. Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.
5. Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
6. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning.

BPH524: EMBEDDED SYSTEM: INTRODUCTION TO MICROCONTROLLERS LABORATORY

Credits : 02

LTP : 004

Course Description: The main objective of this course is to provide the student with the basic understanding and hands-on practice of embedded systems design. This includes system requirements specifications, architectural and detailed design, and implementation, focusing on real-time applications.

Course learning outcomes:

Completion of this course will enable the students to:

Co1: Have knowledge about the basic working of a microcontroller system and its programming in assembly language.

CO2: To provide experience to integrate hardware and software for microcontroller applications systems.

CO3: To provide experience of embedded systems and applications.

List of Experiments:

8051 microcontroller-based Programs and experiments

1. To find that the given numbers is prime or not.
2. To find the factorial of a number.
3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's.
5. Program to glow the first four LEDs then next four using TIMER application.
6. Program to rotate the contents of the accumulator first right and then left.
7. Program to run a countdown from 9-0 in the seven segment LED display.
8. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9. To toggle '1234' as '1324' in the seven segment LED display.

10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.

11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

Arduino based programs and experiments:

12. Make a LED flash at different time intervals.

13. To vary the intensity of LED connected to Arduino.

14. To control speed of a stepper motor using a potential meter connected to Arduino.

15. To display "PHYSICS" on LCD/CRO

Reference Books:

1. Embedded Systems: Architecture, Programming& Design, R. Kamal, 2008,Tata McGraw Hill

2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.

3. Embedded Microcomputor System: Real Time Interfacing, J. W. Valvano, 2000, Brooks/Cole

4. Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.

5. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

BPH505: PHYSICS OF DEVICES AND COMMUNICATION

Credits : 04

LTP : 400

Course Description: To enhance students' comprehension capabilities through understanding analog electronic devices, BJT, FET etc. To introduce the concept of analytical Instrumentation, methods, techniques and applications.

Course learning outcomes: Students will be able to:

Co1: To develop basic knowledge and practical skills.

CO2: To introduce pressure, level, flow & temperature measurement.

CO3: To do basic calibration of simple instruments.

CO4: Understand Basic of oscilloscope, signal and pulse generator.

Course content:

Unit I

Devices: Characteristic and small signal equivalent circuits of UJT and JFET, Metal-semiconductor Junction, Metal oxide semiconductor (MOS) device, Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits, Enhancement and Depletion Mode MOSFETS, CMOS, Charge-coupled devices, Tunnel diode.

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, short circuit protection

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters

Unit II

Multivibrators: A stable and Monostable Multivibrators using transistors.

Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture, Basic idea of PLL IC (565 or 4046).

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon, Crystal plane and orientation, Defects in the lattice, Oxide layer, Oxidation Technique for Si, Metallization technique, Positive and Negative Masks, Optical lithography, Electron lithography, Feature size control and wet anisotropic etching, Lift off Technique, Diffusion and implantation.

Unit III

Digital Data Communication Standards:

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers, Devices (Basic idea of UART).

Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC, Basic idea of sending data through a COM port.

Unit IV

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation, Amplitude modulation, Modulation Index, Analysis of Amplitude Modulated wave, Sideband frequencies in AM wave, CE Amplitude Modulator, Demodulation of AM wave using Diode Detector, basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

Reference Books:

1. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
2. Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
3. Op-Amps & Linear Integrated Circuits, R. A. Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
4. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
5. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
6. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
7. Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
8. PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India

BPH525: PHYSICS OF DEVICES AND COMMUNICATION LABORATORY

Credits : 02

LTP : 004

Course Description: To enhance comprehension capabilities of students through understanding of analog electronic devices, BJT, FET etc. To introduce the concept of analytical Instrumentation, methods, techniques and applications.

Course learning outcomes:

Students in this course will be able –

CO1: To develop the basic knowledge and practical skills.

CO2: To introduce pressure, level, flow & temperature measurement.

CO3: To do basic calibration of simple instruments.

CO4: Understand Basic of oscilloscope, signal and pulse generator.

List of Experiments:

5-8 Experiments from both Section A and Section B:

Section-A

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To study the output characteristics of a MOSFET.
6. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
7. To design an Amplitude Modulator using Transistor.
8. To design PWM, PPM, PAM and Pulse code modulation using ICs.
9. To study envelope detector for demodulation of AM signal.
10. Glow an LED via USB port of PC.

Section-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain

4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.

Reference Books:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M. A. Miller,1994, McGraw Hill
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata McGraw Hill.
3. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
5. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning.
6. PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India

BPH506: ADVANCED MATHEMATICAL PHYSICS

Credits : 04

LTP : 400

Course Description: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Learning Objectives

Completion of this course will enable the students to:

CO1: Understand linear algebra.

CO2: Understand basics of linear transformations and tensors.

CO3: Understand calculus of variations.

CO4: Understand the General Tensors and its applications.

Course content:

Unit I

Linear Vector Spaces: Abstract Systems, Binary Operations and Relations, Introduction to Groups and Fields, Vector Spaces and Subspaces, Linear Independence and Dependence of Vectors, Basis and Dimensions of a Vector Space. Change of basis, Homomorphism and Isomorphism of Vector Spaces, Linear Transformations, Algebra of Linear Transformations, Non-singular Transformations, Representation of Linear Transformations by Matrices.

Unit II

Matrices: Addition and Multiplication of Matrices, Null Matrices, Diagonal, Scalar and Unit Matrices, Upper-Triangular and Lower-Triangular Matrices, Transpose of a Matrix, Symmetric and Skew-Symmetric Matrices, Conjugate of a Matrix, Hermitian and Skew-Hermitian Matrices, Singular and Non-Singular matrices, Orthogonal and Unitary Matrices, Trace of a Matrix. Inner Product, Eigen-values and Eigenvectors, Cayley- Hamiliton Theorem, Diagonalization of Matrices, Solutions of Coupled Linear Ordinary Differential Equations, Functions of a Matrix.

Unit III

Cartesian Tensors: Transformation of Co-ordinates, Einstein's Summation Convention, Relation between Direction Cosines, Tensors, Algebra of Tensors, Sum, Difference and

Product of Two Tensors, Contraction, Quotient Law of Tensors, Symmetric and Anti-symmetric Tensors, Invariant Tensors : Kronecker and Alternating Tensors, Association of Antisymmetric Tensor of Order Two and Vectors, Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products, Differentiation, Gradient, Divergence and Curl of Tensor Fields, Vector Identities, Tensorial Formulation of Analytical Solid Geometry: Equation of a Line, Angle between Lines, Projection of a Line on another Line, Condition for Two Lines to be Coplanar, Foot of the Perpendicular from a Point on a Line, Rotation Tensor (No Derivation), Isotropic Tensors, Tensorial Character of Physical Quantities, Moment of Inertia Tensor, Stress and Strain Tensors : Symmetric Nature, Elasticity Tensor, Generalized Hooke's Law.

Unit IV

General Tensors: Transformation of Co-ordinates, Minkowski Space, Contravariant & Covariant Vectors, Contravariant, Covariant and Mixed Tensors, Kronecker Delta and Permutation Tensors, Algebra of Tensors, Sum, Difference & Product of Two Tensors, Contraction, Quotient Law of Tensors, Symmetric and Anti-symmetric Tensors, Metric Tensor.

Reference Books:

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.

3. Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press

4. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.

5. Linear Algebra, W. Cheney, E. W. Cheney & D. R. Kincaid, 2012, Jones & Bartlett Learning

6. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole

7. Mathematical Methods for Physicis & Engineers, K. F. Riley, M. P. Hobson, S. J. Bence, 3rd Ed., 2006, Cambridge University Press

BPH526: ADVANCED MATHEMATICAL PHYSICS LABORATORY

Credits : 02

LTP : 004

Course Description: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Learning Objectives

Completion of this course will enable the students to:

CO1: Learn Scilab and C++ based experiments on Mathematical Physics

CO2: Understand linear algebra.

CO3: Understand basics of linear transformations and tensors.

CO4: Understand calculus of variations.

List of Experiments:

Scilab/ C^{++} based simulations experiments based on Mathematical Physics problems like

1. Linear algebra:
   - Multiplication of two 3 x 3 matrices.
   - Eigenvalue and eigenvectors of

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix};\begin{pmatrix} 1 & -i & 3+4i \\ +i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix};\begin{pmatrix} 2 & -i & 2i \\ +i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}$$

2. Orthogonal polynomials as eigenfunctions of Hermitian differential operators.

3. Determination of the principal axes of moment of inertia through diagonalization.

4. Vector space of wave functions in Quantum Mechanics: Position and momentum differential operators and their commutator, wave functions for stationary states as eigenfunctions of Hermitian differential operator.

5. Lagrangian formulation in Classical Mechanics with constraints.

6. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).

7. Estimation of ground state energy and wave function of a quantum system**.**

Reference Books:

1. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and

Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández, 2014 Springer ISBN: 978-3319067896

2. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444

3. Scilab Image Processing: L. M. Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

BPH507: CLASSICAL DYNAMICS

Credits : 06

LTP : 510

Course Description: The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Learning Objectives

Students will have understanding of:

CO1: The terminology used in Classical Mechanics.

CO2: Lagrangian and Hamiltonian formulations.

CO3: Essential features of a problem (like motion under central force, rigid body dynamics, periodic motions), use them to set up and solve the appropriate mathematical equations,

CO4: Understand Variational principle and Canonical transformations.

Course content:

Unit I

Applications: Hamiltonian for harmonic oscillators, solution of Hamilton's education for simple harmonic oscilations, particles in central free field, conservation of angular momentum and energy.

Classical Mechanics of Point Particles: Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian, Hamilton's equations of motion.

Unit II

Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Unit III

Special Theory of Relativity: Postulates of Special Theory of Relativity, Lorentz Transformations. Minkowski space, The invariant interval, light cone and world lines, Space-time diagrams, Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like, Four-velocity and acceleration, Metric and alternating tensors, Four-momentum and energy-momentum relation, Doppler effect from a four-vector perspective, Concept of four-force, Conservation of four-momentum, Relativistic kinematics, Application to two-body decay of an unstable particle.

Unit II

Fluid Dynamics: Density and pressure in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

Reference Books:

1. Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edition. 2002, Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Electrodynamics, J.D. Jackson, 3rd Edition, 1998, Wiley.
4. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edition, 2003, Elsevier.
5. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
6. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edition, McGraw Hall.
7. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
8. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
9. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

BPH508: APPLIED DYNAMICS

Credits : 04

LTP : 400

Course Description: This course will introduce students to the concepts of dynamics. The students are expected to develop working skills in the dynamic analysis of both particles and rigid bodies. Students will learn the mathematical formulations of dynamics problems.

Course Learning Objectives

Upon successful course completion, a student will be able to:

CO1: Demonstrate understanding of the concepts that underlay the study of dynamical systems. Use the analytical and computational methods covered in this course to analyze dynamical systems models.

CO2: Understand fractals as self-similar structures by giving examples from nature and develop mathematical models for simple fractal structures.

CO3: Understand various forms of dynamics and different routes to chaos.

CO4: Analyze the behavior of dynamical systems (e.g. find periodic orbits and assess their stability, draw phase portraits, etc.). Analyze uniform and non-uniform oscillators (flows on circle)

Course content:

Unit I

Introduction to Dynamical systems: Definition of a continuous first order dynamical system, idea of phase space, flows and trajectories, Simple mechanical systems as first order dynamical systems : the free particle, particle under uniform gravity, simple and damped harmonic oscillator. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying physical intuition.

Other examples of dynamical systems –

In Biology: Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits

In Chemistry: Rate equations for chemical reactions e.g. auto catalysis, bistability

In Economics: Examples from game theory, Illustrative examples from other disciplines.

Unit II

Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples,

Computing and visualizing trajectories on the computer using software packages, Discrete dynamical systems, The logistic map as an example.

Unit III

Introduction to Chaos and Fractals: Examples of 2-dimensional billiard, Projection of the trajectory on momentum space, Sinai Billiard and its variants, Computational visualization of trajectories in the Sinai Billiard, Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of the obstacle, Electron motion in mesoscopic conductors as a chaotic billiard problem, Other examples of chaotic systems; visualization of their trajectories on the computer.

Self-similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe the self-similar structure, Deterministic fractal vs. self-similar fractal structure, Fractals in dynamics – Serpinski gasket and DLA.

Chaos in nonlinear finite-difference equations- Logistic map: Dynamics from time series, Parameter dependence- steady, periodic and chaos states, Cobweb iteration, Fixed points, Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions, Period- Doubling route to chaos.

Nonlinear time series analysis and chaos characterization: Detecting chaos from return map, Power spectrum, autocorrelation, Lyapunov exponent, correlation dimension.

Unit IV

Elementary Fluid Dynamics: Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesis-concept of the fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform & non-uniform flows, viscous & inviscid flows, incompressible & compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated & unseparated flows. Flow visualization - streamlines, pathlines, Streaklines.

Reference Books:

1. Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
4. Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987.

BPH528: APPLIED DYNAMICS LABORATORY

Credits : 02

LTP : 004

Course Description: The students are expected to develop working skills in the dynamic analysis of both particles and rigid bodies. Students will learn the mathematical formulations of dynamics problems.

Course Learning Objectives

Upon successful course completion, a student will be able to:

CO1: Demonstrate understanding of the practical concepts that underlay the study of dynamical systems.

CO2: Understand various forms of dynamics and different routes to chaos.

CO3: Understand the use of various computer languages and solve problems related to dynamics.

CO4: Understand the use of Computational visualization for fractal.

List of Experiments:

Laboratory/Computing and visualizing trajectories using software such as Scilab, Maple, Octave, XPPAUT based on Applied Dynamics problems like

1. To determine the coupling coefficient of coupled pendulums.
2. To determine the coupling coefficient of coupled oscillators.
3. To determine the coupling and damping coefficient of damped coupled oscillator.
4. To study population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits.
5. To study rate equations for chemical reactions e.g. auto catalysis, bistability.
6. To study examples from game theory.
7. Computational visualization of trajectories in the Sinai Billiard.
8. Computational visualization of trajectories Electron motion in mesoscopic conductors as a chaotic billiard problem
9. Computational visualization of fractal formations of Deterministic fractal.
10. Computational visualization of fractal formations of self-similar fractal.
11. Computational visualization of fractal formations of Fractals in nature – trees, coastlines, earthquakes.
12. Computational Flow visualization - streamlines, pathlines, Streaklines.

Reference Books

1. Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge Univ. Press, 2002
4. Fluid Mechanics, 2nd Edition, L. D. Landau & E.M. Lifshitz, Pergamon Press, Oxford, 1987
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
6. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
7. Scilab Image Processing: L. M. Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

BPH509: COMMUNICATION SYSTEMS

Credits : 04

LTP : 400

Course Description: To provide in-depth knowledge of modern design tools to solve real-life problems in the field of Electronics and Communication.

Course Learning Objectives

In this course students will

CO1: Gain knowledge of some basic electronic components and circuits.

CO2: Learn about Mobile telephony system.

CO3: Learn about amplitude and digital modulation.

CO4: Learn about Satellite Communication and Mobile Telephony System.

Course content:

Unit I

Electronic communication: Introduction to communication – means and modes. Need for modulation, Block diagram of an electronic communication system, Brief idea of frequency allocation for radio communication system in India (TRAI), Electromagnetic communication spectrum, band designations and usage, Channels and base-band signals, Concept of Noise, signal-to-noise (S/N) ratio.

Unit II

Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum, Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

Unit III

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of

Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Unit IV

Introduction to Communication and Navigation systems:

Satellite Communication – Introduction, need, geosynchronous satellite orbits, and geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station, Uplink and downlink.

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only).

GPS navigation system (qualitative idea only).

Reference Books:

1. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
2. Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
3. Electronic Communication systems, G. Kennedy, 3rd Edition, 1999, Tata McGraw Hill.
4. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
5. Communication Systems, S. Haykin, 2006, Wiley India
6. Electronic Communication system, Blake, Cengage, 5th edition.
7. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

BPH529: COMMUNICATION SYSTEMS LABORATORY

Credits : 02

LTP : 004

Course Description: To provide in-depth knowledge of modern design tools to solve real-life problems in the field of Electronics and Communication.

Course Learning Objectives

In this lab course students will have hands-on practice for

CO1: Some basic electronic components and circuits.

CO2: Learn about Mobile telephony system.

CO3: Learn about amplitude and digital modulation.

List of Experiments:

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators

Reference Books:

1. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
2. Electronic Communication system, Blake, Cengage, 5th edition.

BPH510: NUCLEAR AND PARTICLE PHYSICS

Credits : 06

LTP : 510

Course Description: This course is offered to the students as an advanced course. The emphasis of the course is on nuclear and particle physics. The students are to be examined entirely on the basis of practical knowledge.

Course Learning Objectives

Upon completion of the course, Students will have understanding of:

CO1: Basic properties of the nucleus and nuclear models to study the nuclear structure properties.

CO2: Various aspects of nuclear reactions will give idea how nuclear power can be generated.

CO3: Nuclear fission and fusion.

Co4: Basic of elementary particles and Interaction of Nuclear Radiation with matter.

Course content:

Unit I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), 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 its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Unit II

Radioactivity decay :(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) b-decay: energy kinematics for b-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 III

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 and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Unit IV

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.

Reference Books:

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 High Energy Physics, D.H. Perkins, Cambridge Univ. Press
5. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
6. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
8. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
9. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
10. Theoretical Nuclear Physics, J.M. Blatt & V. F. Weisskopf (Dover Pub.Inc, 1991)

BPH603: ASTRONOMY AND ASTROPHYSICS

Credits : 06

LTP : 510

Course Description: To explore the composition of the universe better. To reveal the truths and dispel the myths related to the universe. To develop new techniques of observation for a better understanding of the solar system.

Course Learning Objectives

CO1: After this course students will be familiar with essential features and techniques of astronomy and will understand how laws of physics are applied to astrophysical phenomenon.

CO2: Students will also gain an understanding of the latest developments in the field of astronomy and astrophysics.

CO3: Students will also gain an understanding Stellar spectra and classification Structure.

CO4: Students will also gain an understanding the basic properties of the Milky Way, and Oort Constant.

Course content:

Unit I

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature.

Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram.

Unit II

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).

Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium.

Unit III

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere, Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics, Helioseismology).

The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.

Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification).

Unit IV

The milky way: Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.

Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo), the Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms.

Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance-Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter).

Reference Books:

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.

2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
3. The physical universe: An introduction to astronomy, F. Shu, Mill Valley: University Science Books
4. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
5. K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
6. Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of India Private Limited, New Delhi, 2001.
7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

BPH604: ATMOSPHERIC PHYSICS

Credits : 04

LTP : 400

Course Description: This course gives an introduction to atmospheric physics, radiation and simple principles for remote sensing, elementary aerosol and cloud physics. The course explains key processes in the atmosphere based on basic physical principles.

Course Learning Objectives

After completion of this course, students will gain.

CO1: Good knowledge of Earth's atmosphere, its composition, effective temperature, Greenhouse effect. Hydrostatic equation and atmospheric thermodynamics. Local winds, clouds, fog, monsoon, cyclones, sea breeze and land breeze and thunderstorms etc.

CO2: Essential knowledge of the instruments of meteorological observation, meteorological processes and systems.

CO3: Understanding atmospheric dynamics, fundamental forces, conservation laws, rotating coordinate system and equations of motion. Circulation, vorticity, various types of circulations, atmospheric oscillations: biannual, annual and semi-annual oscillations

CO4: Radiometry phenomena in atmosphere using Lidars.

Course content:

Unit I

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze, Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms.

Unit II

Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.

Unit III

Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration

Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques.

Unit IV

Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars.

Reference Books:

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edition, 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
4. Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

BPH624: ATMOSPHERIC PHYSICS LABORATORY

Credits : 02

LTP : 004

Course Description: This course gives an introduction to atmospheric physics, radiation and simple principles for remote sensing, elementary aerosol and cloud physics. The course explains key processes in the atmosphere based on basic physical principles.

Course Learning Objectives

After completion of this course, students will gain.

CO1: Good knowledge of Earth's atmosphere, its composition, effective temperature, Greenhouse effect. Hydrostatic equation and atmospheric thermodynamics. Local winds, clouds, fog, monsoon, cyclones, sea breeze and land breeze and thunderstorms etc.

CO2: Essential knowledge of the instruments of meteorological observation, meteorological processes, and systems.

CO3: Knowledge about various software to solve experiments based on Atmospheric Physics

CO4: Acquire the knowledge of radiosonde data and its interpretation in atmospheric parameters using vertical profiles.

List of Experiments:

Scilab/C++ based simulations experiments based on Atmospheric Physics problems like

1. Numerical Simulation for atmospheric waves using dispersion relations.
   a) Atmospheric gravity waves (AGW)
   b) Kelvin waves
   c) Rossby waves, and mountain waves
2. Offline and online processing of radar data
   a) VHF radar,
   b) X-band radar, and
   c) UHF radar
3. Offline and online processing of LIDAR data
4. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles in different regions of the globe.

5. Handling of satellite data and plotting of atmospheric parameters using radio occultation technique

6. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change.

Reference Books:

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – J.T. Houghton; Cambridge Univ. Press; 3rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
4. Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

BPH605: NANOMATERIALS AND APPLICATIONS

Credits : 04

LTP : 400

Course Description: The course should give a basic introduction to chemical and physical principles in the synthesis of inorganic nanostructured materials. In addition, basic principles of finite size effects will be covered. The course will also cover different methods for synthesis and characterization of different nanostructures and nanostructured bulk materials.

Course Learning Objectives

On successful completion of the module students should be able to

CO1: Explain the difference between 1D, 2D and 3D nanomaterials and their properties.

CO2: Explain various methods for the synthesis/growth of nanomaterials including top down and bottom-up approaches.

CO3: Explain the different types of vacuum techniques and its applications.

CO4: Understand the concept of optical, dielectric and data storage applications.

Course content:

Unit I

NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit II

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography, Ball milling, Gas phase condensation, Vacuum deposition, Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapor deposition (CVD), Sol-Gel, Electro deposition, Spray pyrolysis, Hydrothermal synthesis, Preparation through colloidal methods, MBE growth of quantum dots.

CHARACTERIZATION: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy

Unit III

OPTICAL PROPERTIES: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons, Excitons in direct and indirect band gap semiconductor nanocrystals, Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence, Optical properties of heterostructures and nanostructures.

ELECTRON TRANSPORT: Carrier transport in nanostructures, Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

Unit IV

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells), Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage, Magnetic quantum well; magnetic dots - magnetic data storage, Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Reference Books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
7. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

BPH625: NANOMATERIALS AND APPLICATIONS LABORATORY

Credits : 02

LTP : 004

Course Description: The lab course should give a basic introduction to chemical and physical principles in the synthesis of inorganic nanostructured materials. In addition, basic principles of finite size effects will be covered. The course will also cover different methods for synthesis and characterization of different nanostructures and nanostructured bulk materials.

Course Learning Objectives

On successful completion of the module students should be able to

CO1: Explain various methods for the synthesis/growth of nanomaterials including top down and bottom-up approaches.

CO2: Explain the various concept of spectroscopy.

CO3: Understand the fabrication of thin films in technology applications.

Co4: Understand the concept of Quantum dots, and nanowires for P-type and N-type junctions.

List of Experiments:

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.

11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

Reference Books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

BPH606: PHYSICS OF EARTH

Credits : 06

LTP : 510

Course Description: The course will provide an overview of the structure and evolution of the earth as a dynamic planet within our solar system. The course is an introduction to physics of the solid earth intended for students with substantial background in physics and mathematics including calculus.

Course Learning Objectives

At the end of this course student will be able to

CO1: Have an overview of structure of the earth as well as various dynamical processes occurring on it.

CO2: Develop an understanding of evolution of the earth.

CO3: Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure.

CO4: Acquire the knowledge of major geological and biological events on earth.

Course content:

Unit I

1. The Earth and the Universe:

(a) Origin of universe, creation of elements and earth, a Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography, Introduction to various branches of Earth Sciences.

(b) General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin, The terrestrial and Jovian planets, Meteorites & Asteroids, Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.

(c) Energy and particle fluxes incident on the Earth.

(d) The Cosmic Microwave Background.

Unit II

2. Structure:

(a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior?

(b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.

(c)The Atmosphere: variation of temperature, density and composition with altitude, clouds.

(d) The Cryosphere: Polar caps and ice sheets, Mountain glaciers.

(e) The Biosphere: Plants and animals, Chemical composition, mass, Marine and land organisms.

Unit III

3. Dynamical Processes:

(a) The Solid Earth: Origin of the magnetic field, Source of geothermal energy, Convection in Earth's core and production of its magnetic field, Mechanical layering of the Earth, Introduction to geophysical methods of earth investigations, Concept of plate tectonics; sea-floor spreading and continental drift, Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, ransform faults and island arcs, Origin of oceans, continents, mountains and rift valleys, Earthquake and earthquake belts. Volcanoes: types products and distribution.

(b) The Hydrosphere: Ocean circulations, Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes, Tides, Tsunamis,

(c) The Atmosphere: Atmospheric circulation, Weather and climatic changes, Earth's heat budget, Cyclones.

Climate:

I. Earth's temperature and greenhouse effect.

ii. Paleoclimate and recent climate changes.

iii. The Indian monsoon system.

(d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle, The role of cycles in maintaining a steady state.

Unit IV

4. Evolution:

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies, Introduction to geochronological methods in their application in geological studies, History of development in concepts of uniformitarianism, catastrophism and neptunism, Law of superposition and faunal succession, Introduction to the geology and geomorphology of Indian subcontinent.

1. Time line of major geological and biological events.
2. Origin of life on Earth.
3. Role of the biosphere in shaping the environment.
4. Future of evolution of the Earth and solar system: Death of the Earth.

5. Disturbing the Earth – Contemporary dilemmas

(a) Human population growth.

(b) Atmosphere: Greenhouse gas emissions, climate change, air pollution.

(c) Hydrosphere: Fresh water depletion.

(d) Geosphere: Chemical effluents, nuclear waste.

(e) Biosphere: Biodiversity loss, Deforestation, Robustness and fragility of ecosystems

Reference Books:

1. Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
2. Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
3. Holme's Principles of Physical Geology. 1992. Chapman & Hall.
4. Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

BPH607: DIGITAL SIGNAL PROCESSING

Credits : 04

LTP : 400

Course Description: This course focuses to make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors. This course makes students aware about the meaning and implications of the properties of systems and signals.

Course Learning Objectives

Completion of this course will enable the students to:

CO1: Understand the logical behavior of digital circuits.

CO2: Know how to describe digital hardware using a software-style language

CO3: Understand how a basic microprocessor can be built from standard building blocks.

CO4: Understand CRO basic and IC fabrication.

Course content:

Unit I

Discrete-Time Signals and Systems: Classification of Signals, Transformations of the Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Graphical Method; Analytical Method, Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property System Response to Periodic Inputs, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability; Invertibility, Unit Step Response.

Unit II

Discrete-Time Fourier Transform: Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting; Differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. The z-Transform: Bilateral (Two-Sided) z-Transform, Inverse z-Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-plane, Region-of-Convergence; Properties of ROC, Properties; Time Reversal; Differentiation in the z-Domain; Power Series Expansion Method (or Long Division Method); Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System, Solving Difference Equations.

Unit III

Filter Concepts: Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters, All pass Filters, Averaging Filters, Notch Filters.

Discrete Fourier Transform: Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation, Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution), Circular Convolution as Linear Convolution with aliasing.

Unit IV

Realization of Digital Filters: Non-Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method; Rectangular; Triangular; Kaiser Window, FIR Digital Differentiators.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Backward Difference Algorithm, Impulse Invariance Method.

Reference Books:

1. Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India

2. Digital Signal Processing, S. K. Mitra, McGraw Hill, India.

3. Modern Digital and Analog Communication Systems, B.P. Lathi, 1998, 3rd Edition, Oxford University Press.

4. Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris,

2005, Cengage Learning.

5. Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.

6. Digital Signal Processing Principles Algorithm & Applications, J.G. Proakis and D.G. Manolakis, 2007, 4th Edition, Prentice Hall.

BPH627: DIGITAL SIGNAL PROCESSING LABORATORY

Credits : 02

LTP : 004

Course Description: This course focuses to make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors. This course makes students aware about the meaning and implications of the properties of systems and signals.

Course Learning Objectives

Completion of this course will enable the students to:

CO1: Understand the concept of simulations based software.

CO2: Know the advantages and disadvantages of simulations based programming.

CO3: Know the basic language of software for equations.

CO4: Understand how a basic microprocessor can be built from standard building blocks.

List of Experiments:

Scilab based simulations experiments based problems like

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence $r(n)$, (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \le n \le 50$.

2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for N = 5
$$x(n) = rect\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 & -N \le n \le N \\ 0 & otherwise \end{cases}$$

3. An LTI system is specified by the difference equation
$$y(n) = 0.8y(n-1) + x(n)$$
(a) Determine $H(e^{jw})$
(b) Calculate and plot the steady state response $y_{ss}(n)$ to
$$x(n) = \cos(0.5\pi n)u(n)$$

4. Given a casual system
$$y(n) = 0.9y(n-1) + x(n)$$
(a) Find $H(z)$ and sketch its pole-zero plot
(b) Plot the frequency response $|H(e^{jw})|$ and $\angle H(e^{jw})$

5. Design a digital filter to eliminate the lower frequency sinusoid of $x(t) = \sin 7t + \sin 200t$. The sampling frequency is $f_s = 500\, Hz$. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let $x(n)$ be a 4-point sequence:
$$x(n) = \underset{\uparrow}{\{1,1,1,1\}} = \begin{cases} 1 & 0 \le n \le 3 \\ 0 & otherwise \end{cases}$$
Compute the DTFT $X(e^{jw})$ and plot its magnitude
(a) Compute and plot the 4 point DFT of $x(n)$
(b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros)
(c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros)

7. Let $x(n)$ and $h(n)$ be the two 4-point sequences,

$$x(n) = \{\underset{\uparrow}{1},2,2,1\}$$

$$h(n) = \{\underset{\uparrow}{1},-1,-1,1\}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.

9. Design an FIR filter to meet the following specifications:
passband edge $F_p = 2\,KHz$
stopband edge $F_s = 5\,KHz$
Passband attenuation $A_p = 2\,dB$
Stopband attenuation $A_s = 42\,dB$
Sampling frequency $F_s = 20\,KHz$

10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{jw}) = jwe^{-j\tau w} \qquad |w| \le \pi$$

Using a Hamming window of length M = 21, design a digital FIR differentiator. Plot the amplitude response.

Reference Books:

1. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, India.
2. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
3. Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
4. Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
5. Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.
6. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
7. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
8. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

PH608: MEDICAL PHYSICS

Credits : 04

LTP : 400

Course Description: This course is offered to the students as a fundamental course. The topics included in the course provide the students with broad understanding of Physics in Medical field.

Course Learning Objectives

At the end of this course student will be able to

CO1: Focus on the application of Physics to clinical medicine.

CO2: Gain a broad and fundamental understanding of Physics while developing particular expertise in medical applications.

CO3: Learn about the human body, its anatomy, physiology, and Bio Physics, exploring its performance as a physical machine.

CO4: Learn diagnostic and therapeutic applications like the ECG, Radiation Physics, X-ray technology, ultrasound and magnetic resonance imaging.

CO5: Gain knowledge with reference to working of various diagnostic tools, medical imaging techniques.

Course content:

Unit I

PHYSICS OF THE BODY-I

Basic Anatomical Terminology: Standard Anatomical Position, Planes, Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal.

Mechanics of the body: Skeleton, forces, and body stability, Muscles and dynamics of body movement, Physics of Locomotors Systems: joints and movements, Stability and Equilibrium.

Energy household of the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation.

Pressure system of body: Physics of breathing, Physics of cardiovascular system.

PHYSICS OF THE BODY-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound.

Optical system of the body: Physics of the eye.

Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

Unit II

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I

X-RAYS: Electromagnetic spectrum, production of x-rays, x-ray spectra, Brehmsstrahlung, Characteristic x-ray.

X-ray tubes & types: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, Single and three phase electric supply, Power ratings, Types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables.

RADIATION PHYSICS: Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose- Rem & Sievert, inverse square law, Interaction of radiation with matter Compton & photoelectric effect, linear attenuation coefficient.

Radiation Detectors: ionization (Thimble chamber, condenser chamber), chamber. Geiger Muller counter, Scintillation counters and Solid-State detectors, TFT.

Unit III

MEDICAL IMAGING PHYSICS: Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy.

Computed tomography scanner -principle and function, display, generations, mammography, Thyroid uptake system and Gamma camera (Only Principle, function, and display).

RADIATION ONCOLOGY PHYSICS: External Beam Therapy (Basic Idea): Telecobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife, Contact Beam Therapy (Basic Idea): Brachytherapy- LDR and HDR, Intra Operative Brachytherapy, Radiotherapy, kilo voltage machines, deep therapy machines, Telecobalt machines, Medical linear accelerator. Basics of Teletherapy units, deep X-ray, Telecobalt units, Radiation protection, external beam characteristics, dose maximum and build up – bolus, percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume.

Unit IV

RADIATION AND RADIATION PROTECTION: Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic and deterministic effect. Personal monitoring devices: TLD film badge, pocket dosimeter, OSL dosimeter, Radiation dosimeter, Natural radioactivity, biological effects of radiation, Radiation monitors, Steps to reduce radiation to Patient, Staff and Public, Dose Limits for Occupational workers and Public, AERB: Existence and Purpose.

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment. Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes.

Reference Books:

1. Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
2. Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
3. Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
4. Physics of the human body, Irving P. Herman, Springer (2007).
5. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rd edition (2003)
6. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
7. Handbook of Physics in Diagnostic Imaging: R. S. Livingstone: B.I. Publication Pvt Ltd.
8. The Physics of Radiology-H E Johns and Cunningham.

BPH628: MEDICAL PHYSICS LABORATORY

Credits : 02

LTP : 004

Course Description: This course is offered to the students as a fundamental course. The topics included in the course provide the students with broad understanding of Physics in Medical field.

Course Learning Objectives

At the end of this course student will be able to

CO1: Focus on the application of Physics to clinical medicine.

CO2: Gain a broad and fundamental understanding of Physics while developing particular expertise in medical applications.

CO3: Learn diagnostic and therapeutic applications like the ECG, Radiation Physics, X-ray technology, ultrasound and magnetic resonance imaging.

CO4: Gain knowledge with reference to working of various diagnostic tools, medical imaging techniques.

List of Experiments:

1. Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.
2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing procedure.
3. Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4. Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5. To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6. Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7. Familiarization with Radiation meter and to measure background radiation.
8. Familiarization with the Use of a Vascular Doppler.

Reference Books:

1. Basic Radiological Physics, Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
2. Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
3. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3rd edition (2003)
4. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
5. Handbook of Physics in Diagnostic Imaging: Roshan S. Livingstone: B. I. Publications Pvt Ltd.
6. The Physics of Radiology-H E Johns and Cunningham.

BPH609: BIOLOGICAL PHYSICS

Credits : 06

LTP : 510

Course Description: This course teaches the students how to apply the principles of physical sciences to understand and solve biological complexities. Using the knowledge gained during the course, students should be able to address the academic and industrial research problems.

Course Learning Objectives

Completion of this course will enable the students to:

CO1: Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective.

CO2: Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution.

CO3: Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes.

CO4: Acquire the knowledge of genotype-phenotype map.

Course content:

Unit I

Overview:

The boundary, interior and exterior environment of living cells, Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution, Self-replication as a distinct property of biological systems, Time scales and spatial scales, Universality of microscopic processes and diversity of macroscopic form, Types of cells, Multicellularity, Allometric scaling laws.

Unit II

Molecules of life:

Metabolites, proteins and nucleic acids, Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling.

Typical populations of molecules of various types present in cells, their rates of production and turnover, Energy required to make a bacterial cell.

Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways, Random walks and applications to biology, Mathematical models to be studied analytically and computationally.

Unit III

The complexity of life:

At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell, Complex networks of molecular interactions: metabolic, regulatory and signaling networks, Dynamics of metabolic networks; the stoichiometric matrix, Living systems as complex organizations; systems biology, Models of cellular dynamics, The implausibility of life based on a simplified probability estimate, and the origin of life problem.

At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cell types as distinct attractors of a dynamical system, Stem cells and cellular differentiation, Pattern formation and development.

Brain structure: neurons and neural networks, Brain as an information processing system. Associative memory models, Memories as attractors of the neural network dynamics.

At the level of an ecosystem and the biosphere: Food webs, Feedback cycles and self-sustaining ecosystems.

Unit IV

Evolution:

The mechanism of evolution: variation at the molecular level, selection at the level of the organism, Models of evolution, The concept of genotype-phenotype map, Examples.

References:

1. Physics in Molecular Biology; Kim Sneppen & Giovanni Zocchi (CUP 2005)
2. Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004)
3. Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013)
4. An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013)
5. Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

BMT306: Python Programming Lab

Credits : 02

LTP : 004

Course Description: The course aims to equip the students with a comprehensive study of Python Programming. The course includes Object-Oriented paradigms in Python programs, Python functions, and Python exception-handling mechanisms.

Course Learning Objectives

Upon successful completion of the course, the students should be able to:

CO1: Solve simple to advanced problems using Python language.

CO2: Develop logic of various programming problems using numerous data types and control structures of Python.

CO3: Implement different data structures using Python.

CO4: Implement modules and functions using Python.

CO5: Design and implement the concept of object-oriented programming structures.

CO6: Implement files handling.

List of Practical:

1. Write a program to add two numbers.
2. Write a program that declares 3 integers, determines, and prints the largest and smallest in the group.
3. Write a program for factorial of a number.
4. Write a program to calculate simple interest.
5. Write a program to find that given year is leap year or not.
6. Write a program to implement linear search and binary search.
7. Write a program to find that given number is Armstrong or not.
8. Write a program to print Fibonacci Series.
9. Write a program to convert decimal number into binary numbers.
10. Python Program to find sum of array.
11. Write a program to find largest number of elements in array.
12. Write a program to check if a string is palindrome or not.
13. Maintain book record as per their serial numbers in library using dictionary.
14. Write a program to concatenate two dictionaries into one.
15. Perform following operations on dictionary 1) Insert 2) delete 3) change 4) update.
16. Write a program to calculate addition of two number using methods.
17. Program to calculate average of numbers using function.
18. Fibonacci series using recursion.
19. Write a program to create a module of factorial in Python.
20. Write A Program to Find the Area of a Rectangle Using Classes
21. Write A Program to Append, Delete and Display Elements of a List Using Classes
22. Write A Program to Create a Class and Compute the Area and the Perimeter of the Circle
23. Write A Program to Create a Class which Performs Basic Calculator Operations
24. Write A Program to Create a Class in which One Method Accepts a String from the User and another prints it.
25. Write A Program that Reads a Text File and Counts the Number of Times a Certain Letter Appears in the Text File.
26. Write A Program to Read a Text File and Print all the Numbers Present in the Text File.
27. Write a program for generation of pyramid.

Pyramid 1	Pyramid 2	Pyramid 3	Pyramid 4	Pyramid 5
* * * * * * * * * *	* * * * * * * * * *	* * * * * * * * * *	* * * * * * * * * * * *	1 1 2 1 2 3 1 2 3 4

BMT307: MATLAB Programming Lab

Credits : 02

LTP : 004

Course Description: The course aims to equip the students able to carry out simple numerical computations and analyses using MATLAB. The course includes simple calculations using MATLAB.

Course Learning Objectives

Upon successful completion of the course, the students should be able to:

CO1: Understand the main features of the MATLAB development environment.

CO2: Write simple programs in MATLAB to solve scientific and mathematical problems.

CO3: Program to display or addition of matrix.

CO4: Understand how to draw a basic graph application.

List of Practical:

1. Introduction to MATLAB.
2. Explain the main windows in MATLAB desktop.
3. Programming in MATLAB: Introduction, Branching statements, loops, functions, additional data types, arrays, inputs/outputs etc.
4. Program to display a Matrix.
5. Program to Addition of matrix.
6. Basic graphic applications: Draw Curve, Refine the plot: Line pattern, color, and thickness, Draw multiple curves.

Recommended Books / Suggested Readings:

1. MATLAB: An Introduction with Applications, by Amos Gilat, 2nd edition, Wiley, 2004.
2. C.B. Moler, Numerical Computing with MATLAB, SIAM, 2004.

BMT308: LaTeX Lab

Credits : 02

LTP : 004

Course Description: The course aims to equip the students equip the students with a comprehensive study of the LATEX.

The course includes Typesetting text, references.

Course Outcomes (CO):

Upon successful completion of the course, the students should be able to:

CO1: Structure the document with well familiarized documenting abilities.

CO2: Frame a research document for self or University.

List of Practical:

1. Installation of the software LaTeX
2. Understanding Latex compilation, Basic Syntex, Writing equations, Matrix, Tables
3. Page Layout –Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Generating new commands, Figure handling numbering, List of figures, List of tables, Generating index.
4. Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tilez listing.
5. Classes: article, book, report, beamer, slides. IEEtran.
6. Applications to:

Writing Resume

Writing question paper

Writing articles/ research papers

Presentation using beamer.

Recommended Books / Suggested Readings:

1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.
2. L. Lamport. LATEX: A Document Preparation System, User's Guide and ReferenceManual. Addison-Wesley, New York, second edition, 1994.

BMT309: Operating Systems: Linux

Credits : 02

LTP : 102

Course Description: In this course student will be able learn about Basics of Linux, its applications.

Course Learning Objectives: After completion of this course students will be able to

CO1: understand Linux, its features.

CO2: various tools utilized in Linux.

CO3: Resource management in Linux

CO3: Operate different functions, file directory management, library & system memory.

Unit I

Linux – The operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, overview of Linux architecture, installation, startup scripts, system processes (an overview), Linux security.

Unit II

The Ext2 and Ext3 file systems: General characteristics of the Ext3 file system, file permissions. User management: types of users, the powers of root, managing users (adding and deleting): using the command line and GUI tools.

Unit III

Resource management in Linux: file and directory management, system calls for files process Management, signals, IPC: Pipes, FIFOs, System V IPC,

Unit IV

Message queues, system calls for processes, memory management, library and system calls for memory.

Reference Books

1. Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., Pearson Education, 2008.

2. Cox K, Red Hat Linux Administrator's Guide, PHI, 2009.

3. R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.

4.= Sumitabha Das, UNIX Concepts and Applications, 4th Ed., TMH, 2009

BPH304: APPLIED OPTICS

Credits : 02

LTP : 200

Course Description: Theory includes only qualitative explanation therefore students will be able to understand the optics practically and effectively. Minimum five experiments should be performed covering minimum three sections.

Course Outcomes (CO):

This course will help students to:

CO1: Understand basic lasing mechanism qualitatively, types of Lasers, characteristics of Laser Light, types of Lasers, and its applications in developing LED, Holography.

CO2: Learn concept of Fourier optics and Fourier transform spectroscopy.

CO3: Understanding of basic principle and theory of Holography.

CO4: Concept of total internal reflection.

CO5: Characteristics of optical fibre.

Course Contents:

(i) 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:

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

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

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

d. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

a. V-I characteristics of LED.

b. Study the characteristics of solid state laser.

c. Study the characteristics of LDR.

d. Photovoltaic Cell.

e. Characteristics of IR sensor.

(ii) Fourier Optics

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

Experiments on Fourier Optics:

a. Fourier optic and image processing

1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system

b. 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.

(iii) 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:

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

(iv) 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

a. To measure the numerical aperture of an optical fibre.

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

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

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

e. To determine the power loss at a splice between two multimode fibres.

Reference Books:

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 Edition, 1996, Cambridge Univ. Press

BPH305: PHYSICS WORKSHOP SKILLS

Credits : 02

LTP : 200

Course Description: The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode.

Course Learning Objectives: After completion of this course students will be able to

Co1: Learning measuring devices like Vernier callipers, Screw gauge, travelling microscope and Sextant for measuring various length scales.

CO2: Acquire skills in the usage of multimeters, soldering iron, oscilloscopes, power supplies and relays.

CO3: Developing mechanical skill such as casting, foundry, machining, forming and welding and will become familiar with common machine tools like lathe, shaper, drilling, milling, surface machines and Cutting tools.

CO4: Getting acquaintance with prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axle. Lever mechanism. Lifting of heavy weight using lever, braking systems, pulleys.

Unit I

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.

Unit II

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 III

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 IV

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.

Reference Books

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 Edition.

3. Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.

4. Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edition, Newness [ISBN: 0750660732]

5. New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]9

BPH306: ELECTRICAL CIRCUITS AND NETWORK SKILLS

Credits : 02

LTP : 200

Course Description: The aim of this course is to enable the students to design, and trouble shoots the electrical circuits, networks and appliances through hands-on mode.

Course Learning Objectives:

At the end of this course, students will be able to achieve the following learning outcomes:

CO1: They would be able to demonstrate good comprehension of basic principles of electricity including ideas about voltage, current and resistance.

CO2: They would also be proficient in identifying different combinations of circuit elements besides having sound knowledge about varying types of voltage & current - alternating and direct.

CO3: Their familiarization with basic tenets of electrical circuits like measurement of resistance, current and voltages in different circuits would be complete.

CO4: They would be able to analyze complicated AC and DC electrical circuits.

CO5: They would have the ability to calculate real, imaginary, and complex power components of AC sources.

Contents:

Unit I

Basic Electricity Principles: Voltage, Current, Resistance, and Power, Ohm's law, Series, parallel, and series-parallel combinations, AC Electricity and DC Electricity, Familiarization with multimeter, voltmeter and ammeter.

Understanding Electrical Circuits: Main electric circuit elements and their combination, Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements, Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits, Real, imaginary and complex power components of AC source, Power factor, Saving energy and money.

Unit II

Electrical Drawing and Symbols: Drawing symbols, Blueprints, Reading Schematics. Ladder diagrams, Electrical Schematics, Power circuits, Control circuits, reading of circuit schematics, Tracking the connections of elements and identify current flow and voltage drop

Generators and Transformers: DC Power sources, AC/DC generators, Inductance, capacitance, and impedance, Operation of transformers.

Unit III

Electric Motors: Single-phase, three-phase & DC motors, Basic design, Interfacing DC or AC sources to control heaters & motors, Speed & power of ac motor.

Solid-State Devices: Resistors, inductors and capacitors, Diode and rectifiers, Components in Series or in shunt, Response of inductors and capacitors with DC or AC sources.

Unit IV

Electrical Protection: Relays. Fuses and disconnect switches, Circuit breakers, Overload devices, Ground-fault protection, Grounding and isolating, Phase reversal, Surge protection. Interfacing DC or AC sources to control elements (relay protection device).

Electrical Wiring: Different types of conductors and cables, Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors, Instruments to measure current, voltage, power in DC and AC circuits, Insulation. Solid and stranded cable, Conduit, Cable trays, Splices: wirenuts, crimps, terminal blocks, split bolts, and solder, Preparation of extension board.

Reference Books

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

BPH307: BASIC INSTRUMENTATION SKILLS

Credits : 02

LTP : 200

Course Description: This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Course Learning Objectives:

At the end of this course, students will be able to achieve the following learning outcomes:

CO1: The student is expected to have the necessary working knowledge on accuracy, precision, resolution, range and errors/uncertainty in measurements.

CO2: Course learning begins with the basic understanding of the measurement and errors in measurement. It then familiarizes about each and every specification of a multimeter, multimeters, multivibrators, rectifiers, amplifiers, oscillators and high voltage probes and their significance with hands on mode.

CO3: Explanation of the Specifications of CRO and their significance. Complete explanation of CRT.

CO4: Students learn the use of CRO for the measurement of voltage (dc and ac), frequency and time period. Covers the Digital storage Oscilloscope and its principle of working.

Contents:

Unit I

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.

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 II

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.

Use of CRO for the measurement of voltage (dc and ac frequency, time period, Special features of dual trace, introduction to digital oscilloscope, probes, Digital storage Oscilloscope: Block diagram and principle of working.

Unit III

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.

Impedance Bridges & Q-Meters: Block diagram of bridge. Working principles of basic (balancing type) RLC bridge, Specifications of RLC Bridge. Block diagram & working principles of a Q- Meter, Digital LCR bridges.

Unit IV

Digital Instruments: Principle and working of digital meters, Comparison of analog & digital instruments, characteristics of a digital meter, working principles of digital voltmeter.

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.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit.
9. Balancing of bridges.

Reference Books

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 Edition.

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 McGraw 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

BPH308: RENEWABLE ENERGY AND ENERGY HARVESTING

Credits : 02

LTP : 200

Course Description: The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible.

Course Outcomes:

Students will be able to

CO1: Significance of renewable energy and details concerning various sources of energy will be imparted to the students. The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible.

CO2: Some of the renewable sources of energy which should be studied here are: (i) offshore wind energy, (ii) tidal energy, (iii) solar energy, (iv) Biogas energy and (v) hydroelectricity.

CO3: Knowledge of various sources of energy for harvesting will be given.

CO4: Understand the need of energy conversion and the various methods of energy storage

CO5: Students will have a good understanding of various renewable energy systems, and its components.

Course Contents:

Unit I

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 II

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 III

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 IV

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, recent applications Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability.

Demonstrations and Experiments

1. Demonstration of Training modules on solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

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, (2004), "Renewable Energy, Power for a sustainable future", Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, (2009) Solar Energy: Resource Assesment Handbook,
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

BPH309: RADIATION SAFETY

Credits : 02

LTP : 200

Course Description: The aim of this course is for awareness and understanding regarding radiation hazards and safety.

Course Outcomes:

This course will help students in the following ways:

CO1: Awareness and understanding the hazards of radiation and the safety measures to guard against these hazards.

CO2: Learning the basic aspects of the atomic and nuclear Physics, especially the radiations that originate from the atom and the nucleus.

CO3: Having a comprehensive knowledge about the nature of interaction of matter with radiations like gamma, beta, alpha rays, neutrons etc. and radiation shielding by appropriate materials.

CO4: Knowing about the units of radiations and their safety limits, the devises to detect and measure radiation, such as the Geiger-Mueller counter and scintillation counter.

Course Contents:

Unit I

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half-life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.

Unit II

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons – Photoelectric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation, Beta

Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.

Unit III

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

Unit IV

Radiation safety management: *Biological effects of ionizing radiation*, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation, Nuclear waste and disposal management, Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterization, Food preservation

Reference Books:

1. W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
2. G.F.Knoll, Radiation detection and measurements
3. Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
8. NCRP, ICRP, ICRU, IAEA, AERB Publications.
9. W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981

BPH310: WEATHER FORECASTING

Credits : 02

LTP : 200

Course Description: The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.

Course Outcomes:

After completion of this course, students will be able to:

CO1: Acquire basic knowledge of the elements of the atmosphere, its composition at various heights, variation of pressure and temperature with height.

CO2: To learn basic techniques to measure temperature and its relation with cyclones and anti-cyclones.

CO3: Knowledge of simple techniques to measure wind speed and its directions, humidity and rainfall.

CO4: Absorption, emission and scattering of radiations in atmosphere. Radiation laws.

CO5: Knowledge of global wind systems, jet streams, local thunderstorms, tropical cyclones, tornadoes and hurricanes.

CO6: Knowledge of climate and its classification. Understanding various causes of climate change like global warming, air pollution, aerosols, ozone depletion, acid rain.

CO7: Develop skills needed for weather forecasting, mathematical simulations, weather forecasting methods, types of weather forecasting, role of satellite observations in weather forecasting, weather maps etc. Uncertainties in predicting weather based on statistical analysis.

CO8: Develop ability to do weather forecasts using input data.

Course Contents:

Unit I

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and

anticyclones: its characteristics.

Unit II

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Unit III

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

Unit IV

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.

2.Processing and analysis of weather data:

(a) To calculate the sunniest time of the year.

(b) To study the variation of rainfall amount and intensity by wind direction.

(c) To observe the sunniest/driest day of the week.

(d) To examine the maximum and minimum temperature throughout the year.

(e) To evaluate the relative humidity of the day.

(f) To examine the rainfall amount month-wise.

3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and their analysis.

4.Formats and elements in different types of weather forecasts/warnings (both aviation and non-aviation).

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books

2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.

3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.

4. Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.

5. Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.

6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

BCH304: IT SKILLS FOR CHEMISTS

Credits : 02

LTP : 200

Course Description: This course deal with Mathematics, Computer programming, Hands On, Introductory writing activities, Handling numeric data, Numeric modeling, Statistical analysis, Presentation.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Basic fundamentals of Mathematics,

CO2: Numerical curve fitting in term of regression, finding roots and differential calculus

CO3: Basic of computer programming,

CO4: Introductory writing activities, handling numeric data, numeric modeling, statistical analysis and presentation.

Course Contents:

Unit I

1. Mathematics

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs. Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.

Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction.

Unit II

2. Numerical curve fitting:

The method of least squares (regression). Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid).

Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a Vander Waals gas, potentiometric titrations).

Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

Unit III

3. Computer programming:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language.

BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

HANDS ON

4. Introductory writing activities: Introduction to word processor and structure drawing (Chem Sketch) software. Incorporating chemical structures, chemical equations, and expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents.

5. Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals Isotherms), data from phase equilibria studies. Graphical solution of equations.

Unit IV

6. Numeric modelling:

Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration-time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).

Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The t test. The F test.

Presentation: Presentation graphics.

Reference Books:

- Mc Quarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
- Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
- Steiner, E. The Chemical Maths Book Oxford University Press (1996).
- Yates, P. Chemical calculations. 2ndEd. CRC Press (2007).
- Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis,* Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown &Co. (1985).
- Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

BCH305: BASIC ANALYTICAL CHEMISTRY

Credits : 02

LTP : 200

Course Description: This course deal with Introduction, Analysis of soil, Analysis of water, Analysis of food products, Chromatography, Ion-exchange, Analysis of cosmetics, Suggested Applications, Suggested Instrumental demonstrations.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Analytical chemistry, concept of sampling and soil analysis

CO2: Analysis of water and its source of contaminations, Analysis of food products and adulterations,

CO3: Use of chromatography technique in for separation in term of TLC and ion-exchange chromatography.

CO4: Analysis of cosmetics composition, their applications and instrumental demonstrations.

Course Contents:

Unit I

1. Introduction: 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.

2. Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a) Determination of pH of soil samples.

b) Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Unit II

3. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a) Determination of pH, acidity and alkalinity of a water sample.

b) Determination of dissolved oxygen (DO) of a water sample.

4. Analysis of food products: 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, chili powder, turmeric powder, coriander powder and pulses, etc.

b) Analysis of preservatives and coloring matter.

Unit III

5. Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a) Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).

b) To compare paint samples by TLC method.

6. Ion-exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

7. Analysis of cosmetics: Major and minor constituents and their function

a) Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

b) Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Unit IV

8. Suggested Applications (Any one):

a) To study the use of phenolphthalein in trap cases.

b) To analyze arson accelerants.

c) To carry out analysis of gasoline.

9. Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

- 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.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis,* Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry* 6th Ed., Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. *Quantitative Chemical Analysis,* W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook,* McGraw Hill.
- Day, R. A. & Underwood, A. L. *Quantitative Analysis,* Prentice Hall of India.
- Freifelder, D. *Physical Biochemistry 2nd Ed.*, W.H. Freeman and Co., N.Y.USA (1982).
- Cooper, T.G. *The Tools of Biochemistry,* John Wiley and Sons, N.Y. USA. (1977).
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis* 7th Ed., Prentice Hall.
- Vogel, A. I. *Vogel's Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
- Robinson, J.W. *Undergraduate Instrumental Analysis* 5th Ed., Marcel Dekker, Inc., New York (1995).

BCH306: CHEMICAL TECHNOLOGY AND SOCIETY

Credits : 02

LTP : 200

Course Description: This course deals with Chemical Technology, Scaling, energy from Natural Sources, Nucleic acids.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Process of distillation, extraction and other techniques.

CO2: Role of chemical technology in scaling for better understanding of trace materials

CO3: Various energy resources

CO4: Composition of nucleic acid for chemical perspective

Course Contents:

Unit I

1. 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.

Unit II

2. Scaling

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants).

Unit III

3. 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.

Unit IV

4. Nucleic acids, and molecular reactivity and inter conversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Reference Books:

John W. Hill, Terry W. Mc Creary & Doris K. Kolb, Chemistry for changing times 13thEd.

BCH307: CHEMOINFORMATICS

Credits : 02

LTP : 200

Course Description: This course deals with Introduction of Chemo informatics, Representation of molecules and chemical reactions, Searching chemical structures, Applications and Hands-on Exercises.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Knowledge of Chemo informatics,

CO2: Representation of molecules and chemical reactions,

CO3: Representation of chemical structures in 2D and 3D

CO4: Application and identification of compounds

Course Contents:

Unit I

1. Introduction to Chemo informatics: History and evolution of chemo informatics, Use of chemo informatics, Prospects of chemo informatics, Molecular Modelling and Structure elucidation.

Unit II

2. Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sd files, Libraries and tool kits, Different electronic effects, Reaction classification.

Unit III

3. Searching chemical structures: Full structure search, sub-structure search, basicideas, similarity search, three-dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Unit IV

4. Applications: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of chemo informatics in Drug Design.

Reference Books:

- Andrew R. Leach & Valerie, J. Gillet (2007) An introduction to Cheminformatics. Springer: The Netherlands.
- Gasteiger, J. & Engel, T. (2003) cheminformatics: A text-book. Wiley-VCH.
- Gupta, S. P. (2011) QSAR & Molecular Modeling. Anamaya Pub.: New Delhi.b

BCH308: BUSINESS SKILLS FOR CHEMISTS

Credits : 02

LTP : 200

Course Description: This course deals with Business Basics, Chemistry in Industry, Making money and Intellectual property.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Business basics,

CO2: Chemistry in Industry to solve challenges,

CO3: Financial aspect of business

CO4: Meaning of Intellectual property.

Course Contents:

Unit I

1. Business Basics

Key business concepts: Business plans, market needs, project management and routes to market.

Unit II

2. Chemistry in Industry

Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies..

Unit III

3. Making money

Financial aspects of business with case studies

Unit IV

4. Intellectual property

Concept of intellectual property, patents.

Reference

www.rsc.org

.

BCH404: INTELLECTUAL PROPERTY RIGHTS

Credits : 02

LTP : 200

Course Description: This course deals with Introduction to Intellectual Property, Copyrights, Trade Marks, Patents, Geographical Indications, Industrial Designs, Layout design of integrated circuits, Trade Secrets, Different International agreements, IP Infringement issue and enforcement.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Introduction to Intellectual Property, Copyrights, Trade Marks, Patents, Geographical Indications,

CO2: Industrial Designs, Layout design of integrated circuits,

CO3: Trade Secrets, Different International agreements,

CO4: IP Infringement issue and enforcement.

Course Contents:

Unit I

1. Introduction to Intellectual Property:

Historical Perspective, Different Types of IP and importance of protecting IP.

2. Copyrights

Introduction, how to obtain, Differences from Patents.

3. Trade Marks

Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Unit II

4. Patents

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

5. Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

6. Industrial Designs

Definition, how to obtain, features, International design registration.

7. Layout design of integrated circuits

Circuit Boards, Integrated Chips, Importance for electronic industry.

Unit III

8. Trade Secrets

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

9. Different International agreements

(a) Word Trade Organization (WTO):

(I) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement

(ii) General Agreement on Trade related Services (GATS)

(iii) Madrid Protocol

(iv) Berne Convention

(v) Budapest Treaty

Unit IV

(b) Paris Convention

WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity

10. IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property

– Intangible assets and their valuation, Intellectual Property in the Indian Context

–Various laws in India Licensing and technology transfer.

Reference

- N.K. Acharya: *Textbook on intellectual property rights,* Asia Law House (2001).
- Manjula Guru & M.B. Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
- P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).
- Arthur Raphael Miller, Micheal H. Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell,* West Group Publishers (2000).
- Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

BCH406: GREEN METHODS IN CHEMISTRY

Credits : 02

LTP : 200

Course Description: This course deal with Introduction, Green Solvents, Surfactants for carbon dioxide, Rand ightfit pigment.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Meaning of green chemistry,

CO2: Green solvents and green energy,

CO3: Surfactants for carbon dioxide

CO4: Use of synthetic pigments.

Unit I

1. Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity.

Unit II

2. Green Solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability.

Unit III

3. The following Real-world Cases in Green Chemistry should be discussed:

1. Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.

2. Designing of environmentally safe marine antifoulant.

Unit IV

3. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.

4. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

4. Practicals

1. Preparation and characterization of biodiesel from vegetable oil.

2. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice.

3. Mechano chemical solvent free synthesis of azomethine.

4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Reference Books:

1. Anastas, P.T. & Warner, J.K. *Green Chemistry- Theory and Practical,* Oxford University Press (1998).

2. Matlack, A.S. *Introduction to Green Chemistry,* Marcel Dekker (2001).

3. Cann, M.C. & Connely, M.E. Real-*World cases in Green Chemistry,* American Chemical Society, Washington (2000).

4. Ryan, M.A. & Tinnes and, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

5. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiments: A monograph* I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.

6. Lancaster, M. *Green Chemistry: An introductory text* RSC publishing, 2nd Edition.

7. Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malovika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated*"A Social Awareness Project", Delhi University Journal of Undergraduate Research and Innovation,* **1(1):** 2015.

BCH405: ANALYTICAL CLINICAL BIOCHEMISTRY

Credits : 02

LTP : 200

Course Description: This course deals with Carbohydrates, Proteins, Enzymes, Lipids, Structure of DNA, Enzymes, Biochemistry of disease, Blood, Urine.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins.

CO2: Concept of enzymes, and their mechanism of actions.

CO3: Lipids and their functions, Structure of DNA

CO4: Biochemistry of disease, Blood, Urine.

Course Contents:

Unit I

1. Carbohydrates:

Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebscycle. Isolation and characterization of polysaccharides.

2. Proteins:

Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Unit II

3. Enzymes:

Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereo specificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Bio catalysis: Importance in "Green Chemistry" and Chemical Industry.

Unit III

4. Lipids:

Classification. Biological importance of triglycerides and phosphoglycerates and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins. Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

5. Structure of DNA (Watson - Crick Model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

6. Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Unit IV

7. Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anemia, Regulation, estimation and interpretation of datafor blood sugar, urea, creatinine, cholesterol and bilirubin.

8. Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

9. Practicals

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oils.
4. Determination of the saponification number of oils.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:

- T.G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry,W.H. Freeman, 2002

• Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology,3rd Ed. PHI Learning.
• Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.,W. H. Freeman.
• Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

BCH407: PHARMACEUTICAL CHEMISTRY

Credits : 02

LTP : 200

Course Description: This course deals with Drugs & Pharmaceuticals, Antibiotics, Cardiovascular, Fermentation.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: Classifications and synthetic approach of Drugs & Pharmaceuticals,

CO2: Uses and types of antibiotics,

CO3: Cardiovascular and HIV-AIDS treatment drugs,

CO4: concept and uses of fermentation.

Unit I

1. 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, lbuprofen).

Unit II

2. Antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),

Unit III

3. Cardiovascular (Glyceryltrinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine).

Unit IV

4. Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

5. Practicals

1. Preparation of Aspirin and its analysis.

2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

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.

BCH408: CHEMISTRY OF COSMETICS & PERFUMES

Credits : 02

LTP : 200

Course Description: This course deals with a general study including the preparation and uses of the following: Hair dye, Creams, Essential oils, 2-phenyl ethyl alcohol.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: preparation and uses of Hair dye, Creams, Essential oils, 2-phenyl ethyl alcohol**.**

CO2: preparation and uses of Creams,

CO3: preparation and uses of Essential oils**,**

CO4: preparation and uses of 2-phenyl ethyl alcohol.

Unit I

1. A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel,

Unit II

2. Creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.

Unit III

3. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil,

Unit IV

4. 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

5. Practicals

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.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

BCH409: PESTICIDE CHEMISTRY

Credits : 02

LTP : 200

Course Description: This course deals with general introduction to pesticides, Structure Activity Relationship, Organophosphates, Quinones.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: natural and synthetic pesticides,

CO2: Structure activity relationship of organochlorines

CO3: Organophosphates with examples,

CO4: Quinones with examples.

Unit I

1. General introduction to pesticides

(natural and synthetic), benefits and adverse effects, changing concepts of pesticides,

Unit II

2. Structure Activity Relationship

Synthesis and technical manufacture and use of representative pesticides in the following classes: Organochlorines (DDT, Gammexene);

Unit III

3. Organophosphates

(Malathion, Parathion); Carbamates (Carbofuran and carbaryl);

Unit IV

4. Quinones

(Chloranil), Anilides (Alachlor and Butachlor).

5. Practicals

1. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

- Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.

COMM 101: English Communication

Credits : 02

LTP : 200

Course Description: This course deals with the basics of the English Language and enhances effective reading and writing skills.

Course Outcomes:

After reading this course student will be able to have knowledge of

CO1: The students will develop a minute of practical knowledge about English grammar and its usage

CO2: The students will develop an understanding of the importance of free expression.

Unit I

Reading Skills: Comprehension of Unseen Passage [Reading articles] (Intermediate) Summary Paraphrasing, Translation and Precis Writing

Unit II

English Grammar and Usage: Parts of speech, common errors in writing (based on Parts of Speech) Tenses, Change of Voice, Transformation of Sentences

Unit III

Basic Writing Skills and Writing Practices: Paragraph/essay writing, short life story writing, Notice (General like trip, change of name, function) making notes and Letter writing.

Unit IV

Vocabulary Enhancement: Synonym, Antonym, Idioms and Phrasal verbs

Reference Book:

1. Practical English Usage. Michael Swan OUP. 1995

Suggested Readings:

1. *On Writing Well.* William Zinsser. Harper Resource Book. 2001
2. *Communication Skills.* Sanjay Kumar and Pushp Lata. Oxford University Press. 2006
3. *Exercises in Spoken English.* CIEFL, Hyderabad. Oxford University Press

Internet Links:

1. https://www.englishgrammar101.com/
2. http://learnenglish.britishcouncil.org/en/english-grammar
3. http://www.englishgrammarsecrets.com/
4. http://www.myenglishpages.com/
5. http://www.english-for-students.com/Homonyms-B.html

ENS001: Environmental Studies

Credits : 02

LTP : 200

Course Description: This course deals with the environment components, ecosystems and how to maintain equilibrium in nature, its conservation, and different methods to reduce pollution and maintain our nature.

Course Outcomes:

After completion of this course, student will be able to

CO1: Understand about environment, its role and importance for living beings.

CO2: Understand the structure of ecosystem, food chain/ web.

CO3: Understand natural resources and their uses.

CO4: Understand different types of pollution created by human beings and their side effects as well as the methods to reduce these pollutions and their alternatives.

Unit I

Introduction to environmental studies

Multidisciplinary nature of environmental studies; components of the environment – atmosphere, hydrosphere, lithosphere, and biosphere.

Scope and importance; Concept of sustainability and sustainable development.

Ecosystems

What is an ecosystem? Structure and function of the ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems:

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit II

Natural Resources: Renewable and Non-renewable Resources

- Land Resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity, and tribal populations.

- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Heating of earth and circulation of air; air mass formation and precipitation.
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Biodiversity and Conservation

- Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit III

Environmental Pollution

- Environmental pollution: types, causes, effects and controls; Air, water, soil, chemical and noise pollution.
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).
- Nature reserves, tribal population and rights, and human, and wildlife conflicts in the Indian context

Unit IV

Human Communities and the Environment

- Human population and growth: Impact on environment, human health, and welfare.
- Carbon footprint.
- Resettlement and rehabilitation of project-affected persons, case studies.
- Disaster management: floods, earthquakes, cyclones, and landslides.
- Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

**** Field work**

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds, and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

Suggested Readings:

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P.1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.
8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, h.T. & Andrews, J.1971. Fundamentals of Ecology. Philadelphia:

Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. Wastewater Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.
14. Sengupta, R. 2003.Ecology and economics: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18. Warren, C.E. 1971. Biology and Water Pollution Control. WB Saunders.
19. Wilson, E.O. 2006. The Creation: An appeal to save life on earth. New York: Norton.
20. World Commission on environment and Development. 1987. Our Common Future. Oxford University Press.
21. www.nacwc.nic.in
22. www.opcw.org

GWE101: Gender Equality and Woman Empowerment

Credits : 02

LTP : 200

Course Objectives:

1. To sensitize the participants regarding the issues of gender and the gender inequalities prevalent in society.
2. To raise and develop social consciousness among the students.
3. To introduce gender sensitization and related issues.

Course Outcomes:

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

CO1: Recognize the intersections between gender and other social and cultural identities.

CO2: Engage in promoting social justice and human rights.

CO3: Explain how theories of gender and sexuality have been influenced by and influence their social contexts

CO4: Describe the social construction of gender and sexuality and explain who these constructions are shaped by the time, location, and culture that they are situated in.

Contents:

I) Introduction to Women's Studies

Sex and Gender, socialization, Definition, Nature, Scope, and various dimensions

II) Approaches of Feminism

Feminism and Patriarchy, Feminist ideology, Feminist Movements in brief

(III) Basic concepts of Gender and Society

The sexual division of Labour, Masculinity & femininity, Man and Woman relationship, Self-awareness, consciousness-raising

(IV) Women and Law

Constitutional Laws and Fundamental rights, Human Rights, Women related Law, Women in Politics

(V) Skill development and presentation

Film/Documentary Screening, Field Visits, Group discussion and debate, Awareness Songs, Street plays, theatre, and presentation skills for personality development

(VI) Prevention of Sexual Harassment

Preconditions for Effective Working of Sexual Harassment, Complaints Committees, Role of men in the prevention of sexual harassment at workplace, Gender-sensitive language, work culture and workplace.

Suggested Readings:

1. Gill, Rajesh, Contemporary Indian Urban Society- Ethnicity, Gender and Governance, Bookwell Publishers, New Delhi, 2009
2. Jain, Devaki and Rajput, Pam, (eds), Narratives from the Women's Studies Family, Sage, New Delhi, 2003

Suggested Books:

1. Mies, Maria, Indian Women and Patriarchy, Concept Publishing Company, New Delhi, 2004