Name of the Faculty: Faculty of Science

Name of the Program: B.Sc. (Non-Medical)

Batch: 2021-2022 onwards

Program Structure as per NEP 2020

Semester	Core Course (CC)	Discipline Specific Elective (DSE)	Multidiscip -linary Generic Elective (MGE)	Ability Enhancement Compulsory Courses (AECC)	Skill Enhancemen t Courses (SEC)	Value Addition Courses (VAC)	Project	Total Credits	Total Contact Hours
I	CC-1 (5) CC-2 (5) CC-3 (5)		MGE-1(4)	AECC -1 (2)		VAC-1 (2)		23	29
II	CC-4 (5) CC-5 (5) CC-6 (5)		MGE-2(4)	AECC -2 (2)		VAC-2 (2)		23	29
Provision to provide Certificate Course in Basic Sciences							**Total**	46	58
III	CC-7 (5) CC- 8(5) CC- 9 (5)		MGE-3(4)	AECC -3 (2)		VAC-3 (2)		23	29
IV	CC- 10(5) CC- 11(5) CC- 12(5)		MGE-4(4)	AECC -4 (2)		VAC-4 (2)		23	29
Provision to provide Diploma in Basic Sciences							**Total**	**92**	**58**
V		DSE-1 (6) DSE-2 (6) DSE-3 (6)			SEC-1 (3)			21	27
VI		DSE-4 (6) DSE-5 (6) DSE-6 (6)			SEC-2 (3)			21	27
BSc (NM) will be awarded							**Total**	**134**	**112**
VII		DSE-7 (6) DSE-8 (6)					8	20	32
VIII		DSE-9 (6) DSE-10(6)					8	20	32
BSc (NM) with Research (Phy /Chem /Maths /EVS) will be awarded							**Total**	**174**	**176**
Note: 20% credits need to be earned by the studenst through online courses									

28/5/22

28/5/2022

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28.06.22

28/5/2022

Name of the Faculty : Faculty of Science

Name of the Programme : B.Sc (Non-Medical) 2021-2022

											Theor		Theory (Internal)					Practical				Practical (Internal)							
S. No.	Semester/Year	Course Code	Nomenclature	Theory/ Practical	Core/ AECC/ MGE/VAC/ DSE	L	T	P	Credits	Max	Pass	Midterm	Assignment	Professional Activities	Max	Pass	Demonstration/Conduct/Presentation	Viva-voce	Max	Pass	Attendance & Regularity in lab Work	Project/Laboratory Work Report	Midterm oral examination/Assesment	Conduct/Demonstration	Max	Pass	Overall Max Marks	Overall Pass Marks
1	I / I	--	English Communiation	Theory	AECC	2	0	0	2	30	12	10	5	5	20	8											50	20
2		17030101	Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
3		17030102	MechanicsLab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
4		17030103	Atomic Structure, Chemical Bonding, Chemical Energetics and Equilibria	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
5		17030104	Atomic Structure, Chemical Bonding, Chemical Energetics and Equilibria Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
6		17030105	Calculus	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
7		17030106	Calculus lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
8		--	Multidisiplinary Generic Elective (MGE)-1	Theory	MGE	4	0	0	4	60	24	20	10	10	40	16											100	40
9		--	Value Added Course (VAC)-1	Theory	VAC	2	0	0	2	30	12	10	5	5	20	8											50	20
10	II/I	--	Environmental Science	Theory	AECC	2	0	0	2	30	12	10	5	5	20	8											50	20
11		17030201	Electricity, Magnetism and EMT	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
12		17030202	Electricity, Magnetism and EMT Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
13		17030203	General Organic Chemistry and Introduction to Organic Functional Groups	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
14		17030204	General Organic Chemistry and Introduction to Organic Functional Groups Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
15		17030205	Differential Equations	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
16		17030206	Differential Equations Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
17		--	Multidisiplinary Genereic Elective (MGE)-2	Theory	MGE	4	0	0	4	60	24	20	10	10	40	16											100	40
18		--	Value Added Course (VAC)-2	Theory	VAC	2	0	0	2	30	12	10	5	5	20	8											50	20
19	III / II	--	Human Values & Ethics	Theory	AECC	2	0	0	2	30	12	10	5	5	20	8											50	20
20		17030301	Thermal Physicsand Statistical Mechanics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
21		17030302	Thermal Physicsand Statistical Mechanics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
22		17030303	States of Matter, Thermodynamics and Chemistry of Organic Functional Groups	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
23		17030304	States of Matter, Thermodynamics and Chemistry of Organic Functional Groups Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
24		17030305	Analysis-1	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
25		17030306	Analysis-1 Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
26		--	Multidisiplinary Generic Elective (MGE)-3	Theory	MGE	4	0	0	4	60	24	20	10	10	40	16											100	40
27		--	Value Added Course (VAC)-3	Theory	VAC	2	0	0	2	30	12	10	5	5	20	8											50	20
28	IV/II	--	Soft Skills	Theory	AECC	2	0	0	2	30	12	10	5	5	20	8											50	20
29		17030401	Waves and Optics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
30		17030402	Waves and Optics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
31		17030403	Transition Metal & Coordination Chemistry, Electrochemistry and Chemical Kinetics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
32		17030404	Transition Metal & Coordination Chemistry, Electrochemistry and Chemical Kinetics Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
33		17030405	Linear and Abstract Algebra	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40
34		17030406	Linear and Abstract Algebra Lab	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40

35		--	Multidisiplinary Genereic Elective (MGE)-4	Theory	MGE	4	0	0	4	60	24	20	10	10	40	16																	100	40
36		--	Value Added Course (VAC)-4	Theory	VAC	2	0	0	2	30	12	10	5	5	20	8																	50	20
37		17030501	Computational Physics Skills	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
38		17030502	Applied Optics	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
39		17030503	Renewable Energy and Energy Harvesting	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
40		17030504	Basic Analytical Chemistry	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
41		17030505	Fuel Chemistry	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
42		17030506	Chemical Technology & Society	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
43		17030507	Solid Geometry	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
44		17030508	Mathematical Modelling	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
45		17030509	Discrete Mathematics	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
46		17030510	Solid State Physics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
47		17030511	Solid State Physics Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
48		17030512	Atomic Molecular and Laser Physics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
49		17030513	Atomic Molecular and Laser Physics Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
50	V/II	17030514	Biophysics and Radiation Science	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
51		17030515	Biophysics and Radiation Science Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
52		17030516	Analytical Methods in Chemistry	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
53		17030517	Analytical Methods in Chemistry Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
54		17030518	Molecules of Life	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
55		17030519	Molecules of Life Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
56		17030520	Quantum Chemistry, Spectroscopy & Photochemistry	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
57		17030521	Quantum Chemistry, Spectroscopy & Photochemistry Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
58		17030522	Vector Calculus	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
59		17030523	Vector Calculus Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
60		17030524	Operation Research	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
61		17030525	Operation Research Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
62		17030526	Special functions	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
63		17030527	Special Functions Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
64		17030601	Sensors and Detectors	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
65		17030602	Physics Modeling using Python	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
66		17030603	Satellite Communication and its Applicaions	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
67		17030604	Pharmaceutical Chemistry	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
68		17030605	Chemistry of Cosmetics & Perfumes	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
69		17030606	Pesticide Chemistry	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
70		17030607	Cryprography	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
71		17030608	Integral Equations	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
72		17030609	Fluid Dynamics	Theory	SEC	3	0	0	3	60	24	20	10	10	40	16																	100	40
73		17030610	Quantum Mechanics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
74		17030611	Quantum Mechanics Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
75		17030612	Nuclear and Particle Physics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
76		17030613	Nuclear and Particle Physics Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
77	VI/III	17030614	Astrophysics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
78		17030615	Astrophysics Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
79		17030616	Polymer Chemistry	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
80		17030617	Polymer Chemistry Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
81		17030618	Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16																	100	40
82		17030619	Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40

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83		17030620	Chemistry of Main Group Elements, Theories of Acids and Bases	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
84		17030621	Chemistry of Main Group Elements, Theories of Acids and Bases Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
85		17030622	Integral Transformation	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
86		17030623	Integral Transformation Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
87		17030624	Partial Differential Equations	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
88		17030625	Partial Differential Equations Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
89		17030626	Numerical Methods	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
90		17030627	Numerical Methods Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
91		17030701	Mathematical and Computational Physics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
92		17030702	Physics Practical-1	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
93		17030703	Classical Mechanics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
94		17030704	Physics Practical-2	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
95		17030705	Quantum Chemistry and Thermodynamics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
96		17030706	Physical Chemistry Practical-I	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
97		17030707	Stereo Chemistry and Organic Reaction Mechanism	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
98		17030708	Organic Chemistry Practical-I	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
99	VII/IV	17030709	Metric Space	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
100		17030710	Functional Analaysis	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
101		17030711	Advanced Differential Equations	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
102		17030712	Advanced Differential Equations Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
103		17030713	Ecology and Biodiversity	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
104		17030714	Ecology and Biodiversity-Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
105		17030715	Air and Noise Pollution	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
106		17030716	Air and Noise Pollution-Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
107		17030717	Project - I	Practical	DSE	0	0	8	8								40	40	80	32	20	20	20	60	120	48	200	80
108			PYTHON Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
109		17030801	Advanced Quantum Mechanics	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
110		17030802	Physics Practical-3	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
111		17030803	Physics of Nanomaterials	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
112		17030804	Physics Practical-4	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
113		17030805	Transition Metal Chemistry	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
114		17030806	Inorganic Chemistry Practical-I	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
115		17030807	Instrumental Techniques	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
116		17030808	Instrumental Techniques Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
117	VIII/IV	17030809	Analysis-II	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
118		17030810	Algebra-II	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
119		17030811	Mathematical Programming	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
120		17030812	Mathematical Programming Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
121		17030813	Soil and water Pollution	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
122		17030814	Soil and water Pollution-Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
123		17030815	EIA and Sustainable development	Theory	DSE	4	0	0	4	60	24	20	10	10	40	16														100	40
124		17030816	EIA and Sustainable developmen-Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40
125		17030817	Project - II	Practical	DSE	0	0	8	8								40	40	80	32	20	20	20	60	120	48	200	80
126			LATEX Lab	Practical	DSE	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40

SEMESTER-I (CORE)

1. Name of the Faculty: Faculty of Science						
2. Course Name	English			**L**	**T**	**P**
3. Course Code				4	0	0
4.Type of Course (use tick mark)		Core ()	DSE ()	GE ()	AEC (✓)	
5. Pre-requisite (if any)	10+2 with Science stream	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

In this Ability Enhancement Compulsory course, the students will be able to know about the basic knowledge of English Comprehension, Speeches with its terminologies.

9.Course Objectives (COs):

1. To learn basics of English language
2. To gain knowledge of English terminology and concept
3. To study the concept of grammar and its appropriate implications
4. To enhance writing and communication skills.

10. Course Outcomes (COs):

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

1. Know about the English Language
2. Describe the terminology and basics concept of English Grammar.
3. Improve writing skills, note making etc.
4. Apply the concept of English language in their written and verbal communications.

11. Unit wise detailed content

Unit-1	**Number of lectures=13**	**Title of the unit: Listening Comprehension**
Speeches, Interviews, audio-video clippings followed by exercises, Introduction to Communication, Importance of Communication, Barriers to Communication and ways to overcome them		
Unit – 2	**Number of lectures=13**	**Title of the unit: Conversation skills**
Greetings and Introducing oneself, Framing questions and answers, Role play, Buying: asking details etc., Word formation strategies, Vocabulary building: Antonyms, Synonyms, Affixation, Suffixation, One word substitution		
Unit – 3	**Number of lectures=13**	**Title of the unit: Reading Comprehension**
Simple narration and Stories, Newspaper and articles clippings, Sentence types, Note Making, Paragraph Writing, Comprehension		
Unit – 4	**Number of lectures=13**	**Title of the unit: Writing Comprehension**
Report Writing: types, characteristics. Letters: types, format, style, Précis Writing, Paragraph: Order, Topic sentence, consistency, coherence, Report and Proposal, Project Writing: Features, Structure. Pronunciation, Syllable and Stress, Intonation and Modulation		

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=G_ZeBr6bhyw
2. https://www.youtube.com/watch?v=4l5RciQZxyk
3. https://www.youtube.com/watch?v=ijrMpZWUUcc

4. https://www.youtube.com/watch?v=OgNVUZvB9Ow
5. https://www.youtube.com/watch?v=OfTIrsSliLM
6. https://www.youtube.com/watch?v=LquflXdZRVo

13. Books Recommended

1. Fluency in English-II, Department of English, Delhi University, Oxford University Press.
2. Murphy's English Grammar with CD, Murphy, Cambridge University Press.
3. English Vocabulary in Use (Advanced), Michael McCarthy and Felicity, CUP.
4. Learning Spoken English by Lynn Lundquist-ASIN: B0094XNOPW.
5. Essential English Grammar: A Self-Study Reference and Practice Book for Elementary

1. Name of the Department: Physics						
2. Course Name	Mechanics	**L**	**T**		**P**	
3. Course Code	1703101	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem()

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

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

After going through this course, the student

1. Will have understanding of Mechanics knowledge
2. Can implement, the elastic properties of the materials in everyday life
3. Acquire skills to understand the mechanism of satellite motion,
4. Help students in critical thinking and problem solving.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Vectors**

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

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

Unit - 2	**Number of lectures = 11**	**Title of the unit: Momentum and Energy**

Momentum and Energy: Dynamics of a system of particles, centre of mass, Conservation of momentum, Work and energy, Conservation of energy, Motion of rockets.

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

Gravitation: Newton's Law of Gravitation, Kepler's Laws (statement only), Satellite in circular orbit and applications, Geosynchronous orbits, Weightlessness.

Unit -3	**Number of lectures = 10**	**Title of the unit: Elasticity**

Elasticity: Hooke's law - Stress-strain diagram - Elastic Moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work

done in stretching a wire, Twisting couple on a cylinder		
Unit - 4	**Number of lectures = 09**	**Title of the unit: Special Theory of Relativity**
Special Theory of Relativity: Frame of Reference, Constancy of speed of light, Postulates of Special Theory of Relativity, Length contraction, Time dilation, Twin Paradox, Relativistic addition of velocities.		
12. Books Recommended		
1. University Physics, FW Sears, MW Zemansky and HD Young13/e, 1986, Addison-Wesley (ISBN-10- 0201603225; ISBN-13 : 978-0201603224) 2. Mechanics Berkeley Physics course,v,1: Charles Kittel, et, Al, 2007, Tata McGraw-Hill, (ISBN:9780070667280, 0070667284) 3. Physics – Resnick, Halliday& Walker 9/e, 2010, Wiley (ISBN: 978-1-119-30685-6) 4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole, (ISBN-10:0534369642; ISBN-13 : 978-0534369644)		
13. Links		
1. https://nptel.ac.in/courses/122103011/6 2.http://web.mit.edu/8.01t/www/materials/modules/chapter23.pdf 3. http://www.feynmanlectures.caltech.edu/III_17.html 4. https://nptel.ac.in/courses/105108070/1 5. https://nptel.ac.in/courses/122104014/		

1. Name of the Department: Physics						
2. Course Name	Mechanics Lab	**L**	**T**		**P**	
3. Course Code	17030102	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 36**			

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

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

11. List of Experiments

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

12. Book Recommended

1.Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House ISBN-10 : 0423738909, ISBN-13 : 978-0423738902
2. A Text book of Practical Physics, Indu Parkash, Ram Krishan and A.K.Jha, 11th Edition,2011, Kitab Mahal, New Delhi, ISBN-10 : 8122504167, ISBN-13 : 978-8122504163
3.B.Sc. Practical Physics, C.L. Arora S.Chand & Company, 2010 ISBN-10 : 8121909090

4.Engineering Practical Physics, S.Panigrahi& B.Mallick,2015, Cengage Learning India Pvt. Ltd, ISBN: 9788131525203

1. Name of the Department: Chemistry						
2. Course Name	Atomic Structure, Chemical Bonding, Chemical Energetics and Equilibria		**L**	**T**		**P**
3. Course Code	17030103		3	0		0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 40		**Tutorials = 0**		**Practical = 0**		

8. Course Description

This course will help the students to understand and rationalize the concepts of atomic structure and chemical bonding.

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

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

9. Course Objectives

The objectives of this course are to:

1. Introduce the insights of atomic structures with reference to quantum mechanics.
2. To learn the concepts of chemical bonding with the help the different theories.
3. Introduce students to energetics of chemical reactions through Laws of Thermodynamics
4. learn various concepts of chemical and ionic equilibria

10. Course Outcomes (COs)

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

1. Predict complete structure of atom with electronic configurations
2. Explain ionic and covalent bonding in detail.
3. Explain energetics of chemical reactions through important principles and definitions of thermo chemistry
4. Explain degree of ionization and the differences between strong, moderate and weak electrolytes and other important concepts of chemical equilibria

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Atomic Structure**

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

Introduction to Quantum mechanics. Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Significance of quantum numbers and orbital angular momentum. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit-2	**Number of lectures = 10**	**Title of the unit: Chemical Bonding and Molecular Structure**

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

29/5/22

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds.
MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

Unit-3	**Number of lectures = 10**	**Title of the unit: Chemical Energetics**

Review of thermodynamics and the Laws of thermodynamics
Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature- Kirchoff's equation.
Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit-4	**Number of lectures = 10**	**Title of the unit: Chemical Equilibrium and Ionic Equilibria**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^0, Le Chatlier's Principle.
Relationships between K_p, K_c and K_x for reactions involving ideal gases.
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts- applications of solubility product principle.

12. **Brief Description of self-learning/ E – learning component**

1. http://www.digimat.in/nptel/courses/video/104106096/L19.html
2. https://ncert.nic.in/ncerts/l/lech104.pdf
3. https://nptel.ac.in/courses/104/106/104106089/

13. **Books Recommended**

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991 ISBN 0-412-40290-4
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley, ISBN 0471505323.
3. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006, ISBN 978-0060429959
4. The Principles of Chemical Equilibrium: With Applications in Chemistry and Chemical Engineering 4th Edition, by KG Denbigh, Cambridge University Press, ISBN 978-0521281508

1. Name of the Department: Chemistry						
2. Course Name	Atomic Structure, Chemical Bonding, Chemical Energetics and Equilibria Lab		**L**		**T**	**P**
3. Course Code	17030104		0		0	4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

The lab work emphasizes learning of basic skills helpful not only to chemistry students but all those who want to pursue any experimental science. It includes using instruments, to determine physical parameters, *e.g.*, heat capacity, enthalpy, solubility and pH. It also includes volumetric analysis of compounds.

9. Course Objectives

The objectives of this course are to:

1. Introduce students to energetics of chemical reactions through laws of thermodynamics
2. Explain various concepts of chemical and ionic equilibria
3. Determination of strength of solution through volumetric analysis
4. Learn separation of Na_2CO_3 and $NaHCO_3$ by volumetric analysis

10. Course Outcomes (COs)

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

1. Learn various experimental concepts of thermochemistry such as heat capacity, enthalpy and solubility using different solutions
2. Preparation of buffer solutions and determination of pH of various solutions, for instance, aerated drinks, fruit juices, shampoos and soaps
3. Predict the technique of volumetric analysis
4. Determine strengths of Fe(II), Cu(II) solutions

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

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of *H*.

Ionic equilibria

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

Section B: Inorganic Chemistry - Volumetric Analysis

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

12. Brief Description of self-learning/ E – learning component

1. https://vlab.amrita.edu/?sub=2&brch=191&sim=344&cnt=1
2. http://bbec.ac.in/wp-content/uploads/2015/08/Practical_first-semester.pdf
3. https://pubs.acs.org/doi/abs/10.1021/ed007p724

13. Books Recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012, ISBN, 978-8131773710.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009, ISBN 9788131723258.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011), ISBN 978-81-265-3016-8.
4. B Viswanathan, PS Raghavan, Practical Physical Chemistry, Viva Books, ISBN 978-8130929699.

1. Name of the Department: Mathematics						
2. Course Name	Calculus	**L**	**T**		**P**	
3. Course Code	17030105	3	0		0	
4. Type of Course (use tick mark)		Core (✔)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

This course is designed to develop the topics of differential calculus. Emphasis is placed on limits, continuity, derivatives. Upon completion, students should be able to select and use appropriate models and techniques for finding solutions to derivative-related problems with and without technology, evaluation of areas, volumes of revolution, force, and work; fundamental formulas and various techniques of integration applied to both single variable and multivariable functions.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. Learn to find and use limits of functions,
2. To understand Rolle's Theorem, Mean Value theorems, series andMaclaurin's series.
3. Understand the meaning of differentiation and integration.
4. Apply the various methods of calculating derivatives of a function.

10. Course Outcomes (COs):

After completing the course, students are expected to be able:

1. To understand limits, continuity and differentiability of functions in two variables and their properties.
2. To expand the two variables functions in series, form and discuss the maxima & minima using expansion of functions.
3. To understand the concept of asymptotes and curve tracing of the functions and their properties.
4. To evaluate the double & triple integral and apply the multiple integrals to find the area and volume.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 12**	**Title of the unit: Continuity and Differentiation**

Limit and Continuity, Types of discontinuities, Differentiability of functions, Successive differentiation, n^{th} Differentiation of functions, Leibnitz's theorem, Limit, Continuity & Differentiability of functions in two variables, Partial differentiation, Euler's theorem on homogeneous functions and Jacobians.

Unit – 2	**Number of lectures = 08**	**Title of the unit: Mean Value Theorems and Series expansions**

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $sin\,x,\ cos\,x,\ e^x,\ log(1+x),\ (1+x)^m$, Taylor's theorem in two variables, Maxima and Minima of two variable functions,

Unit – 3	Number of lectures = 10	Title of the unit: Asymptote and Curve Tracing and Curvature
Asymptotes in cartesian coordinates, Asymptotes in polar coordinates, Oblique asymptotes, Concavity, Convexity & Points of Inflexion, Tangents and normal curvature, Singular points, Tracing of curves in cartesian, Parametric and Polar coordinates, Curvature, Radius of curvature for cartesian curves, Parametric curves, Polar curves.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Multiple Integrals and its Applications**
Double integral in cartesian and polar form, Change of order of integration, Double integral by changing the variable, Area, Triple integral in cartesian, Triple integration by changing the variable in cylindrical and spherical coordinates, Volume.		
12. Brief Description of self-learning / E-learning component		
1. https://nptel.ac.in/courses/111/104/111104085/ 2. https://nptel.ac.in/courses/111/107/111107108/		
13. Books Recommended		
1. Thomas and Finny, Calculus (9th ed.), Addison-Wesley, 1996. 2. Anton, Howard, Bivens, Irl, & Davis, Stephen, Calculus (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian Reprint (2016). 3. D.V. Widder, Advanced Calculus (2nd ed.), Prentice Hall of India Pvt. Ltd, New Delhi, 2012. 4. Gorakh Prasad: Differential Calculus, Pothishasla Pvt. Ltd. Allahabad 2016. 5. Shanti Narayan And P. K. Mittal, Integral Calculus (35th ed.), S. Chand, New Delhi, 2005.		

C.S. Lalita

1. Name of the Department: Mathematics						
2. Course Name	Calculus Lab	**L**	**T**		**P**	
3. Course Code	17030106	0	0		4	
4. Type of Course (use tick mark)		Core (✔)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

This course is designed to emphasize the knowledge of differential calculus using the visible picture of the function. Emphasis is placed on limits, continuity, derivatives, evaluation of areas, volumes of revolution, force, and work; fundamental formulas and various techniques of integration applied to both single variable and multivariable functions.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. Discuss the existence of limits and continuity of a function with graphs.
2. Discuss the existence of derivatives of a function with graphs.
3. Understand the meaning of differentiation and integration.
4. Apply the various methods of calculating derivative of a function

10. Course Outcomes (COs):

After completing the course, students are expected

1. To be able to evaluate various limit & continuity problem
2. Calculus is a primary gateway to an engineering and technology
3. Properly carry out integration through the use of the fundamental formulae and/or the various techniques of integration.

11. The list of practicals to perform in the computer lab.

1. To calculate limit, right hand limit and left hand limit of functions and draw the graph of the function
2. To calculate continuity of functions and draw the graph of the function
3. To identify points of discontinuity with the help of graph
4. To calculate derivatives of a one and two variable functions with graph
5. To find Jacobians of the functions in two and three variables.
6. To discuss the applicability of Mean value theorems through graph
7. To calculate value of 'c' using Mean value theorems
8. To find Taylor's and Maclaurin's series
9. To find the maximum and minimum of two variable functions.
10. Evaluate double and triple integrals.
11. Evaluate integrals using a change of variable.
12. Evaluate Area and volume

12. Brief Description of self-learning / E-learning component

1. https://in.mathworks.com/academia/courseware/teaching-calculus-with-matlab.html
2. https://in.mathworks.com/discovery/integral.html
3. https://www.wolfram.com/language/12/core-calculus/learn-calculus-in-a-free-course.html?product=mathematica
4. https://www.youtube.com/watch?v=EaYEQ30KlWw

13. Books Recommended

1. Ronald L. Lipsman (Author), Jonathan M. Rosenberg, Multivariable Calculus with MATLAB®: With Applications to Geometry and Physics (1st edition), Springer, 2017.
2. C. Lopez, MATLAB Differential and Integral Calculus (1st edition), Apress, 2014.
3. Selwn Hollis, Calculus with Mathematica: An Interactive Book, Applied Symbols.com, 2004.
4. C. A. Knoll, M. D. Shaw, J. Johnson and B. Evans, Discovering Calculus with Mathematica (2nd edition), John Wiley & Sons, 1995.

SEMESTER-II (CORE)

1. Name of the Department: Physics						
2. Course Name	Electricity, Magnetism and EMT	**L**	**T**		**P**	
3. Course Code	17030201	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

After successful completion of this course, students will have

1. Basic understanding of electricity and magnetism, and their everyday life applications
2. Understanding of propagation of electromagnetic radiation in different medium like vacuum, isotropic dielectric medium etc.
3. Skills to design the projects based on basics of electricity and magnetism,
4. Assistance to students in critical thinking and problem solving.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Vector Analysis**

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

Unit - 2	**Number of lectures = 11**	**Title of the unit: Electrostatics**

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

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

	11	
Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current, Divergence and curl of magnetic field, Magnetic vector potential, Ampere's circuital law, Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, Brief introduction of dia-, para-and ferro-magnetic materials, Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, Energy stored in magnetic field.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Maxwell`s equations and Electromagnetic wave propagation**
Equation of continuity of current, Displacement current, Maxwell's equations, Pointing Theorem, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.		

12. Book Recommended:

1. Electricity and Magnetism, Edward M, Purcell, 1986, McGraw-Hill Education, ISBN 13: 9780070049086
2. Electricity and Magnetism, J,H, Fewkes& J, Yarwood, Vol, I, 1991, Oxford Univ, Press
3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House, ISBN-13: 978-9350975534
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole, ISBN-13: 978-0534369644
5. D,J, Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings, ISBN-13: 9780138053260

13. links

1. https://nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-23.pdf
2. https://nptel.ac.in/courses/113106032/15%20-%20Magnetic%20Properties.pdf
3. https://theopenacademy.com/sites/default/files/oadb/Sciences/Physics/Physics%20II%3B%20Electricity%20and%20Magnetism%20-%20MIT%20-%20Walter%20Lewin%20-%20BYNCSA/Notes/Course%20Notes/The-Displacement-Current-And-Maxwells-Equations.pdf
4. https://ocw.mit.edu/courses/mechanical-engineering/2-71-optics-spring-2009/video-lectures/lecture-14-maxwells-equations-polarization-poyntings-vector/
5. https://www.eit.lth.se/fileadmin/eit/courses/eten05/ht2016/lectures/lecture1.pdf

1. Name of the Department: Physics						
2. Course Name	Electricity, Magnetism and EMT Lab	**L**	**T**		**P**	
3. Course Code	17030202	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 36**		

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

1. Apply the concepts of basic electronic devices to design various electronic circuits.
2. Understand operation of diodes, transistors in order to design basic circuits.
3. Measure frequency of A.C. mains by sonometer using an electromagnet.
4. Measure low resistance by Carey Foster's Bridge

11. List of Experiments

1. To draw common base and common emitter characteristics of a transistor and calculate transistor and calculate transistor characteristics parameters.
2. To study the ripple factor in a D.C. power supply.
3. To draw frequency response curve of transistorized R.C. coupled amplifier.
4. To find out the frequency of a tuning fork by Melde's experiment.
5. Study of series and parallel resonance circuits.
6. Electronic Voltmeter measurement of peak, average & R.M.S. values of signal.
7. Study of voltage doubler and trippler circuits.
8. Frequency of A.C. mains by sonometer using an electromagnet.

5. To find Jacobians of the functions in two and three variables.
6. To discuss the applicability of Mean value theorems through graph
7. To calculate value of 'c' using Mean value theorems
8. To find Taylor's and Maclaurin's series
9. To find maximum and minimum of two variable functions.
10. Evaluate double and triple integrals.
11. Evaluate integrals using a change of variable.
12. Evaluate Area and volume

1. Gurpreet Singh Tuteja, "Practical Mathematics, International BOOK house Pvt Ltd.
2. https://www.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
3. https://in.mathworks.com/help/symbolic/solve-a-system-of-differential-equations.html
4. https://www.mathworks.com/help/matlab/math/choose-an-ode-solver.html
5. http://www.math.tamu.edu/undergraduate/research/REU/comp/matode.pdf

11. Books Recommended

1. Shanti Narayan: Differential and Integral Calculus.
2. Murray R.Speigel: Theory and Problems of Advanced Calculus, Schaum's Outline series, Schaum Publishing Co., New York.
3. N. Piskunov: Differential and Integral Calculus, Peace Publishers, Moscow.
4. Gorakh Prasad: Differential Calculus, Pothishasla Pvt. Ltd. Allahabad.
5. Gorakh Prasad: Integral Calculus, Pothishasla Pvt. Ltd. Allahabad

1. Name of the Faculty: Faculty of Science						
2.Course Name	Environmental Science			**L**	**T**	**P**
3.Course Code				4	0	0
4. Type of Course (use tick mark)		Core ( )	DSE ()	AECC(✓)	SEC ( )	
5. Pre-requisite (if any)	10+ 2 with Science Stream	**6. Frequency** (use tick marks)	Even (✓)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This course study of environmental problems is inherently interdisciplinary, blending perspectives from the sciences, social sciences, and humanities.

9. Course Objectives:

1. To learn the Organizational level of ecological systems
2. To understand the scope of environmental sciences in the current scenario.
3. To gain the knowledge and impact of various types of pollutions along with their preventive measures.
4. To understand the different environmental issues and there social impact.

10. Course Outcomes (COs):

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

1. Know the Importance of environmental studies and methods of conservation of natural resources..
2. Describe the structure and function of an ecosystem and explain the values and Conservation of bio-diversity.
3. Recall social issues and legal provision and describe the necessities for environmental act
4. To describe the impact of various pollutants in society and the parameters to overcome these pollutants.

11. Unit wise detailed content

Unit-1	**Number of lectures=13**	**Title of the unit:-** The Multidisciplinary nature of environmental studies.

The Multidisciplinary nature of environmental studies, Definition, scope and importance. Need for public awareness. Natural Resources, Renewable and non-renewable resources: Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Unit – 2	**Number of**	**Title of the unit:-** Ecosystems

	lectures=13	
Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Biodiversity and its conservation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.		
Unit – 3	**Number of lectures=13**	**Title of the unit:** Environmental Pollution
Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Fireworks, their impacts and hazards. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.		
Unit – 4	**Number of lectures=13**	**Title of the unit:** Social Issues and the Environment
Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Consumerism and waste products. Environmental Legislation (Acts and Laws) Issues involved in enforcement of environmental legislation. Human Population and the Environment. Population growth, variation among nations with case studies, Population explosion – Family Welfare Programmes and Family Planning Programmes, Human Rights, Value Education, Women and Child Welfare		

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=9TmZRZ-w1Y4
2. https://www.youtube.com/watch?v=YaRkQ6mYNC4
3. https://www.youtube.com/watch?v=bCVtowxwqR8
4. https://www.youtube.com/watch?v=v-RMhW4Xcyw
5. https://www.youtube.com/watch?v=InD80_yGLR0
6. https://www.youtube.com/watch?v=QzP2mnrVdeY

13. Books Recommended

1. Dhameja, S. K., Environmental Engineering and Management, S. K. Kataria and sons, New Delhi, 1st Edition2015.
2. Anubha Kaushik and Kaushik C.P., Environmental Science & Engineering" New Age international Publishers, New Delhi, 2010.
3. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., 2nd edition, 2004.
4. ErachBharucha, Textbook for Environmental Studies, UGC, New Delhi, 2004.
5. Miller T.G. Jr., "Environmental Science", Wadsworth Publishing Co. USA, 2nd Edition2004.
6. ErachBharucha, "The Biodiversity of India", Mapin publishing Pvt. Ltd., Ahmedabad India, 2002.
7. Trivedi R.K., "Handbook of Environmental Laws", Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro media, 2003.
8. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001. 7. Wager K.D., "Environmental Management", W.B. Saunders Co., Philadelphia, USA, 1998.
9. Sawyer C. N, McCarty P. L, and Parkin G. F., Chemistry for Environmental Engineering, McGraw-Hill, Inc., New York, 1994.

1. Name of the Department: Chemistry						
2. Course Name	General Organic Chemistry & Introduction to Organic Functional Groups		**L**	**T**	**P**	
3. Course Code	17030203		3	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

The course highlights the various electronic effects with emphasis on inductive effect, hyperconjugation, resonance and how they affect the properties of compounds. Nucleophilic and electrophilic behavior of organic compounds and the intermediates formed during reactions; carbocations; carbanions; and free radicals will be explained along with stereochemistry of organic compounds, which involves the study of the relative spatial arrangement of atoms that form the structure of molecules will be discussed at length. Various functional groups of organic chemistry will also be discussed in detail.

9. Course Objectives

The objectives of this course are to:

1. Introduce the properties of organic compounds with special emphasis on inductive effect, hyperconjugation and resonance. electrophilicity and nucleophilicity and impact of functional groups on reactions
2. Understand stereochemistry of compounds
3. Learn important properties of various functional groups.

10. Course Outcomes (COs)

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

1. Explain various electronic effects and their role in organic reaction mechanism.
2. Learn basics of stereochemistry
3. Know about various organic functional groups and their properties

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Fundamentals of Organic Chemistry and Stereochemistry

Fundamentals of Organic Chemistry: Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

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

Stereochemistry: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit-2	Number of lectures = 10	Title of the unit: Aliphatic Hydrocarbons

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

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

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. KMnO4.

Unit-3	Number of lectures = 10	Title of the unit: Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols:
Preparation: Preparation of 1°, 2° and 3° alcohols using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acids and esters.
Reactions: With Sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation
Diols: (Upto 6 Carbons), oxidation of diols. Pinacol-Pinacolone rearrangement.
Phenols: (Phenol case)
Preparation: Cumene hydroperoxide method, from diazonium salts.
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten-Baumann Reaction.
Ethers (aliphatic and aromatic): Cleavage of ethers with HI.
Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)
Preparation: from acid chlorides and nitriles
Reactions: Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol condensation, Canizzaro's reaction, Wittig reaction, Benzoin condensation.
Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Unit-4	Number of lectures = 10	Title of the unit: Carboxylic Acids and their derivatives; Amines and Diazonium Salts

Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.
Carboxylic acids and their derivatives
Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of esters
Reactions: Hell-Vollhard-Zelinsky Reaction
Carboxylic acid derivatives (Upto 5 carbons)
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.
Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.
Amines and Diazonium Salts
Amines (Aliphatic and Aromatic) (Upto 5 Carbons)
Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.
Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test with HNO_2, Schotten-Baumann Reaction, Electrophilic substitution (case aniline), nitration, bromination, sulphonation.
Diazonium salts
Preparation: from aromatic amines
Reactions: conversion to benzene, phenol, dyes.

12. Brief Description of self-learning/ E – learning component

1. http://www.wou.edu/chemistry/files/2017/01/CH105-Chapter-8-PDF-file.pdf
2. http://ncert.nic.in/ncerts/l/kech205.pdf
3. https://www.utdallas.edu/~scortes/ochem/OChem1_Lecture/Class_Materials/09_stereo_notes.pdf

13. Books Recommended

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014) ISBN 978-1-118-65305-0 .
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013,ISBN 0-495-05101-2.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988), ISBN978-8177584332.
4. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000, ISBN

9780070992900.
5. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S., ISBN 978-8177585421
6. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010, ISBN,978-8131704813
7. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010 ISBN, 978-8121935159

1. Name of the Department: Chemistry						
2. Course Name	General Organic Chemistry & Introduction to Organic Functional Groups Lab		**L**	**T**		**P**
3. Course Code	17030204		0	0		4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

The lab work emphasizes learning of basic skills helpful not only to chemistry students but all those who want to pursue any experimental science. It includes simple chromatographic techniques, extra element detection, and functional group analysis.

9. Course Objectives

The objectives of this course are to:

1. Detect various extra elements in organic compounds
2. Separate mixture by paper chromatography
3. Analysis of various organic functional groups

10. Course Outcomes (COs)

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

1. Detect heteroatoms (N, S, Cl, Br, I) in organic compounds
2. Separate amino acids and sugars with paper chromatography
3. Analyze various functional groups of organic compounds

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

Section A: Organic Chemistry-I

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   - Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   - Identify and separate the sugars present in the given mixture by paper chromatography.

Section B: Organic Chemistry-II

3. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
4. Criteria of Purity: Determination of melting and boiling points.
5. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
6. Bromination of Phenol/Aniline
7. Benzoylation of amines/phenols
8. Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
9. Analysis of selected functional groups such as -COOH, -OH, -C=O, $-CONH_2$

12. Brief Description of self-learning/ E – learning component

1. https://vlab.amrita.edu/?sub=2&brch=191&sim=344&cnt=1
2. http://bbec.ac.in/wp-content/uploads/2015/08/Practical_first-semester.pdf
3. https://www.macalester.edu/~kuwata/Classes/200102/Chem%2011/Revised%20Amino%20Acids%20(9%201%2001).pdf
4. https://pubs.acs.org/doi/abs/10.1021/ed007p724

13. Books Recommended

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G. ISBN 978-0582462366.
2. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996, ISBN 978-0582462366
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman,1960 ISBN 978-8131727102

1. Name of the Department: Mathematics						
2. Course Name	Differential Equations	**L**	**T**		**P**	
3. Course Code	17030205	3	0		0	
4. Type of Course (use tick mark)		Core (✔)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
Differential equations and their solutions. Linear Differential equation. Homogeneous Differential Equations. Second order linear differential equations. Total differential equations.						
9. Course Objectives:						
To introduce the basic concept of Differential equations and their solutions. Strength of these concepts in engineering and real world problems will be highlighted.						
10. Course Outcomes (COs):						
After completing the course, students are expected 1. To learn about the basic concept of Differential equations. 2. To understand orthogonal trajectory and Homogeneous ordinary differential equation. 3. To learn about the basic concept of second order Differential equations. 4. To solve the Differential equation by general method.						
11. Unit wise detailed content						
Unit – 1	**Number of lectures = 10**	**Title of the Unit: Introduction to Differential Equations**				
Order and degree of a differential equation, Linear & Non-Linear differential equations, Homogeneous differential equations, Geometrical meaning of differential equations (DE), Exact differential equations, Integrating factors, First order higher degree differential equations solvable for x,y,p, Lagrange's differential equations, Clairaut's equations, Equations reducible to Clairaut's form, Singular solutions of differential equations.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Orthogonal Trajectories and Homogeneous DE**				
Orthogonal trajectories in cartesian coordinates and polar coordinates, Self-orthogonal family of curves, Linear differential equations with constant coefficients, Homogeneous linear differential equations, Cauchy's differential equations.						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Linear DE and Non-homogeneous DE**				
Linear DE of second order with variable coefficients: Reduction to normal form, Method of undetermined coefficients, Transformation of the equation by changing the dependent variable/independent variable, Solution by operators of non-homogeneous linear DE, Reduction of order of a DE						

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Unit - 4	Number of lectures = 10	Title of the unit: General Methods to solve DE and Solutions of Simultaneous DE and Total DE and Methods
Method of variations of parameters, Ordinary simultaneous DE, Solution of simultaneous DE involving operators x (d/dx) or t (d/dt) etc, Simultaneous equation of the form dx/P=dy/Q=dz/R. Total DE, Condition for Pdx+Qdy=Rdz=0 to be exact, General method of solving Pdx+Qdy+Rdz=0 by taking one variable constant, Method of auxiliary equations.		
12. Brief Description of self-learning / E-learning component		
1. https://nptel.ac.in/courses/111/106/111106100/ 2. https://nptel.ac.in/courses/111/107/111107111/		
13. Books Recommended		
1. A.R. Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd. London 1956. 2. E.A. Codington: An Introduction to Differential Equations, Dover1961. 3. S.L. Ross: Differential Equations (3rd edition), John Wiley & Sons 2004. 4. B. Rai and D.P. Chaudhary: Ordinary Differential Equations: An Introduction; Narosa, Publishing House Pvt. Ltd, 2019.		

1. Name of the Department: Mathematics						
2. Course Name	Differential Equations Lab	**L**	**T**		**P**	
3. Course Code	17030206	0	0		4	
4. Type of Course (use tick mark)		Core (✔)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

This course is designed to emphasize the knowledge of differential equations. Emphasis is placed on different forms of linear and non-linear differential equations. Upon completion, students should be able to write the programs in MATLAB or other software.

9. Course Objectives:

1. Give an account of basic concepts and definitions for differential equations;
2. Use methods for obtaining exact solutions of linear homogeneous and non-homogeneous differential equations;
3. Describe some simple numerical solution techniques and be familiar with mathematical software for differential equations;
4. Use elementary methods for linear systems of differential equations.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to solve differential equations analytically.

11. The list of practicals to perform in the computer lab.

1. Solve a differential equation analytically by using the dsolve function, with or without initial conditions.
2. To solve a system of differential equations.
3. To solve first order Linear ODE
4. To solve First order linear differential equations
5. To solve first order Bernoulli equations
6. To solve ODE with initial conditions
7. To solve Nonlinear differential equations with initial conditions
8. To solve second order ODE with initial conditions
9. To solve a system of Ordinary differential equations
10. To find the explicit solution of first order differential equations
11. To find the explicit solution of second order differential equations

12. Brief Description of self-learning / E-learning component

1. https://www.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
2. https://in.mathworks.com/help/symbolic/solve-a-system-of-differential-equations.html
3. https://reference.wolfram.com/language/tutorial/DSolveIntroduction.html

13. Books Recommended

1. Barnes, Belinda &Fulford, Glenn R. Mathematical Modelling with CaseStudies, Using Maple and MATLAB (3rd edition). CRC Press, Taylor & Francis Group, 2015.
2. C. P. López, MATLAB Differential Equations, Apress, 2014.
3. Dingyü Xue, Differential Equation Solutions with MATLAB, De Gruyter, 2020.
4. Brian R. Hunt, Ronald L. Lipsman, John E. Osborn, Donald A. Outing, Jonathan Rosenberg, Differential Equations with Mathematica (3rd edition), John Wiley & Sons, (2009).

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SEMESTER-III (CORE)

1.Name of the Department: Physics						
2. Course Name	Thermal Physics and Statistical Mechanics	L	T		P	
3. Course Code	17030301	3	0		0	
4. Type of Course (use tick mark)		Core (√)	DSE ()	AEC ()	SEC ()	GE ()
5. Pre-requisite (if any)		6. Frequency (use tick marks)	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		Tutorials = 0	Practical = 0			

8. Course Description:

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

9. Course Objectives:

The objectives of this course are

1. To study the different laws of thermodynamics and their practical applications.
2. To define the thermodynamic potentials and derive the Maxwell's equations.
3. To study the transport phenomena in the gases.
4. To study the three different statistics and differentiate between them.

10. Course Outcomes (COs):

After completion of this course, students will have understanding of

1. The laws of thermodynamics and will be able to apply them in day to day life.
2. Maxwell's relations and will be able to apply it to calculate specific heats, Joule coefficient etc.
3. Distribution of velocities and its experimental verification.
4. Classical and Quantum mechanics and their comparison.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Thermodynamic Description of system

Zeroth Law of thermodynamics and temperature, First law and internal energy, various thermodynamical processes, work done during isothermal and adiabatic processes, reversible & irreversible processes, Carnot's cycle & theorem, Carnot Engine and its Efficiency, Refrigerator and its Efficiency. Entropy changes in reversible & irreversible processes, Second law & Entropy,

Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero temperature.		
Unit - 2	**Number of lectures = 10**	**Title of the unit: Thermodynamic Potentials**
Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials U, H, F and G : Their Definitions, Properties and Applications, Maxwell's thermodynamic relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V, T.dS equations.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Kinetic Theory of Gases**
Derivation of Maxwell's law of distribution of velocities andits experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Mean, RMS and Most Probable Speeds. Degrees of Freedom.Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.		
Unit - 4	**Number of lectures = 10**	**Title of the unit: Statistical Mechanics**
Basics of probability, Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law, limitations of classical statistical mechanics - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.		

12. Books Recommended:

1. Thermal Physics, S, Garg, R, Bansal and C, Ghosh, 1993, Tata McGraw-Hill, ISBN: 9781259003356

2. A Treatise on Heat, Meghnad Saha, and B,N, Srivastava, 1969, Indian Press, ISBN: 978-0856550683

3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications, ISBN: 978-0486603612

4. Heat and Thermodynamics, M,W,Zemasky and R, Dittman, 1981, McGraw Hill, ISBN: 978-0070170599

5. Thermodynamics, Kinetic theory & Statistical thermodynamics, F,W,Sears & G,L,Salinger, 1988,ISBN: 978-8185015712

6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole, ISBN: 978-0534369644

7. Thermal Physics, A, Kumar and S,P, Taneja, 2014, R, chand Publications, ASIN : B08F7MCVH1

13. links

1. https://nptel.ac.in/courses/103103036/9
2. https://courses.physics.ucsd.edu/2010/Spring/physics210a/LECTURES/210_COURSE.pdf
3. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/lecture-notes/5_60_lecture1.pdf
4. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/lecture-notes/5_60_lecture10.pdf
5. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/lecture-notes/5_60_lecture8_9.pdf

1. Name of the Department: Physics						
2. Course Name	Thermal Physics and Statistical Mechanics Lab	**L**	**T**		**P**	
3. Course Code	17030302	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem()

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

8. Course Description:

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

9. Course Objectives:

1. To understand the working principles of thermocouples and various effects associated with thermocouple.
2. Students will learn about the various processes of transmission of heat and basic principle of thermodynamics
3. Students will be able to calculate the optical parameters
4. Students will learn about optically active substances

10. Course Outcomes (COs):

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

1. Apply the concepts of basic thermodynamics principle to design the different type's thermocouples for daily life applications such as a refrigerator, cooling etc.
2. Correlate the theoretical concepts with the experimental ones
3. Acquire and analyze the experimental data
4. 4. To calculate one parameter using different experimental techniques

11. List of Experiments

1. To study the variation of thermo emf across two junction of a thermo couple with temperature.
2. To determine the coefficient of thermal conductivity of copper by Searl's apparatus.
3. To determine mechanical equivalent of heat by Callender and Barne's constant flow method.

4. Calibration of a thermocouple by potential meter.
5. To calculate probability distribution function using MATLAB/Python.
6. To study the random walk using MATLAB/Python.
7. To study the Brownian motion using MATLAB/Python.
8. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
9. Comparison of Illuminating Powers by a Photometer.
10. Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.

12.Book Recommended

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsop, 1971, Asia Publishing House, ISBN: 978-0423738902
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi, ISBN: 978-8122500844
3. Engineering Practical Physics, S. Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd., ISBN: 978-8131525203

1. Name of the Department: Chemistry						
2. Course Name	States of Matter, Thermodynamics and Chemistry of Organic Functional Groups		**L**	**T**	**P**	
3. Course Code	17030303		3	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (Use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40	**Tutorials = 0**		**Practical = 0**			

8. Course Description

This course will give an excellent opportunity to study and use the knowledge of Gaseous State, Liquid State, Solid State, thermodynamics and solutions. In organic chemistry, preparation and reactions of ether and epoxides, amino acids, peptides and proteins; and carbohydrates will be discussed.

9. Course Objectives

The objectives of this course are to:

1. Introduce students to the chemistry of gaseous, liquid and solid states of matter.
2. Introduce students to thermodynamics of ideal solutions and Raoult's law
3. Familiarize students with principles governing miscibility of liquids
4. Explain phase diagrams of one component system (water and Sulphur) and two component systems (Pb-Ag, $FeCl_3$-H_2O and Na-K) involving eutectics, congruent and incongruent melting points
5. Explain preparation and reactions of ether, epoxides, amino acids, peptides and proteins; and carbohydrates.

10. Course Outcomes (COs)

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

1. Understand the chemistry of Gaseous, Liquid and Solid states
2. Understand the behavior of ideal solutions and Raoult's law and deviations from Raoult's law
3. Explain phase diagrams for selected one component and two component systems
4. Explain preparation and reactions of ether and epoxides, amino acids, peptides and proteins; and carbohydrates.

11. Unit wise detailed content

Section A: Physical Chemistry (20 Lectures)

Unit-1	**Number of lectures = 10**	**Title of the unit: State of Matter**

Gaseous State: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical constants and their calculation from van der Waals equation. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions.

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

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

Unit-2	**Number of lectures = 10**	**Title of the unit: Thermodynamics**

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

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

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius-Clapeyron equation and its importance

in phase equilibria. Phase diagrams of one-component systems (water and Sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only)

Section B: Organic Chemistry (20 Lectures)

Unit-3	**Number of lectures = 10**	**Title of the unit: Ethers, Epoxides, and Carbohydrates**

Ethers and Epoxides: Preparation and reactions with acids; Preparation of ether by dehydration of alcohols and by Williamson Synthesis. Reactions of epoxides with alcohols, ammonia derivatives and lithium aluminium hydride.

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

Unit-4	**No. of Lectures = 10**	**Title of the unit: Amino acids, Peptides and Proteins**

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

Reactions of amino acids: ester of -COOH group, acetylation of $-NH_2$ group, complexation with Cu^{2+}ions, ninhydrin test

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

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

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

12. Brief Description of self-learning/ E – learning component

1. https://youtu.be/suUaAJVvGXI
2. https://nptel.ac.in/courses/113106032/9%20-%20Phase%20diagrams.pdf
3. http://chemistry2.csudh.edu/rpendarvis/aminrxn.html
4. https://olemiss.edu/courses/bisc102/macromol.html
5. https://www.google.com/url?q=https://drive.google.com/open?id%3D1z9E0o8y0prgSNfUS2dNHUL2qYOGmDqOh&sa=D&ust=1555314141234000&usg=AFQjCNEx62Pf-Ce1gLbpmSZClBkKLwBixQ
6. http://uou.ac.in/sites/default/files/slm/BSCCH-103.pdf

13. Books Recommended

1. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004), ISBN-13: 978-8185015590
2. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, 1st Edition, Cengage Learning India Pvt. Ltd.: New Delhi (2009), ISBN: 9788131508442
3. Morrison, R.T. & Boyd, R.N. Organic Chemistry, 6th Edition, (2016) Pearson India, ISBN: 978-8177581690
4. Finar, I.L. Organic Chemistry (Volume 1), 6th Edition, Pearson Education India, ISBN: 9788177585421
5. Nelson, D.L. & Cox, M.M. Lehninger's Principles of Biochemistry, 2017, 7th Ed., W.H. Freeman, ISBN: 978-1464187964
6. Berg, J.M., Tymoczko, J.L. &Stryer, L. Biochemistry, W. H. Freeman; Fifth Edition (February 15, 2002), ISBN: 978-0716746843.
7. B.S. Lark & Silby Joseph, States of matter physical chemistry, VISHAL PUBLISHING CO., 2013, ISBN: 978-8192143248

1. Name of the Department: Chemistry						
2. Course Name	States of Matter, Thermodynamics and Chemistry of Organic Functional Groups Lab		**L**	**T**		**P**
3. Course Code	17030304		0	0		4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

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

9. Course Objectives

1. To perform experiment on surface tension and viscosity
2. To study the equilibrium of selected reactions by distribution method
3. Construction of phase diagram of a binary system (simple eutectic) using cooling curves and determination of critical temperatures and composition.
4. Perform qualitative analyses of selected organic compounds possessing monofunctional groups
5. Separation of amino acids by paper chromatography
6. Titration of glycine and determination of its concentration
7. To study the action of salivary amylase on starch
8. Performing the experiments to differentiate between a reducing and a nonreducing sugar

10. Course Outcomes (COs)

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

1. Calculate surface tension and viscosity of the given sample.
2. Explain the equilibrium of selected reactions by distribution method
3. Construct phase diagrams of binary systems (simple eutectic) with cooling curves and determine critical parameters
4. Perform the qualitative analyses of selected organic compounds possessing monofunctional groups
5. To separate the amino acids by paper chromatography
6. To determine the glycine concentration
7. Explain the action of salivary amylase on starch
8. Differentiate between a reducing and a non-reducing sugar

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

Section A: Physical Chemistry

Surface tension measurement (use of organic solvents excluded)

a. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
b. Study of the variation of surface tension of a detergent solution with concentration.

Viscosity measurement (use of organic solvents excluded)

a. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b. Study of the variation of viscosity of an aqueous solution with concentration of solute.

Distribution

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

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

$$Cu^{2+}(aq) + xNH_3(aq) \longrightarrow [Cu(NH_3)_x]^{2+}$$

Phase equilibria

a. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.

b. Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c. Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Section B: Organic Chemistry

a. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (amines, amides, ether, epoxide, aldehydic, nitro) and preparation of one derivative.
b. Separation of amino acids by paper chromatography
c. Determination of the concentration of glycine solution by formylation method.
d. Titration curve of glycine
e. Action of salivary amylase on starch
f. Effect of temperature on the action of salivary amylase on starch.
g. Differentiation between a reducing and a non-reducing sugar

12. Brief Description of self-learning/ E – learning component

1. https://www.youtube.com/watch?v=qvUyVrUb8Fo&t=543s
2. https://www.youtube.com/watch?v=68bo-h3Kf7s&t=2s
3. https://www.youtube.com/watch?v=uto6OlbBwEo
4. https://nptel.ac.in/courses/103104129
5. https://www.youtube.com/watch?v=ZCzgQXGz9Tg

13. Books Recommended

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Pearson; 5th edition (February 19, 1996), Prentice-Hall, 5th edition, ISBN-13: 978-0582462366.
2. Mann, F.G. & Saunders, B.C., Practical Organic Chemistry, 4th Edition, Pearson Education India; 4th edition (1 January 2009), ISBN-13: 978-8131727102.
3. Experimental Physical Chemistry by Mathur, Parul; Athawale, 1st Edition, ISBN: 9788122413366
4. Khosla, B. D., Garg, V. C., Gulati, A., Senior Practical Physical Chemistry, R. Chand & Company: 18th edition, ISBN: 978-8180450792.

1. Name of the Department: Mathematics						
2. Course Name	Analysis-I	**L**	**T**		**P**	
3. Course Code	17030305	3	0		0	
4. Type of Course (use tick mark)		Core (✓)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course covers some fundamental topics of mathematical analysis. In this course the students will be taught convergence and divergence of the sequence and series, continuity and differentiability of real valued function, the theory of functions of complex variables, analytic and harmonic functions and their properties, Integration of complex functions, Cauchy Integral theorem and formula.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. Learn to find limit points, interior point, isolated, continuity and differentiability of real veiled functions.
2. study on convergence and divergence of sequences and some important tests.
3. study on the continuity and differentiability of complex valued function, C-R equation and analytic functions.
4. solve definite integrals, Contours and Contour integrals of complex valued functions.

10. Course Outcomes (COs):

After completing the course, students are expected to be able:

1. To understand the concept of limit points, open sets, closed sets, interior of a set, closure of a set in Real numbers.
2. To know the basics of sequences and series and discuss the convergence using various tests of convergence.
3. To evaluate analyticity, differentiability and continuity of complex valued function and discuss the applicability of complex function in flow equation.
4. To understand the concept of exponential function, logarithmic function, trigonometric function and apply the methods of complex analysis to evaluate definite integrals.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 08**	**Title of the unit: Continuity and Differentiability**

Real line, bounded sets, intervals, Boundedness of set of real numbers, Supremum and infimum, Neighborhoods, interior points and isolated points, Limit points, Bolzano-Weierstrass theorem, continuity and differentiability of real valued function, Rolle's theorem, Mean value theorem, Intermediate value theorem.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Sequences and Series**

Real sequence, Subsequences, Divergent sequence, Bounded sequence, Cauchy sequence, Convergence and divergence of infinite series, Comparison tests, Cauchy's general principle of convergence of series, Auxiliary series or *p*-series, D-Alembert's ratio test, Rabbe's test, Logarithmic test, Cauchy Root test, Cauchy Integral test, absolute and conditional convergence.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Analytic Functions**

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Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples, Harmonic functions.

Unit – 4	**Number of lectures = 08**	**Title of the unit: Elementary Functions and Integrals**

Exponential function, Logarithmic function, Trigonometric function, Derivatives of complex valued functions, Definite integrals of complex valued functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=md5UCR7mcIY
2. https://www.youtube.com/watch?v=7iBqrqHA1oQ&list=PLbMVogVj5nJS_i8vfVWJG16mPcoEKMuWT&index=8

13. Books Recommended

1. T.M. Apostol: Mathematical Analysis, Narosa Publishing House (2nd edition), 2002.
2. R.R. Goldberg: Methods of Real Analysis, Oxford & IBH publishing Co., 2020.
3. D. Somasundaram and B. Choudhary: A First Course in Mathematical Analysis, Narosa Publishing House, 1997.
4. Shanti Narayan: A Course of Mathematical Analysis, S. Chand & Co, 2005.
5. Shanti Narayan: Theory of Functions of a Complex Variable, S. Chand & Co, 2005.

1. Name of the Department: Mathematics						
2. Course Name	Analysis I Lab	**L**	**T**		**P**	
3. Course Code	17030306	0	0		4	
4. Type of Course (use tick mark)		Core (✓)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

This course is designed to enhance the knowledge of students using the analysis practicals. Emphasis is placed on checking continuity, differentiability, analyticity using graphs and limits. Upon completion, students should be able to write the programs in MATLAB or other software.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. To compute the limit of functions and sequences.
2. To check for continuity, differentiability using graphs.
3. To compute the derivatives, integrals of elementary functions.
4. To plot elementary functions and complex valued functions.

10. Course Outcomes (COs):

After completing the course, students are expected to be able:

1. To understand the concept of right hand limit and left hand limit by MATLAB and Mathematica.
2. To demonstrate convergence of series and to find the sum of the sequence by MATLAB.
3. To evaluate analyticity, differentiability and continuity of complex functions by MATLAB.
4. To visualize complex valued functions graphically by MATLAB.

11. Unit wise detailed content

Using both MATLAB and Mathematica:

1. To find the right hand limit, left hand limit of a function.
2. To check for continuity and differentiability of functions using graphs.
3. To find derivatives using limits.
4. To find the limit of a sequence.
5. To find the sum of a convergent series.
6. To verify the Cauchy Riemann equations.
7. To find the derivatives of elementary functions.
8. To find the definite integral of functions.
9. To plot exponential, logarithmic and trigonometric functions.
10. To visualize complex valued functions graphically.

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12. Brief Description of self-learning / E-learning component
1. https://www.youtube.com/watch?v=WmHs1-hWPNs 2. https://www.youtube.com/watch?v=ySqevAKo_tc 3. https://www.youtube.com/watch?v=6ywCkiAaVd8
13. Books Recommended
1. Amos Gilat: MATLAB: An Introduction with Applications (8th edition), John Wiley & Sons Inc, 2016. 2. S. Wolfram: The Mathematica book (5th edition) Cambridge: Cambridge University Press, 2003.

SEMESTER-IV (CORE)

1. Name of the Department: Physics						
2. Course Name	Waves and Optics	**L**	**T**		**P**	
3. Course Code	17030401	3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
The course will teach about different types of simple harmonic motion and their superposition, flow of fluids, free forced and resonant oscillation and the phenomenon of interference, diffraction and polarization.						
9. Course Objectives:						
To impart knowledge about harmonic oscillations, and their superposition, various fluids phenomenon, propagation of sound, and different optical phenomenon.						
10. Course Outcomes (COs):						
After completion of this course, students will have understanding of 1. Harmonic Oscillator, Superposition of Two Perpendicular Harmonic Oscillations, Wave motion and Sound 2. Phenomenon and application of Fluids 3. Wave Optics, Interference and Michelson's Interferometer 4. Understanding of Diffraction and Polarization.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Harmonic oscillations**				
Superposition of Two Perpendicular Harmonic Oscillations: - Introduction to Simple Harmonic Oscillations, Superposition of Two Mutually Perpendicular Simple Harmonic Motions with Frequency Ratios 1:1 and 1:2 using Graphical and Analytical Methods. Lissajous Figures and their uses. **Waves Motion- General**: Transverse waves on a string, Travelling and standing waves on a string, Normal Modes of a string, Group velocity, Phase velocity, Relation between phase velocity and group velocity, Wave intensity, **Sound:** Forced vibrations and resonance , Fourier's Theorem (Application to saw tooth wave and square wave), Characteristics of sound, Musical sound and noise, musical scale, Acoustics of buildings: Reverberation and time of reverberation, Sabine's formula.						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Fluids**				

Fluids: Surface Tension, Excess pressure, Application to spherical and cylindrical drops and bubbles, variation of surface tension with temperature, Jaeger's method, Viscosity: Rate flow of liquid in a capillary tube - Poiseuille's formula, Determination of coefficient of viscosity of a liquid, Variations of viscosity of a liquid with temperature.

Physics of low pressure - production and measurement of low pressure , Rotary pump, Diffusion pump, Molecular pump, Knudsen absolute gauge, pirani gauge.

Unit – 3	Number of lectures = 10	Title of the unit: Wave Optics

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

Interference: Interference by Division of wavefront, Young's Double Slit experiment, Lloyd's Mirror and Fresnel's Bi-prism, Phase change on reflection, Interference by Division of amplitude: Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination and equal thickness, Newton's Rings: measurement of wavelength and refractive index,

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

Unit – 4	Number of lectures =10	Title of the unit: Diffraction and Polarization

Diffraction: Fresnel Diffraction, Fraunhofer diffraction: Single slit & Diffraction grating, Resolving and Dispersive Power of grating.

Polarization: Transverse nature of light waves, Plane polarized light – production and analysis, Nicol Prism, Double refraction, Circular and elliptical polarization, Production of circularly and elliptical polarized light, Quarter wave plate and Half wave plate, Specific Rotation.

12. Books Recommended

1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill, ISBN Num. 0070323305 9780070323308
2. Fundamentals of Optics, H.R., Gulati and D.R., Khanna, R. Chand Publication, 1991, ISBN No. 8180450821
3. University Physics, F.W., Sears, M.W., Zemansky and H.D., Young, Addison-Wesley, 1986, ISBN Number 0201603225

13. Online links :

1. https://www.youtube.com/watch?v=nOb_iQjTy-Q&list=PLUl4u3cNGP61R5sPDPKVfcFlu95wSs2Kx
2. https://nptel.ac.in/courses/122105023/
3. https://swayam.gov.in/course/1408-mechanics-heat-oscillations-and-waves
4. https://freevideolectures.com/course/2271/physics-i-oscillations-and-waves
5. https://nptel.ac.in/courses/122103011/52

1. Name of the Department: Physics						
2. Course Name	Waves and Optics Lab	**L**	**T**		**P**	
3. Course Code	17030402	0	0		4	
4. Type of Course (use tick mark)		**Core (√)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

After performing these experiment, students will be able to implement and demonstrate the use of

1. Optical instruments like Fresnel's Bi-prism
2. Determination of various physical quantities related to light and materials
3. Study of double slit interference and thin wire by diffraction method (using He-Ne Laser)
4. Study of Telescope and measurement's Specific rotation and concentration using Polarimeter

11. List of Experiments

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

11. Resolving power of telescope. 12. Measurement of (a) Specific rotation (b)concentration of sugar solution using Polarimeter. 13. Ordinary and extra ordinary refractive indices for calcite or quartz.
12. Book Recommended:
1. Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill, ISBN No. 0070323305 9780070323308 2. Fundamentals of Optics, H.R., Gulati and D.R., Khanna, R. Chand Publication, 1991, ISBN No. 8180450821. 3. University Physics, F.W., Sears, M.W., Zemansky and H.D., Young, Addison-Wesley, 1986, ISBN No. 0201603225 4. Wave and Optics, Dr. D.C. Tayal, Himalaya Publishing House Pvt. Ltd. 2019, ISBN No. 978-93-5299-710-7.

1. Name of the Department: Chemistry						
2. Course Name	Transition Metal & Coordination Chemistry, Electrochemistry & Chemical Kinetics		**L**	**T**	**P**	
3. Course Code	17030403		3	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

1. Study the properties of transition elements.
2. Understand the key features of coordination compounds.
3. Discuss various concepts of electrochemistry.
4. Study the reaction rates, theories of reaction rates and different order reactions.

10. Course Outcomes (COs)

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

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

11. Unit wise detailed content

Unit-1	Number of lectures = 09	Title of the unit: Transition Elements (3d series)

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

Unit-2	Number of lectures = 10	Title of the unit: Coordination Chemistry

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

Unit-3	Number of lectures = 11	Title of the unit: Electrochemistry

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

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

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

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

pH determination using hydrogen electrode and quinhydrone electrode.

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

Unit-4	Number of lectures = 10	Title of the unit: Chemical Kinetics

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

12. Brief Description of self-learning/ E – learning component

1. https://www.hcpgcollege.edu.in/sites/default/files/TRANSITION%20ELEMENTS%20%28B.SC-II%29%20INORGANIC%20CHEMISTRY%20PAPER-I.pdf
2. https://ncerthelp.com/cbse%20notes/class%2012/chemistry/Chemistry%20Notes%20for%20class%2012%20Chapter%209%20Coordination%20Compounds%20.pdf
3. https://www.slideshare.net/shahzad_ali27/chemical-kinetics-32001888
4. https://ncerthelp.com/cbse%20notes/class%2012/chemistry/Chemistry%20Notes%20for%20class%2012%20Chapter%203%20Electrochemistry%20.pdf

13. Books Recommended

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007), ISBN 13: 9780070647749
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004), ISBN-13 : 978-818501559
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009), ISBN-13 : 978-8131508442
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998), ISBN-13: 978-8185015804
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985), ISBN-13 :978-0023947919
6. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley, ISBN-13 : 978-0471505327
7. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press, ISBN-13 : 978-0198552314
8. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd, ISBN-13 : 978-8176492881

1. Name of the Department: Chemistry						
2. Course Name	Transition Metal & Coordination Chemistry, Electrochemistry & Chemical Kinetics Lab			**L**	**T**	**P**
3. Course Code	17030404			0	0	4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (Use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

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

10. Course Outcomes (COs)

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

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

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

Inorganic Chemistry:

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

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

Anions: CO_3^{2-}, S^{2-}, SO_2^-, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-

(Spot tests should be carried out wherever feasible)

II. Estimations

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

Physical Chemistry:

I. Electrochemistry

Conductance

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

Potentiometry

1. Perform the following potentiometric titrations:
   a. Strong acid vs. strong base
   b. Weak acid vs. strong base
   c. Potassium dichromate vs. Mohr's salt

II. Chemical Kinetics

Study the kinetics of the following reactions by:

1. Initial rate method: Iodide-persulphate reaction

2. Integrated rate method:
    a. Acid hydrolysis of methyl acetate with hydrochloric acid.
    b. Saponification of ethyl acetate with sodium hydroxide.
    c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

12. Brief Description of self-learning/ E – learning component

1. https://amrita.olabs.edu.in/?sub=73&brch=7&sim=31&cnt=1
2. http://chemlab.truman.edu/files/2015/07/edta.pdf

13. Books recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012 ISBN 13- 978-8131773710
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009, ISBN-13: 978-058222628-9
3. Vishwanathan, B..; Raghavan, P. S. Practical Physical Chemistry, Viva Books, ISBN-13 : 978-8130929699.
4. Khosla, B. D., Garg, V. C., Gulati, A., Senior Practical Physical Chemistry, R. Chand & Company: 18th edition, ISBN: 978-8180450792.

1. Name of the Department: Mathematics						
2. Course Name	Linear and Abstract Algebra	**L**	**T**		**P**	
3. Course Code	17030405	3	0		0	
4. Type of Course (use tick mark)		Core (✔)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description:

This course gives an introduction to groups, properties of groups, rings, fields, vector spaces, basis, Dimension of vector spaces, Quotient spaces etc. It further covers linear transformations, algebra of linear transformations and inner product spaces.

9. Course Objectives:

1. To study certain structures called groups, rings, fields and some related structures.
2. To gain mathematical maturity which enables the students to develop abstract thinking and mathematical skills.
3. To present the basic concepts of vector spaces, linear transformations and inner product spaces.
4. To understand orthogonality and the Gram-Schmidt orthogonalization process.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To understand finite and infinite dimensional vector spaces and subspaces over a field and their properties including the basis structure of vector spaces.
2. To study inner products and understand their related properties.
3. To demonstrate the importance of algebraic properties of groups, rings, fields and vector spaces.
4. To understand basic concepts of linear transformations, the Rank-Nullity theorem, matrix of a linear transformation, algebra of transformations and the change of basis.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Title of the unit: Groups**

Binary operation, Groups, Subgroups, Finite and Infinite groups, order of a group, Order of an element, Cyclic groups, Permutations groups, Homomorphism and isomorphism of groups, Cayley's theorem, Cosets, Largrage's theorem, Normal subgroups and Quotient groups.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Rings, Fields, Polynomial rings**

Introduction to rings, subrings, integral domains, fields, ideals and quotient rings, Characteristics of a ring, Homomorphism and isomorphism of rings, Chinese remainder theorem, Polynomial rings, Factorization of polynomials. Polynomial over the rational fields, Irreducibility criterion, Gauss lemma, Eisenstein criterion for irreducibility.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Matrices and Vector Spaces**

Elementary transformations, Echelon form, Rank of a matrix, Linear independence and dependence, Solution of systems of linear equations, Eigenvalues and Eigenvectors, Cayley-Hamilton theorem and its applications, Vector spaces: Vector spaces over a field, Subspaces, Spanning Set, Existence of basis, Dimension.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Linear Transformations and Inner Product Spaces**

Linear transformations, Null space, Range space of a linear transformation, Matrix of a linear transformation, Change of basis, Rank-nullity theorem, Invariant subspaces, Eigenvalues and Eigenvector of linear transformations, linear functional and dual space, Inner product spaces, adjoint of an operator, normal, unitary and self adjoint operators, Cauchy-Schwarz inequality, Orthogonality, Gram-Schmidt orthogonalization process.

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/playlist?list=PLEAYkSg4uSQ2PS2t1LNFMHrr1h9Fo2TxT
2. https://www.youtube.com/playlist?list=PLyqSpQzTE6M8aLVVwxkJ44abrFFzdioId
3. https://www.youtube.com/playlist?list=PLbMVogVj5nJQ2vsW_hmyvVfO4GYWaaPp7

13. Books Recommended

1. Joseph A. Gallian: Contemporary Abstract Algebra, (10th edition), CRC Press, 2021..
2. P. B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd edition), Cambridge University Press, 2003.
3. Shanti Narayan and Sat Pal: A Textbook of Modern Abstract Algebra, S. Chand, 1985.
4. Seymour Lipschutz and Marc Lipson: Schaum's Outline of Linear Algebra (5th edition), McGraw-Hill, 2012.
5. John B. Fraleigh: A First Course in Abstract Algebra (7th edition), Pearson, 2013.
6. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence: Linear Algebra (4th edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

1. Name of the Department: Mathematics						
2. Course Name	Linear and Abstract Algebra Lab	**L**	**T**		**P**	
3. Course Code	17030406	0	0		4	
4. Type of Course (use tick mark)		Core (✔)	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

This course is designed to enhance the knowledge of students using the algebra practicals. Emphasis is placed on computing different results related to matrices and linear transformations and inner product spaces. Upon completion, students should be able to write the programs in MATLAB or other software.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. To compute determinant, rank, inverses of matrices
2. To solve system of linear equations using Echelon form of corresponding coefficient matrix
3. To compute eigenvalues, eigenvector, rank, nullity of a linear transformation
4. To compute inner products in $\mathbb{R}^n$ and $\mathbb{C}^n$.

10. Course Outcomes (COs):

After completing the course, students are expected to be able:

1. To evaluate different properties of matrices such as rank, inverse, determinant MATLAB and Mathematica.
2. To solve a system of linear equations.
3. To compute rank, nullity of linear transformation.
4. To understand the concept of inner products.

11. Unit wise detailed content

C. S. Lalitha

Using both MATLAB and Mathematica:

1. To find the determinants of matrices
2. To find the inverse of matrices
3. To find echelon form and rank of the matrices
4. To find the solution of system of linear equations
5. To find the eigenvalues and eigenvectors of the linear transformations
6. To find the nullity and rank of linear transformations
7. To find the roots of algebraic, Transcendental, Logarithmic equations
8. To solve the definite and indefinite integrals
9. To compute inner products on $\mathbb{R}^n$ and $\mathbb{C}^n$

12. Brief Description of self-learning / E-learning component

1. https://in.mathworks.com/learn/tutorials/matlab-onramp.html
2. https://www.tutorialspoint.com/matlab/index.htm

13. Books Recommended

1. Amos Gilat: MATLAB: An Introduction with Applications (8th edition), John Wiley & Sons Inc, 2016.
2. S. Wolfram: The Mathematica book (5th edition) Cambridge: Cambridge University Press, 2003.

SEMESTER-V (SEC)

1. Name of the Department: Physics						
2. Course Name	Computational Physics Skills	**L**	**T**		**P**	
3. Course Code	17030501	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**GE ()**
5. Pre-requisite (If any)		**6. Frequency (Use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

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

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution, Introduction to basics of Linux, Windows.

Algorithms and Flowcharts: Introduction: Problem formulation, algorithm development, algorithm implementation, and algorithm verification. Structure and documentation

Flowchart: Concept of flowchart, symbols, guidelines, types.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Machine representation, precision and errors**

Representation on a computer: Integer representation; floating-point representation; Machine precision; Errors: round-off; approximation errors; random errors; errors of the third kind.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Roots of equations (flowchart and programme, Matlab/Python)**

Real roots of single variable function; iterative approach; qualitative behavior of the function; Closed domain methods (bracketing): Bisection; False position method; Open domain methods: Newton Raphson, Secant method. Flowchart of root finding programme and actual programme (Python/Matlab) to calculate the roots using the above-mentioned methods.

Unit - 4	**Number of lectures = 10**	**Title of the unit: Data Visualization**

Visualization: Introduction to graphical analysis and its limitations, Introduction to Matplotlib, importance of visualization of computational and computational data, basic Matplotlib

commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Matplotlib (equations, building functions, user defined variables and functions), Understanding data with Matplotlib

1. To write program to generate data and plot it using Matplotlib,
2. Saving the output for figure, Saving it as an eps file and as a pdf file.

12. Books Recommended

1. Introduction to Numerical Analysis, S,S, Sastry, 5thEdn,, 2012, PHI Learning Pvt, Ltd,
2. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co,
3. Computational Physics: An Introduction, R, C, Verma, et al, New Age International Publishers, New Delhi (1999)
4. A first course in Numerical Methods, U,M, Ascher and C, Greif, 2012, PHI Learning
5. Elementary Numerical Analysis, K,E, Atkinson, 3rdEdn ,, 2007, Wiley India Edition
6. Learning Scientific Programming with Python, Christian Hill, Cambridge University Press, 2016

13. Online Links

1. https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-010-computational-methods-of-scientific-programming-fall-2011/lecture-notes/
2. http://www.physics.ntua.gr/~konstant/ComputationalPhysics/Book/ComputationalPhysicsKNA.html
3. https://www3.nd.edu/~powers/ame.20214/

1. Name of the Department: Physics						
2. Course Name	Applied Optics	**L**	**T**		**P**	
3. Course Code	17030502	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Course Description:						
The course will teach about different types of light source and detectors, Fourier transform spectroscopy, holography and the phenomenon of interference, diffraction and polarization.						
9. Course Objectives:						
To impart knowledge about different types of light source and detectors, fourier transform spectroscopy, holography and the phenomenon of interference, diffraction and polarization.						
10. Course Outcomes (COs):						
Students will have understanding of 1. different types of light sources and detectors 2. how to use Fourier transform spectroscopy for analyzing various physical phenomenon related to light						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Sources and Detectors**				
Sources and Detectors Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam and He-Ne laser. **Semiconductor Sources and Detectors:** Light Emitting Diode, V-I characteristics of LED, Solid State Laser, characteristics of solid state laser, characteristics of LDR, Photovoltaic Cell and Semiconductor lasers.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Fourier Optics**				
Fourier Optics Concept of Spatial frequency filtering, Fourier transforming property of a thin lens, Harmonic analysis of a signal, Amplitude and phase modulations, Transfer function of free space, Optical Fourier transform, Diffraction & Interference, Image shaping, optical image processing. **Fourier Transform Spectroscopy:** Fourier Transform Spectroscopy (FTS) and application in atmospheric remote sensing, NMR spectrometry						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Holography**				
Holography Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, Interferometry, and character recognition in-						

line and off-axis holography; Transmission and reflection holograms, Amplitude and phase holograms, Thick and thin holograms

Unit - 4	Number of lectures = 10	Title of the unit: Photonics: Fibre Optics

Photonics: Fibre Optics

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Dispersion, Attenuation in optical fibre and attenuation limit, Absorption loss, scattering loss, bending loss, splice loss. Single mode and multimode fibres, ,Erbium-doped fiber amplifiers and lasers, Fibre optic sensors: Fibre Bragg Grating

12. Books Recommended

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

13. Online Links

1. https://en.wikipedia.org/wiki/Holography
2. https://www.youtube.com/watch?v=j4qbhVQQdBQ
3. https://www.youtube.com/watch?v=saVE7pMhaxk

1. Name of the Department: Physics							
2. Course Name	Renewable energy and energy harvesting	**L**	**T**		**P**		
3. Course Code	17030503	3			0		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (√)**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 40		**Tutorials = 0**		**Practical = 0**			

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

Students will have enhanced their abilities to:

1. Explain the need to reduce the nonrenewable sources of energy.
2. Explain the importance of natural processes which can act as renewable energy sources.
3. Explain the modern techniques for energy harvesting.
4. Develop critical thinking and solve the problem for energy requirements.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Fossil fuels and Alternate Sources of energy**

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

Unit – 2	**Number of lectures = 8**	**Title of the unit: Solar energy**

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.

Unit-3	**Number of lectures = 13**	**Other renewable energy harvesting methods**

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. Geothermal

Energy: Geothermal Resources, Geothermal Technologies. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.		
Unit- 4	**Number of lectures = 11**	**Piezoelectric and electromagnetic energy harvesting.**
Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power. **Electromagnetic Energy Harvesting**: Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability.		
12. Brief Description of self learning / E-learning component		
1. online NPTEL course on Non-Conventional Energy Systems, Prof. L. Umanand, IISc Bangalore, https://nptel.ac.in/courses/108108078/ 2. https://www.edx.org/course/solar-energy-delftx-et3034x-0 3. https://www.edx.org/course/sustainable-energy-design-renewable-delftx-energyx-0 4. https://www.edx.org/course/energy-principles-and-renewable-energy-2		
13. Books Recommended		
1. Non-conventional energy sources - G, D Rai - Khanna Publishers, New Delhi, ISBN: 978-81-7409073-7 2. Solar energy - M P Agarwal - S Chand and Co, Ltd, ISBN: 9788121939713 3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd, ISBN 978-1-56720105-5 4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University, ISBN- 9780199261789 5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009, ISBN: 978-93-87374-12-6, 6. J, Balfour, M,Shaw and S, Jarosek, Photovoltaics, Lawrence J Goodrich (USA), ISBN: 0750660732		

1. Name of the Department: Chemistry						
2. Course Name	Basic Analytical Chemistry	**L**	**T**	**P**		
3. Course Code	17030504	3	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

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

8. Course Description

In the course, students will practice hands-on training in analytical chemistry, for example, the testing experiments of soil, water, food products, and cosmetic analysis. In the course, practices of chromatographical and instrumental techniques will also be taught.

9. Course Objectives

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

10. Course Outcomes (COs)

1. The students will gain an understanding of the application of analytical methods.
2. The students will gain hands-on practice with chromatographic techniques.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Introduction to Analytical Chemistry

Introduction to Analytical Chemistry and its interdisciplinary nature, Chemicals and Materials analysis methods, General steps in chemical analysis, Role of Analytical Chemistry and Techniques (Evaporation and Wet Ashing). Applications of Chemical Analysis.

Unit-2	Number of lectures = 08	Title of the unit: Errors in Chemical Analysis

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

Unit-3	Number of lectures = 12	Title of the unit: Solvent Extraction

Classification, principle and efficiency of the technique. Mechanism of Extraction: Extraction by solvation and chelation. The method 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-4	Number of lectures = 10	Title of the unit: Chromatography

Classification of chromatographic methods: Principle of differential migration, Techniques of paper chromatography: experimental modifications, various modes of development, nature of the paper, detection of spots, retardation factors, factors that affect the reproducibility of R_f values (due to paper, solvent system, sample, development procedure), selection of solvent, quantitative analysis. Applications

Thin-layer chromatography: stationary phase, adsorbents, liquid phase supports, plate preparation, mobile phase, sample application, development, a saturation of chamber, detection of spot, R_f values (effect of the adsorbent, solvent, solute, development process), quantitative analysis, applications

12. Brief Description of self-learning / E-learning component

1. https://nptel.ac.in/courses/104105084/11
2. http://www.federica.unina.it/agraria/analytical-chemistry/analytical-chemistry/
3. https://www.th-owl.de/fb8/fileadmin/download_verzeichnis/chemie/Analytical_Chemistry.pdf
4. https://nptel.ac.in/courses/102103044/28
5. https://nptel.ac.in/courses/102106048/8

13. Books Recommended

1. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).ISBN:0030059380 9780030059384 0030168732 9780030168734
2. Vogel, A. I., Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice-Hall. ISBN-10: 582218667
3. Robinson, J.W., Undergraduate Instrumental Analysis 7th Ed., Marcel Dekker, Inc., New York (1995).ISBN-13 : 978-1420061352
4. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004. ISBN-10:

0471214728
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009. ISBN-10: 1906574006
6. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979. SBN 10: 0853120803 ISBN 13: 9780853120803
7. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974. ISBN-10 : 0442221584; ISBN-13 : 978-0442221584

1. Name of the Department: Chemistry						
2. Course Name	Fuel Chemistry	**L**	**T**		**P**	
3. Course Code	17030505	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**		**Practical = 0**		

8. Course Description

This course includes the study of energy sources (renewable and non-renewable). It also describes fuels, coal, gasification and liquefaction techniques, Petroleum and its applications in industries, lubricants, Nuclear power, and nuclear reactions.

9. Course Objectives

The objectives of this course are to:

1. Make the students aware of renewable and non-renewable energy sources.
2. To build up knowledge of the concepts and science of fuel chemistry.
3. To make them aware of the fundamental physical and chemical principles regarding the formation and control of air pollutants in industrial and technological processes.
4. Endow an awareness of the Petroleum and Petrochemical Industry applications.
5. To explain scientific and fundamental concepts about nuclear fuel and nuclear reactions

10. Course Outcomes (COs)

At the end of the course, students should be able to:

1. Identify and characterize various renewable and non-renewable energy sources.
2. Develop an understanding of solid, liquid, gaseous and nuclear fuel.
3. Develop an understanding of the Petrochemical Industry applications.
4. Use techniques such as coal liquefaction, solvent refining and gasification, etc.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Fuels and Coal**

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Description of Fractionation of coal tar and the uses of coal tar bases and chemicals requisites for an excellent metallurgical coke. Details of Coal gasification (Hydro gasification and Catalytic gasification), liquefaction, etc. Solvent Refining.

Unit-2	**Number of lectures = 10**	**Title of the unit: Petroleum and Petrochemical Industries**

Knowledge of the composition of crude Petroleum oil, methods used for refining the oil, types of Petroleum products, and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit-3	**Number of lectures = 10**	**Title of the unit: Lubricants**

An Introduction involving the classification of lubricants, functions of lubricants, lubricating oils (conducting and nonconducting), solid or semisolid lubricants, and synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pour point) and their determination, Mechanism of Lubrication: Hydrodynamic or Fluid film lubrication, Thin film or boundary lubrication, extreme pressure lubrication

Unit-4	**Number of lectures = 10**	**Title of the unit: Gaseous and Nuclear Fuels**

Introduction to Gaseous fuels, Natural gas, Producer gas, Water gas, Analysis of Fuel Gas by using Orsat's apparatus, Nuclear Fuels, nuclear reactions, mass defect and binding energy, Nuclear Fission, Nuclear chain reaction, Critical Mass, Mechanism of nuclear reactions, Nuclear Reactor, and Nuclear Fusion, Fusion reactors, Nuclear fission vs Nuclear fusion, Nuclear Safety

12. Brief Description of self-learning/ E-learning component

1. https://www.svce.ac.in/departments/chemistry/CITM/CY%206251/Engg.%20Chem.%20II%20word/

Unit%20V%20-%20Fuels%20&%20Combustion.pdf

2. https://nptel.ac.in/courses/112101007/
3. https://nptel.ac.in/courses/103105110/

13. Books Recommended

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. U.K. (1990). ISBN-10 : 0134573188; ISBN-13: 978-0134573182
2. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi. ISBN-10: 9352160002
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).ISBN-10: 8182838290.

1. Name of the Department: Chemistry						
2. Course Name	Chemical Technology & Society		**L**		**T**	**P**
3. Course Code	17030506		3		0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**GE ()**
71788992. **Pre-requisite (if any)**	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

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

8. Course Description

This course will provide an introduction to different principles used in chemical technology. It will delineate the usage of significant processes and equipment. Students will be skilled in how to evaluate the exact strategies in the Research and Development Laboratories.
Creating Scientific literacy to understand the complex environmental issues prevailing in the modern era.

9. Course Objectives

The objectives of this course are to:
1. Introduce students to Major industrial chemical technology
2. Explain the Industrial processes deployed in chemical extractions.
3. Familiarize students with chemical safety
4. Induce scientific literacy to understand fermentation and polymer chemistry.

10. Course Outcomes (COs)

Upon successful completion of this course, the student will be able to:
1. Build a basic knowledge of the processes carried out in the chemical industry.
2. Review the practical importance and relevance of the process taking place in the chemical industry.
3. Understand the technological methods to circumvent the issues in the process plant.
4. Study the salient features of the chemical processes used to manufacture daily needs.
5. Build a bridge between theoretical and practical concepts used in industry

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Fermentation Industry and Technology of Soaps and Surfactants**

Introduction to fermentation and types of fermentation processes. Production of ethyl alcohol by fermentation and manufacture of industrial alcohol, Beers, Wines & Liquors.
The manufacturing of soap from glycerin, by-products from soap; manufacturing Detergents, Raw materials for the soap industry and their selection.

Unit-2	**Number of lectures = 10**	**Title of the unit: Paper, Pulp and Polymer Industries**

Raw materials, pulping processes, recovery of chemicals, stock preparation and paper. Manufacture of Polymer and Synthetic Fiber, Introduction to polymerization, commodity polymers, rayon, polyester, polyamide, acrylic fibre and nylons.

Unit-3	**Number of lectures = 10**	**Title of the unit: Sulphur, Phosphorous, Nitrogen and Chloro-alkali Industries**

Origin and Extraction of sulphur, production routes of Sulphuric acid and oleum, Extraction of phosphorus, and manufacture of phosphoric acid and phosphate fertilizers. Manufacturing of ammonia, nitric acid, and mixed nitrogenous fertilizers.

Unit -4	**Number of lectures = 10**	**Title of the unit: Safety in Chemical Process Industries**

Concept and definitions, safety culture, storage of dangerous materials, plant and plant layout, safety system, technology and process selection, and the scale of the disaster. Vapour cloud, explosion, control and handling of toxic chemicals, runaway reactions, fire and explosion, high-pressure relief system, hazardous properties of chemicals. Risk assessment and analysis, hazard models and risk data identification, minimization, and hazard analysis. Handling of disaster, plant of emergency, risk management routines, emergency shutdown systems, Role of computer in safety, prevention of human hazard element, technology and process selection.

12. Brief Description of self-learning/ E-learning component

1. https://nptel.ac.in/courses/103103029/30
2. https://www.cleaninginstitute.org/sites/default/files/assets/1/AssetManager/SoapsandDetergentsBook.pdf
3. http://www.ictmumbai.edu.in/uploaded_files/Polymer_Engg_and_Tech_all_Sem._Syllabus.pdf
4. file:///C:/Users/Dell/Downloads/introduction%20to%20polymer%20science%20(book).pdf
5. https://nptel.ac.in/courses/103107086/
6. https://www.elsevier.com/books/biermanns-handbook-of-pulp-and-paper/bajpai/978-0-12-814240-0
7.https://biokamikazi.files.wordpress.com/2013/09/principles_of_fermentation_technology-stanburry_whittaker.pdf

13. Books Recommended

1. Gopala, Rao M., Marshall S., "Dryden's Outlines of Chemical Technology for the 21st Century", Edited by Affiliated East-West Press. ISBN-10: 9788185938790
2. Moulijn J. K; Makkee M. and van Diepen A; "Chemical Process Technology", Wiley. ISBN: 978-1-444-32025-1
3. Basta, N., "Shreve's Chemical Process Industries Handbook", 5th Ed; McGraw Hill. ISBN-10: 9781259029455
4. A joint venture by IISc and IITs, funded by MHRD, Govt of India John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed. ISBN-10; 032175087X
5. Pulp and Paper Science & Technology Vol. I & II by C.E.Libby. ISBN:NA 1962 edition
6. Pulp & Paper Manufacture Vol. I, II, III by Mac Donald. ASIN : B002KLT77Y
7. Hand Book of Pulp and Paper Technology by K.W. Britt 2nd edition. ISBN-10; 8123911440
8. F.W. Billmeyer, —Text Book of Polymer sciencel. ISBN-13: 9788126511105
9. M.S. Bhatnagar, —Text Book of polymerl. ASIN : B08YKGDRDJ
10. C.E. Dryden, —Outlines of Chemical Technologyl, Affiliated East-West Press, 1973. ISBN-10: 9788185938790
11. Charles D.Fleddermann, —Engineering Ethicsl, Prentice-Hall, New Mexico, 1999. ISBN-13: 978-0-13-214521-3
12. Safety in Process Plant Designl, Wells, G.L. Godwin, London (1980). ISBN: 0711455066 9780711455061 0852951264 9780852951262 0470269073 9780470269077
13. Loss Prevention in Process Industriesl, Lees, F.P. Butterworth, Oxford. ISBN: 9780123971890

1. Name of the Department: Mathematics						
2. Course Name	**Solid Geometry**	**L**	**T**		**P**	
3. Course Code	17030507	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**			**Practicals: 0**	

8. Course Description:

In mathematics, solid geometry is the traditional name for the geometry of three-dimensional Euclidian spaces. This course is aimed to provide an introduction to the theories for general equation of second degree and conic, sphere, cones, cylinders, central conicoids and paraboloids.

9. Course Objectives:

The objective of this course is "to exercise further the spatial imagination of the student and to give him both a knowledge of the fundamental spatial relationship and the power to work with them and the development of greater facility in visualizing spatial relations and figures in representing such figures on paper.".

10. Course Outcomes (COs):

After completing this course, students will be able to:

1. To classify the type of conic from its second degree equation and write equation of tangents and normal to the conic.
2. To understand the various properties of a Sphere.
3. To demonstrate the knowledge of cylinders and Cones.
4. To understand the concepts of Conicoids and Paraboloids.

11. Unit wise detailed content

Unit-1	**Number of lectures = 5**	**Title of the unit: General equation of second degree and conic**

General equation of second degree, Tracing of conics, Tangent at any point to the conic, Line joining the origin to the points of intersection of a curve and a Line, chord of contact, pole of line to the conic, director circle of conic, system of conic, Confocal conics, polar equation of a conic..

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

Equation of a Sphere, Plane section of a sphere, Plane of contact and Polar Plane, Tangent plane, Sphere through a given circle, Intersection of two spheres, radical plane of two spheres, Co-axial system of spheres, Conjugate system of Spheres...

Unit-3	**Number of lectures = 5**	**Title of the unit: Cone and Cylinder**

Cones: Equation of a Cone, Intersection of Cone with Plane and a Line, Right circular Cone, enveloping Cone and reciprocal Cone, Equation of a Cylinder, Enveloping and right circular Cylinder,
Unit-4 | **Number of lectures = 8** | **Title of the unit: Central Conicoids and Paraboloids**
Central Conicoids: Equation of tangent plane. Director sphere, Normal to the conicoids, polar plane of a point, Enveloping cone of a conicoid, enveloping cylinder of a conicoid , Standard equation of a Paraboloid and its simple properties, Intersection with a Line or a Plane
12. Web links:
1. https:/www.youtube.com/watch?v=AWXGMeN0Ets 2. https://www.youtube.com/watch?v=s1kaJMtZt60
13. Books Recommended
1. R. J.T. Bill, Elementary Treatise on Coordinary Geometry of Three Dimentions, Macmillan india Ltd. 1994. 2. P.k. Jain and Khalil ahmad: a textbook of Analytical Geometry of Three Dimentions,, Wiley Eastern Ltd. 1999. 3. G.B. Thomas and R.L. Finney: calculas, 9th Ed.., Pearson Education, Delhi, 2005. 4. H. Anton, I. Bivens and S.Davis: Calculas. John Wiley and Sons(Asia) Pvt. Ltd., 2002. 5. S. L. Loney: The Elements of Coordinate Geometry, McMillan and Company, London.

1. Name of the Department: Mathematics						
2. Course Name	Mathematical Modelling	**L**	**T**		**P**	
3. Course Code	17030508	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✔)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

Formulation and analysis of mathematical models. Mathematical tools include dimensional analysis, optimization, simulation, probability, and elementary differential equations. Applications to biology, sports, economics, and other areas of science. To develop mathematical and scientific problems based on modelling. Students will participate in formulating models as well as in analyzing them.

9. Course Objectives:

The objective of the course is to introduce mathematical modelling, that is, the construction and analysis of mathematical models inspired by real life problems. The course will present several modelling techniques and the means to analyze the resulting systems.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To understand the core principles of mathematical modelling.
2. To apply precise and logical reasoning to design various problems and solve them.
3. To frame quantitative problems and model through difference equations mathematically.
4. To analyze the importance of graph theory in mathematical modelling.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 12**	**Title of the unit: Introduction to Mathematical Modelling**

Basics of Mathematical Modelling: Elementary mathematical models, Role of Mathematics in problem solving, Concept of mathematical modelling, System approach; formulation, analysis of models; Sensitivity analysis, Mathematical Modelling through ordinary differential equations: Linear growth and decay model.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Mathematical Modelling through System of Differential Equations**

Mathematical modelling through a system of ordinary differential equations of first order: Prey-Predator models, Mathematical modelling of epidemics, Stability for autonomous systems, Lyapunov functions.

Unit – 3	**Number of lectures = 8**	**Title of the unit: Mathematical Modelling through Difference Equations**

Mathematical Modelling through difference equations: Mathematical modelling in population dynamics and genetics, Mathematical modelling in probability theory, Stability for continuous and discrete time.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Mathematical Modelling through Partial Differential Equations**

C. S. Lalitha

Mathematical modelling through partial differential equations: PDE model for birth-death immigration-emigration process, PDE model for a stochastic epidemic process with no removal, Mathematical modelling through stochastic differential equations, Brownian motion and its properties, Ito formula, Ito integrals and its properties.
12. Brief Description of self-learning / E-learning component
1. https://onlinecourses.nptel.ac.in/noc22_ma20/preview 2. https://nptel.ac.in/courses/111107113
13. Books Recommended
1. J.N. Kapur: Mathematical Modelling (2nd ed.) NEW AGE International Pvt Ltd, 2021. 2. B. Barnes, and G.R. Fulford: G. R., Mathematical Modelling with Case Studies (3rd ed.), CRC Press, 2015. 3. E. A. Bender: An introduction to Mathematical Modeling (1st ed.) Dover Publications, 2012. 4. J.D. Logan and W.R. Wolesensky: Mathematical Methods in Biology, John Wiley & Sons, New York, 2009.

1. Name of the Department: Mathematics						
2. Course Name	Discrete Mathematics	**L**	**T**		**P**	
3. Course Code	17030509	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✔)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

Introduction to discrete structures and their applications like logic, gate and set theory, recursive programming, digital logic and combinatorial circuits, real number representation and finite automata used in computer science.

9. Course Objectives:

1. To provide basic and theoretical competencies those are majorly used in Computer Science.
2. To help students understand and appreciate the basic mathematical knowledge which is fundamental to Computer Science.
3. To understand the counting principles.
4. To discuss some important applications of Boolean algebra and graph theory in real life situations through switching circuits and shortest path algorithms.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To determine the logical equivalence of propositions and the validity of formal arguments via truth tables.
2. To design and construct a combinatorial circuit from a verbal description.
3. To understand switching circuits and their applications.
4. To understand Graphs and its applications in study of shortest path algorithms.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Title of the unit: Sets, Counting and Lattices**

Sets, Relations and their properties, Equivalence relation, Partial order relation, Hasse diagram, Mathematical induction, The basics of counting, Pigeon hole principle and its application, Recurrence relations, Solving recurrence relations, Generating functions, inclusion-exclusion principle

Unit – 2	**Number of lectures = 8**	**Title of the unit: Logics, Lattices**

Logic: Statement, Symbolic representation, Proposition, Propositional logic, Compound proposition, Logical operators, Tautologies and Contradiction, Logical equivalence, Validity of arguments, Quantifier, Predicates, Definition of Lattice, Lattices as partially ordered sets and their properties.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Boolean Algebra**

Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean Forms and their Equivalence. Minterm Boolean Forms, Sum of products, Canonical forms. Disjunctive normal form and conjunctive normal form, Minimization of Boolean functions, The Karnaugh map method, Switching circuits and applications of switching circuits.

Unit – 4	**Number of lectures = 12**	**Graph Theory**

Graph, Types of graphs, Matrix representations of graphs, Graph isomorphism, Weighted undirected graphs, Paths, Cycles and circuits, connectivity, Subgraphs, Induced subgraphs, Complete graphs, Bipartite graphs, Euler and Hamilton paths, Travelling salesman problem, Shortest path problem, Dijkstra's algorithm, Euler's theorem on the existence of Eulerian paths and circuits. Trees, Spanning Trees. Minimal spanning Trees and Kruskal's algorithm, Application of trees.

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/playlist?list=PL0862D1A947252D20
2. https://www.youtube.com/playlist?list=PLbMVogVj5nJQ-tIzyygzzLLxomzlbIiE4

13. Books Recommended

1. M. K. Venkataraman, N. Sridharan, N. Chandrasekaran: Discrete Mathematics, The National Publishing company, 2003.
2. C. L. Liu: Elements of Discrete Mathematics (3rd ed,). Tata McGraw Hill, 2008.
3. K. Rosen: Discrete Mathematics and Its Applications (8th ed,), McGraw Hill, 2019.
4. Babu Ram: Discrete Mathematics, Pearson Education, 2012.

SEMESTER-VI (SEC)

1. Name of the Department: Physics						
2. Course Name	Solid State Physics	**L**	**T**		**P**	
3. Course Code	17030510	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

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

9. Course Objectives:

1. To study the basics of crystallography and lattice dynamics.
2. To understand the diamagnetic, paramagnetic and ferromagnetic properties of the materials
3. To understand the dielectric properties of materials.
4. To study basics of band theory and get familiar with superconducting phenomenon.

10. Course Outcomes (COs):

After successful completion of the course, students will

1. have a basic knowledge of crystal systems and will be able to calculate thermal and electrical properties in the free-electron model.
2. understand the magnetic properties of matter and its applications
3. understand the dielectric properties of materials with its applications.
4. know the band theory of solids and theory of superconductivity.

11. Unit wise detailed content

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

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

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

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

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

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

Dielectric Properties of Materials: Polarization, Local Electric Field at an Atom, Depolarization Field, Electric Susceptibility, Polarizability, Clausius Mosotti Equation,

Classical Theory of Electric Polarizability, Normal and Anomalous Dispersion.		
Unit - 4	**Number of lectures = 13**	**Title of the unit: Elementary band theory and superconductivity**

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

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

12. Books Recommended

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed,, 2004, Wiley India Pvt, Ltd, ISBN : 978-8126535187
2. Elements of Solid State Physics, J,P, Srivastava, 2nd Ed,, 2006, Prentice-Hall of India, ISBN : 978-8120350663
3. Introduction to Solids, Leonid V, Azaroff, 2004, Tata Mc-Graw Hill, ISBN : 978-0882753454
4. Solid State Physics, Neil W, Ashcroft and N, David Mermin, 1976, Cengage Learning, ISBN : 978-9387067721
5. Solid State Physics, Rita John, 2014, McGraw Hill, ISBN : 978-9332901797
6. Elementary Solid State Physics, 1/e M, Ali Omar, 1999, Pearson India, ISBN : 978-0201607338
7. Solid State Physics, M, A, Wahab, 2011, Narosa Publications, ISBN : 978-8184874938

13.Online links

1. https://www.youtube.com/watch?v=qh29mj6uXoM
2. https://www.youtube.com/watch?v=2pCdQ2gkwjQ
3. https://www.youtube.com/watch?v=nBW4max0fuU
4. https://nptel.ac.in/courses/115101012/
5. https://nptel.ac.in/courses/122101001/20

1. Name of the Department: Physics						
2. Course Name	Solid State Physics Lab	**L**	**T**		**P**	
3. Course Code	17030511	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

11. List of Experiments

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

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House, ISBN : 978-0423738902.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers, ISBN : 978-0435686666.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, KitabMahal, New Delhi, ISBN : 978-8122504163.
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India, ISBN: 978-8120350663.

1. Name of the Department: Physics						
2. Course Name	Atomic, Molecular and Laser Physics	**L**	**T**		**P**	
3. Course Code	17030512	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

1. Describe theories explaining the structure of atoms and the origin of the observed spectra.
2. Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields
3. Understand the basics of Laser.
4. Explain different Laser used and make a comparison between them.

11. Unit wise detailed content

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

Basic concept of atom model and need of vector atom model, Vector atom model, Quantum numbers associated with vector atom model, Penetrating & non- penetrating orbits, Alkali spectra (Description), Spectral lines in different series of alkali spectra, Spin orbit interaction and doublet

term separation, LS coupling and jj coupling description, Expression for interaction energy in LS coupling, Expression for interaction energy in jj coupling.		
Unit - 2	**Number of lectures = 13**	**Title of the unit: Molecular Spectroscopy**
Normal Zeeman effect, Anomalous Zeeman Effect, Zeeman pattern of D_1 and D_2 lines of Na atom, Paschen Back effect of a single valance electron system, Weak field Stark effect of H-atom, Discrete set of electronic energies of molecules, Quantization of vibrational energies, Quantization of rotational energies, Raman effect (Quantitative Description), Stokes and Anti-stokes lines. Fundamentals of ESR and NMR.		
Unit - 3	**Number of lectures = 13**	**Title of the unit: Basics of lasers**
Main features of Laser (Directionality and Intensity, Monochromaticity and Coherence), Spontaneous and stimulated emission, Einstein coefficients and population inversion, Laser pumping. Modes of resonators and coherence length.		
Unit - 4	**Number of lectures = 13**	**Title of the unit: Working of lasers**
RUBY Laser (Principle, construction & working), He-Ne Laser (Principle, construction & working), Nd-YAG Laser, CO_2 Laser (Principle, construction & working), Semiconductor Laser (Principle, construction & working), Application of Laser in the field of medicine and industry.		

12. Books Recommended

1. Jain, V,K, Introduction to Atomic and Molecular Spectroscopy, New Delhi: Narosa, ISBN : 978-8173197758
2. White, H E, Introduction to Atomic Spectra, ISBN: 978-9352604777
3. Herzberg, G, Molecular Spectra and Molecular Structure, ISBN : 978-0486601151
4. Banwell, Fundamentals of Molecular Spectroscopy, ISBN : 978-9352601738
5. Thyagrajan and Ajay Ghatak, Lasers, Theory and Applications, 2nd ed, ISBN : 978-1461426943
6. Laud, B,B, Laser and Nonlinear Optics, 2nd ed, ISBN : 978-8122430561

13. Online links

1. https://nptel.ac.in/courses/104104085/
2. https://nptel.ac.in/courses/115105100/56

1. Name of the Department: Physics						
2. Course Name	Atomic, Molecular and Laser Physics Lab	**L**	**T**		**P**	
3. Course Code	17030513	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

11. List of Experiments

1. To measure thickness of wire using He-Ne Laser.
2. To measure the wavelength of Laser Light using Diffraction method.
3. To measure the wavelength of Laser Light using Michealson interferomenter.
4. e/m by Thomson method.
5. Transistor as voltage Amplifier in C-B configuration.
6. Transistor as voltage Amplifier in C-E configuration.
7. Study of B-H Curve by C.R.O.
8. Study of Hartley Oscillator (Calibration of Gang Condenser).
9. Measurement of Energy Gap of Four Probe Method.
10. Rydberg constant by Hydrogen gas spectrum.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House, ISBN : 978-0423738902.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers, ISBN : 978-0435686666.
3. A Text Book of Practical Physics, InduPrakash and Ramakrishna, 11th Ed., 2011, KitabMahal, New Delhi, ISBN : 978-8122504163.
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India, ISBN : 978-8120350663.

1. Name of the Department: Physics						
2. Course Name	Biophysics and Radiation Science	**L**	**T**		**P**	
3. Course Code	17030514	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		
8. Course Description:						
The biophysics course provides an introduction to the rapidly growing inter-disciplinary subject at the interface of physics and biology. It employs physics concepts and explores their applicability in biology. This course assists students in developing a system-level understanding of biology and provides students with the necessary mathematical and scientific skills.						
9. Course Objectives:						
The aim of this course is to develop problem-solving ability across a wide range of biologically-pertinent physical, chemical and mathematical domains. Have a foundation in evolutionary biology, cell biology, and other biological science areas						
10. Course Outcomes (COs):						
After completing this course, students will be able to understand and explain the basic concepts of: 1. Atomic & molecular structure 2. Thermodynamic & Bioenergetic in biological systems 3. Physio-chemical Foundations 4. Basics of Nuclear Physics						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 13**	**Title of the unit: Atomic & Molecular structure**				
Structure of atom, Various Models & theories, Periodic table, Concept of bonding; Types of bonding valence of carbon; hybridizations of carbon; molecular orbital theories, polar & nonpolar molecules; inductive effect; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions; covalent, Hydrogen, Electrostatic, Van der Waals forces Bond lengths & Bond energies, Bond angles, Concept of isomerism.						
Unit - 2	**Number of lectures = 13**	**Title of the unit: Physio-chemical Foundations**				
Acid & Bases, mole concept, Molarity & Normality, weak acids, Ampholyte, pH, Calculations of pH, numerical problems. Redox potential: Oxidation-Reduction, Equivalence of electrical & chemical energy, Electrochemical cell, contact potentials, galvanic cell, the potential of half-cell, redox potentials & its calculations by Nernst equation, standard electrode potentials & its determination, its relationship with emf, Types of electrodes.						
Unit - 3	**Number of lectures = 13**	**Title of the unit: Physical Foundations of Biophysics**				
Thermodynamics of Biological system: First and second laws of thermodynamics,						

Activation energy. Biological systems as open, non-equilibrium systems, Concept of free energy, unavailable energy, entropy, the heat content of food, bomb calorimetry, Enthalpy, Negative entropy as applied to biological systems. thermodynamics of Passive and active transport, biological clocks.

Unit - 4	**Number of lectures = 13**	**Title of the Unit: Basics of Nuclear Physics and Effects of Radiation**

Nucleus, constituents of the nucleus, Properties of Nucleus size, mass, density, energy, charge, binding energy, nuclear angular momentum, nuclear force, Nuclear Transformations: Radioactivity, decay constant, activity half-life, mean life, radioactive series, radioactive equilibrium, modes of decay: α-decay, β-decay, Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell

12. Books Recommended

1. Rodney Cotterill; Biophysics: An Introduction, John Wiley & Sons.
2. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill.
3. Modern Physics, John R, Taylor, Chris D, Zafiratos, Michael A, Dubson,2009, PHI Learning
4. Chemical Bonds: An Introduction to Atomic and Molecular Structure, Harry B. Gray, University Science Books, 1994.
5. Principles of Modern Chemistry by David W. Oxtoby, 2002, S.Chand (G/L) & Company.
6. Introduction To Biophysics by Pranab Kumar, S Chand & Company 2010

13. Online Links

1. https://nptel.ac.in/courses/115101121
2. https://nptel.ac.in/courses/115102017/2
3. https://www.youtube.com/watch?v=iMhDYarsfII&rel=1&color1=0xcbba9f&color2=0xcbba9f&border=0&fs=1
4. https://nptel.ac.in/courses/115101010/downloads/lec1.pdf
5. https://nptel.ac.in/courses/115104043

1. Name of the Department: Physics						
2. Course Name	Biophysics and Radiation Science Lab	**L**	**T**		**P**	
3. Course Code	17030515	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (If any)		**6. Frequency (Use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

The experiments are designed to assistance students in their biophysics laboratory class. It helps them to understand laboratory operations and essential information about physical and chemical phenomena that support many biological processes.

9. Course Objectives:

This course aims to facilitate the acquisition of knowledge of physical phenomena fundamental for biological processes and the understanding of the principles and modern methods in biophysics.

10. Course Outcomes (COs):

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

1. The theoretical and practical understanding of biophysics by performing experiment
2. Demonstrate the practical application of biophysics etc. in actual practice

11. List of Experiments

1. Determination of the frequency of an electrically maintained tuning fork by Melde's experiment.
2. Determination of the coefficient of Viscosity of water by capillary flow method (Poiseuille's method).
3. Verification of Beer Lamberts Law.
4. Simulating Cellular Automata Matlab/Python
5. Finding Equilibrium Points in Lotka Volterra System using Python/Matlab.
6. Simulate Random Walks with Python/Matlab.
7. To draw the Plateau of G.M. Counter
8. To determine the Mass attenuation coefficient by G.M. Counter.
9. Study some simple tests of proteins.
10. Study the variation of cell potential of Zn | Zn2+ | | Cu2+ | Cu cell with change in the concentration of electrolytes (CuSO4 and ZnSO4) at room temperature.

12. Recommended Books and Virtual Labs

1. https://math.libretexts.org/Bookshelves/Scientific_Computing_Simulations_and_Modeling/
2. http://amrita.olabs.edu.in/?sub=73&brch=8&sim=153&cnt=1
3. http://amrita.olabs.edu.in/?sub=73&brch=8&sim=140&cnt=1
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
5. A Text Book of Practical Physics, InduPrakash and Ramakrishna, 11th Ed., 2011, KitabMahal, New Delhi
6. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
7. College Practical Chemistry, By V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, University Press, 2005

1. Name of the Department: Chemistry						
2. Course Name	Analytical Methods in Chemistry		**L**		**T**	**P**
3. Course Code	17030516		4		0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

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

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

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

10. Course Outcomes (COs)

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

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

11. Unit wise detailed content

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

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

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

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

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

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

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

Unit-3	Number of lectures = 10	Title of the unit: Thermal methods of analysis and Electroanalytical Methods
Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Classification of electro analytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values.		
Unit-4	**Number of lectures = 14**	**Title of the unit: Separation Techniques**
Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. **Chromatography:** Classification, principle and efficiency of the technique, Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess		

12. Brief Description of self-learning/ E – learning component

1. http://www.oswego.edu/~kadima/CHE425/chapter1_all_one%20slide%20per%20handout.pdf
2. http://web.iitd.ac.in/~sdeep/Electronic.pdf
3. https://nptel.ac.in/courses/103108100/module5/module5.pdf
4. https://nptel.ac.in/courses/103108100/module4/module4.pdf

13. Books Recommended

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.ISBN-10: 9780582446939
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988. ISBN-10: 0534081428
3. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004. ISBN-10: 0471214728
4. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.ISBN-10: 0716705710.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.ISBN-10:1906574006
6. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. ISSN: 2279–0543
7. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.ISBN-10: 0853120803
8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974. ISBN-10;0442221584

1. Name of the Department: Chemistry						
2. Course Name	Analytical Methods in Chemistry Lab		**L**	**T**		**P**
3. Course Code	17030517		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

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

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

9. Course Objectives

The objectives of this course are to:

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

10. Course Outcomes (COs)

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

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

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

I. Chromatography

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

II. Solvent Extractions:

1. 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.
2. Solvent extraction of zirconium with amberlite LA-1, separation from a mixture of irons and gallium.
3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
5. Analysis of soil:

Ion exchange:

I. Determination of exchange capacity of cation exchange resins and anion exchange resins.
II. Separation of metal ions from their binary mixture.
III. Separation of amino acids from organic acids by ion exchange chromatography.

III. Spectrophotometry:

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

12. Brief Description of self-learning/E – learning component

1. http://www.egyankosh.ac.in/bitstream/123456789/15886/1/Experiment-5.pdf
2. http://www.cee.ntu.edu.sg/aboutus/CEELabs/Env/Documents/LabManu/CV2701%202A-6.pdf
3. https://pubs.acs.org/doi/abs/10.1021/ed007p724

13. Books Recommended

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.ISBN-10: 9780582446939
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.ISBN-10: 0534081428
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004. ISBN-10: 0471214728
4. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.ISBN-10: 0716705710.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.ISBN-10:1906574006
6. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. ISSN: 2279–0543
7. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.ISBN-10 : 0853120803
8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974. ISBN-10;0442221584

1. Name of the Department: Chemistry						
2. Course Name	Molecules of Life	**L**	**T**		**P**	
3. Course Code	17030518	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

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

8. Course Description

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

9. Course Objectives

The objectives of this course are:

1. To study the classification and general properties of carbohydrates, proteins, amino acids, enzymes and lipids.
2. To determine the primary structure and synthesis of peptides
3. To understand the mode of action of enzymes.
4. To understand how DNA carries genetic information.
5. To understand the interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

10. Course Outcomes (COs)

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

1. Identify the different biomolecules and elucidate their structure.
2. Explain Specificity of enzyme action, Enzyme inhibitors and their importance.
3. Differentiate between oil and fats; calculate saponification value and iodine number.
4. Get detailed knowledge about Nucleic acids and DNA.
5. Describe the Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs cycle, and other biomolecules.

11. Unit wise detailed content

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

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

Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

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

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition(Competitive and Non- competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring,

Unit-3	Number of lectures = 10	Title of the unit: Nucleic Acids and Lipids

Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature)**, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation. Introduction to lipids, classification. Oils and fats: Common fatty

acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).		
Unit-4	**Number of lectures = 10**	**Title of the unit: Concept of Energy in Biosystems**
Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate-Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.		
12. Brief Description of self-learning/E – learning component		
1.https://www.chem.purdue.edu/courses/chm333/ 2.https://ocw.mit.edu/high-school/biology/exam-prep/molecular-genetics/rna-dna-structure-function/		
13. Books Recommended		

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN-9788131704813
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).ISBN-13 : 978-8177585421
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) ISBN-13: 978-8177585414
4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.,W. H. Freeman ISBN-13: 978-1464126116
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002, ISBN-13: 978-0716746843

1. Name of the Department: Chemistry						
2. Course Name	Molecules of Life Lab	**L**	**T**		**P**	
3. Course Code	17030519	0	0		4	
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**	
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0	**Tutorials = 0**	**Practical = 52 hrs.**				

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

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

10. Course Outcomes (COs)

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

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

11. List of Experiments

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

12. Brief Description of self-learning/ E – learning component

1. https://eprayoglekha.org/demo/pdf/Experiment3.pdf
2. http://egyankosh.ac.in/bitstream/123456789/15897/1/Experiment-12.pdf
3. http://www.collectionscanada.gc.ca/eppparchive/100/205/301/ic/cdc/science/english/bio/projects/genetics.html

13. Books Recommended

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ISBN No-9788177589573
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.ISBN-13: 978-8173714757

1. Name of the Department: Chemistry						
2. Course Name	Quantum Chemistry, Spectroscopy & Photochemistry		**L**	**T**		**P**
3. Course Code	17030520		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

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

8. Course Description

This course provides a thorough knowledge of the methods of Quantum mechanics and the different types of spectroscopic techniques like Vibrational, Rotational, Electronic, Raman and Nuclear Magnetic Resonance (NMR) spectroscopies for understanding the molecular structure and nature of chemical bonding. It also highlights the basic laws of photochemistry, energy levels, quantum yield and examples of photochemical reactions.

9. Course Objectives

The objectives of this course are to:

1. Introduce the concept of need of quantum mechanics on failure of classical mechanics.
2. Aware the student about postulates of quantum mechanics and apply them to derive equations for various models including hydrogen atom too.
3. Study of various types of spectra and their use in structure elucidation.
4. Study the principles and laws of photochemistry and apply them in field of chemistry, biology, biochemistry, biomedicine etc.

10. Course Outcomes (COs)

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

1. Understand and basic principles of quantum mechanics
2. Define chemical bonding and able to understand its various theories
3. Gain importance of vibrational, Raman, Electronic, NMR and ESR spectroscopic techniques in structure determination.
4. Apply the laws of photochemistry, Lambert-Beer's law, define terms like photosensitization, quenching, chemiluminescence etc.

11. Unit wise detailed content

Unit-1	Number of lectures = 18	Title of the unit: Quantum Chemistry

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

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

Angular momentum, Rigid rotator model of rotation of diatomic molecule, Separation of variables, Spherical harmonics, Discussion of solution.

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

Unit-2	Number of lectures = 08	Title of the unit: Chemical Bonding (Qualitative aspects only)

Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH, CO, NO).

Unit-3	Number of lectures = 18	Title of the unit: Molecular Spectroscopy

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution

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

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

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

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

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

Unit-4	**Number of lectures = 08**	**Title of the unit: Photochemistry**

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

12. Brief Description of self-learning/ E – learning component

1. https://www.shodor.org/chemviz/overview/quantum.html
2. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2007/lecture-notes/
3. https://nptel.ac.in/courses/122101001/13

13. Books Recommended

1. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006), ISBN 978-9352601738
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001), ISBN 978-0074620540
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004), ISBN 9780123567710
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005), ISBN 978-0124575516
5. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015), ISBN 978-1107063884

1. Name of the Department: Chemistry						
2. Course Name	Quantum Chemistry, Spectroscopy & Photochemistry Lab		**L**	**T**		**P**
3. Course Code	17030521		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

This course provides practical training to handle UV spectrophotometer and study absorbance spectra of various samples in the visible range. Solutions of transition metal ions can be colored (i.e., absorb visible light) because *d*-electrons within the metal atoms can be excited from one electronic state to another. Organic compounds, especially those with a high degree of conjugation, also absorb light in the UV or visible regions of the electromagnetic spectrum. (Organic solvents may have significant UV absorption; not all solvents are suitable for use in UV spectroscopy. Ethanol absorbs very weakly at most wavelengths.) Solvent polarity and pH can affect the absorption spectrum of organic compounds.

9. Course Objectives

The objectives of this course are to:

1. Find out the unknown concentration of a sample and verification of Beer-Lambert's Law
2. Determine concentration of various solutions using colorimetry

10. Course Outcomes (COs)

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

1. Record the spectra of different organic compounds.
2. Determine the kinetics or rate constant of a chemical reaction

11. List of Experiments

I. **Spectrophotometry**

1. 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 (kJ molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

II. **Colorimetry**

1. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration
2. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
3. Study the kinetics of iodination of propanone in an acidic medium.
4. Determine the amount of iron present in a sample using 1,10-phenanthroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

12. Brief Description of self-learning/ E – learning component

1. https://en.wikipedia.org/wiki/Ultraviolet%E2%80%93visible_spectroscopy
2. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/uv-vis/uvspec.htm
3. http://life.nthu.edu.tw/~labcjw/BioPhyChem/Spectroscopy/beerslaw.htm
4. https://cd1.edb.hkedcity.net/cd/science/chemistry/s67chem/pdf/sDL_2_Iodination.pdf

13. Books Recommended

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009, ISBN 978-8131723258.
2. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011) ISBN 978-1906574000

3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003), ISBN 9780070570078.
4. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003), ISBN 978-0716717355.

1. Name of the Department: Mathematics						
2. Course Name	Vector Calculus	**L**	**T**		**P**	
3. Course Code	17030522	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	DSE (✓)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

Course in multivariable calculus. Topics include scalar and vector product, gradient divergence and curl; line and surface integrals; and the theorems of Green, Stokes, and Gauss.

9. Course Objectives:

After the course, the student will be able to:

1. To explain vector addition, dot product, cross product, scalar fields and vector fields.
2. To make students familiar with Curl, Divergence, Gradient and its properties.
3. To make students familiar with Theorems of Gauss, Green and Stokes and problems based on these theorems.
4. Scalar and vector quantities, Types of vector, Directional vector, Evaluate vector integration of Surface & Volume.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To understand the basics of dot product, cross product and length of vectors.
2. To introduce partial derivatives, derivatives of vector-valued functions, gradient functions.
3. To apply the basic concept of gradient, divergent, curl and their applications in the flow of water, heat.
4. To evaluate integrals of functions or vector-related quantities over curves, surfaces, and domains in two- and three-dimensional space.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 13**	**Title of the unit: Vector Algebra**

Vectors and scalars, Definition of a vector and a scalar, Addition of vectors, Components of a vector, Dot product, Applications of the dot product, Cross product, Applications of the cross product, Scalar triple product, Vector triple product, Scalar fields and vector fields.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Vector Differential Calculus**

Curves. Arc length. Curvature. Torsion, Functions of several variables, Gradient of a Scalar Field. Directional Derivative, Divergence, Curl and their geometric representation. Solenoidal and irrotational vectors.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Vector integral calculus**

Line integral, Application of line integral, Work, Circulation, Independence of path and potential in a plane, Conservative vector field, Test for a conservative field, Evaluation of surface integrals, other forms of surface integrals, Volume integral, Introductory example of volume integral, Mass of an object with variable density.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Integral Theorems**

Green's theorem, Stoke's theorem, Applications of Stokes's theorem, Related theorems linking line and surface integrals. Gauss-divergence theorem, Applications of the Divergence theorem, Related theorems linking surface and volume integrals.
12. Brief Description of self-learning/ E-learning component
1. https://archive.nptel.ac.in/courses/111/105/111105122/ 2. https://archive.nptel.ac.in/courses/111/105/111105134/ 3. https://www.coursera.org/learn/vector-calculus-engineers
13. Books Recommended
1. Shanti Narayana and P.K. Mittal: A Text Book of Vector Analysis. S. Chand & Co., New Delhi 2010. 2. G.B. Thomas and R.L. Finney: Calculus, (9th ed.), Pearson Education, Delhi 2005. 3. H. Anton, I. Bivens and S. Davis: Calculus (10th ed.), John Wiley & Sons Inc., 2012. 4. P.C. Matthews: Vector Calculus, Springer, 2000.

1. Name of the Department: Mathematics						
2. Course Name	Vector Calculus Lab	**L**	**T**		**P**	
3. Course Code	17030523	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

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

8. Course Description:

This course is designed to emphasize the knowledge of vector calculus. Emphasis is placed on evaluating gradient, divergence, curl, line integration, surface integration, volume integration etc. Upon completion, students should be able to select and use appropriate models and techniques for finding solutions to vector related problems.

9. Course Objectives:

1. To explain vector algebra concepts.
2. To familiarize arc length, curvature and torsion etc.
3. Application of line integral, surface integrals and other forms of surface integrals.
4. To discuss the divergence theorem of Gauss, Stoke's theorem and applications Stoke's theorem.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To explain vectors and scalars, components of a vector, dot product, cross product, Scalar triple product, scalar fields and vector fields.
2. To explain the Directional Derivative.
3. To determine solutions to curl and angular velocity of vector fields.
4. To determine the solution to flux integral and Stokes's theorem.

11. List of Practical's to perform in computer lab using software MATLAB:

1. Evaluate vector addition and multiplication.
2. Evaluate dot product, scalar triple product.
3. Evaluate divergence of a vector field.
4. Evaluate curl of a vector field.
5. Evaluate directional derivative.
6. Evaluate curl and angular velocity of vector field.
7. Evaluate the flux of a vector field.
7. Evaluate surface integral using Stokes' theorem.
9. Evaluate flux integral.
10. Evaluate flux of a vector field using Divergence theorem.

12. Brief Description of self-learning / E-learning component

1. https://in.mathworks.com/help/matlab/ref/divergence.html
2. https://in.mathworks.com/help/matlab/ref/curl.html?s_tid=doc_ta
3. https://in.mathworks.com/help/matlab/vector-fields.html

13. Books Recommended

Malik. C.S. Lalita

1. Brian H. Hann, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists (7th ed.), Academic Press Inc., 2019.
2. Amos Gilat: MATLAB: An Introduction with Applications (8th ed.), John Wiley & Sons Inc, 2016.

1. Name of the Department: Mathematics						
2. Course Name	Operations Research	**L**	**T**		**P**	
3. Course Code	17030524	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓	Either Sem ()	Every Sem ()

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

8. Course Description:

Operations Research is a science of modeling and optimization which helps to model real-world problems by using mathematics, statistics, and computers. The course deals with methods to solve linear programming problems. This course also deals with duality theory in linear programming. Various applications of linear programming such as transportation, assignment and game problems are discussed in this course. Another class of problems, namely sequencing problems, is also introduced in this course.

9. Course Objectives:

This module aims to introduce students to use quantitative methods and techniques for effective decision making; model formulation and applications that are used in solving decision making problems.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To formulate and solve linear programming problems for a physical situation like production, distribution of goods and economics and solve them by graphical method.
2. To solve a LPP by simplex, Big-M and two phase methods.
3. To analyze the problem of transporting the products from origins to destinations with least transportation cost and solve it.
4. To understand the basic concept of Game theory and sequencing problems.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Title of the unit: Linear Programming**

Operation research and its scope, Necessity of operations research in industry, Linear programming problems: Formulation and graphical solution, Convex sets, Convex linear combination, Convex hull, Hyper plane.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Simplex Method and Duality Theory**

Basic solution, Degenerate solution, Fundamental theorem of linear programming, Simplex method, Big-M and Two Phase methods, Dual simplex method, Duality in linear programming, Weak duality theorem, Basic duality theorem, Fundamental theorem of duality.

Unit – 3	Number of lectures = 15	Title of the unit: Transportation and Assignment Problem
Linear programming formulation of transportation problem, Initial basic feasible solution by north-west corner, least-cost and Vogel's approximation method, Test for optimality, Transportation algorithm (MODI Method), Unbalanced transportation problem, Mathematical formulation of assignment problem, Hungarian assignment method.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Game theory & Sequencing**
Two-person zero- sum games, Pure strategies, Saddle points, Minimax-Maximin principle, Mixed strategy games, Solution of mixed strategy games by graphical and linear programming methods, Problem of sequencing, Optimal sequencing algorithm, Processing n jobs through 2 machines.		

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=VNr4wGJTeSE
2. https://www.youtube.com/watch?v=a2QgdDk4Xj
3. https://www.youtube.com/watch?v=ziHfSkOhAmg
4. https://www.youtube.com/watch?v=BUGIhEecipE
5. https://www.youtube.com/watch?v=RnZnIIksdwU
6. https://www.youtube.com/watch?v=h0bdo06qNVw
7. https://www.youtube.com/watch?v=533dp83Er6E

13. Books Recommended

1. M.S. Bazaraa, J.J. Jarvis and H.D. Sherali: Linear Programming and Network Flows (4th ed.), John Wiley & Sons, 2010
2. K. Swarup, P.K. Gupta and M. Mohan: Operations Research (15th ed.), Sultan Chand & Sons, 2010.
3. H. A. Taha: Operations Research: An Introduction (10th ed), Pearson, 2017.
4. G. Hadley: Linear Programming (5th ed.), Narosa Publishing House, 2002.

1. Name of the Department: Mathematics						
2. Course Name	Operations Research Lab	**L**	**T**		**P**	
3. Course Code	17030525	0	0		4	
4.Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5.Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7.Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8.Course Description:

Operations Research is a science of modeling and optimization. It allows you to model real-world problems by using mathematics, statistics, and computers. It provides you tools and theories to solve these real-world problems by finding the optimal solutions to the model's subject to constraints of time, labor, resource, material, and business rules. In this course various softwares has been introduced which helps students to solve Linear Programming problem using Graphical as well as algebraic methods.

9.Course Objectives:

This module aims to enhance student computational capabilities in solving linear programming problems. Lengthy and tedious calculations involved in Simplex, Big-M and 2 Phase Method can be done within seconds using software like TORA. Students can also compare different methods that are used to find the initial basic feasible solution of a Transportation problem.

10.Course Outcomes (COs):

After completing this course, students will be able to:

Solve linear programming problems using softwares like TORA, Mathematica and MATLAB.

11. List of Practical's to perform in computer lab using TORA

1. To determine the solution of a linear programming problem by graphical method.
2. To analyze the behavior of the solution of a LPP by changing coefficients in the constraints for a fixed objective function.
3. To solve the LPP by simplex method and dual simplex method.
4. To solve the LPP by two phase method.
5. To solve the LPP by Big M method.
6. Determine the basic feasible solution of a transportation problem by the north-west corner method.
7. Determine the basic feasible solution of a transportation problem by least-cost method.
8. Determine the basic feasible solution of a transportation problem by Vogel's approximation method.
9. Determine the optimal solution of a transportation problem.
10. Determine the optimal solution of an assignment problem.

11. Brief Description of self-learning / E-learning component
1. https://www.youtube.com/watch?v=kavYLZatz44 2. https://www.youtube.com/watch?v=WSfro4frQY 3. https://www.youtube.com/watch?v=ufYtueq2Dw

13. Books Recommended
1. H. A. Taha: Operations Research: An Introduction (10th edition), Pearson, 2017. 2. S.K. Mishra and B. Ram: Introduction to Linear Programming with MATLAB, CRC Press, 2017. 3. I. Stanimirović: Advances in Optimization and Linear Programming, Apple Academic Press, 2022. 4. D. C. Vella: Invitation to Linear Programming and Game Theory, Cambridge University Press, 2021.

1. Name of the Department: Mathematics						
2. Course Name	Special Functions	**L**	**T**		**P**	
3. Course Code	17030526	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

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

8. Course Description:

This course is designed to describe the different types of tools/operators to solve the various difficult problems of differential equations. Emphasis is placed on differential equations with variable coefficient with and the difficult integrations and solution of differential equations. Different types of special functions are also understood and applied in real life problems.

9. Course Objectives:

Students that successfully complete this course will be able to:

1. Know about the series solution of differential equations about ordinary, and singular points.
2. Know about beta and gamma functions and their properties.
3. Understand Gauss hypergeometric and confluent hypergeometric function and its properties.
4. Know about orthogonality and special types of function and apply them to solve many problems in terms of Bessel functions.

10. Course Outcomes (COs):

After completing this course, students will be able to:

1. To investigate a series solution of differential equations with variable coefficients.
2. To understand beta and gamma functions and apply them to solve various definite integrals.
3. To discuss Gauss hypergeometric and confluent hypergeometric function and its properties and expand various functions in terms of hypergeometric function.
4. To apply the concept of series solution and discuss the solution of Legendre's equation and Bessel's equation.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 13**	**Title of the unit: Series Solutions**

Ordinary point, Singular point, Types of singular point, Differential equation with singular point, Regular and irregular singular point, Series solution of second order differential equations using Power series method and Frobenius method.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Functions Defined by Infinite Integrals**

Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Hypergeometric Functions**

Gauss hypergeometric equation, Solution of Gauss hypergeometric equation, Gauss Hypergeometric function and its properties, Integral representation, Gauss formula, Linear transformation formulas, Contiguous function relations. Differentiation formulae, Linear relation between the solutions of Gauss hypergeometric equation, confluent hypergeometric function and its properties, Integral representation Kummer's first transformation.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Legendre and Bessel Functions**
Legendre equation and its solution, Legendre functions and their properties, Recurrence relations and generating functions, Orthogonality of Legendre polynomials, Rodrigues' formula for Legendre polynomials. Bessel equation and its solution, Bessel functions and their properties, Recurrence relations and generating functions, Rodrigues' formula, Orthogonality of Bessel functions, Expansion of functions in terms of Lagendre and Bessel function.		
12. Brief Description of self-learning / E-learning component		
1. https://www.youtube.com/watch?v=9_m36W3cK74 2. https://www.youtube.com/watch?v=p0tCauMh6Q8 3. http://web.mst.edu/~lmhall/SPFNS/spfns.pdf		
13. Books Recommended		
1. Erwin Kreyszig: Advanced Engineering Mathematics (10th ed.), John Wiley & Sons, New York, 2011. 2. I.N. Sneddon: Special Functions of Mathematical Physics & Chemistry (3rd ed.), Longman Higher Education, 1980. 3. W.W. Bell: Special Functions for Scientists and Engineers, Dover Publications, 2013.		

1. Name of the Department: Mathematics						
2. Course Name	Special Function Lab	**L**	**T**		**P**	
3. Course Code	17030527	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

This course is designed to emphasize the knowledge of special functions. Emphasis is placed on gamma and beta functions, Bessel function zeros, orthogonal polynomials. Upon completion, students should be able to select and use appropriate models and techniques for finding solutions to orthogonal polynomials, series solutions of differential equations.

9. Course Objectives:

1. The interplay between Euler's integral of gamma function and properties of beta and gamma functions.
2. To investigate and derive the properties of hypergeometric functions.
3. To study the properties of special functions as well as orthogonal polynomials.
4. To know the certain specific systems of orthogonal polynomials and their properties.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To evaluate various definite integrals.
2. To investigate Bessel function zeros.
3. To determine solutions to orthogonal polynomials.
4. To determine the solution in terms of a series of differential equations.

11. List of Practical's to perform in computer lab using software MATLAB

1. Evaluate Bessel function zeros.
2. Evaluate orthogonal polynomials
3. Evaluate zeros of orthogonal polynomials.
4. Evaluate hypergeometric function.
5. Evaluate Legendre polynomials.
6. Evaluate Hermite polynomials.
7. Evaluate beta and gamma functions.
8. Evaluate Gauss's multiplication theorem
9. Evaluate series solution of differential equations.
10. Evaluate recurrence relations.

12. Brief Description of self-learning / E-learning component

1. https://in.mathworks.com/matlabcentral/fileexchange/6794-bessel-function-zeros
2. https://in.mathworks.com/matlabcentral/fileexchange/69956-orthogonalpolynomials?s_tid=srchtitle
3. https://in.mathworks.com/matlabcentral/fileexchange/46930-first-derivative-of-normal-associated-legendre-polynomials?s_tid=srchtitle

13. Books Recommended
1. Wolfgang Schweizer: Special Functions in Physics with MATLAB, Springer Cham, 2021. 2. Amos Gilat: MATLAB: An Introduction with Applications (8th ed.), John Wiley & Sons Inc, 2016.

SEMESTER-VI (DSE)

1. Name of the Department: Physics						
2. Course Name	Sensors and Detectors	**L**	**T**		**P**	
3. Course Code	17030601	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description:

The syllabus is divided into four units. First two units introduction to sensors and types of sensors cover the basics of sensors and various sensors used in technology in detail. Last two units basic processes involved in radiation detectors and Detection techniques elaborate the concept of development of various types of radiation detectors using the process involved in interaction of radiation with matter.

9. Course Objectives:

This course is designed to enhance the students' knowledge about sensors and detectors. The students will learn about the basics of sensors, their properties, various types of sensors and their applications. Also they will learn about basic processes involved in radiation detectors, their characteristics and various types of detection techniques developed to detect the charged particles and gamma radiation.

10. Course Outcomes (COs):

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

1. Explain the basic of sensors and their properties.
2. Explain the principle, construction, working and applications of various types of sensors.
3. Explain the basic processes used to detect radiation and characteristics of detectors
4. Explain the principle, construction, working and applications of various types of charged particle and gamma radiation detection systems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to Sensors**

Introduction, Human Body as a sensor system, Sensors in an Automobile, Classification of Sensors, Gas sensor, Sensor as a passive or active element, The sensor as part of a measurement system, Sensor Properties, Response time, Recovery time, Reproducibility, Stability, Sensitivity and resolution, dynamic range, selectivity, Historical development of sensors, Sensor system.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Types of sensors**

Electrochemical Sensors, Conductimetric sensors, semiconductor sensors, chemi resisters, electrochemical gas sensors, Piezoelectric sensors, types of piezoelectric sensors, FIbre Optic Sensors, Thermal sensors, resistance thermometers, Magnetic Sensors, Applications.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Basic processes involved in radiation detectors**

Basic Nuclear processes in radioactive sources, alpha decay, beta decay, gamma emission, Interaction of Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy

loss of electrons and positrons, Cerenkov radiation, interaction of Photons, interaction of neutrons. Characteristics of a detector, Sensitivity, detector response, energy resolution, fano factor and the response function, response time, detector efficiency, dead time, errors.

Unit – 4	Number of lectures = 10	Title of the unit: Detection techniques

Principle of Gas detectors, Ionization chamber, proportional counter, GM Counter, Semiconductor Detectors (Si &Ge) for charge particle and photon detection, ΔE-E detector telescopes, Short ΔE-E time of flight spectroscopy, Modem Gas Detectors: Basic principle and operation of split anode ionization chamber, Position sensitive ionization chamber, Multi-wire proportional counter, Scintillation detectors, photo-multiplier tube (PMT).

12. Books Recommended

1. Introduction to Sensors by John Vetelino and Aravind Reghu, CRC Press, 1st edition (2 August 2010), Taylor & Francis Group), ISBN-13: 978-1439808528;
2. An Introduction to Sensors and Instrumentations by Shobh Nath Singh, Alpha Science International Ltd (30 June, 2017), ISBN-13: 978-1783322626;
3. Introductory nuclear Physics by Kenneth S, Krane (Wiley India Pvt, Ltd,, 2008), ISBN-978-8126517855;
4. Techniques for Nuclear and Particle Physics Experiments by W.R. Leo, Springer; 2nd rev. ed. 1994 edition (25 February 1994), ISBN-13: 978-3540572800;
5. Radiation detection and measurement, G,F, Knoll (John Wiley & Sons, 2000). ISBN: 978-0-470-13148-0.

13. Online links

1. Pressure, Force, Motion, and Humidity Sensors by James Zweighaft and Jay Mendelson, offered by University of Colorado Boulder on Coursera https://www.coursera.org/learn/pressure-force-motion-humidity-sensors
2. Sensor Manufacturing and Process Control Sensors by James Zweighaft and Jay Mendelson, offered by University of Colorado Boulder on Coursera https://www.coursera.org/learn/sensor-manufacturing-process-control
3. Sensors and Actuators By Prof. Hardik Jeetendra Pandya, IISc Bangalore, https://onlinecourses.nptel.ac.in/noc21_ee32/preview

1. Name of the Department: Physics						
2. Course Name	Physics Modeling using Python	**L**	**T**		**P**	
3. Course Code	17030602	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**		**Practical = 0**		
8. Course Description:						
Introduction to Python Programming course is proposed. Its ease of use and simple syntax which makes it easy to adapt for students who have little or no programming experience. It aims to provide students with an understanding and importance of the computation and its application in solving problems and simulation.						
9. Course Objectives:						
1. Provide an introduction to the Python programming language. 2. Basic Numerical Analysis Using Python 3. Plot data using appropriate Python visualization libraries.						
10. Course Outcomes (COs):						
1. To have basic understanding of Python and be able to design, code, and test small programs. 2. Be fluent in the use of procedural statements assignments, conditional statements, and loops. 3. Basic Libraries, Matplotlib, Maths, Numpy, Pandas 4. Basics of Pygame, Turtle and Simpy						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to Python and Development Environment**				
Introduction: Features of Python, syntax, dynamic typing, built in object types, numerous libraries and tools, chronology and uses, installation of anaconda, installing and Using Jupyter Notebook.						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Parts of Python Programming Language**				
Simple data-types: integer, float, string, Introduce the notion of a variable, and methods of manipulation, data types and operators: accepting input from the console, assignment, statement, expressions, operators and their precedence.						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Basic Syntax and Loop**				
Identifiers, keywords, integer and string values, identifiers, user input, string formatting, expressions and arithmetic - expressions, conditional statements, Boolean expressions, if/else						

statement, other conditional expressions, iteration, Loops, introduction to using functions, functions and modules, introduction to MATPLOTLIB, the plot function, subplots, dimensional plotting		
Unit - 4	**Number of lectures = 10**	**Title of the unit: Introduction to Libraries and Basic Statistics and Probability**
Plotting library, Matplotlib, seaborn, data manipulation library Pandas, array interface library, Numpy, basic data analysis like mean, median, mode, variance etc. using Numpy library, pygame, turtle and simpy for basic simulations.		
12. Books Recommended		
1. The Python Tutorial (https://docs.python.org/3/tutorial/) 2. Code Academy Python Track (http://www.codecademy.com/tracks/python) 3. Python 101 (http://www.blog.pythonlibrary.org/2014/06/03/python-101-book-published-today/) 4. Python Practice Book: https://anandology.com/python-practice-book/index.html		
13. Online Links		
1. Python Crash Course' by Eric Matthews 2. A Byte of Python: free eBook: https://github.com/swaroopch/byte-of-python/releases/latest 3. Learn Python the Hard Way' by Zed A. Shaw 4. Discrete event simulation for Python [https://simpy.readthedocs.io/en/latest/examples/index.html] 5. Making Games with Python & Pygame Kindle Edition by A Sweigart [https://inventwithpython.com/pygame/] 6. https://realpython.com/beginners-guide-python-turtle/		

1. **Name of the Department: Physics**						
2. Course Name	**Satellite Communication & its applications**	**L**	**T**		**P**	
3. Course Code	17030603	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (√)**	
5. Pre-requisite (if any)	Basic knowledge of Antennas and Digital Communication	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials** = 0		**Practical** = 0		
8. Course Description:						
The course includes, the basics of satellite orbits, satellite link design and segments, methods of satellite access and applications of satellite communication.						
9. Course Objectives:						
1. To understand the basics of satellite orbits. 2. To understand the satellite link design & segment. 3. To analyze the various methods of satellite access. 4. To understand the applications of satellites.						
10. Course Outcomes (COs):						
At the end of the course, the students should be able to: 1. Analyze the satellite orbits. 2. Understand the earth segment and space segment. 3. Demonstrate the various methods of satellite access. 4. Design various satellite applications						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Satellite Orbits**				
Kepler's Laws, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo-stationary orbits – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.						
Unit - 2	**Number of lectures = 12**	**Title of the unit: Satellite link design & Segments**				
Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example. **Space Segments:** Power supply units, altitude control, station keeping, thermal control, TT&C, transponders, antenna subsystem (elementary ideas). **Earth Segment:** Receive – Only home TV systems (TVRO) – Outdoor UNIT – Indoor UNIT for analog (FM) TV – Master antenna TV system (MATV) – Community Antenna TV system (CATV) – Transmit – Receive earth stations (elementary ideas)						
Unit - 3	**Number of lectures = 8**	**Title of the unit: Satellite Access**				
Frequency division multiple access (FDMA) Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA),Spread spectrum transmission and reception.						
Unit – 4	**Number of lectures = 10**	**Title of the unit: Satellite Applications**				

Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), Digital audio broadcast (DAB), Business TV (BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet.

12. Brief Description of self-learning / E-learning component

1. https://www.toppr.com/guides/physics/communication-systems/satellite-communication/
2. https://sites.pitt.edu/~dtipper/2720/2720_Slides17.pdf
3. https://www.accessengineeringlibrary.com/content/book/9780071462983/chapter/chapter14
4. https://link.springer.com/referenceworkentry/10.1007/978-1-4419-7671-0_91

13. **Books Recommended**

Text Book:

1. Dennis Roddy, "Satellite Communication", Fourth Edition, McGraw Hill International, 2006.

Reference Books:

Satellite Communications, Timothy Pratt, Charles Bostian and Jeremy Allnutt, 2nd Edition, John Wiley & Sons, 2003.

2. Satellite Communication Systems Engineering, W. L. Pitchand, H. L. Suyderhoud, R. A. Nelson, 2nd Ed., Pearson Education., 2007.

Other References:

1. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/Pearson, 2007.
2. N. Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.
3. Bruce R. Elbert, "Satellite Communication Applications", Hand Book, Artech House Bostan London, 1997.
4. Emanuel Fthenakis, "Manual of Satellite Communications", McGraw Hill Book Co., 1984.
5. Robert G. Winch, "Telecommunication Transmission Systems", McGraw-Hill Book Co., 1983.
6. M. Richharia, "Satellite Communication Systems-Design Principles", Macmillan 2003.

1. Name of the Department: Chemistry						
2. Course Name	Pharmaceutical Chemistry	**L**	**T**		**P**	
3. Course Code	17030604	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 40	**Tutorials = 0**		**Practical = 0**			

8. Course Description

The findings on drug design and development in oncology, cardiovascular disease, and bacterial and viral infections have always remained at the forefront of cutting edge medical research. There is utmost demand for pharmaceutical graduates with a strong background in organic chemistry, blended with a good understanding of medicinal chemistry and pharmacology. This course will offer ample opportunities to understand the medicinal and pharmacological critical aspects useful for drug designing.

9. Course Objectives

The objectives of this course are to:

1. Introduce the aspect of drug discovery, design and development.
2. Describe the distinctive element of drug metabolism.
3. Create an understanding of the synthesis of representative drugs of classes, *e.g.*, analgesic agents, antipyretic agents, anti-inflammatory agents, antibiotics etc.
4. Explain aerobic and anaerobic fermentation and its use in the production of selected products.
5. Detailed mechanism of action of therapeutics.

10. Course Outcomes (COs)

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

1. Understand the exciting aspects of drug discovery, design and development.
2. Recognize representative classes of drugs, *e.g.*, analgesic agents, antipyretic agents, antibiotics etc.
3. Understand the mode of action, synthesis and metabolism of selected medicines and Vitamins *via* the fermentation process.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Drug Design and Drug Metabolism**

Biotransformation, Factors Affecting Drug Metabolism, Pathway of Drug Metabolism-Phase-I, Phase-II and conjugation Reaction, Significance of Drug Metabolism in Medicinal Chemistry: A general study of Physio-Chemical Properties related to biological activities. Stereochemistry and Drug Action. Isosterism and Bioisosterism, Concept of Lead Compound. Computer-Aided Drug Design and Molecular Modeling.

Unit-2	**Number of lectures = 10**	**Title of the unit: Medicinal Chemistry – I**

Synthesis of the representative drugs of the following classes:

Analgesics, antipyretic & anti-inflammatory agents: Morphine, Pethidine, Codeine, Methadone, Aspirin, Paracetamol, Anlagen, Dextropropoxphene, Pentazocine, ibuprofen.

Antibiotics: Penicillin, Ampicillin, Chloramphenicol, Cephalosporin, Chloromycetin and Streptomycin.

Antibacterial and antifungal agents: Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim

Local Anesthetics: Lignocaine, Procaine, Benzocaine

Antiviral agents: Acyclovir, Amantadine HCl, HIV-AIDS related drugs: AZT- Zidovudine

Central Nervous System agents: Phenobarbital, Diazepam.

Unit-3	**Number of lectures = 10**	**Title of the unit: Medicinal Chemistry – II**

Cardiovascular Drugs: Introduction and classification of Cardiovascular Diseases, Synthesis, Mode of Action, uses and side-effects of Amyl Nitrate, Sorbitrate, Verapamil, and Atenolol.

Drugs acting on Cardiovascular System: Cardiac glycosides, Anti-Arrhythmic agents, Anti-Anginal drugs, Anti-Hypertensive, Anti-Hyperlipidemic drugs.

Unit-4	**Number of lectures = 10**	**Title of the unit: Medicinal Chemistry – III**

Antimalarial Drugs: Chloroquine, Primaquine, Pyrimethamine, Quinine, Trimethoprim.

Antineoplastic drugs: Actinomycin, Azathioprine, Busulphan, Chloramubucil, Cisplatin, Methotrexate

Adrenergic drugs: Adrenaline, Noradrenaline, Salbutamol, Terbutaline, Ephedrine

Diagnostic Agents: Lopanoic Acid, Propyliodone, Sulfobromopthalein-sodium, Indigotindisulfonate, Indigo Carmine, Evans blue, Congo Red, Fluorescein Sodium. Aerobic and anaerobic fermentation. Production of Ethyl alcohol and citric acid, Vitamin B2, Vitamin B12 and Vitamin C.
12. Brief Description of self-learning/ E-learning component
1. https://www.fpharm.uniba.sk/uploads/media/Seminar_1_from_Pharmaceutical_chemistry_I_02.pdf 2. http://library.umac.mo/ebooks/b28050332.pdf 3. https://www.mheducation.co.uk/openup/chapters/9780335243976.pdf 4. http://www.d.umn.edu/~jfitzake/Lectures/MedSchool/Downloads/2006HistopathAntineoplasticsI.pdf
13. Books Recommended
1. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, U.K.ISBN-10: 9780199697397 2. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi. ISBN-10: 8185731772 3. William O. Foye, Thomas L., Lemke, David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi. ISBN 10: 0683033239

1. Name of the Department: Chemistry						
2. Course Name	Chemistry of Cosmetics & Perfumes	**L**	**T**		**P**	
3. Course Code	17030605	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 40	**Tutorials = 0**	**Practical = 0**				
8. Course Description						
This course provides training in chemistry with applications in perfumery and cosmetic science. You will have an integrated learning experience where you will build a strong chemistry foundation and apply your knowledge in specific applications using your senses.						
9. Course Objectives						
The objectives of this course are to: 1. Understand the science behind Perfumes and Cosmetics. 2. To understand the various safety testing methods to evaluate the quality of the products. 3. To understand the preparation methods of several Perfumes and Cosmetics.						
10. Course Outcomes (COs)						
Upon successful completion of this course, the student will be able to: 1. To discover social and scientific concepts of human beauty 2. To deliver the safety of cosmetics and perfumes. 3. To deliver the history and science of cosmetics and perfumes.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Chemistry of Cosmetics & Perfumes**				
General methods of preparation and applications of the following cosmetics: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries include Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, and Civet Moscone.						
Unit-2	**Number of lectures = 10**	**Title of the unit: Physical properties of Cosmetic compounds**				
Physical Properties of materials potentially used in cosmetics. Dielectric constant, including polarization of non-polar molecules refractive index, molar refraction, optical activity, interfacial tension, cohesion, adhesion and spreading adsorption at solid/liquid and solid /gas interfaces and their applications in cosmetics						
Unit-3	**Number of lectures = 10**	**Title of the unit: Cosmetic Necessities**				
Acids, Bases, Buffers, Topical agents. Protectives and antimicrobials, Astringents. Chemistry of emulsions in cosmetic formulation and importance of branched-chain compounds in cosmetics. Hazards in chemistry laboratories and necessary precautions						
Unit-4	**Number of lectures = 10**	**Title of the unit: Herbal Cosmetics**				
Study of the sources, characters, chemical constituents, identification test & cosmetic uses of Lipids – Castor oil, Linseed oil, Olive oil, Arachis Oil, Sesame oil, Coconut oil, chaulmoogra Oil, shark liver oil, kokum butter, lanolin.						
12. Brief Description of self-learning/ E-learning component						
1. https://nptel.ac.in/courses/103107082/module4/lecture1/lecture1.pdf 2. https://youtu.be/GcfNQXk4-g8 3. https://youtu.be/vFdyJKfFwwg 4. https://youtu.be/GShqaPLndho 5. http://nopr.niscair.res.in/bitstream/123456789/27249/1/IJPAP%2052%283%29%20183-191.pdf						
13. Books Recommended						

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. U.K. (1990). ISBN-10: 0134573188; ISBN-13: 978-0134573182
2. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi. ISBN-10: 9352160002
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).ISBN-10 : 8182838290.

1. Name of the Department: Chemistry						
2. Course Name	Pesticide Chemistry	**L**	**T**		**P**	
3. Course Code	17030606	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

This course provides training on pesticide and their applications. It will leverage students with scientific insight in synthesizing pesticides, their chemical properties, and usage to help users apply their knowledge in specific applications using their senses.

9. Course Objectives

The objectives of this course are to:

1. Understand the science behind pesticides.
2. Understand the classification and chemical nature of pesticides.
3. Understand the synthetic methods of various pesticides.

10. Course Outcomes (COs)

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

1. Delineate the usage of pesticides.
2. Provide the importance of pesticides.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Pesticide classification and Chemical nature**

Pesticides (natural and synthetic), benefits, Pesticides classification on use, chemical nature, formulation, toxicity and action. Processes for manufacturing insecticides, fungicides and herbicides.

Unit-2	**Number of lectures = 10**	**Title of the unit: Synthesis and Technical manufacture of pesticides**

The Changing concepts of pesticides, structure-activity relationship. Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Lindane, Aldrin, Dieldrin, Gammexene); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Unit-3	**Number of lectures = 10**	**Title of the unit: Pesticides Pollution**

Pesticides and pollution of the soil, water, Pesticide handling practices to protect groundwater, Pesticide Management, Soil & Water Pollution from Fertilizers, Eutrophication, diseases due to overuse of fertilizers (like blue baby syndrome)

Unit-4	**Number of lectures = 10**	**Title of the unit: Biopesticides**

Biopesticides, Weedicides (Anilophos, Butachlor, Diuron, 2,4-D, Fluchlorallin, Glyphosate, Isoproturon, Paraquat dichloride), Plant Growth Regulator (Alpha naphthalene acetic acid, Chloromequat chloride), Fumigants (Aluminiumphasphide, Ethylene bromide, Methyl bromide), New Generation Insecticides, Insect Growth Regulators (IGRS)

12. Brief Description of self-learning/ E-learning component

1. https://nptel.ac.in/courses/104103020/26
2. https://nptel.ac.in/courses/103107082/module9/lecture1/lecture1.pdf
3. http;//en.wikkipedia.org/wiki/Biopesticide
4. https://nptel.ac.in/courses/103107081/39

13. Books Recommended

1. Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.ISBN 10: 0471996319
2. Ohkawa. H, Miyagawa. H and Lee. P. W. Pesticide Chemistry, Wiley-VCH Verlag Gmbh & Co.2007. ISBN: 9783527316632

1. Name of the Department: Mathematics							
2. Course Name	Cryptography	**L**	**T**		**P**		
3. Course Code	17030607	3	0		0		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

The art of protecting information by transforming it (encrypting it) into an unreadable format is called ciphertext. Only those who possess a secret key can decipher (or decrypt) the message into plain text. Cryptographic systems, digital signatures etc are used to protect e-mail, messages, credit card information, and corporate data.

9. Course Objectives:

The objectives of this course are to:

1. To develop skills and knowledge of standard concepts in cryptography
2. To demonstrate the role of cryptography in the present digital world.
3. To understand how to deploy encryption techniques to secure data in transit across data networks.
4. To design security applications in the field of information technology.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To develop a framework to understand and implement cryptographic concepts.
2. To acquire knowledge of standard algorithms that can be used to provide confidentiality, integrity and authentication of data.
3. To encrypt and decrypt messages using block ciphers including data and advanced encryption standard (DES & AES), public key cryptosystems (RSA, ElGamal).
4. To enhance the ability to analyze a problem, and identify and define the computing requirements for data security

11. Unit wise detailed content

Unit – 1	**Number of lectures = 8**	**Title of Unit-I: Overview of Cryptography**

Cryptology, Computer security concepts, Security attacks, Cryptanalysis and brute-force attack, Classical Ciphers: Substitution ciphers- Caesar cipher, Mono-alphabetic ciphers, Playfair cipher, Hill cipher, Poly-alphabetic ciphers-Vigenere Cipher, One-time pad.

Unit - 2	**Number of lectures = 12**	**Title of Unit-II: Symmetric Key Cryptography**

Pseudo-random bit generation, Random number generator, Substitution ciphers, Permutation cipher and their composition, Stream cipher and block cipher, Mode of operations, Product cipher and Feistal cipher, Data Encryption Standard (DES), DES example, Triple DES, Advanced Encryption Standard (AES), AES transformation functions, AES key expansion, AES example. Hash Functions, Message Authentication Code (MAC).

Unit - 3	**Number of lectures = 10**	**Title of Unit-III: Number theory in Cryptography**

Basics of Number theory: Divisibility, Modular arithmetic and set of residue (Z_n), Fermat's and Euler's theorems, GCD, Euclidean algorithm, Extended Euclidean algorithm, Prime numbers, Euler's totient function, Primality testing, Galois fields ($GF(p)$ *and* $GF(2^n)$), Primitive root, Discrete logarithms, Polynomial arithmetic: Addition, multiplication and division over Galois field.

Unit - 4	Number of lectures = 10	Title of Unit-IV: Public Key Cryptography
Public key cryptosystems, Hybrid cryptosystem, Diffie-Hellman key exchange, Man-in-the-middle attack, The RSA algorithm and security of RSA, Elgamal cryptosystem, Digital signatures, Elliptic curve cryptography, Lattice based cryptography.		

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=iTVyKbDCJrA&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2&index=1
2. https://www.youtube.com/watch?v=Q-HugPvA7GQ&list=PL71FE85723FD414D7
3. https://www.youtube.com/watch?v=1plMO7ChXMU&list=PLJ5C_6qdAvBFAuGoLC2wFGruY_E2gYtev

13. Books Recommended

1. J. Hoffstein, J. Pipher and J. H. Silverman: An Introduction to Mathematical Cryptography (2nd ed.), Springer, 2014.
2. N. Koblitz: A Course in Number Theory and Cryptography, Springer, 2012.
3. A. J. Menezes, P. C. van Oorschot, S. A. Vanstone: Handbook of Applied Cryptography, CRC Press, 1996.
4. J. A. Buchmann: Introduction to Cryptography (2nd ed.), Springer, 2013.
5. D. R. Stinson and M. B. Paterson: Cryptography - Theory and Practice (4th edition), Chapman Hall / CRC 2019.

1. Name of the Department: Mathematics						
2. Course Name	Integral Equations	**L**	**T**		**P**	
3. Course Code	17030608	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course covers Fredholm and Volterra integral equations and their solutions using various methods such as Neumann series, resolvent kernels, Euler's equation, variational derivative and invariance of Euler's equations.

9. Course Objectives:

The objectives of this course are to:

1. Give an account of the foundations of integral equations and calculus of variations and their applications in mathematics;
2. Solve simple initial and boundary value problems by using several variable calculus.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To understand different kinds of Fredholm and Voltera integral equations.
2. To know the concept of orthonormal systems of functions in Integral equations
3. To apply the methods of calculus of variations in physics and engineering.
4. To understand the basic concept of canonical transformations.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 12**	**Title of the unit: Definitions, Classifications and Eigenfunctions of Integral Equations**

Definitions of integral equations and their classification, Relation between integral and differential equations, Fredholm integral equations of second kind with separable kernels, Reduction to a system of algebraic equations. Eigenvalues and eigenfunctions, Iterated kernels, Iterative scheme for solving Fredholm integral equation of second kind (Neumann series), Resolvent kernel, Application of iterative scheme to Volterra's integral equation of second kind.

Unit – 2	**Number of lectures = 8**	**Title of the unit: Hilbert Schmidt Theory**

Hilbert Schmidt theory, Symmetric kernels, Orthonormal systems of functions. Fundamental properties of Eigenvalues and eigenfunctions for symmetric kernels. Solution of integral equations by using Hilbert Schmidt theory.

Unit – 3	**Number of lectures = 8**	**Title of the unit: Calculus of Variations**

Introduction to calculus of variations, Review of basic multi-variable calculus, Constrained maxima and minima, Lagrange multipliers. The Euler-Lagrange equation. Variational problem with moving boundaries: Transversality conditions, one sided variations.

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Unit – 4	Number of lectures = 12	Title of the unit: Extremum and Canonical Transformations
General definitions, Jacobi condition, Weierstrass function, Legendre condition, Principle of least action, Lagrange's equation from Hamilton's principle. Canonical transformation, Direct methods in variational problems, Ritz method, Galerkin's method, Collection method and least square method.		

12. Brief Description of self-learning / E-learning component

1. http://nptel.ac.in/courses/111104025/NPTEL-CoV-IE-Solutions.pdf
2. http://nptel.ac.in/courses/111104025/NPTEL-CoV-IE-Problems.pdf
3. http://www.nptelvideos.in/2012/12/calculus-of-variations-and-integral.html

13. Books Recommended

1. A. S. Gupta: Calculus of Variations with Applications, PHI Learning, 2015.
2. A M Wazwaz, A First Course in Integral Equations (2nd ed.), World Scientific, 2015.
3. R. P. Kanwal: Linear Integral Equation: Theory and Technique (2nd ed.), Birkhäuser, 1997.
4. M.D. Raisinghania: Integral Equations and Boundary Value Problems, S Chand & Co Ltd, 2016.

C.S. Lalitha

1. Name of the Department: Mathematics						
2. Course Name	Fluid Dynamics	**L**	**T**		**P**	
3. Course Code	17030609	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	SEC (✔)	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 40	**Tutorials = 0**	**Practicals = 0**

8. Course Description:

This course is aimed to provide an introduction to the theories for fluid dynamics. Topic covers: Kinematics (Equation of continuity), Equation of motion, General theory of irrotational motion, Motion of sphere (Motion in three dimensions), Sources, sinks and doublets (Motion in two-dimension), Motion of cylinders.

9. Course Objectives:

The objective of this course is to expose students to understand the importance of fluid dynamics in science and engineering.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To classify and exploit fluids based on the physical properties of a fluid.
2. To compute correctly the kinematical properties of a fluid element.
3. To apply correctly the conservation principles of mass, linear momentum and energy to fluid flow systems with emphasis on aerodynamics.
4. To apply the general theory of irrotational motion and motion of sphere and cylinders.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Title of the unit: Kinematics (Equation of continuity)**

Kinematics, Eulerian and Lagrangian methods, Stream lines, path lines and streak lines, Velocity potential , Irrotational and rotational motions, Vortex lines, Equation of continuity, Boundary surfaces.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Equations of Motion**

Acceleration at a point of a fluid , Components of acceleration in cylindrical and spherical polar coordinates, Pressure at a point of a moving fluid, Euler's and Lagrange's equations of motion, Bernoulli's equation, Impulsive motion.

Unit – 3	**Number of lectures = 10**	**Title of the unit: General Theory of Irrotational Motion**

Acyclic and cyclic irrotational motions, Kinetic energy of irrotational flow, Kelvin's minimum energy theorem, Axially symmetric flows, Liquid streaming past a fixed sphere, Motion of a sphere through a liquid at rest at infinity, Equation of motion of a sphere.

Unit – 4	Number of lectures = 10	Title of the unit: Two-Dimensional and Three-Dimensional Fluid Flow

Irrotational motion in two-dimension, Complex velocity potential, Milne-Thomson circle theorem, Two dimensional sources, sinks, doublets and their images, Blasius theorem, Two dimensional irrotational motion produced by motion of circular and coaxial cylinders in an infinite mass of liquid. Three dimensional sources, sinks, doublets and their images, Stokes stream function, Property of Stoke's function.

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=lZ7NG16XFGA
2. https://www.youtube.com/watch?v=8wM7_vgBSQA
3. https://www.youtube.com/watch?v=QeKWOStChiE

13. Books Recommended

1. F. Chorlton: Text Book of Fluid Dynamics, CBS Publishers, Delhi, 1985.
2. W.H. Besaint and A.S. Ramsey: A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
3. R.K. Rathy: An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
4. G.K. Batchelor: An Introduction to Fluid Mechanics, Cambridge University Press, 2000.

1. Name of the Department: Physics						
2. Course Name	Quantum Mechanics	**L**	**T**		**P**	
3. Course Code	17030610	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		
8. Course Description:						
The course will include the Planck quantum concepts of particle and wave natures, atomic models, uncertainty principle, operators, Schrodinger wave equation, and its applications.						
9. Course Objectives:						
The aim of this course is to understand the quantum mechanical view of particle and wave nature, uncertainty in measurements, certainty and probability in measurements, time-dependent and time-independent Schrodinger wave equations and its solution for the hydrogen atom and many-electron atoms.						
10. Course Outcomes (COs):						
After completing this course, students will be able to explain the quantum mechanical view of particle and wave nature, uncertainty in measurements, certainty, and probability in measurements, time-dependent and time-independent Schrodinger wave equations, and its solution for the hydrogen atom and many-electron atoms						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 13**	**Title of the unit: Wave Particle Duality**				
Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two Slit experiments with electrons. Probability. Wave amplitude and wave functions. Applications of uncertainty principle.						
Unit – 2	**Number of lectures = 13**	**Title of the unit: Time-independent and Time-dependent Schrodinger equation**				
Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function, Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions, Normalization, Linearity and Superposition Principles, Eigenvalues and Eigenfunctions, Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum, Wave Function of a Free Particle, Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states.						
Unit – 3	**Number of lectures = 13**	**Title of the Unit: General Discussion df Bound States In An Arbitrary Potential**				

Continuity of wavefunction, boundary condition, and the emergence of discrete energy levels; application to the one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions,

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

Unit – 4	**Number of lectures = 13**	**Title of the unit: Atoms in Electric and Magnetic Fields**

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

Atoms in External Magnetic Fields: - Normal and Anomalous Zeeman Effect.

12. Books Recommended

1. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn,, 2002, Wiley,
3. Quantum Mechanics, Leonard I, Schiff, 3rd Edn, 2010, Tata McGraw Hill,
4. Quantum Mechanics, G, Aruldhas, 2nd Edn, 2002, PHI Learning of India,
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning,

13. Online Links

1. https://www.youtube.com/watch?v=1az10iSmCzA
2. https://www.youtube.com/watch?v=2ejyr-E7q2M
3. https://nptel.ac.in/courses/115101003/downloads/module2/lecture7.pdf

1. Name of the Department: Physics						
2. Course Name	Quantum Mechanics Lab	**L**	**T**		**P**	
3. Course Code	17030611	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE(√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem()	Ever Sem()

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

8. Course Description:

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

9. Course Objectives:

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

10. Course Outcomes (COs):

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

11. List of Experiments

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

12. Books Recommended:

1. Scilab Image Processing: Lambert M. Surhone. 2010Betascript Publishing ISBN: 978-6133459274A
2. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
3. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

4. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
6. A Text Book of Practical Physics, InduPrakash and Ramakrishna, 11th Edition, 2011, KitabMahal, New Delhi.
7. https://vlab.amrita.edu/index.php?sub=1&brch=195&sim=359&cnt=1
8. https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=548&cnt=4

1. Name of the Department: Physics						
2. Course Name	Nuclear and particle physics	**L**	**T**		**P**	
3. Course Code	17030612	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

The syllabus is divided into four units i.e. general properties of nuclei and nuclear models, radioactive decay and nuclear reactions, elementary particles and particle accelerator.

9. Course Objectives:

In this course students will learn about the nuclear structure and its constituent's properties, the phenomenon involve in radioactive decay processes, Nuclear reactions and basics of high energy physics.

10. Course Outcomes (COs):

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

1. Explain the general properties of nuclei and nucleons.
2. Explain the basic physics of radioactivity.
3. Explain the various nuclear models, Physics of nuclear reactions and Particle accelerators.
4. Describe the basic features involved in Particle Physics.

11. Unit wise detailed content

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

Discovery of the nucleus, composition, theories of nuclear composition, Proton-electron theory, failure of Proton-electron theory, Proton-neutron theory basic properties; charge, mass, size, spin, magnetic moment, electric Quadrupole moment, binding energy, binding energy per nucleon and its observed variation with mass number of the nucleus, coulomb energy, volume energy, surface energy, other corrections, explanation of the binding energy curve, liquid drop model of the nucleus.

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

The radioactive decay law, decay constant and half-life; methods of measurement of half-life, spectra of emitters. Alpha decay: Basic decay process, Geiger-Nuttal law, Gamow's explanation, angular momentum and parity in a decay, energy release in alpha decay. Beta decay: Fermi's theory, angular momentum and parity selection rules, neutrino and antineutrino, non-conservation of parity in beta decay and its experimental verification. Gamma decay: Energetics of a decay, elementary theory of multiple transitions, angular momentum and parity selection rules, internal conversion, nuclear absorption and fluorescence, Mössbauer effect, energy levels.

Unit-3	**Number of lectures = 13**	**Title of the unit: Nuclear Models and Nuclear reactions**

Nuclear Models: Liquid drop model approach, Bethe-Weizsacker formula, applications to semi empirical mass formula, Fermi gas model of nucleus, evidence for nuclear shell structure, nuclear

magic numbers, Nuclear shell model, collective model.
Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, Direct reactions. Nuclear fusion and fission. Fission and Fusion reactors (Fundamentals) Need for accelerators: Van de Graff, cyclic accelerators, cyclotron, synchrocyclotron, variable energy cyclotron.

Unit-4	Number of lectures = 13	Title of the unit: Cosmic Rays and Elementary Particles

Discovery of cosmic rays: hard and soft components, discovery of muon, pion, heavy mesons and hyperons, mass and life time determination for muon and pion. Primary Cosmic Rays: Extensive air showers, solar modulation of primary cosmic rays, effect of earth's magnetic field on the cosmic ray trajectories. Classification of elementary Particles, Fundamental interaction, conservation laws, invariance under charge, parity, CP, time and CPT, particles and antiparticles, mesons, Hyperons, resonance states, elementary particle symmetries, Strangeness, conservation of strangeness in particle interactions, quark hypothesis.

12. Books Recommended

1. Introductory nuclear Physics by Kenneth S, Krane (Wiley India Pvt, Ltd,, 2008), ISBN-978-8126517855
2. Concepts of nuclear physics by Bernard L, Cohen, (Tata Mcgraw Hill, 1998), ISBN-9780070992498
3. Introduction to the physics of nuclei & particles, R,A, Dunlap, (Thomson Asia, 2004). ISBN- 978-0534392949
4. Introduction to Elementary Particles, D, Griffith, John Wiley & Sons. ISBN- 978-0-471-60386-3
5. Quarks and Leptons, F, Halzen and A,D, Martin, Wiley India, New Delhi. ISBN- 978-8126516568
6. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K, Heyde (IOP-Institute of Physics Publishing, 2004), ISBN-978-0750309806.
7. Radiation detection and measurement, G,F, Knoll (John Wiley & Sons, 2000). ISBN: 978-0-470-13148-0
8. Theoretical Nuclear Physics, J,M, Blatt &V,F,Weisskopf (Dover Pub,Inc,, 1991).ISBN- 78-1-4612-9961-5

13. Online links

1.https://nptel.ac.in/courses/115102017/2

2. https://www.youtube.com/watch?v=iMhDYarsfII&rel=1&color1=0xcbba9f&color2=0xcbba9f&border=0&fs=1

3. https://home.cern/science/accelerators

4. http://oregonstate.edu/instruct/ch374/ch418518/Chapter%2017%20Interaction%20of%20Radiation%20with%20Matter-rev.pdf

1. Name of the Department: Physics						
2. Course Name	**Nuclear and Particle Physics Laboratory**	**L**	**T**		**P**	
3. Course Code	17030613	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures		**Tutorials**		**Practical = 52**		
8. Course Description:						
In this course student will hand on the experiments using weak radioactive sources, G.M. counters, Scintillation Counters, MCA, SCA, DAC and CRO.						
9. Course Objectives:						
The course aims to provide students with a practical knowledge of the radiation measurement, basic electronics behind nuclear techniques and radiation detectors.						
10. Course Outcomes (COs):						
After performing these experiments, students will be able to 1. Demonstrate experiments involving Nuclear phenomenon. 2. Develop their hand on sophisticated experimental set ups in lab. 3. Understand the basic methods followed in research. 4. Work with radiation detection systems.						
11. List of Experiments						
1. To determine the plank's constant using stopping potential measurements. 2. To determine e/m ratio by Thomson method. 3. To study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage. 4. Measurement of dead time. 5. To investigate the statistics related to measurements with a Geiger counter. 6. To find the absorption coefficient of given material using G.M. counter and deduce end-point energy of a beta emitter. 7. To study the absorption of Beta particles in different materials. 8. Source strength of a Beta Source. 9. Measurement of Short Half-life. 10. To determine the absorption of gamma rays using absorption coefficients using simulation.						
12. Books Recommended:						
1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994. ISBN-978-3540572800 2. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010. ISBN: 978-0-470-13148-0 3. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001. ISBN-978-0511622588						

1. Name of the Department: Physics						
2. Course Name	Astrophysics	**L**	**T**		**P**	
3. Course Code	17030614	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	Classical Mechanics, Thermodynamics and Statistical Mechanics, Quantum Mechanics, Basic understanding of Optics.	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

Students completing this course will gain an understanding of:

Theoretical basis for our modern cosmological view of the universe, including the beginning at Big Bang and the development up to early galaxy formation, Astronomical objects, Astronomical coordinate system, Component of solar system and its evolution, Components of Solar System and its evolution, The large-scale structure of the Universe and its history, hands on experiment with the latest observational results within cosmological research, and an insight into the current issues.

9. Course Objectives:

This course is designed to provide students with the basic knowledge about astrophysical phenomena and cosmology.

10. Course Outcomes (COs):

1. Theoretical background to modern cosmology and the most common misconceptions about the Big Bang model.
2. Calculations concerning cosmological distances, cosmic dynamics, the energy content of the universe, cosmic background radiation.
3. Learn and present the content of research papers relevant for some subfield of cosmology.
4. Analyze observational data relevant for modern cosmology and formulate conclusions based on these.
5. propose strategies for observations and theoretical models that may lead to new insight about unsolved problems in cosmology, possible to work at CCSP, SGT University.

11. Unit wise detailed content

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

History of astronomy, Overview of the Night Sky, Astronomical Objects and their physical structures, Light and its properties, Distances, Magnitudes, Telescopes: Optical, Radio and X-Ray Telescopes, Basic concepts of Positional Astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Horizon System, Equatorial System, Conversion of Coordinates, Rising and Setting Times, Measurement of Time, Side real Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Time Systems (LMT, UT, UTC). Diurnal and Yearly motions of the Sun, Stars and Constellations.

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

Star, Star formation, Spectra and Classification, Stellar Structure Equations and Survey of Stellar Evolution, Stellar Oscillations, Degenerate and Collapsed Stars, Radio Pulsars, Interacting Binary Systems, Blackholes, Accretion Disks, X-ray Sources, Interstellar Medium: HII Regions, Supernova Remnants, Molecular Clouds, Dust, Radiative Transfer, Jeans' Mass.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Sun and the Milky Way**
Galactic Stellar Distributions and Populations: Oort Constants, Oort Limit, Globular Clusters. Solar Parameters, Sun's Internal Structure, Solar Photosphere, Corona, Solar Activity, Solar Magneto-Hydrodynamics, Basic Structure and Properties of the Milky Way.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Cosmology**
Cosmic Distance Ladder, Olbers Paradox, Cosmological principle. The expansion of the universe and Hubble's Law,Newtonian Cosmology, Freidman evolution equations. Hot big-bang model, Radiation and matter dominated universe, Age of Universe, origin of Cosmic Microwave Background, Dark matter, Dark Energy.		

12. Books Recommended

1. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer

2. Astrophysics Stars and Galaxies K D Abhyankar, Universities Press

3. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.

4. BaidyanathBasu, An introduction to Astrophysics, Second printing, Prentice - Hall of India Private limited, New Delhi, 2001.

5. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College

6. Hansen, Carl J., Steven D. Kawaler, and Virginia Trimble. *Stellar Interiors: Physical Principles, Structure and Evolution*. New York, NY: Springer, 2004.

7. Carroll, Bradley W., and Dale A. Ostlie. *An Introduction to Modern Astrophysics*. Reading, MA: Addison-Wesley Pub., 1995.

8. Kippenhahn, Rudolf, and Alfred Weigert. *Stellar Structure and Evolution*. New York, NY: Springer-Verlag, 1990.

9. Shapiro, Stuart L., and Saul A. Teukolsky. *Black Holes, White Dwarfs, and Neutron Stars*. New York, NY: Wiley

13. Online Links:

https://egyankosh.ac.in/bitstream/123456789/19450/1/Unit-1.pdf

https://ocw.mit.edu/courses/8-901-astrophysics-i-spring-2006/pages/syllabus/

https://www.britannica.com/science/astronomy/The-techniques-of-astronomy

1. Name of the Department: Physics						
2. Course Name	Astrophysics Lab	**L**	**T**		**P**	
3. Course Code	17030615	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

This course is designed to provide students with the basic knowledge about astrophysical phenomena and cosmology

9. Course Objectives:

This course is designed to provide students with the basic knowledge about astrophysical phenomena and cosmology

10. Course Outcomes (COs):

1. Sun is the constant source of energy to our planet Earth. This energy comes to us in the form of sun light. This experiment will help us to measure the quantity of solar energy that comes to Earth.
2. The students will determine a value for Hubble's constant, based on the observations of the images and spectra of 10 spiral galaxies.
3. the age of the Universe
4. Students will calculate and plot the galaxy rotation curve from observational data from any spiral galaxy data from the data catalogue of experiment 2 and will compare it with the curve predicted by the gravitational theory applied only to the visible matter of the galaxy.
5. The students will use star data catalogue to construct H-R diagram.

11. List of Experiments

1.Calculation of Solar constant
2. Hubble's Law
3. Age of the Universe
4. Galaxy Rotation Curve
5. The Hertzsprung-Russell diagram(H-R diagram)
6.Comeelin between Galaxies and their central black hole
7. Ring of stars
8. Blackbody radiation
9. RGB analysis

12. Books Recommended:

1. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
2. Astrophysics Stars and Galaxies K D Abhyankar, Universities Press
3. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.

4. BaidyanathBasu, An introduction to Astrophysics, Second printing, Prentice - Hall of India Private limited, New Delhi, 2001.

5. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College

6. Hansen, Carl J., Steven D. Kawaler, and Virginia Trimble. *Stellar Interiors: Physical Principles, Structure and Evolution*. New York, NY: Springer, 2004.

7. Carroll, Bradley W., and Dale A. Ostlie. *An Introduction to Modern Astrophysics*. Reading, MA: Addison-Wesley Pub., 1995.

8. Kippenhahn, Rudolf, and Alfred Weigert. *Stellar Structure and Evolution*. New York, NY: Springer-Verlag, 1990.

9. Shapiro, Stuart L., and Saul A. Teukolsky. *Black Holes, White Dwarfs, and Neutron Stars*. New York, NY: Wiley

13. Online Links

https://egyankosh.ac.in/bitstream/123456789/19450/1/Unit-1.pdf

https://ocw.mit.edu/courses/8-901-astrophysics-i-spring-2006/pages/syllabus/

https://www.britannica.com/science/astronomy/The-techniques-of-astronomy

1. Name of the Department: Chemistry						
2. Course Name	Polymer Chemistry	**L**	**T**		**P**	
3. Course Code	17030616	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

The course introduces polymer chemistry, its classification, Functionality and its importance. Kinetics and mechanism of Polymerization, Crystallization and crystallinity, Nature and structure of polymers, Molecular weight distribution in polymers, Glass transition temperature and determination of Tg, Polymer Solution and properties of the polymers.

9. Course Objectives

The objectives of this course are to:

1. To study the fundamental concepts of polymer chemistry.
2. To study the structure of monomers, functionality, classification and nomenclature of polymers.
3. To evaluate the effect of factors such as polymer structure, molecular weight, branching and diluents on crystallinity.
4. To study the various methods of polymerization reactions, their mechanism, kinetics, structure properties and applications.

10. Course Outcomes (COs)

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

1. Understand the basic concept of polymer chemistry and different methods of polymerizations and their kinetics.
2. Develop skills for synthesizing polymeric products and understand their physical and thermodynamics properties.
3. Demonstrate an ability to acquire knowledge in new polymer-related applications quickly.
4. Develop specific skills, competencies, and thought processes sufficient to support further study or work in the field of Polymer Chemistry.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction and Functionality of polymeric materials**

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

Unit-2	**Number of lectures = 14**	**Title of the unit: Kinetics of Polymerization and Crystallinity**

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, mechanism and kinetics of copolymerization, polymerization techniques. Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Unit-3	**Number of lectures = 14**	**Title of the unit: Molecular weight, Glass transition temperature (Tg) and determination of Tg, Polymer Solution**

Determination of molecular weight of polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance.
Polydispersity index. Glass transition temperature (Tg) and determination of Tg: Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Unit-4	Number of lectures = 14	Title of the unit: Properties of Polymers
Properties of Polymers (Physical, thermal, flow & mechanical properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinylchloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates. Introduction to Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylenesulphide polypyrrole, polythiophene)].		

12. Brief Description of self-learning/ E-learning component

1. http://www.malcolmmackley.com/polymers/lecture-notes/
   https://egyankosh.ac.in/bitstream/123456789/29632/1/Unit-7.pdf
2. https://nptel.ac.in/courses/104105039
3. Web.mit.edu/5.33/www/lec/poly.pdf
4. https://ocw.mit.edu/courses/3-064-polymer-engineering-fall-2003/pages/lecture-notes/

13. Books Recommended

1. Carraher, C.E. Jr Carraher's Polymer Chemistry, 4th Ed. CRC Press, 2017. ISBN: 9781498737494
2. Odian, G. Principles of Polymerization, 4th Ed. Wiley, 2004. ISBN: 9780471274001
3. Billmeyer, F.W. Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1994. ISBN:978-0471031963
4. Ghosh, P. Polymer Science and Technology: Plastics, Rubbers, Blends and Composites, Tata McGraw-Hill Education, 2001. ISBN: 0074639943
5. Fried J.R, Polymer Science & Technology, Prentice Hall (2005), ISBN: 013685561X
6. Feldman D., Barbalata. A, Synthetic Polymers: Technology, Properties, Applications. Springer Science & Business Media, 1996. ISBN: 0412710404

1. Name of the Department: Chemistry						
2. Course Name	Polymer Chemistry Lab	**L**		**T**		**P**
3. Course Code	17030617	0		0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

1. To gain the basic knowledge of polymer synthesis
2. To develop synthetic skills of purification and characterization of polymers.
3. To study the, methods of measuring the molecular weight, polymerization kinetics and co-polymerization and polymer processing technologies.

10. Course Outcomes (COs)

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

1. Master the basic experimental skills for the synthesis of polymers via various polymerization techniques
2. Develop specific skills about the mechanical properties and applications of polymers.
3. Develop the ability to design a hypothesis driven research project and design and execute experiments to evaluate the stated hypothesis.

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

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

12. Brief Description of self-learning/ E – learning component

1. http://www.egyankosh.ac.in/bitstream/123456789/15899/1/Experiment-13.pdf
2. https://ocw.mit.edu/courses/chemical-engineering/10-569-synthesis-of-polymers-fall-2006/lecture-notes/lec16_10182006.pdf

13. Books Recommended

1. M.P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, 1998, ISBN: 9780195124446
2. H.R. Allcock, F.W. Lampe & J.E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003), ISBN: 0130650560
3. Fried J.R, Polymer Science & Technology, Prentice Hall (2005), ISBN: 013685561X
4. P. Munk & T.M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002), ISBN: 9780471417163
5. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005), ISBN: 9780471757115
6. M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford University Press (1999). ISBN: 9780195124446
7. Carraher, C.E. Jr Carraher's Polymer Chemistry, 4th Ed. CRC Press, (2017). ISBN: 9781498737494

1. Name of the Department: Chemistry						
2. Course Name	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy		**L**	**T**	**P**	
3. Course Code	17030618		4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

To introduce students the chemistry of 3d metals. They will learn about Organometallic Compounds, Bio-Inorganic Chemistry, which are frontier areas of Chemistry. The learners are introduced to Polynuclear and heteronuclear aromatic compounds, Active methylene compounds. The students will learn about Spectroscopy, which is an important analytical tool for identification of organic compounds.

9. Course Objectives

The objectives of this course are to:

1. Introduce the knowledge of organic and inorganic chemistry
2. To know the basic chemistry of different oxidation state of 3d metals
3. To learn about basic concepts on structure elucidation of various polynuclear, heteronuclear aromatic compounds.
4. To gain basic knowledge about spectroscopic techniques and their usage in structure elucidation of known compounds.

10. Course Outcomes (COs)

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

1. Applications of organometallics, bio inorganic chemistry in frontier areas of Chemistry
2. Understand the basic concepts on structure elucidation of various polynuclear, heteronuclear aromatic compounds and their important reactions.
3. Use basic principles of UV-visible and IR spectroscopy for qualitative organic analysis of known compounds.
4. Understand and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.

11. Unit wise detailed content

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

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. pi-acceptor behaviour of carbon monoxide. Synergic effects -VB approach.

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

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Ca^{2+} in blood clotting, Metalloenzymes:chlorophyll and oxygen carriers in blood, metal toxicity and detoxification.

Unit-3	**Number of lectures = 12**	**Title of the unit: Polynuclear, Heteronuclear Aromatic Compounds, and Active Methylene Compounds**

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

Preparation: Claisen ester condensation. Keto-enol tautomerism.

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

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

Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λmax of conjugated dienes and α,β – unsaturated compounds.
Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).
Application of visible, ultraviolet and Infrared spectroscopy in organic molecules.

12. Brief Description of self-learning/ E – learning component

1. https://nptel.ac.in/courses/104101006
2. web.uvic.ca/~mcindoe/423/423syllabus.html
3. https://nptel.ac.in/courses/104108062
4. https://www.youtube.com/watch?v=uMaKBybnfrk
5. https://nptel.ac.in/courses/102103044/3

13. Books Recommended

1. Lee J.D. A New Concise Inorganic Chemistry, Oxford University Press; 5th Ed.. (2008) ISBN:978-8126515547.
2. Cotton F.A. & Wilkinson G. Basic Inorganic Chemistry, John Wiley & Sons; (1995), ISBN: 978-0471505327.
3. Finar I.L. Organic Chemistry, Volume 1, 6th Ed. Pearson (2012) ISBN: 9788177585421
4. Silverstein R.M., Bassler G.C. & Morrill T.C. Spectrometric identification of organic compounds, 6th Ed. , John Wiley & Sons. (2006), ISBN: 9788126509720.
5. Morrison R.T., Boyd, R.N. Organic Chemistry, 6th Ed. Prentice Hall. (1992) ISBN: 9780136436690.

1. Name of the Department: Chemistry						
2. Course Name	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy Lab		**L**	**T**	**P**	
3. Course Code	17030619		0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

1. To identify the unknown organic compounds.
2. To develop qualitative technique skills in students including preparation of the metal complexes, chromatographic separation.
3. Prepare and purify complexes and compare their conductances with those of standard solutions

10. Course Outcomes (COs)

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

1. Understand theoretical principle of chromatography and separate and identify cations of analytical group I and II with the help of paper chromatography
2. Describe the steps involved in the identification organic compounds by classical qualitative organic analysis
3. Describe the functional group tests and methods of the preparation of derivatives

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

1. Separation of mixtures by chromatography: Measure the *Rf* value in each case. (Combination of two ions to be given)
   a. Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or
   b. Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:
   a. tetraamminecarbonatocobalt (III) nitrate
   b. tetraamminecopper (II) sulphate
   c. potassium trioxalatoferrate (III) trihydrate
3. Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.
4. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

12. Brief Description of self-learning/ E – learning component

1. http://nopr.niscair.res.in/bitstream/123456789/7002/1/IJCT%2013%281%29%2084-87.pdf
2. http://egyankosh.ac.in//handle/123456789/85366
3. http://www.egyankosh.ac.in/bitstream/123456789/15885/1/Experiment-4.pdf

13. Books Recommended

1. A.I. Vogel; Qualitative Inorganic Analysis, Prentice Hall, 7th Ed. (1996) ISBN:9780582218666
2. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th Ed. (1996) ISBN: 978-0582462366
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Pearson; 4th Ed. (2009). ISBN:978-8131727102

1. Name of the Department: Chemistry						
2. Course Name	Chemistry of Main Group Elements, Theories of Acids and Bases		**L**	**T**	**P**	
3. Course Code	17030620		4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description

This course provides students the knowledge of Acids and Bases, General Principles of Metallurgy, *s*- and *p*-Block Elements, Noble gases, inorganic polymers, etc. It offers discussion on various terms such as minerals, ores, concentration, calcination, roasting, refining, principles of oxidation and reduction as applied to the extraction procedures. It also includes the patterns and trends exhibited by s and p block elements and their compounds with emphasis on synthesis, structure, bonding and uses.

9. Course Objectives

The objectives of this course are to:

1. Introduce the knowledge of acids, bases and Metallurgy
2. Introduce the knowledge of *s*- and *p*-Block Elements
3. Learn structure, bonding, and properties of oxidising and reducing agents
4. Attain the knowledge of Noble gases and inorganic polymers.

10. Course Outcomes (COs)

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

1. Explain various concepts related to acids, bases, and metallurgy
2. Understand detail properties of s- and p-Block Elements
3. Explain the preparation and properties of Noble gases and inorganic polymers
4. Predict the role of oxidizing and reducing agents in chemistry

11. Unit wise detailed content

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

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

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

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

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

Unit-3	**Number of lectures = 12**	**Title of the unit: Structure, Bonding, Properties and Applications of p-block Elements**

Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and hydrolysis) of the following compounds and their applications in industrial and environmental chemistry wherever applicable: Diborane and concept of multicentre bonding, hydrides of Groups 13 (BH_3), 14, 15, 16 and 17.

Oxides of N and P, Oxoacids of P, S and Cl. Halides and oxohalides of P and S (PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2). Interhalogen compounds. A brief idea of pseudohalides.		
Unit-4	**Number of lectures = 14**	**Title of the unit: Noble Gases and Inorganic Polymers**
Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF_2, XeF_4 and XeF_6 ,bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory. Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in $(NPCl_2)_3$.		
12. Brief Description of self-learning/ E – learning component		
1. https://www.chem.uci.edu/~lawm/11-4.pdf 2. https://www.slideshare.net/DevanshGupta25/classification-of-inorganic-polymers 3. http://what-when-how.com/materialsparts-and-finishes/inorganic-polymer/ 4. https://www.tau.ac.il/~jortner/Publications/Pub1-200/61.pdf		
13. Books Recommended		
1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991, ISBN 978-0412402906 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley, ISBN 978-0471505327. 3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons ISBN 978-0471629788 4. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997, ISBN 978-0750633659. 5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002, ISBN 978-0840068460. 6. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010, ISBN 978-0321811059. 7. Atkin, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010), ISBN 978-0199236176		

1. Name of the Department: Chemistry						
2. Course Name	Chemistry of Main Group Elements, Theories of Acids and Bases Lab		**L**	**T**	**P**	
3. Course Code	17030621		0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**	**Practical = 52 hrs.**			

8. Course Description

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

9. Course Objectives

The objectives of this course are to:

1. Learn iodometric estimations of various solutions
2. Understand Gravimetric estimation techniques
3. Attain knowledge of preparation of salt complexes
4. Learn the iodimetric estimation of different components

10. Course Outcomes (COs)

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

1. Predict the application of analytical methods based on titrations viz iodimetric, gravimetric, and isolation, separations methods, etc.
2. Solve most important problems of quantitative analysis
3. Synthesize various salt complexes
4. Apply quantitative analysis in daily life.

11. List of experiments (Students has to perform 5 experiments.)

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

12. Brief Description of self-learning/ E – learning component

1. https://www.academia.edu/32601929/Experiment_no._1_Iodometric_titration_of_potassium_dichromate_and_sodium_thiosulphate_Objective
2. https://www.cutm.ac.in/pdf/Env Engg Lab Manual.pdf
3. https://www.slideshare.net/Ernest13/determination-of-sulphate-as-barium-sulphate

13. Books Recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012, ISBN 978-8131773710.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009, ISBN 978-8131723258

1. Name of the Department: Mathematics						
2. Course Name	Integral Transformation	**L**	**T**		**P**	
3. Course Code	17030622	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course focuses on various integral transforms which are required to analyze problems in engineering and scientific professions. The topics covered include Laplace transforms, inverse Laplace transform, Application of Laplace transform to solve ordinary differential equations, Fourier series, Fourier transforms and discrete Fourier Transform, z-transformations. The mathematical skills derived from this course form a necessary base for analytical and design concepts encountered in the program.

9. Course Objectives:

The aim is to develop the knowledge of different transforms and their applications among students. To equip with the methods of finding Laplace transform and Fourier Transforms of other functions. To make them familiar with solving differential equations, partial differential equations, and Boundary Value problems using Laplace Transforms, and Fourier Transforms.

10. Course Outcomes (COs):

After completing the course, students are expected to be able:

1. To apply Laplace transform and inverse Laplace transform in solving differential equations and integral equations arising in network analysis, control system and other fields of engineering.
2. To Derive Fourier series representation of Periodic functions.
3. To determine Fourier transform, Fourier sine and cosine transform of a function.
4. To apply z-transformation on real life problems like signals and systems.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 13**	**Title of the unit: Laplace Transform And Its Applications**

Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac-delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve simple linear and simultaneous differential equations.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Fourier Series**

Definition of periodic function, determination of Fourier coefficients, Fourier expansion of periodic function in a given interval of length 2π, Fourier series of even and odd functions, Fourier series in an arbitrary interval, Half-range Fourier sine and cosine expansions.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Fourier Transforms And Its Applications**
Fourier integral, Fourier transform, Complex Fourier transform, Inverse transforms, Convolution theorems, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equations, wave equations and Laplace equations, Finite Fourier transforms, Parseval's identity.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: *Z*-Transforms And Its Applications**
Difference equations, Basic definitions, *Z*-transform definition, Standard *z*-transforms, ROC, Damping rule, Shifting rule, Initial value and final value theorems (without proofs) and problems, Inverse *z*-transform, Simple problems. Applications-solutions of difference equations using *z*-transforms.		
12. Brief Description of self-learning / E-learning component		
1. https://www.youtube.com/watch?v=KqokoYr_h1A 2. https://www.youtube.com/watch?v=spUNpyF58BY		
13. Books Recommended:		
1. Erwin Kreyszig: Advanced Engineering Mathematics (10th ed.),Wiley India Pvt. Ltd, 2015. **2.** Michael Greenberg: Advanced Engineering Mathematics (2nd ed.), Pearson Education, 1998. **3.** Baidyanath Patra, An Introduction to Integral Transforms, CRC Press, (1st ed.), 2018. **4.** A.V. Oppenheim, A.S. Willsky and S. H. Nawab, Signals and Systems (2nd ed.), Prentice Hall, New Jersey, 1996.		

1. Name of the Department: Mathematics						
2. Course Name	Integral Transformation Lab	**L**	**T**		**P**	
3. Course Code	17030623	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

This course is designed to emphasize the knowledge of integral transformation using MATLAB. We use MATLAB to solve various integral transformations, Laplace Transform, Inverse Laplace Transform, Application of Laplace transforms to solve ordinary differential equations, Fourier series, Fourier transforms and Fourier series expansion of a periodic function.

9. Course Objectives:

Many applications in engineering, physics, geology and other specifications containing complicated problems usually require solving one of the integral transformation problems. In this course students learn the classification of many complicated problems and how to attain their solutions. Application of Laplace and Fourier transforms for obtaining an approximate solution to the problems with desired accuracy.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. Implement integral transformation in MATLAB.
2. To develop the knowledge of different transforms and its applications among students using MATLAB.
3. Practical and theoretical knowledge of schemes for integral transformation.
4. Practical and theoretical knowledge of schemes for solving Laplace transform, Fourier transform and z-transformation.

11. List of practicals to perform in computer lab using software MATLAB

1. Solution of Laplace transforms of derivatives and integrals.
2. Solution of Unit step function and Dirac-delta function.
3. Solution of application to solve simple linear and simultaneous differential equations.
4. Solution of determination of Fourier coefficients.
5. Solution of Fourier series of even and odd functions.
6. Solution of wave equations and Laplace equations.
7. Solution of independent variable and transformation variable.
8. Solution of Fourier transform used in the signal, and also create the vector.
9. Solution of z-transforms involving Heaviside function and Binomial coefficient.
10. Solution of difference equations using z-transform.

12. Brief Description of self-learning / E-learning component

1. https://in.mathworks.com/help/symbolic/compute-z-transforms-and-inverse-z transforms.html
2. https://in.mathworks.com/help/symbolic/ztrans.html
3. https://in.mathworks.com/help/matlab/math/fourier-transforms.html
4. https://in.mathworks.com/help/symbolic/sym.laplace.html
5. https://www.youtube.com/watch?v=xVClNJxtj78

13. Books Recommended

1. Alexander D. Poularikas,Transforms and Applications Primer for Engineers with Examples and MATLAB, CRC Press, 2010.
2. Prem K. Kythe and Michael R. Schäfferkotter, Handbook of Computational Methods for Integration, Chapman & Hall/CRC, 2005.

1. Name of the Department: Mathematics						
2. Course Name	Partial Differential Equations	**L**	**T**		**P**	
3. Course Code	17030624	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

Formation and classification of first-order PDEs, Linear and quasilinear first-order PDEs, Integral surfaces, Nonlinear first-order PDEs and Second-Order PDEs, Second-Order PDEs, Derivation of the heat equation, Method of separation of variables, Time independent boundary conditions, Time-dependent boundary conditions, Duhamel's principle, Wave equation, Derivation of wave equation, Infinite string problem, D'Alembert solution of the wave equation, Laplace's Equation and Method of Green's Functions

9. Course Objectives:

The course includes initial and boundary value problems for Partial Differential Equations (PDEs) of first and second order, and includes, to a limited extent, systems of such equations. Emphasis is on the qualitative behavior of solutions of Partial Differential Equations.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To apply a range of techniques to find solutions of standard PDEs.
2. To demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDEs.
3. To demonstrate capacity to model physical phenomena using PDEs (in particular using the heat and wave equations).
4. To apply problem solving using concepts and techniques from PDEs and Fourier analysis applied to diverse situations in physics, engineering, financial mathematics and in other mathematical contexts.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 15**	**Title of the unit: First-Order Partial Differential Equations**

Integral Curves and Surfaces of Vector Fields, Solving DEs of the form: $dx/P = dy/Q = dz/R$, First-order PDEs, Formation and classification of first-order PDEs, Linear and quasilinear first-order PDEs, Cauchy's problem for first order PDEs.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Integral surfaces, Nonlinear first-order PDEs and Second-Order PDEs**

Integral surfaces passing through a given curve, Nonlinear first-order PDEs, Method of characteristics, Compatible systems, Charpit's method, Jacobi's method for nonlinear PDEs, Second-Order PDEs, Classification, Canonical forms.

Unit – 3	Number of lectures = 12	Title of the unit: Heat Equation, Duhamel's principle and Wave Equations
Derivation of the heat equation, Uniqueness, Continuous dependence, Method of separation of variables, Time independent boundary conditions, Time-dependent boundary conditions, Duhamel's principle, Wave equation, Derivation of wave equation, Infinite string problem, D'Alembert solution of the wave equation, Semi-infinite string problem, Finite vibrating string problem, Method of separation variables, Inhomogeneous wave equation.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Laplace's Equation and Method of Green's Functions**
Basic concepts of Laplace's equation, Types of boundary value problems Green's identity and fundamental solution, Poisson integral formula, Method of separation of variables, Dirichlet problem for the rectangle, Integral formulation of Green's function, Method of Green's functions for the Laplace, heat and wave equations.		

12. Brief Description of self-learning / E-learning component

1. https://nptel.ac.in/courses/111108144
2. https://nptel.ac.in/courses/111104145
3. https://archive.nptel.ac.in/courses/111/107/111107111/
4. https://archive.nptel.ac.in/courses/111/105/111105093/

13. Books Recommended

1. C. Constanda: Solution Techniques for Elementary Partial Differential Equations (3rd ed.) Chapman & Hall/CRC, New York, 2016.
2. S. J. Farlow: Partial Differential Equations for Scientists and Engineers, Dover Publications Inc. New York, 1993.
3. F. John: Partial Differential Equations (4th ed.), Springer-Verlag, New York, 1982.
4. I. N. Sneddon: Elements of Partial Differential Equations, Dover Publications, New York, 2006.

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1. Name of the Department: Mathematics						
2. Course Name	Partial Differential Equations Lab	**L**	**T**		**P**	
3. Course Code	17030625	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description:

This course is designed to emphasize the knowledge of partial differential equations. Emphasis is placed on different forms of linear and non-linear Partial differential equations. Upon completion, students should be able to write the programs for solving the partial differential equations in MATLAB or other software.

9. Course Objectives:

1. Give an account of basic concepts and definitions for partial differential equations.
2. Use methods for obtaining the solutions of heat and wave equations.
3. Describe some simple numerical solution techniques and be familiar with mathematical software for partial differential equations.
4. Use MATLAB for the visualization of solutions to PDEs.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to solve partial differential equations using MATLAB.

11. List of Practical's (using any one from C++ , MATLAB)

1. To solve the problem of single partial differential equations.
2. Determine the Dirichlet and Neumann boundary conditions.
3. To solve the heat equation.
4. To solve the PDEs with discontinuity.
5. To solve the wave equation with initial conditions.
6. To solve nonhomogeneous boundary conditions and steady-state solutions for heat equations.
7. Implement the maximum principle to establish the uniqueness of the solution for the heat equations.
8. Determine the D'Alembert's solution of the initial value problem for wave equations.
9. To solve the energy integrals and determine the uniqueness of the solutions for the wave equations.
10. To solve boundary value problems in rectangular coordinates for Laplace's equations.
11. To solve Neumann problems and mixed boundary conditions for Laplace's equations.

12. Brief Description of self-learning / E-learning component

1. https://in.mathworks.com/help/matlab/math/partial-differential-equations.html
2. https://in.mathworks.com/help/matlab/examples.html?category=partial-differential-equations&s_tid=CRUX_topnav
3. https://in.mathworks.com/help/matlab/math/solve-single-pde.html
4. https://in.mathworks.com/help/matlab/math/solve-pde-with-material-interface.html

13. Books Recommended

1. Matthew P. Coleman, An Introduction to Partial Differential Equations with MATLAB(2nd ed.), Chapman and Hall/CRC, 2013.
2. Amos Gilat: MATLAB: An Introduction with Applications (8th ed.), Wiley India Edition, 2020.

1. Name of the Department: Mathematics						
2. Course Name	Numerical Methods	**L**	**T**		**P**	
3. Course Code	17030626	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

This course analyzed the basic techniques (direct and iterative methods) for the efficient numerical solution of problems in science and engineering. Topics covered are: Number representation and errors, Polynomials, Finite Difference, Interpolation and Approximation of function, Interpolation and approximation, Numerical differentiation, Numerical integration, Systems of linear equations, Solution of differential equations.

9. Course Objectives:

Many applications in engineering, physics, geology and other specifications containing complicated problems that will require one of the numerical methods to be solved. In this course students will learn the classification of many complicated problems and the suitable numerical methods for obtaining an approximated solution to these problems with desired accuracy.

10. Course Outcomes (COs):

On completion of this course, the students will be able:

1. To demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2. To derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear, and the solution of differential equations.
3. To apply numerical methods to obtain approximate solutions to mathematical problems.
4. To evaluate the system of linear equations and ordinary differential equations using numerical methods.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 12**	**Title of the unit: Errors and Solution of Transcendental and Algebraic Equations**

Representations of numbers, Round off error, Truncation error, Significant error, Error in numerical computations, Bisection, secant, Regula-Falsi, fixed-point, Newton-Raphson, Graffe's and Muller's methods.

Unit – 2	**Number of lectures = 15**	**Title of the unit: Finite Difference, Interpolation and Approximation of Function**

Difference operators and their relations, Difference table, Newton interpolation, Central difference formulae of Gauss, Newton divided difference formula, Lagrange interpolation, Hermite interpolation, Stirling formula, Bessel formula, Cubic spline interpolation, Curve fitting by least square method (linear, polynomial, geometric).

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Unit – 3	Number of lectures = 10	Title of the unit: Numerical differentiation and Numerical Integration
Numerical differentiation, Numerical integration, Newton-Cotes formulae, Trapezoidal, Simpson's and Weddle's rules, Gaussian quadrature (Gauss-Legendre and Gauss-Chebyshev quadrature).		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Solution of a System of Linear Equations, Eigenvalue Problems and Solution of Ordinary Differential Equation (ODEs)**
Partial and complete pivoting for system of linear equations, LU decomposition method, Solution of tridiagonal system of equations: Gauss-Seidel, Gauss-Jacobi. Eigenvalue problem: Power method, Solution of ODEs: Picard's method, Taylor's, Euler's and modified Euler's methods, Runge-Kutta method of fourth order.		

12. Brief Description of self-learning / E-learning component

1. https://nptel.ac.in/courses/111107105
2. https://nptel.ac.in/courses/111106101

13. Books Recommended

1. J. H. Mathews and K. K. Fink: Numerical Methods using MATLAB (4th ed.), Prentice Hall Inc., 2004.
2. M. K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical Methods: For Scientific and Engineering Computation (7th ed.), New Age International Publishers, 2019.
3. S. S. Sastry: Introductory Methods of Numerical Analysis (5th ed.), PHI Learning , New Delhi, 2012.

1. Name of the Department: Mathematics						
2. Course Name	Numerical Methods Lab	**L**	**T**		**P**	
3. Course Code	17030627	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Prerequisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

Obtaining numerical solution of a problem upto an acceptable error requires a lot of iterations which consumes a lot of time if done manually. Chances of errors are also very high in manual calculation. To overcome these we introduce this course in which softwares like MATLAB provides numerical solutions to various problems including differentiation, integration, differential equations and system of equations .

9. Course Objectives:

Students will be introduced to various tools and techniques in MATLAB that will help him to analyze the solution of a problem both numerically and graphically. Students can solve the system of linear equations using iterative as well as direct methods on MATLAB. They will learn how to design programmes in MATLAB for numerical integration, differentiation and interpolation.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To solve a system of linear equations using iterative and direct methods.
2. To learn how to interpolate the given set of values using MATLAB.
3. To write programmes in MATLAB for numerical differentiation and integration.
4. To obtain numerical solutions of an Ordinary differential equation and plot their graphs..

11. List of practical to perform in computer lab using software MATLAB

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1. Solution of nonlinear equations in a single variable using the method of successive bisection.
2. Solution of nonlinear equations in single variables using the Newton-Raphson, secant, Regula-falsi and modified Euler's methods.
3. Solution of a system of simultaneous algebraic equations using the Gaussian elimination procedure.
4. Solution of a system of simultaneous algebraic equations using the Gauss-Jacobi iterative method.
5. Solution of a system of simultaneous algebraic equations using the Gauss-Seidel iterative method employing the technique of successive relaxation.
6. Numerical solution of an ordinary differential equation using the Euler's method.
7. Numerical solution of an ordinary differential equation using the Runge-Kutta 4th order method.
8. Numerical solution of an ordinary differential equation using the predictor-corrector method.
9. Numerical solution of a system of two ordinary differential equations using numerical integration.
10. Numerical solution of an elliptic boundary value problem using the method of finite differences.

12. Brief Description of self-learning / E-learning component

1. https://youtu.be/5W46xcVInL8?list=PLRWKj4sFG7-6_Xr9yqg6SMr_F80KdFVhN
2. https://youtu.be/bsgPR0lWiTg?list=PLRWKj4sFG7-6_Xr9yqg6SMr_F80KdFVhN
3. https://youtu.be/51PwCoFtyXw?list=PLRWKj4sFG7-6_Xr9yqg6SMr_F80KdFVhN

13. Books Recommended

1. Lester W. Schmerr: Engineering Dynamics 2.0: Fundamentals and Numerical Solutions, Springer International Publishing, 2019.
2. Brian H. Hann and Daniel T. Valentine: Essential MATLAB for Engineers and Scientists (3rd ed.), Academic Press Inc, 2007.
3. Richard L. Burden, J. Douglas Faires and Annette M. Burden: Numerical Analysis (10th ed.), Cengage Learning, 2016.

SEMESTER-VII (DSE)

1. Name of the Department: Physics						
2. Course Name	Mathematical and Computational Physics	L	T		P	
3. Course Code	17030701	4	0		0	
4. Type of Course (use tick mark)		Core ()	DSE (√)	AEC ()	SEC ()	GE ()
5. Pre-requisite (If any)		6. Frequency (Use tick marks)	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		Tutorials = 0		Practical = 0		

8. Course Description:

Mathematical physics gives a solid foundation in the numerous mathematical approaches that have been developed and used to the study of diverse physical phenomenon. This course gives mathematical skills to address formalisms utilized in the bachelor's level physics program's core subject.

9. Course Objectives

The aim of this course is to understand the focus of the course is on application of various mathematical techniques in solving Physics problems.

10. Course Outcomes (COs):

After completing this course, Students will be able to apply various mathematical methods to different set of problems in theoretical and experimental physics.

11. Unit wise detailed content

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

Errors and error Analysis Truncation and round off errors, Absolute and relative errors, Floating point computations. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients.

Unit – 2	Number of lectures = 16	Title of the unit: Vector Algebra and Vector Calculus

Linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product. Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field. Divergence and curl of a vector field. Del and Laplacian operators. Ordinary Integrals of Vectors. Notion of infinitesimal line, surface and volume elements. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications.

Unit – 3	Number of lectures = 10	Title of the unit: Orthogonal Curvilinear

		Coordinates
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Matrices**
Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit 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. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.		
12. Books Recommended		
1. Differential Equations, George F. Simmons, 2007, McGraw Hill 2. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India. 3. Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley. 4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications. 5. Mathematical Methods for Physicists,G.B.Arfken, H.J.Weber, F.E.Harris,2013, 7th Edn., Elsevier.		
13. Online Links		
1. https://nptel.ac.in/courses/115103036. 2. https://www.youtube.com/watch?v=_tdI8QK31s4 3. https://nptel.ac.in/courses/115105097 4. https://onlinecourses.nptel.ac.in/noc21_ma27/preview		

1. Name of the Department: Physics						
2. Course Name	Physics Practical-1	**L**	**T**		**P**	
3. Course Code	17030702	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

Experiments include the Basic concepts of measurement of Planck's constant using LEDs, wavelength calculation using diffraction pattern, work function, IV characteristics and solving physics problems using programming.

9. Course Objectives:

The aim of this paper is that the student performs the experiment based on the description and calculate the results. Quantitatively and qualitatively evaluate the method and consequences of an experiment. Compare the result with the standard value wherever applicable and know how to calculate different type of errors. Communicate an experiment's procedure and results.

10. Course Outcomes (COs):

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

1. The theoretical formulas by performing experiment
2. Demonstrate the practical application of properties of materials, effect that is how radiation can be converted into electric energy, PN diode characteristics.
3. Solving basic mathematical problems numerically.

11. List of Experiments

1. Basic Curve plotting in Matlab/Python.
2. Basic curve fitting in Matlab/Python
3. Data extrapolation in Matlab/Python.
4. To calculate the roots of transcendental equation in Matlab/Python.
5. To calculate the value of integral using trapezoidal rule.
6. To evaluate Scalar and Vector Product using MATLAB/Python
7. To evaluate Eigenvalue and eigenvectors of various matrices using MATLAB/Python.
8. Solving systems of linear equations in MATLAB/Python.
9. Solving a second order differential equation with variable coefficients in MATLAB/Python.
10. Computing Fourier Series with MATLAB/Python

11. To plot trajectory of particle in two and three dimensions.

12. Book Recommended:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash, and Ramakrishna, 11th Edition,□2011, KitabMahal, New Delhi.
4. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
5. A Byte of Python: free eBook: https://github.com/swaroopch/byte-of-python/releases/latest
6. Learn Python the Hard Way' by Zed A. Shaw

1. Name of the Department: Physics						
2. Course Name	Classical Mechanics	**L**	**T**	**P**		
3. Course Code	17030703	4	0	0		
4. Type of Course (use tick mark)	**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52	**Tutorials = 0**	**Practical = 0**				

8. Course Description:

A study of classical mechanics including different perspectives of traditional Newtonian, Lagrangian and Hamiltonian methods. The course also places emphasis on practical applications of these general principles towards specific problems

9. Course Objectives:

The objectives of the course are to:

1. Demonstrate conceptual understanding of the basic principles of classical mechanics.
2. Develop the equations of motion using different formalisms.
3. Differentiate between the different formalisms and to identify the type of problem.
4. Be familiar with the concepts of relativity

10. Course Outcomes (COs):

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

1. Apply basic methods of Newtonian mechanics to problems like Two-body central force field motion. Kepler's laws of planetary motion
2. Apply basic methods of Lagrangian formalism to simple mechanical problems.
3. Analyse canonical transformations and understand Hamilton Jacobi theory.
4. Understand General Theory of Relativity

11. Unit wise detailed content

Unit-1	**Number of lectures = 14**	**Title of the unit: Newtonian mechanics**

Single and many particle systems-Conservation laws of linear momentum, angular momentum and energy. Application of Newtonian mechanics: Two-body central force field motion. Kepler's laws of planetary motion. Scattering in a central force field, scattering cross section, The Rutherford scattering problem

Unit - 2	**Number of lectures = 14**	**Title of the unit: Lagrangian formalism**

Constrains in motion, generalised co-ordinates, virtual work and D'Alembert's principle. Lagrangian equation of motion. Symmetry and cyclic co-ordinates. Hamilton variational principle; Lagrangian equation of motion from variational principle. Simple applications.

Unit - 3	Number of lectures = 13	Title of the unit: Hamiltonian formalism
Hamilton's equations of motion- from Legendre transformations and the variational Principle. Simple applications. Canonical transformations. Poisson brackets-Canonical equations of motion in Poisson bracket notation. Hamilton-Jocobi equations.		
Unit - 4	**Number of lectures = 11**	**Title of the unit: Relativistic mechanics**
Relativistic mechanics: Four-dimensional formulation- four-vectors, four-velocity and four-acceleration. Lerentz co-variant form of equation of motion.		

12. Books Recommended

1. Classical Mechanics: H. Goldstein, Publisher – Pearson Education, ISBN-13 978-8131758915
2. Mechanics: L . D. Landau and E. M. Lifshitz, Publisher - Butterworth-Heinemann. ISBN 978-0750628969
3. Introduction to Classical Mechanics: R. G. Takwale and Puranik. Publisher - McGraw Hill Education. ISBN 978-0070966178
4. Introduction to Classical Mechanics: N. C. Rana and P. Joag. Publisher - McGraw Hill Education. ISBN 978-0074603154

13. Online links

1. https://nptel.ac.in/courses/115106123
2. https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/

1. Name of the Department: Physics							
2. Course Name	**Physics Practical-2**		**L**	**T**		**P**	
3. Course Code	17030704		0	0		4	
4. Type of Course (use tick mark)	**Core (√)**		**DSE ()**			**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)		Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical							
Lectures = 0	**Tutorials = 0**	**Practical = 52**					
7. Course Description:							
In this course student will gain the practical knowledge about the Understand laws of motion and their application to various dynamical situations, computer Simulation of projectile motion and orbital mechanics, hyperbolic orbit motion with conic section, Hamilton's Least Action principle for a particle under the action of gravity, Action field of the Kepler/Coulomb problem							
8. Course Objectives:							
1. Understand laws of motion and their application to various dynamical situations. 2. Understand and study of Kepler's laws to describe the motion of planets and satellite in circular orbit. 3. Explain the phenomenon of simple harmonic motion. 4. Study of Hamilton's Least Action principle for a particle under the action of gravity							
9. Course Outcomes (COs):							
After successful completion of this course, students will be able to 1.Visualize the simulation, and correlate the theoretical concepts and identify its practical applications through experiments. 2. Understand laws of motion and their application to various dynamical situations 3. Understand and study of Kepler's laws to describe the motion of planets and satellite in circular orbit 4. Explain the phenomenon of simple harmonic motion 5. Study of Hamilton's Least Action principle for a particle under the action of gravity							
10. List of Experiments							
1. Simulation of projectile motion and orbital mechanics using both the Classical 4th Order Runge-Kutta method and Euler's Method (Simulation and Computational) 2. Conic section projectile hyperbolic orbit motion (Simulation and Computational) 3. Conic section curves with r min and r max (Simulation and Computational)							

4. Hamilton's Least Action principle for a particle under the action of gravity (Computational and Simulation)
5. Attractive Potential, energy, curves for a body under a central force (Computational)
6. Orbit period to obtain the time it takes to go from r min to r max in an orbit due to a force of the form arp (Simulation and Computational)
7. Action field of the Kepler/Coulomb problem (Simulation and Computational)
8. Keplerian orbits and principle (Simulation and Computational)
9. Roll pendulum (Simulation and Computational)
10. (The suspension point K1of a plane pendulum slides frictionless along the x-axis. The pendulum body K2 has the distance L from the suspension point. Both bodies have the same mass m1=m2=m and the connection between K1 and K2 is mass less)
11. To determine the height of a building using a Sextant.
12. To determine g and velocity for a freely falling body using Digital Timing Technique.
13. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
14. To determine the Young's Modulus of a Wire by Optical Lever Method.

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorised to add or delete from this list whenever considered necessary.

12. Book Recommended

References for Laboratory Work:

1.Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House, ISBN-13 : 978-0423738902
2.Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd. ISBN: 9788131525203
3. Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press, ISBN-9781139164498
4. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11/e, 2011, Kitab Mahal. ISBN-13 : 978-8122500844.

1. Name of the Department: Chemistry						
2. Course Name	Quantum Chemistry & Thermodynamics		**L**	**T**	**P**	
3. Course Code	17030705		4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description

This course will enable the graduate students to understand the advance concepts of statistical thermodynamics such as concept of distribution, types of statistic and various partition functions. It will also include information on quantum chemistry advancements, such as approximation methods and chemical bonding.

9. Course Objectives

The objectives of this course are:

1. To provide the firm foundation in statistical thermodynamics.
2. To understand the chemistry of partition function and entropy.
3. To explain the advancements in quantum mechanics
4. To understand the approximation methods and chemical bonding

10. Course Outcomes (COs)

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

1. Apply the knowledge of statistical thermodynamics in related areas
2. Correlate partition functions and entropy with reference to chemical equilibrium
3. Explain the approximation methods
4. Demonstrate the concepts with reference to chemical bonding

11. Unit wise detailed content

Unit-1	**Number of lectures = 14**	**Title of the unit: Statistical Thermodynamics I**

Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution, Types of statistics: Boltzmann, Bose-Einstein & Fermi-Dirac statistics and its statistical thermodynamic formulation, Idea of microstates and macrostates. Canonical, grand canonical and microcanonical ensembles. Statistical thermodynamic formulation of Maxwell - Boltzmann distribution law, Maxwell - Boltzmann law of distribution of energy and evaluation of average velocity, root mean square velocity; law of equipartition of energy; Partition function and its factorization, relationship of atomic and molar partition function to thermodynamic properties(I) internal energy (ii) entropy (iii) Gibb's free energy (iv) heat content (v) work function (vi) pressure (vii) heat capacity at constant volume. Derivation of equation of state for a monoatomic ideal gas.

Unit-2	**Number of lectures = 12**	**Title of the unit: Statistical Thermodynamics II**

Evaluation of Translational partition function, calculation of absolute entropy of an ideal monoatomic gas, Vibrational, Rotational, & electronic partition function of diatomic molecules, Derivation of expressions for transitional, vibrational, rotational, electronic energy; expressions for entropy, Gibbs free energy, work function due to transitional, vibrational and rotational motion of a molecule. Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function.

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

Approximate methods: First order time-independent perturbation theory for non-degenerate states, variation principle. Application of first order perturbation and variation principle to evaluate ground state of helium atom. Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field.

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

Born-Oppenheimer approximation, Valence bond method to hydrogen molecule ion and hydrogen molecule their symmetric and anti-symmetric solution without actual evaluation of various integrals, energy of molecular hydrogen system, LCAO-MO approximation of hydrogen molecule, Configuration Interaction. Extension of MO theory to other systems- HMO theory applied to simple systems – ethene,butadiene

12. Brief Description of self-learning / E-learning component

1. http://epgp.inflibnet.ac.in/
2. https://youtu.be/bE7Z6Zkst1I
3. https://youtu.be/CBrsWPCp_rs
4. https://youtu.be/7ItAyG_m7jA
5. http://chemistry.umeche.maine.edu/Modeling/lcao.html.

13. Books Recommended

1. Glasstone, S. Theoretical Chemistry, ISBN: 9781446545461
2. Levine.Quantum Chemistry, ISBN: 978-9332558533
3. Pauling, Eyring and Wilson. Quantum Chemistry, ISBN: 978-0486648712
4. Nash, L.K. Introduction to Statistical Mechanics, ISBN: 978-0486449784
5. Donald. A. McQuarrie - Statistical Mechanics-2011, ISBN: 978-8130918938
6. Frank L. Pilar, Elementary Quantum Chemistry – 2001, ISBN: 9780486414645.

1. Name of the Department: Chemistry						
2. Course Name	Physical Chemistry Practical – I		**L**	**T**	**P**	
3. Course Code	17030706		0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = Nil	**Tutorials = Nil**	**Practical = 52 hrs.**				

8. Course Description

This Course will enable the students to learn various conductometric and pH metric titration techniques. It also helps the students to understand the surface tension and adsorption properties of liquids. This course will provide a platform to develop methods for the analysis of various properties of liquids.

9. Course Objectives

The objectives of this course are:

1. To impart the knowledge of concept of various conductometric titrations of
2. To introduce the concepts of partition coefficient and equilibrium constant
3. To understand the surface tension and adsorption of different systems
4. To explain knowledge of concept of pH meter

10. Course Outcomes (COs)

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

1. Describe various conductometric titrations
2. Explain the concept of pH by using pH meter.
3. Determine partition coefficient and equilibrium constant of various systems
4. Predict surface tension of liquids and adsorption of solids

11. List of Experiments (At least seven experiments to be performed by the student)

1. **Conductometry**
   - i. HCl vs NaOH titration.
   - ii. Oxalic acid vs NaOH titration.
   - iii. CH_3COOH vs NaOH titration.
   - iv. Mixture of CH_3COOH+HCl vs NaOH
2. **Surface tension**
   Determine interfacial tension of two immiscible liquids.
3. **Adsorption**
   To study the adsorption of Oxalic acid and Acetic acid on charcoal.
4. **pH metric**
   - i. HCl vs NaOH titration.
   - ii. Oxalic acid vs NaOH titration.
   - iii. CH_3COOH vs NaOH titration.
5. **Distribution Law**
   - i. To determine partition coefficient of benzoic acid between benzene and water.
   - ii. To determine the partition coefficient of Iodine between Carbon tetrachloride and water.

12. Brief Description of self-learning / E-learning component

1. https://youtu.be/E0oYzyJrKGg
2. https://www.britannica.com/science/surface-tension
3. https://youtu.be/vMOa7wrP3w0
4. https://nptel.ac.in/courses/108105063/pdf/L-08(SS)(IA&C)%20((EE)NPTEL).pdf
5. https://www.thefreedictionary.com/distribution+law

13. Books Recommended

1. Khosla, B.D., V.C. Garg and A. Gulati.Senior Practical Physical Chemistry (ISBN-13: 9788180450792).

2. Thawale,A. and P. Mathur. Experimental Physical Chemistry. (ISBN : 81-224-1336-6)
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry. (ISBN : 9788130920696)
4. Sindhu, P.S. Practical in Physical Chemistry. (ISBN-13 : 978-1403929167)

1. Name of the Department: Chemistry						
2. Course Name	Stereochemistry and Organic Reaction Mechanism		**L**		**T**	**P**
3. Course Code	17030707		4		0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

7. Course Description

Nowadays, chiral drugs have become an integral part of the pharmaceutical industry, and it's essential to know the stereochemistry of drug molecules to understand their mechanism of action. This course provides the opportunity to understand the various aspects of stereochemistry, emphasizing conformations and configurations. This course will also provide the knowledge of the mechanisms of different chemical reactions and will lay the foundation on which further advanced topics can be built up.

8. Course Objectives

The objectives of this course are to:

1. Provide the knowledge about understanding stereochemistry, emphasizing asymmetric synthesis and its importance in organic synthesis.
2. Understand different conformations and configurations of organic molecules
3. Explain different types of reactions with their mechanisms.
4. Impart the knowledge of different name reactions

9. Course Outcomes (COs)

Students will be able to:

1. Identify and differentiate the conformations and configurations with their stereochemistry
2. Describe the aliphatic and aromatic nucleophilic substitution reactions.
3. Develop capacity to explain aliphatic and aromatic electrophilic substitution reactions.
4. Describe free radical substitution and elimination reactions.

10. Unit wise detailed content

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

Stereoisomerism: Classification, Optical isomerism due to asymmetric carbon atoms: molecules with one, two or more chiral centers.

Configuration nomenclature: D, L and R,S configurations. Optical isomerism in absence of chiral carbon (biphenyls, allenes, spiranes), Optical isomerism of nitrogenous compounds, geometrical isomerism and E, Z configurations, properties of geometrical isomers.Axial and planar chirality and helicity.

Cyclostereoisomerism: Configurations, conformations and stability of cyclohexanes (mono & di), cyclohexenes, cyclohexanones, halocyclohexanones, decalins, decalols and decalones.

Asymmetric synthesis, Asymmetric Induction:nCram's, Prelog's and Felkin-Ahn model

Unit-2	**Number of lectures = 13**	**Title of the unit: Aliphatic and Aromatic Nucleophilic Substitution (Reaction Mechanisms)**

Aliphatic Nucleophilic Substitution: The S_N2, S_N1 and S_Ni mechanisms, mixed S_N1 & S_N2 mechanism SET mechanism. The neighbouring group mechanism (anchimeric assistance). Neighbouring group participation by pi and sigma bonds, Classical non classical & phenonium cations, Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon. Effect on the reactivity due to – substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophiles and substrates regioselectivity.

Aromatic NucleophilicSubstitution: S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity effect of substrate structure, leaving group and nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Unit-3	**Number of lectures = 13**	**Title of the unit: Aliphatic and Aromatic Electrophilic Substitution**

Aliphatic Electrophilic Substitution: Bimolecular mechanisms - S_E2 and S_Ei.The S_E1 mechanism, Electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Aromatic Electrophilic Substitution: The arenium ion, mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction, Pechmann reaction, Houben – Hoesch reaction, Fries rearrangement.

Unit-4	Number of lectures = 13	Title of the unit: Free Radical Substitution and Elimination Reactions

Free Radical Reactions: Types of free radical reactions, free radical substitution mechanisms. Mechanisms at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. Effect of solvents on reactivity. Allylichalogenation (NBS), oxidation of aldehydes to acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction, Kolbe reaction. Hydroxylation of aromatics by Fenton's reagent.

Elimination Reactions: The E_2, E_1, E_{1cB} mechanisms. Orientation of the double bond. Effects of substrate structure, attacking base, leaving group and medium on reactivity. Mechanism and orientation in pyrolytic eliminations.

12. Brief Description of self-learning / E-learning component

1. http://www.colby.edu/chemistry/CH241F/Chapter%204.pdf
2. https://onlinecourses.nptel.ac.in/noc17_cy11/announcements
3. http://nptel.ac.in/courses/104105086/
4. http://ocw.uci.edu/courses/chem_201_organic_reactions_mechanisms_i.html
5. https://swayam.gov.in/courses/189-organic-chemistry-iii-reaction-mechanisms-2
6. https://faculty.chemistry.harvard.edu/myers/pages/chem-115-handouts
7. http://www.cureffi.org/tag/chem-20/
8. https://archive.org/details/EvansD.A.HarvardsAdvancedOrganicChemistry2003/page/n51
9. https://www.masterorganicchemistry.com/2013/07/30/free-radical-reactions

13. Books Recommended

1. Stereochemistry of carbon compounds, E.L.Eliel and S.H. Wilen, Wiley, ISBN: 9788126515707
2. Stereochemistry of organic compounds- Principles and Applications, D. Nasipuri, NEW AGE; Third edition (2018), ISBN-13: 978-8122430295
3. Advanced Organic Chemistry – Jerry March, John Wiley & Sons Inc; 3rd edition, ISBN:978-0471854722.
4. Advanced Organic Chemistry, Part A: Structure and Mechanisms, F.A. Carey, R.J. Sunberg, Publisher: Springer; 5th edition (2008), ISBN-13: 978-0387683461
5. Highlights of Organic Chemistry, W.J. L. Nobel; An Advanced Text Book, CRC Press; 1 edition (1974), ISBN-13: 978-0824762100
6. Stereochemistry conformation and Mechanism – P. S. Kalsi, New Age Publishers; Tenth edition (1 January 2019), ISBN-13: 978-9387788329
7. A Guide Book to Mechanism in Organic Chemistry, P.Sykes, BH Kishan, earson Education; 1 edition (2013), ISBN-13: 978-8131793558
8. Structure and Mechanism in Organic Chemistry, C. K. Ingold, CBS; 2 edition (2000),ISBN-13: 978-8123909752
9. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall; 6th edition (January 27, 1992), ISBN-13: 978-0136436690
10. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Trinity, Macmillan Publishers India (1984), ISBN-13: 978-0333904619

1. Name of the Department: Chemistry						
2. Course Name	Organic Chemistry Practical - I		**L**	**T**		**P**
3. Course Code	17030708		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

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

8. Course Description

This Course will introduce the students to synthesize the organic compounds and enable them to develop and practice independent experimental skills. Students will learn stereo chemical aspects (geometrical isomers and stereoisomers) and different reactive intermediates formation during the synthesis of organic compounds. This course will also give a platform to develop different methods to synthesize organic compounds.

9. Course Objectives

The objectives of this course are:

1. To introduce the standard techniques used for organic synthesis
2. To learn condensation and carbene addition reactions
3. To understand nucleophilic aromatic/aliphatic substitution reactions
4. To understand rearrangement reactions involving carbocations and carbanions
5. To learn the handling of organic chemicals safely and describe their potential dangers

10. Course Outcomes (COs)

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

1. Perform various organic synthesis by utilizing various synthetic techniques
2. Design different organic synthetic methods
3. Describe disposal techniques and laboratory emergency procedures
4. Apply purification techniques for the purification of organic compounds

11. List of Experiments (At least seven experiments to be performed by the student)

Preparations involving stereochemical aspects (geometrical isomers and stereoisomers) and different reactive intermediates:

(a) Condensation reaction,
(b) Carbene addition,
(c) Nucleophilic aromatic/aliphatic substitution reaction
(d) Rearrangement reactions involving carbocations and carbanions

Note: Overall at least 10 experiments should be performed including one from each category.

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=fbNf_guvK_0
2. https://www.youtube.com/watch?v=6MDPAimsHF4
3. https://www.youtube.com/watch?v=Wucp2wiu3-U

13. Books Recommended

1. Chapman and Hall, Principles of Organic Synthesis 2nd Ed., R.O.C.Norman,1978. (ISBN-13 : 978-0470263174)
2. Stéphane Caron, Practical Synthetic Organic Chemistry: Reactions, Principles, and Techniques (ISBN:9780470037331)
3. John Leonard, Barry Lygo, Garry Procter, Advanced Practical Organic Chemistry, (ISBN 9781138494145)
4. Nicolas Bogliotti, Roba Moumné, Multi step organic synthesis, A guide through experiments, Dec 2017.(ISBN: 978-3-527-34065-1)
5. Brian S,Furniss, Antony J Hannaford, Petr W G Smith, Austin R Tatchell , Vogels text book of practical organic chemistry, 5th addition. (ISBN : 9788177589573)

1. Name of the Department: Mathematics						
2. Course Name	Metric Spaces	**L**	**T**		**P**	
3. Course Code	17030709	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course includes basics of metric spaces, its properties, open and closed sets with respect to metric defined, sequences and their convergence in metric spaces, abstract properties: connected and compactness, Heine-Borel theorem, homeomorphism and isometry of metric spaces

9. Course Objectives:

The main objective of this course is to familiarize students with the basic notions of metric spaces and understand it in a more general setting as an abstraction to real analysis.

10. Course Outcomes (Cos):

On completion of the course the students shall be able to:

1. To identify metric spaces, and analyze its properties in comparison to real valued function spaces.
2. To understand the concepts of sequence and their convergence in metric spaces.
3. To know the basic concepts of connectedness and compactness.
4. To apply the concept of metric space on various functions to describe many properties.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 13**	**Title of the unit: Introduction to Metric Spaces**

Definition and examples of metric spaces, Bounded and unbounded metric spaces, Distance between sets, Diameter of a set, Open and closed balls, Interior points and interior of a set, Open set, Neighbourhood of a point, Limit point of a set, Closure of a set, Closed set, Boundary points and boundary of a set, Exterior points and exterior of a set, Subspace of a metric space.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Sequences in Metric Spaces**

Sequences and sub-sequences in a metric space, Convergent and Cauchy sequences, Complete metric spaces, Relation between completeness and closedness, Cantor intersection theorem, Completion theorem, Dense sets, Separable spaces, Nowhere dense sets, Categories and Baire Category theorem.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Connectedness and Compactness**

Cover of a metric space, Compact metric spaces, Compact sets and their criterion, Properties of compact sets, Relation between compactness, completeness and closedness, Finite intersection property, Bolzano-Weierstrass property, Sequential compactness, Totally bounded spaces; Separated sets, Connected and disconnected metric spaces, Properties of connected sets.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Functions on Metric Spaces**

Continuous functions, Characterizations of continuous functions, Continuous functions on compact and connected spaces, Uniform continuous functions, Homeomorphism and isometry.
12. Brief Description of self-learning / E-learning component
1. https://www.youtube.com/watch?v=Af03P1xVNSs 2. https://www.youtube.com/watch?v=Ry07_mO-iac 3. https://www.youtube.com/watch?v=1DghwIIir-U
13. Books Recommended:
1. Q. H. Ansari: Metric Spaces: Including Fixed Point Theory and Set-Valued Maps, NarosaPublishing House New Delhi. 2010. 2. E. T. Copson: Metric Spaces, Cambridge University Press, 1968. 3. Mícheál O'Searcoid : Metric Spaces, Springer, 2007. 4. S. Kumaresan: Topology of Metric Spaces (2nd ed.), Narosa Publishing House, 2011.

1. Name of the Department: Mathematics						
2. Course Name	Functional Analysis	**L**	**T**		**P**	
3. Course Code	17030710	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✔)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course is for students who are majors in pure mathematics or who need functional analysis in their applied mathematics courses. Functional analysis is the branch of mathematics concerned with the study of spaces of functions. This course is intended to introduce the student to the basic concepts and theorems of functional analysis and its applications.

9. Course Objectives:

The objective of the module is to study linear mappings defined on Banach spaces and Hilbert spaces, especially linear functionals (real-valued mappings) on L^p, C[0,1] and some sequence spaces. In particular, the four big theorems in functional analysis, namely, Hahn-Banach, uniform boundedness, open mapping theorems will be covered

10. Course Outcomes (COs):

On completion of the course the students shall be able:

1. To understand the basic knowledge of normed linear spaces and Banach spaces.
2. To analyze the properties of a linear operator with the dimension of the space on which it is defined.
3. To apply the theory of normed spaces and Hilbert spaces for solving many problems of applied mathematics including integral equations and differential equations.
4. To discuss many research problems on the open mapping, closed graph and Hahn-Banach theorems.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 13**	**Title of the unit: Normed Linear Spaces**

Normed linear spaces, Metric on normed linear spaces, Holder's and Minkowski inequality, Completion of a normed space, Banach spaces, subspace of a Banach space, Completeness of l^p, l^∞,$\mathbb{R}^n$, $\mathbb{C}^n$ and $C[a,b]$. Incomplete normed spaces.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Operators on Normed Linear Spaces**

Finite dimensional normed spaces, Equivalent norms, Compactness and finite dimension, Bounded and continuous linear operators, Linear functionals, Linear operators and functionals on finite dimensional spaces, Normed space of operators, Dual spaces.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Hilbert spaces**

Inner product spaces, Hilbert spaces,Orthogonal complements and direct sums, Bessel inequality, Total orthonormal sets and sequences, Representation of functionals on Hilbert spaces, Hilbert adjoint operators, Self-adjoint, unitary and normal operators.

Unit – 4	Number of lectures = 13	Title of the unit: Fundamental theorems for Normed and Banach Spaces
Hahn-Banach theorem, Hahn-Banach theorem for complex vector spaces and normed spaces, Reflexive spaces, Uniform boundedness theorem, Strong and weak convergence, Convergence of sequence of operators and functionals, Open mapping theorem, Closed graph theorem.		

12. Brief Description of self-learning / E-learning component

1. http://www.nptelvideos.com/lecture.php?id=13908
2. https://www.youtube.com/watch?v=5BfJHZRgoEA&list=PL5022A32B9BCFE3E4&index=2
3. https://www.youtube.com/watch?v=pd3jUcTA5pA&list=PL5022A32B9BCFE3E4&index=10

13. Books Recommended

1. E. Kreyszig: Introductory Functional Analysis with Applications, Wiley India, 2007.
2. R. Bhatia, Notes on Functional Analysis, Hindustan Book Agency, India, 2009.
3. G. Bachman and L. Narici, Functional Analysis, Dover Publication, N.Y. 2000.
4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications, Anshan Ltd., 2007.
5. M. Schechter, Principles of Functional Analysis(2nd ed.),American Mathematical Society, 2002.

1. Name of the Department: Mathematics						
2. Course Name	Advanced Differential Equations	**L**	**T**		**P**	
3. Course Code	17030711	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

Fundamental existence and uniqueness theorem of solution of ODEs, Dependence of solutions on initial conditions, Existence and uniqueness theorem for higher order, Linear system of homogeneous and non-homogeneous equations, Series solution about an ordinary point and a regular singular point,Frobenius method, Lagendre, Bessel, Laguerre, Hernite, Gauss hypergeometric equations and their general solutions. Recurrence relations, Rodrigue's formula, Orthogonality properties

9. Course Objectives:

This course aims to prepare students with a deep understanding of differential equations, research oriented attitude and skill of application of differential equations, computational tools and techniques in formulation and solution of real world problems. It is specially designed to prepare students for a successful career in academic institution, research institution and industry.

10. Course Outcomes (COs):

On completion of the course the students shall be able to:

1. To solve second order and higher order linear differential equations and to determine fundamental solutions and discuss independence solutions using the Wronskian.
2. To understand the basic concept of existence and uniqueness of the differential equations.
3. To know about the series solutions of various differential equations and to discuss special functions.
4. Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillators and circuits.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 15**	**Title of the unit: Linear differential equations**

Linear differential equations of nth order, fundamental sets of solutions, Wronskian, Abel's identity, Theorems on linear dependence of solutions, Adjoint and self-adjoint linear operator, Green's theorem, Adjoint equations, Variation of parameters, zeros of solutions.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Existence- Uniqueness of solutions for ODEs**

Fundamental existence and uniqueness theorem of solution of ODEs, Dependence of solutions on initial conditions, Existence and uniqueness theorem for higher order, Eigenvalue problems, Sturm-Liouville problems, Orthogonality of eigenfunctions, Eigenfunction expansion in a series of orthonormal functions, Green's function method.

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Unit – 3	Number of lectures = 15	Title of the unit: Series Solution of ODEs
Power series solution of linear differential equations,Ordinary and singular points of differential equations, Classification into regular and irregular singular points, Series solution about an ordinary point and a regular singular point,Frobenius method, Lagendre, Bessel, Laguerre, Hernite, Gauss hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula, Orthogonality properties.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Stability analysis of solution to ODEs**
Linear system of homogeneous and non-homogeneous equations (matrix method), Linear and Non-linear autonomous system of equations, Phase plane, Critical points, Stability for linear systems, Principle of linearized stability, Stability for autonomous systems, Lyapunov functions, Plane autonomous systems, Periodic solutions of plane autonomous systems.		

12. Brief Description of self-learning / E-learning component

1. http://nptel.ac.in/courses/111108081/
2. https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/

13. Books Recommended

1. G.F. Simmons, Differential Equations with Applications and Historical Notes (2nd ed.), McGraw Hill Education, India, 2017.
2. M.S.P. Eastham, Theory of Ordinary Differential Equations, Van Nostrand Reinhold London, Florence, Kentucky, U.S.A., 1970.
3. S.L. Ross, Differential Equations (3rd ed.), Wiley,, 2007.
4. E. Rainville, P. Bedient and R. Bedient, Elementary Differential Equations (8th ed.), Pearson, 2016.
5. A.C. King, J. Billingham and S.R. Otto, Differential Equations:Linear, Nonlinear, Ordinary, Partial(1st ed.),, Cambridge University Press, New York, 2003.

C.S. Lalitha

1. Name of the Department: Mathematics						
2. Course Name	Advanced Differential Equations Lab	**L**	**T**		**P**	
3. Course Code	17030712	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	DSE (✔)	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

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

8. Course Description:

This course is designed to emphasize the knowledge of differential equations. Emphasis is placed on different forms of linear and non-linear differential equations. Upon completion, students should be able to write the programs in MATLAB and other software.

9. Course Objectives:

On completion of the course the students shall be able to:

1. Give an account of basic concepts and definitions for differential equations.
2. Use methods for obtaining exact solutions of linear homogeneous and non-homogeneous differential equations.
3. Describe some simple numerical solution techniques and be familiar with mathematical software for differential equations.
4. Use elementary methods for linear systems of differential equations.

10. Course Outcomes (COs):

After completing the course, students are expected to be able to solve differential equations analytically.

11. List of Practical's (using any one from C++, MATLAB)

1. To solve differential equations by basic methods with and without initial conditions.
2. To solve first order Bernoulli equations.
3. To solve non-linear differential equations with initial conditions.
4. To solve second order ODE with initial conditions.
5. To solve *n*th order non-homogeneous linear equations.
6. To solve eigenvalue problems.
7. To solve Sturm-Liouville problems.
8. To find power series solutions of linear differential equations.
9. To plot the Lyapunov Exponent of autonomous systems.
10. To draw th phase plot diagram of autonomous systems.

12. Brief Description of self-learning / E-learning component

1.	https://www.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
2.	https://in.mathworks.com/help/symbolic/solve-a-system-of-differential-equations.html
3.	https://www.mathworks.com/help/matlab/math/choose-an-ode-solver.html
4.	http://www.math.tamu.edu/undergraduate/research/REU/comp/matode.pdf

13. Books Recommended

1. Brian H. Hann, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists (7th ed.), Academic Press Inc., 2019.
2. Amos Gilat: MATLAB: An Introduction with Applications (8th edition), John Wiley & Sons Inc, 2016.

1. Name of the Department: Environmental Science						
2. Course Name	Ecology & Biodiversity		**L**	**T**	**P**	**Credits**
3. Course Code	17030713		4	0	0	4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5. Pre-requisite (if any)	10+2	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)		
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Ecosystem is the interaction between biotic and abiotic components of ecosystems. This course will cover ecological factors & the interaction, adaptation and functional adjustment of organisms to the changes in physical environment. This course will cover detail understanding of pattern of biodiversity and will help in understanding strategies for conserving ecosystem and biodiversity.

9. Course Objectives:

The objectives of this course are:

1. To introduce the students with factors responsible for evolution of life.
2. To understand biodiversity pattern and human interaction with ecological world.
3. To know about various conventions and treaties for biodiversity conservation.
4. To know about the working of organizations for wildlife conservation.

10. Course Outcomes (COs):

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

1. To understand principles of ecology, population and resource dynamics
2. To understand the relationship of living organisms with their environment.
3. To know the effect of human civilization and industrialization on biodiversity.
4. To know about the sustainable development for protection of ecosystem and conserving biodiversity.

11. Unit wise detailed content

Unit-1	Number of lectures = 13	Ecology & Ecosystem

Ecosystem: Definition, structure and function, Evolutionary ecology, Earth's major ecosystems - terrestrial and aquatic ecosystems, Biosphere, Ecosystem productivity, Adaptations to the physical environment, Ecosystem stability, Ecological Succession, Ecades, Ecotypes, Ecotone.

Unit – 2	Number of lectures = 13	Population Ecology

Population: Interaction, distribution, and abundance; Species and communities, Survivorship curves and models, r & k Selection, Concept of carrying capacity, Concept of Habitat and Ecological Niche, Lotka-Voltera Model.

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Unit – 3	Number of lectures = 13	Biodiversity
Historical and geographical pattern of biodiversity; Types of biodiversity, levels, and gradients of Biodiversity, Theories of biological classification, IUCN categories, red data book, green data book, Biodiversity in the welfare of mankind.		
Unit – 4	**Number of lectures = 13**	**Conservation and Sustaining Strategies**
International conventions, treaties and protocols for Biodiversity Conservation, Human impacts: threats to ecosystem and biodiversity, Role of WWF, WCU, CITES, TRAFFIC, Concept of sustainable development		

12. Brief Description of self learning / E-learning component

1. https://www.conserve-energy-future.com/what-is-an-ecosystem.php
2. https://www.youtube.com/watch?v=pv-WbXGtkzU
3. https://www.slideshare.net/TalemosSeta/lecture-note-on-biodiversity-conservation
4. https://nptel.ac.in/courses/102104068/2
5. https://www.easybiologyclass.com/biodiversity-introduction-definition-classification-importance-measurement-of-biodiversity

13. Books Recommended

1. Fundamentals of Ecology by Eugene P. Odum, Gary W. Barrett - Publisher : Cengage(5 edition) ISBN: 9780534420666
2. Ecology and Field Biology by R.L Smith , Publisher: Benjamin Cummings ISBN-10 : 0321042905
3. Principles of Environmental Science by William Cunningham and Mary Cunningham Publisher: McGraw-Hill Education; 8th edition ISBN-10 : 0078036070
4. Global Biodiversity: Volume 2: Selected Countries in Europe by Apple Academic Press ISBN: 9781771887175
5. Ecology of Natural Resources by Francois Ramade Publisher : John Wiley & Sons Inc ISBN 9780471901044

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1. Name of the Department: Environmental Sciences						
2. Course Name	Ecology and Biodiversity-Lab		**L**	**T**	**P**	**Credits**
3. Course Code	1703071		0	0	4	2
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**SEC ()**		
5. Pre-requisite (if any)	10+2	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil	**Tutorials = Nil**	**Practical = 52**				

8. Course Description:

This Course will introduce the students to the basic concept of Ecology and Biodiversity. This course will also give a platform to develop different methods to study population size of an individual organism along with biodiversity survey and conservation.

9. Course Objectives:

The objectives of this course are:

1. To study plant community ecology ecosystem.
2. To learn concepts of biodiversity pattern and value of biodiversity.
3. To describe the methods to study population size, frequency and density.
4. To know about the working of organizations for wildlife conservation

10. Course Outcomes (COs):

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

1. To demonstrate fieldwork skills like species identification and ecological survey.
2. To explain the distribution and abundance of different plant species in any region.
3. To evaluate the relationship/interactions among the different species.
4. To know about the role of wildlife and ground problems in the protection of local and national wildlife.

11. List of Experiments

1. Determination of minimum size of quadrat for community study.
2. To determine the frequency and density of species in a given area.
3. Estimation of chlorophyll content in plant samples.
4. Estimation of organic carbon content in plants.
5. Estimation of Protein content in plants.
6. To study the biodiversity present on campus.

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7. To determine diversity indices in a given area 8. Study of major National parks, Biosphere reserves and Wildlife Sanctuaries and their Flora and Fauna. 9. Biodiversity Photography: Field work 10. Case study of the reintroduction of wild animals.
12. Books Recommended
1. Fundamentals of Ecology by Eugene P. Odum, Gary W. Barrett - Publisher : Cengage (5 edition), ISBN: 9780534420666 2. Ecology and Field Biology by R.L Smith , Publisher: Benjamin Cummings ISBN-10 : 0321042905 3. Global Biodiversity: Volume 2: Selected Countries in Europe by Apple Academic Press, ISBN: 9781771887175 4. Ecology of Natural Resources by Francois Ramade Publisher : John Wiley & Sons Inc ISBN 9780471901044

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1. Name of the Department: Environmental Science						
2. Course Name	**Air and Noise Pollution**	**L**	**T**	**P**	**Credits**	
3. Course Code	17030715	4	0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5. Pre-requisite (if any)	10+2	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Atmospheric Pollution and control is based on the information about different processes in Atmospheric chemistry in relation to gases and particulate matter. This course will cover basic concepts in atmospheric chemistry and noise pollution. It also covers the detail knowledge related to effect of human activities on the natural atmospheric properties. Also the health effects and control measures for air and noise pollution are studied.

9. Course Objectives:

1. To describe the structure, photochemistry and chemical processes existing in the atmosphere.
2. To understand the concepts and unifying features of atmospheric chemistry.
3. To know about causes, effects and control measures of gaseous and particulate pollutants.
4. To understand the sources and harmful impacts of noise pollution on humans and other organisms.

10. Course Outcomes (COs):

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

1. To apply the concepts and unifying features of atmospheric chemistry.
2. To understand the interconnections between different layers of atmosphere and their importance.
3. To understand the effect of human activities on the natural atmosphere.
4. To understand estimation methods of different air pollutants.
5. To know about the different sound indices and control measures for noise pollution.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Air Pollution and its effects**

Air pollution: composition and structure of atmosphere, global implications of air pollution. Sources and Classification of air pollutants, Indoor air pollution, Effects of air pollutants on humans, animals, property and plants, Case Studies.

Unit – 2	**Number of lectures = 13**	**Dispersion of pollutants**

Meteorological aspects of air pollution dispersion; lapse rate, inversion and stability, wind velocity and turbulence, plume behaviour, dispersion of air pollutants, the Gaussian Plume Model, stack height and dispersion.

Unit – 3	**Number of lectures = 13**	**Air pollution control devices**

Ambient air quality standards, Ambient air sampling: gaseous and particulate pollutants, stack sampling, IOT based monitoring systems, Control devices for particulate and gaseous contaminants: gravitational settling chambers, cyclone separators, wet scrubbers, fabric filters (Bag-house filter), Electrostatic precipitators (ESP), Catalytic converters.

Unit – 4	**Number of lectures = 13**	**Noise pollution**

Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; effects of noise on humans, noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices.

12. Brief Description of self learning / E-learning component

1. http://acmg.seas.harvard.edu/people/faculty/djj/book/powerpoints/index.html
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-84j-atmospheric-chemistry-fall-2013/lecture-notes/

13. Books Recommended

1. Industrial Noise Control: Fundamentals And Applications, 2Nd Edition by H. Bell; Douglas H. Bell Publisher : T&F India, ISBN : 9781138583191
2. Introduction to Environmental Engineering and Science (3rd Edition) by Gilbert M. Masters; Wendell P. Ela Publication : Pearson, ISBN : 9780131481930
3. Introduction to Atmospheric Chemistry, Daniel J. Jacob, Publisher: Cambridge University Press, ISBN-13: 978-0521778008
4. Air Pollution: Its Origin and Control.3rd Edition, Kenneth Wark and C F Warner, Publisher : Pearson; ISBN-13 : 978-0673994165
5. Air Pollution Control Engineering. Ist Edition by Rao and Rao, Publisher : McGraw Hill Education
6. ISBN-13 : 978-0074518717

1. Name of the Department: Environmental Science						
2.Course Name	Air and Noise Pollution- Lab		**L**	**T**	**P**	**Credits**
3.Course Code	17030716		0	0	4	2
4.Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5.Pre-requisite (if any)	10+2	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 52**			

8.Course Description:

This Course will introduce the students to understand the principle and working of different instruments used for air quality assessment. To know properties of different pollutants and their sampling methodology. To understand the residence and transport of pollutants in atmosphere.

9.Course Objectives:

The objectives of this course are:

1. To know the concentration of Particulate Matter in air.
2. To acquaint with NO_2 measurement procedure.
3. To acquaint with SO_2 measurement procedure.
4. To get familiar with stack monitoring procedure.
5. To understand procedure of noise measurement using Noise level meter.

10.Course Outcomes (COs):

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

1. Use different instruments for air quality assessment.
2. Analyze various parameters for air quality assessment like concentration of NO_2, SO_2, CO, PM etc.
3. Explain the sources of different types air pollutants.
4. Understand the working and applications of Sound level meter.

11.List of Experiments

1. Determination of respirable suspended particulate matter (RSPM) in ambient air quality.
2. Determination of NO_2 concentration in ambient air quality.
3. Determination of SO_2 concentration in ambient air quality.
4. Study of ambient noise level.
5. Stack monitoring and analysis of different pollutants.
6. Determination of Carbon Monoxide.
7. To compare the pollution level of different location.
8. Indoor air quality monitoring of campus.
9. To study the occupational health effects of air pollution: case study/survey.

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10. To study the occupational health effects of noise pollution: case study/survey.
12.Books Recommended
1. Air pollution by Rao & Rao, Publisher : McGraw Hill Education ISBN-13 : 978-0074518717 2. National Ambient Air Quality Series: Central Pollution Control Board

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

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

8. Course Description:

The goal of this course is to provide an introduction to Python. The course will discuss topics necessary for the participant to be able to create and execute Python programs. The lectures and presentations are designed to provide knowledge and experiences to students that serve as a foundation for continued learning of presented areas.

9. Course Objectives:

This course aims to introduce the fundamentals of Python programming. Students will be learning core Python script elements such as variable and flow control structures. This course will enable the students to write their own Python programmes for various numerical methods related to the problem of integration, differentiation, solution of Ordinary differential equations and system of linear equations.

10. Course Outcomes (COs):

After completing this course students are expected to be able:

1. To install and run the Python interpreter.
2. To create and execute Python programs.
3. To understand the concepts of file I/O.
4. Be able to read data from a text file using Python.
5. To Plot data using appropriate Python visualization libraries.

11. Unit wise detailed content

List of Practicals to perform in a computer lab using Python.

1. Write a program to find the sum of *n* natural numbers.
2. Write a program to check if a number is prime or not.
3. Write a program that stores marks obtained by a student in three different subjects and gives the following outputs: Fail-if less than 40% in at least two subjects, Pass:If more than 40% in all the subjects and Re-If less than 40% in exactly one subject.
4. Make a list of the numbers from one to one million, and then use a *for* loop to print the numbers.
5. Create, edit and delete items in a dictionary.
6. Write a program to find roots of an equation by bisection method.
7. Write a program to find roots of an equation by Newton-Raphson method.
8. Write a program to solve a system of equations by Gauss-Jacobi method.
9. Write a program to integrate a function by trapezoidal rule.
10. Write a program to integrate a function by Simpson's $1/3^{rd}$ rule.
11. Write a program to solve a first order ODE with given initial value by Euler's method.
12. Write a program to solve a first order ODE with given initial value by Runge-Kutta4^{th} order method.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=Y3Ri2GdYfYg&list=PLqftY2uRk7oXvERQEgATSr-KzAh8WLW_D
2. https://www.youtube.com/watch?v=eoPsX7MKfe8&list=PLIdgECt554OVFKXRpo_kuI0XpUQKk0ycO

13. Books Recommended

1. Jason Montojo, Jennifer Campbell and Paul Gries: An Introduction to Computer Science using Python 3, SPD, 2014.
2. P. K. SinhaandPritiSinha: Computer Fundamentals, BPB Publications, 2007.
3. T. Budd: Exploring Python, Tata Mc-Graw Hill, 2011.

SEMESTER-VIII (DSE)

1. Name of the Department: Physics						
2. Course Name	Advance Quantum Mechanics	**L**	**T**		**P**	
3. Course Code	17030801	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (√)**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course contains the physical and mathematical basic of quantum mechanics for relativistic and non-relativistic systems. Relativistic quantum theory like Klein-Gordon equation and Dirac equation is also covered.

9. Course Objectives:

The primary objective is to teach the students the physical and mathematical basis of quantum mechanics for non-relativistic systems and Relativistic quantum theory like Klein-Gordon equation and Dirac equation is also covered.

10. Course Outcomes (COs):

Course Learning Outcomes Students will learn

1. The mathematical formalism of Hilbert space, Hermitian Operators, Eigen values, Eigen states and unitary operators, which form the fundamental basis of quantum theory.
2. Application to simple harmonic oscillators, hydrogen-like atoms and angular momentum operators will teach the students how to obtain Eigen values and Eigen states for such systems elegantly.
3. The topic of density matrices that plays significant roles in quantum information theory and statistical mechanics will also help the students considerably.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Abstract formulation of Quantum Mechanics**

Mathematical properties of linear vector spaces. Dirac's bra and ket notation. Hermitian operators, eigenvalues and eigenvectors. Orthonormality, completeness, closure. Postulates of quantum mechanics. Matrix representation of operators. Position and momentum representations – connection with wave mechanics. Commuting operators. Generalised uncertainty principle. Change of basis and unitary transformation. Expectation values. Ehrenfest theorem.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Quantum Dynamics**

Schrodinger picture,. Heisenberg picture, Heisenberg equation of motion, classical limit, Solution of simple harmonic oscillator problem by the operator method, general view of symmetries and conservation laws, Symmetries in Quantum Mechanics : hydrogen-like atoms and spherical harmonics. Spatial translation – continuous and discrete, time translation. parity, time reversal, Density matrices - properties, pure and mixed density matrices, expectation value of an observable, time-evolution, reduced density matrix

Unit – 3	**Number of lectures = 13**	**Title of the unit: Angular Momentum**

Commutation relations of angular momentum operators. Eigenvalues, eigenvectors. Ladder operators and their matrix representations. Spin angular momentum and Pauli matrices. Identical

particles: Many-particle systems, Exchange degeneracy, symmetric and anti-symmetric wavefunctions. Pauli exclusion principle. Addition of angular momenta. Clebsch-Gordan coefficients. Wigner - Eckart theorem.
Unit - 4 | **Number of lectures = 13** | **Title of the unit: Relativistic Quantum Mechanics**
Klein-Gordon and Dirac equations. Properties of Dirac matrices. Plane wave solutions of Dirac equation. Spin and magnetic moment of the electron, non-relativistic reduction of the Dirac equation.
12. Books Recommended
1. Quantum Mechanics, B. H. Bransden & C. J. Joachain (Pearson Education, 2000) 2. Principles of Quantum Mechanics,R. Shankar (3rd Ed., Springer, 2008) 3. Quantum Mechanics (Vol. I),Claude Cohen-Tannoudji, Bernard and Frank Laloe 16 (Wiley, 1977) 4. Modern Quantum Mechanics, J. J. Sakurai (Addison-Wesley, 1993) 5. Advanced Quantum Mechanics, F. Schwabl (Springer, 2000) 6. Quantum Mechanics, A. S. Davydov (2nd Ed., Pergamon, 1991) 7. Quantum Mechanics, Eugen Merzbacher (3rd Ed., Wiley, 1997) 8. Quantum Mechanics: Concepts and Applications, Nouredine Zettili (Wiley 2nd edition 2009)
13. Online Links **1.** https://en.wikipedia.org/wiki/Mathematical_formulation_of_quantum_mechanics 2.https://www.youtube.com/watch?v=6Wfe82jBxm4&list=PLaNkJORnlhZlLjsbsfiQaw3Hpf1AoqjWb 3. https://www.youtube.com/watch?v=x-PS5QirFu8

1. Name of the Department: Physics						
2. Course Name	Physics Practical-3	**L**	**T**		**P**	
3. Course Code	17030802	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

In this course student will gain the practical and simulation knowledge about the reflection and
transmission of a plane quantum wave at a lD Woods-Saxon potential, Schr0dinger Equation for
arbitrary potential, Energy levels with corresponding eigenfunctions, Quantum mechanical scattering problem, of Electron spin resonance- determine magnetic field as a function of the resonance frequency etc.

9. Course Objectives:

l. To study Probability Density as a function

2. To study quantum mechanical scattering problem

3. Numerical and exact solution for Schrodinger equation for Particle in a box Quantum harmonic oscillator

4. Wave packet propagation using exponential of H

10. Course Outcomes (COs):

1. Demonstrate the comprehensive and theoretical knowledge of Quantum Mechanics and Schrödinger equations with Angular Momentum operator and representation

2. Various tools to calculate Eigen values and total angular momentum of particles

3. Study of Approximation Method and scientific Time independent and dependent perturbation theory

4. To analyze quantum & Schrodinger equations based research and with its applications

11. List of Experiments

1. Wave packet propagation using exponential of H and Parameters for solving the problem in the interval $0 < x < L$
2. Calculate Probability Density as a function of time for a particle trapped in a double-well potential.
3. Calculate first and second derivative numerically showing how to write differential operator as a matrix.
4. Gaussian wave packet as solution of the free Schrödinger equation (Computational and simulation)
5. Matrix representation of differential operators and Solving for Eigenvectors & Eigen values of Infinite Square Well.

6. The quantum mechanical scattering problem (Computational and simulation) (In this practical we will calculate the reflection and transmission of a plane quantum wave at a lD Woods-Saxon potential using an approach that considers the incoming, the reflected and the transmitted wave parts)
7. Numerical and exact solution for Schrodinger equation for Particle in a box Quantum harmonic oscillator
8. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
9. Study of H_2 atom wave function using quantum mechanics
10. Find several lowest eigenmodes V(x) and eigenenergies E of 1D Schrodinger equation $-1/2*hbar^2/m(d^2/dx^2)V(x) + U(x)V(x) = EV(x)$ for arbitrary potentials U(x).

12. Books Recommended:

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 1st ed., (Oxford University Press, 1930).
2. C. C. Silva and R. de Andrade Martins, "Polar and axial vectors versus quaternions," Am. J. Phys. 70, 958-963 (2002).
3. R. W. Robinett, Quantum Mechanics: Classical Results, Modern Systems, and Visualized Examples, (Oxford University Press, 1997).
4. H. Gould, "Computational physics and the undergraduate curriculum," Comput. Phys. Commun. 127, 610 (2000); J. Tobochnik and H. Gould, "Teaching computational physics to undergraduates," in Ann. Rev. Compu. Phys. IX, edited by D. Stauffer (World Scientific, Singapore, 2001), p. 275; H. Gould, J. Tobochnik, W. Christian, An Introduction to Computer Simulation Methods: Applications to Physical Systems, (Benjamin Cummings, Upper Saddle River, NJ, 2006) 3rd ed..
5. R. Spenser, "Teaching computational physics as a laboratory sequence," Am. J. Phys. 73, 151-153 (2005).
6. D. Styer, "Common misconceptions regarding quantum mechanics," Am. J. Phys. 64, 31-34 (1996).
7. A. Goldberg, H. M. Schey, J. L. Schwartz, "Computer Generated Motion Pictures of One-Dimensional Quantum Mechanical Transmission and Reflection Phenomena," Am. J. Phys. 35, 177-186 (1967).
8. C. Singh, M. Belloni, and W. Christian, "Improving students' understanding of quantum mechanics," Physics Today, August 2006, p. 43.
9. These MATLAB commands are explained in an extensive on-line, tutorial within MATLAB and which is also independently available on the MathWorks website, http://www.mathworks.com/.
10. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd Ed., Prentice Hall 2003.
11. A. Garcia, Numerical Methods for Physics, 2nd Ed., (Prentice Hall, 1994).
12. G. Lindblad, "Quantum Mechanics with MATLAB," available on internet,http://mathphys.physics.kth.se/ schrodinger.html.

1. Name of the Department: Physics						
2. Course Name	Physics of Nanomaterials	**L**	**T**	**P**		
3. Course Code	17030803	4	0	0		
4. Type of Course (use tick mark)	Core ()	DSE ()	SEC (√)			
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52	**Tutorials = 0**	**Practical = 0**				

8. Course Description:

It includes Fundamental of Nanomaterials, Nanofabrication Techniques, Characterization of Nanomaterials and Nanomaterials and Devices

9. Course Objectives:

The course aims to provide students with an understanding of the basics of nanomaterials, techniques used in fabrication of nanomaterials, characterization of different types of nanomaterials. It also gives the idea how to design electric devices, magnetic and gas sensors etc. using nanomaterials.

10. Course Outcomes (COs):

After the successful completion of the course, students would be able to
1. understand the fundamentals of nanomaterials.
2. understand different fabrication techniques for the nanomaterials
3. understand the basics of the different characterization techniques used in basic research in the field of nanoscience.
3. describe the basic involved in the design of devices based on nanotechnology.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit:** Fundamental of Nanomaterials

Definition of nanotechnology, Nanomaterials, Novel combination of properties of materials of nanoscale, Functional enhancement, Size dependence on melting point, Size dependence on vapour pressure, Nucleation, Size dependence on Chemical reactivity, Intermolecular interactions, Size dependence on Surface tension of solid surfaces, Quantum confinement & energy levels, Band structure, Density of states in 0D, 1D, 2D & 3D materials, Quantum dots, wires, & wells.

Unit - 2	**Number of lectures = 14**	**Title of the unit:** Nanofabrication Techniques

Top down and bottom up approaches to nanofabrication, Nucleation & growth mechanism, Optical & electron beam lithography, Thin films deposition, Evaporation, Sputtering, Electrode position and sol Gel Technique, Plasma assisted chemical vapour deposition, Molecular beam epitaxy, Atomic layer deposition.

Unit - 3	**Number of lectures = 12**	**Title of the unit:** Characterization of Nanomaterials

X-ray diffraction techniques, Scanning transmission electron microscopy, SEM, TEM, Contact &Non-contact methods of surface characterization, Atomic force microscopy, FTIR, Surface plasma resonance techniques, Electron spectroscopy techniques like AES, XPS, SIMS.

Unit - 4	**Number of lectures = 14**	**Title of the unit:** Nanomaterials and Devices

Carbon based nanomaterials, Small and Large Fullerenes and Other Buckyballs, Carbon nanotubes and their Electronic structure, Graphene, Metal matrix composites, Single electron devices, Molecular electronic devices, Coupled quantum dots, Spintronics, Ultra-sensitive magnetic sensors, Spin dependent transistors, Photonic devices.

12. Brief Description of self-learning / E-learning component:

To understand basic concepts in detail, students may get study materials on following links.
https://onlinecourses.nptel.ac.in/noc18_ph02
https://ocw.mit.edu/courses/physics/
https://www.mooc-list.com/

13. Books Recommended

1. John H. Davies. The Physics of Low Dimensional Semiconductors. Cambridge University Press.
2. J.J. Ramsden. Nanotechnology- An Introduction. William Andrew Elsevier.
3. Ning Xi and King W. Chiu Lai. Nano-optoelectronics Sensors and Devices. William Andrew Elsevier.
4. V.V. Mitin, V.A. Kochetp and M.A. Stroscio. Quantum Heterostructures: Microelectronics and Optoelectronics. Cambridge University Press.
5. G. Cao. Nanostructures and Nanomaterials: Synthesis, Properties and Applications. Imperial College Press.
6. C.P. Poole and F.J. Owens. Introduction to Nanotechnology. New York: John Wiley. M. Wilson, K. Kannangara, M. Simmons and B. Raguse. Nanotechnology. Overseas Press.

1. Name of the Department: Physics							
2. Course Name	**Physics Practical-4**	**L**	**T**	**P**			
3. Course Code	17030804	0	0	4			
4. Type of Course (use tick mark)		**Core ()**	**DSE (√)**		**SEC ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**	**Practical = 26**				

8. Course Description:

This course includes basics of spectroscopy, UV/Visible spectroscopy, Mossbauer and X-ray Photoelectron Spectroscopy, nonlinear phenomenon and applications of Laser spectroscopy

9. Course Objectives:

1. Demonstrate the experimental knowledge of basic spectroscopic techniques that use different spectroscopy and lasers

2. Experimental knowledge of spectroscopy in solving complex problems, and conceptualizing their solutions X-ray diffraction technique

3. Laboratory exercises that illustrate the Provide a degree of experimental skill in the characterization of nanomaterials

4. Research based knowledge on the techniques and instrumentation for laser and spectroscopy with concepts and phenomena that are characteristic of lasers

10. Course Outcomes (Cos):

After successful completion of the course, students will be able to correlate the theoretical concepts of different type of spectroscopy and identify its practical applications through experiment procedure and results

11. List of Experiments

1. To determine the variation of refractive index of the material of prism with wavelength and to verify Cauchy's dispersion formula.
2. Measurement of Raman spectrum of CCl_4 by Raman Spectroscopy.
3. To study the characteristics of the spin coater
4. To index the x-ray diffraction pattern
5. To measure the grain size from the x-ray diffraction peaks
6. Measurement and analysis of Sodium by Photoelectron spectroscopy (XPS)
7. Measurement and analysis of ceramics and inorganic oxides by UV/Visible Absorption Spectroscopy
8. Measurement and analysis of emission spectrum Organic and Inorganic compound by Photo luminance spectroscopy
9. Determination of optical band gap using UV visible spectroscopy of Inorganic compounds
10. Study of balanced state of different atoms present in a Organic/Inorganic compound by XPS Spectroscopy
11. Study of lifetime of photo luminance emission spectrum using time resolve spectroscopy

Note: The list of the experiment given above should be considered as suggestive of the standard and available equipment. The faculty members are authorized to add or delete from this list whenever considered necessary.

12. Book Recommended:

1. W. Demtroder: Laser Spectroscopy: Basic Concepts and Instrumentation and Instrumentation, ISBN No. 978-3-662-05155-9, 2003, Springer-Verlag Berlin Heidelberg.

2. J. M. Hollas. High Resolution Spectroscopy, 2nd Edit. ISBN: 978-0-471-97421-5, 1998, Wiley Publication

3. Anne Thorne, Spectrophysics, ISBN No. 978-94-009-1193-2, Edition. 1, 1988, Springer Netherlands.

4. J. M. Hollas. Modern Spectroscopy, ISBN No. 978-0471911210, 1986, Wiley–Blackwell.

1. Name of the Department: Chemistry						
2. Course Name	Transition Metal Chemistry		**L**		**T**	**P**
3. Course Code	17030805		4		0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description

This course is aimed at familiarizing the students with the concept of metal ligand bonding, important metal ring compounds and the reaction chemistry of coordination complexes. This course will enable students to learn the stability aspects of complexes of transition metal ions with different ligands, taking into account all the possible factors, especially the chelate effect. Further, the course will give detailed description of the substitution reaction mechanisms of octahedral and square planar geometries of coordination complexes as well as insight into the redox reaction mechanisms. A part of this course emphasizes on structure and bonding in important inorganic ring, cage and cluster compounds having wide applicability, and thus learning and understanding of this chemistry will be beneficial to the students.

9. Course Objectives

The objectives of this course are:

1. To explain the concept of energetics of hybridization and study certain anionic species of transition metal ions
2. To explain the stability of metal complexes in terms of formation constants and with respect to metal ion and ligand.
3. To understand the concept of lability and inertness in coordination complexes.
4. To explain the mechanisms of ligand displacement reactions in octahedral and square planar complexes
5. To explain the mechanisms of redox reactions in complexes
6. To understand the chemistry of inorganic rings, cages and cluster compounds.

10. Course Outcomes (COs):

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

1. Understand the finer aspects of energetics of hybridization and structure of iso- and hetero- poly anions
2. Explain the stability constants and the various factors determining stability of complexes
3. Predict the course of ligand displacement reactions in octahedral and square planar complexes
4. Predict the course of redox reactions of transition metal complexes.
5. Develop understanding for the structure and bonding of inorganic chains, rings and cages.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Metal-Ligand Bonding and Equilibria in Solution**

Bent Rule and energetics of hybridization, Isopoly and Heteropoly anions, Stepwise and overall formation constants and their interactions, Trends in stepwise constants, Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin.

Unit-2	**Number of lectures = 15**	**Title of the unit: Reaction Mechanism of Transition Metal Complexes-I**

Inert and labile complexes, Kinetic application of Valence Bond Theory and Crystal Field Theory in lability and inertness, Substitution reactions of octahedral complexes, Acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism, Evidences in favour of conjugate mechanism.

Unit-3	**Number of lectures = 15**	**Title of the unit: Reaction Mechanism of Transition Metal Complexes-II**

Substitution reactions of square planar complexes, Mechanism of substitution reactions, Trans Effect, Theories of Trans Effect, Redox Reactions, Atom transfer reactions, Electron transfer reactions, Mechanism of one-electron transfer reactions, Outer sphere mechanism, Inner sphere mechanism, Marcus Hush Theory

Unit - 4	**Number of lectures = 14**	**Title of the unit: Chemistry of Inorganic Rings, Cages and Metal Cages and Metal Clusters**

Borazines, Phosphazenes, Boranes, Carboranes, Metalloboranes and metallocarboranes, Wade's rules, Metal carbonyl cluster compounds, Metal halide cluster compounds, compounds with metal-metal multiple bonds, Chevrel phases, Zintl ions

12. Brief Description of self-learning / E-learning component

1. https://archive.nptel.ac.in/courses/104/101/104101090/.
2. https://archive.nptel.ac.in/courses/104/105/104105085/
3. https://www.youtube.com/watch?v=1jRo5fTg0KY
4. http://web.mit.edu/5.03/www/readings/polyhedral_boranes/006_cluster_bonding.pdf

13. Books Recommended

1. Selected Topics in Inorganic Chemistry, Malik, Tuli and Madan, New Delhi : S. Chand & Company Ltd, ISBN-13: 978-8121906005
2. Inorganic Chemistry, T. Moeller, Wiley; 2nd edition, ISBN-13: 978-0471612155
3. Modern Aspects of Inorganic Chemistry, H.J. Emeleus and A.G. Sharpe, Routledge & Kegan Paul PLC; Revised ed edition, Routledge and kegan paul PLC ISBN-13: 978-0710075215
4. Chemical Binding by O.P. Agarwal, Disha Publication; Second edition ISBN: 9788188476039, 818847603X.
5. Inorganic Reaction Mechanism by Edberg, vol. 70 , 1st edition, ISBN: 9780128128343
6. Mechanism of Inorganic reaction by F. Basolo R.G. Pearson, John Wiley & Sons Inc, ISBN-13: 978-0471055457
7. Structural Principles in Inorganic Compound, W.E.A. Addison,Longmans, ISBN-13: 978-0582442016
8. Advanced Inorganic Chemistry by Cotton and Wilkinson, A Wiley-Interscience publication, 5th Edition ISBN-13: 978-0471199571
9. Fundamental Concepts in Inorganic Chemistry, Vol. 2, Asim Das and Mahua Das, CBS Publishers & Distributors Pvt Ltd, India; 1st editionISBN-13: 978-8123923512
10. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Prentice Hall; 4 edition, ISBN-13: 978-0060429959
11. Inorganic Chemistry by Shriver and Atkins, Oxford; 5 edition ISBN-13: 978-0199236176
12. Polyoxometalate Molecular Science by Juan J. Borrás-Almenar, Eugenio Coronado, Achim Müller and Michael Pope,NATO Science Series, (NAII, volume 98), ISBN 978-1402012426

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Chemistry Practical - I		**L**	**T**	**P**	
3. Course Code	17030806		0	0	4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = Nil	**Tutorials = Nil**	**Practical = 52 hrs.**

8. Course Description

The lab work focuses on **Quantitative Inorganic Analyses** and **Cerimetry**. In the former analyses, binary mixtures of metal complexes will be taken and strengths of individual metal ions in these mixtures will be determined by **gravimetric** and **volumetric** analyses.

The latter part deals with determination of metal ions by Cerimetry (also called **cerimetric titration** or **cerate oximetry**), which is a redox titration in which a Fe^{2+}-1,10-phenanthroline complex (ferroin) changes colour at the end point. Ferroin is reversibly discoloured in its oxidized form upon titration with a Ce^{4+} solution.

9. Course Objectives

The objectives of this course are:

1. To separate and determine the selected binary mixtures of metal ions employing volumetric methods
2. To separate and determine the selected binary mixtures of metal ions employing gravimetric methods
3. To determine the strengths of anions using cerimetry.
4. To learn quantitative analysis of inorganic compounds.

10. Course Outcomes (COs)

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

1. Perform quantitative estimation of metal ions from their binary mixtures using gravimetric methods
2. Perform quantitative estimation of metal ions from their binary mixtures using volumetric methods
3. Undertake quantitative determination common anions using Cerimetry.
4. Quantitatively analyse the inorganic compounds

11. List of Experiments (At least seven experiments to be performed by the student)

I. Separation and determination of a mixture of following two metal ions involving volumetric and gravimetric methods

a. Silver-Copper
b. Copper-Nickel
c. Copper-Zinc
d. Copper-Magnesium
e. Copper-Barium
f. Copper-Nickel-Zinc
g. Copper-Nickel-Magnesium

II. Determination by Cerimetry

a. Ferrous
b. Oxalate
c. Nitrite

12. Brief Description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=tGHJ6LUUBIY
2. https://www.youtube.com/watch?v=0HZ7_muDE_8
3. https://www.youtube.com/watch?v=GI_o_34dVcM
4. https://www.youtube.com/watch?v=cptn5HCEK54

13. Books Recommended

1. Basic Principles of Practical Chemistry",Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R, 2nd edition, Sultan Chand and Sons Publication, New Delhi. ISBN: 9788180547768
2. Advanced Experimental Chemistry",Gurtur, J. N. and Kapoor, R ., Vol. I, S. Chand & Co., Ltd, New Delhi ISBN: 9788192959887.
3. Advanced Practical Chemistry, 8th Edition, Pragati Prakashan, Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav,L.D.S., Singh, R.K.P., Singh, J., ISBN:: 978-93-86633-50-7
4. Advanced Inorganic Analysis, Agarwal, S.K., Lal, K. Pragati Prakashan ISBN: 978-93-87151-38-3
5. Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education,Mendham, J., ISBN-13: 978-8131723258
6. Vogel's Qualitative Inorganic Analysis, Pearson Education, Svehla, G., Sivasankar, B., ISBN: 9788131773710.

1. Name of the Department: Chemistry						
2. Course Name	Instrumental Techniques	**L**		**T**	**P**	
3. Course Code	17030807	4		0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		
8. Course Description:						
In the course, students will practice hands-on training in analytical chemistry, for example, the testing experiments of soil, water, food product, and cosmetic analysis. In the course, Practices of Chromatographical and instrumental techniques.						
9. Course Objectives						
The objectives of this course are to: 1. Develop the understanding of the Infrared spectroscopy 2. Develop the understanding of the UV-Visible/ Near IR 3. Develop analytical and chromatographic skills 4. To develop instrumental techniques and skills in students.						
10. Course Outcomes (COs)						
Upon successful completion of this course, the student will be able to: 1. Provide the identification of compounds using Infrared spectroscopy. 2. Deliver the understanding the application of UV-Visible spectroscopy. 3. Provide the understanding of the application of analytical methods. 4. perform the hands-on practice with chromatographic techniques.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 13**	**Title of the unit: Infrared Spectroscopy**				
Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of the spectrum (wavelength dispersion, time resolution), Detection of the signal (heat, differential detection), Interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR).						
Unit-2	**Number of lectures = 13**	**Title of the unit: UV-Visible/ Near IR**				
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-3	**Number of lectures = 13**	**Title of the unit: Separation Techniques**				
Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on the increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.						
Unit-4	**Number of lectures = 13**	**Title of the unit: Elemental Analysis**				
Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting a sample into the 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: Principle, Instrumentation, Factors affecting chemical shift, Spin coupling, Applications
12. Brief Description of self-learning / E-learning component
1. https://nptel.ac.in/courses/102106048/8 2. https://nptel.ac.in/courses/104106122 3. https://www.digimat.in/nptel/courses/video/104102113/L19.html
13. Books Recommended
1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch ISBN 0-495-01201-7. 2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle. ISBN: 9788123909431, 9788123909431 3. P.W. Atkins: Physical Chemistry. ISBN-10:9780198814740 4. G. W. Castellan: Physical Chemistry. ISBN-10:8185015597 5. C.N. Banwell: Fundamentals of Molecular Spectroscopy. ISBN-10:9352601734 6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.ISBN-13:978-0849324635 7. W.J. Moore: Physical Chemistry. ISBN-10: 0582442346

1. Name of the Department: Chemistry						
2. Course Name	Instrumental Techniques Lab		**L**	**T**		**P**
3. Course Code	17030808		0	0		4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**GE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 0		**Tutorials = 0**		**Practical = 52 hrs.**		

8. Course Description

The lab work emphasizes learning of basic skills helpful not only to chemistry students but all those who want to pursue any experimental science. It includes using instruments, to determine isoelectric pH of a protein, to identification of compounds using NMR, Spectrometry. It also includes, determination of Calcium, Iron, and Copper in Food by Atomic Absorption.

9. Course Objectives

The objectives of this course are to:

1. Introduce students to Safety Practices in the Chemistry Laboratory
2. Explain various concepts of techniques for the identification of compounds.
3. Learn the determination of a Mixture of Cobalt and Nickel using various techniques.
4. Learn quantitative/qualitive analysis of mixtures by various techniques.

10. Course Outcomes (COs)

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

1. Perform various experimental to identification of compounds.
2. Detection of illegal drugs or steroids in athletes
3. Detection of pollutants or illegal dumping
4. Determine the quantitative/qualitive of mixtures by various techniques.

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

Instrumental Techniques

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/Paper Chromatography
11. Potentiometric Titration of a Chloride-Iodide Mixture
12. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
13. Nuclear Magnetic Resonance of organic compounds
14. Mass spectrometry of organi compounds
15. Detection of illegal drugs or steroids in athletes
16. Detection of pollutants or illegal dumping

12. Brief Description of self-learning/ E – learning component

1. https://www.youtube.com/watch?v=fjiTEUEXfCI
2. https://www.youtube.com/watch?v=d8DftLa3m5M
3. https://www.youtube.com/watch?v=3zAHebLMyI4&list=PLrTvGdxJHsrjro2FT2DyHULMbpCH27_0T&index=3
4. https://www.youtube.com/watch?v=C1PamK587zg&list=PLrTvGdxJHsrjro2FT2DyHULMbpCH27_0T&index=6

13. Books Recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012, ISBN, 978-8131773710.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009, ISBN 9788131723258.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011), ISBN 978-81-265-3016-8.
4. B Viswanathan, PS Raghavan, Practical Physical Chemistry, Viva Books, ISBN 978-8130929699.

1. Name of the Department: Mathematics						
2. Course Name	Analysis-II	**L**	**T**		**P**	
3. Course Code	17030809	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✔)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course covers some fundamental topics of mathematical analysis. In this course the students will be taught Riemann and Riemann-Stieltjes integral, pointwise and uniform convergence of the sequence and series of functions.

In this course the students will be taught and theory of functions of complex variables, discussed in the course are analytic and harmonic functions and their properties, power series and Laurent series, isolated singularities.

9. Course Objectives:

After completing this course, students will be able:

1. To understand the concept of Riemann and Reimann-Stieltjes integral and related consequences.
2. To study pointwise and uniform convergence of the sequence and series of real valued functions.
3. To study analytic function, Cauchy residue theorem, evaluation of integral of complex valued function.
4. To study bilinear transformation, integral function and related results.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To demonstrate the ability to work with Riemann-Stieltjes integrals.
2. To solve problems based on point wise and uniform convergence of sequences of functions.
3. To understand the concept of Cauchy's residue theorem and evaluation of integrals.
4. To identify singularity using power series expansion.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 13**	**Title of the unit: Riemann Integral**

Partition of a set, Upper and lower sum, Riemann integral, Properties of the integral, Change of variable, Integration and differentiation, Fundamental theorem of integral calculus, Integration by parts, First and second mean value theorems for Riemann integrals.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Sequences and Series of Functions**

Point wise and uniform convergence of sequences of functions, Cauchy criterion for uniform convergence, Differentiation and integration of sequence/series of function, Convergence and uniform convergence of series of functions, Weierstrass M-test, Abel's test, Weierstrass approximation theorem.

C.S. Lalitha

Unit – 3	Number of lectures = 13	Title of the unit: Cauchy's Theorems and Fundamental Theorem of Algebra
Anti-derivatives, Proof of anti-derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula, An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem, Fundamental theorem of algebra.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Power Series**
Convergence of sequences and series, Taylor series and its examples, Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity, Types of isolated singular points, Residues at poles and its examples.		
12. Brief Description of self-learning / E-learning component		
1. https://www.youtube.com/watch?v=xPyy2uSzKjU 2. https://www.youtube.com/watch?v=5nIHi09HmrA		
13. Books Recommended		

1. T.M. Apostol: Mathematical Analysis, Narosa Publishing House (2nd ed.), 2002.
2. R.R. Goldberg: Methods of Real Analysis, Oxford & IBH publishing Co., 2020.
3. D. Somasundaram and B. Choudhary: A First Course in Mathematical Analysis, Narosa Publishing House, 1997.
4. Shanti Narayan: A Course of Mathematical Analysis, S.Chand & Co,2005.
5. Shanti Narayan: Theory of Functions of a Complex Variable, S. Chand & Co, 2005.

1. Name of the Department: Mathematics						
2. Course Name	Algebra-II	**L**	**T**		**P**	
3. Course Code	17030810	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✔)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

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

8. Course Description:

This course covers group actions, Sylow's theorems, solvable groups, module theory and Galois fields. It further covers diagonalizability, spectral decomposition, spectral theorem and Jordan canonical form of matrices.

9. Course Objectives:

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

1. To identify and construct examples of modules.
2. To use the skills of abstract algebra in solving different types of problems.
3. Classify finite fields using roots of unity and Galois theory
4. To understand the concepts of solvable groups, nilpotent groups etc.

10. Course Outcomes (COs):

After completing the course, students are expected to be able:

1. To solve the problem of nilpotent groups, field theory and finite fields.
2. To demonstrate the importance of algebraic properties.
3. To define and characterize the Notherian, Artinian module.
4. To apply the techniques of linear algebra to solve different problems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Sylow's Theorem, Solvable and Nilpotent Groups**

Group actions, Class equation of groups, Cauchy's theorems for abelian and non-abelian groups, Sylow's theorems for abelian and non-abelian groups, Applications of Sylow's theorem, Solvable groups, Maximal subgroups, Composition series of a group, Jordan-Hölder theorem, Nilpotent groups, Direct product and semi-direct product of groups, Structure theorem for finite abelian groups.

Unit – 2	**Number of lectures = 12**	**Ideals, Fields, Galois fields**

Ideals (principle, prime and maximal) and quotient rings, Euclidean rings, Euclidean domains, Principal ideal domains (PID), Unique factorization domain, Field of quotients of an integral domain, Field, Finite fields, Field extensions, Galois field and its application to classical problems.

Unit – 3	**Number of lectures = 12**	**Module Theory**

Modules, Definition and examples, Submodules, Direct sum decomposition, Free modules, Quotient modules, Simple modules, Modules over PIDs, Modules with chain conditions, Artenian modules, Noetherian modules, Hilbert's basis theorem.		
Unit – 4	**Number of lectures = 13**	**Linear Algebra**
Diagonalizability, Application of eigenvalues, Least square approximations, Orthogonal projection, Spectral theorem and its applications, Singular value decomposition and pseudo inverses, Spectral decompositions and spectral theorem, Applications of spectral theorem, Primary decomposition theorem, Jordan canonical form, Minimal polynomials.		
12. Brief Description of self-learning / E-learning component		
1. https://www.youtube.com/playlist?list=PLEAYkSg4uSQ1Yhxu2U-BxtRjZElrfVVcO 2. https://www.youtube.com/watch?v=HHyBTlUJyF0&list=PLY2U8CcmALO4HqPsKdghs0JMy0HUL7TLs 3. https://www.youtube.com/watch?v=LJ-LoJhbBA4&list=PLbMVogVj5nJQ2vsW_hmyvVfO4GYWaaPp7		
13. Books Recommended		
1. I.N.Herstein: Topics in Algebra (2nd ed.), Wiley Eastern Ltd., New Delhi, 1975. 2. P. B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd ed.), Cambridge University Press, 2003. 3. P.M. Cohn: Algebra, Vol-1, I. John Wiley, 1991. 4. I.S. Luther and I.B.S.Passi: Algebra. Vol.-1, Narosa Publishing House, 1990; 1996. 5. D.S. Malik, J.N. Mordenson and M.K. Sen: Fundamentals of Abstract Algebra, International ed. McGraw-Hill, 1997.		

1. Name of the Department: Mathematics						
2. Course Name	Mathematical Programming	**L**	**T**		**P**	
3. Course Code	17030811	4	0		0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

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

8. Course Description:

This course consists of different areas like nonlinear programming, goal programming, stochastic programming and unconstrained optimization techniques, types of programming and network analysis. Above areas define various theorems and techniques for modeling real world problems and methods to find their optimal solution.

9. Course Objectives:

1. To explain nonlinear programming with equality and inequality constraints.
2. Explain quadratic programming, convex programming and separable programming.
3. To make students familiar with the network simplex method, project planning and control with PERT-CPM.
4. Learn classical optimization techniques and numerical methods of optimization.

10. Course Outcomes (COs):

After completing this course, students will be able:

1. To understand the basics of optimization models.
2. Ability to apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.
3. Formulate and solve nonlinear programming problems.
4. Analyze problems with goal programming, stochastic programming and optimization techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Non-linear programming**

Lagrangian function, Constrained and unconstrained optimization, Non-linear programmingproblems (NLPP) with equality constraints, NLPP with inequality constraint, Kuhn-Tucker conditions, Quadratic programming, Convex programming.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Goal Programming**

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General goal programming models, Model with single goal, Model with multiple goals-equally ranked, Model with multiple goals-priority ranked, Graphical method of goal programming, Simplex method in goal programming.		
Unit – 3	**Number of lectures = 15**	**Title of the unit: Stochastic Programming and Unconstrained Optimization Techniques**
Chance constrained programming technique, Stochastic linear programming, Stochastic non-linear programming, Two stage programming technique, Rate of convergence, Direct search method, Indirect search method.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Network Analysis**
Shortest path problems, Minimum spanning tree problems, Maximum flow problems, Minimum cost flow problems, Network simplex method, Project planning and control with PERT-CPM.		
12. Brief Description of self-learning / E-learning component		
1. https://nptel.ac.in/courses/111105039 2. https://www.youtube.com/watch?v=Tm2HhqMu5Jg 3. https://nptel.ac.in/courses/111107104		
13. Books Recommended		
1. Singiresu S. Rao: Engineering Optimization-Theory and Practice (3rd ed.), New Age International Publishers, 2013. 2. A. Ravindran, K. M. Ragsdell and G. V. Reklaitis: Engineering Optimization-Methods and Applications (2nd ed.), Wiley-India Edition, 2006. 3. Kanti Swarup, P.K. Guptaand Man Mohan: Operational Research, Sultan Chand and Sons New Delhi, 2010. 4. Z.S. Kambo: Mathematical Programming Techniques, East West Press, 1997. 5. Suresh Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Alpha Science International Ltd., 2009.		

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1. Name of the Department: Mathematics						
2. Course Name	Mathematical Programming Lab	**L**	**T**		**P**	
3. Course Code	17030812	0	0		4	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✔)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**		**Practical = 52**		

8. Course Description:

Mathematical programming lab helps the students to understand the beauty of math application. Mathematical programming is a science of modeling and optimization. It allows you to model real-world problems by using mathematics, statistics, and computers. It provides you tools and theories to solve these real-world problems by finding the optimal solutions to the models subject to constraints of time, labor, resource, material, and business rules.

9. Course Objectives:

This module aims to introduce students to use quantitative methods and techniques for effective decision making; model formulation and applications that are used in solving decision making problems.

10. Course Outcomes (COs):

On successful completion of this course, students will be able to:

Solve the problem with software like (LINGO, MAPLE, Mathematica. MATLAB).

11. List of Practical's (using any one from C++, MATLAB)

1. Problems on LPP by Simplex Method.
2. Problems on LPP by Revised Simplex Method.
3. Problems on Networking.
4. Problems on General goal programming.
5. Problems on Dynamic Programming.
6. Problems on Monte Carlo Simulation.
7. Problems on Minimum Spanning Tree problems.
8. Problems on Maximum Flow Problems.
9. Problems on Minimum Cost Flow Problems.
10. Problems on Network Simplex Method.
11. Explain the application of Nonlinear Programming on any Mathematical software.
12. Solve the shortest path by using PERT and CPM.
13. Find the Minimum Spanning Tree on MATLAB.
14. Solve the project planning by using PERT and CPM.

12. Brief Description of self-learning / E-learning component
1. https://www.youtube.com/watch?v=qTJDNXRfcsc 2.https://in.mathworks.com/matlabcentral/answers/97605-are-there-any-examples-showing-how-to-perform-monte-carlo-simulation-in-matlab 3. https://www.youtube.com/watch?v=M_mpRrGKKMo 4. http://www.digimat.in/nptel/courses/video/111105100/L31.html
13. Books Recommended
1. F.S. Hillier and G.J. Leiberman: Introduction to Operations Research (10th edition), McGraw – Hill International Edition. This book comes with a CD containing tutorial software, 2017. 2. P. Venkataraman: Applied Optimization with MATLAB Programming (2nd edition), John Wiley & Sons Inc, 2009. 3. SukantaNayak: Fundamentals of Optimization Techniques with Algorithms, Academic Press, 2020. 4. S.S. Rao: Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi, 1984.

1.Name of the Department: Environmental Science						
2. Course Name	**Soil and water pollution**	**L**	**T**	**P**	**Credits**	
3. Course Code	17030813	4	0	0	4	
4. Type of Course (use tick mark)	**Core()**	**DSE(✓)**		**SEC()**		
5. Pre-requisite (if any)	10+2	**6.Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks of one semester)						
Lectures=52	**Tutorials=Nil**	**Practical=Nil**				

8. Course Description:

The course mainly covers the soil and water pollution problems and solution. This covers the topics like soil profile, physic-chemical properties of soil, soil pollution and remediation of contaminated soil. It also includes solid waste and its management using different methods such sanitary land-filling, recycling, composting, vermin-composting, incineration, energy recovery from organic waste etc. This also aware students about the various factors affecting the physicochemical properties of water and different treatment methods for industrial and domestic waste water.

9. Course Objectives:

The objectives of this course are:

1. To learn the basic concepts of soil formation and important physic-chemical properties.
2. To know about the remedial measures for soil pollution.
3. To provide knowledge about the different methods of solid waste management.
4. To develop understanding of water quality criteria and standard.
5. To describe the waste water treatment processes.

10. Course Outcomes(COs):

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

1. To know about the various physicochemical properties of soil and major sources of soil pollution.
2. To understand and apply the concept of solid waste management to minimize the adverse effects.
3. To be familiar with relationships between inappropriate waste management practices and their impacts on water and soil.
4. To develop an integrated perspective on water resources and water quality management.
5. To understand the different waste water treatment methodologies.

11.Unitwisedetailedcontent

Unit-1	**Number of lectures=13**	**Soil formation and properties**

Soil Formation: Process, Factors, Soil profile, Types of soils, Physicochemical and biological properties of soil, Soil pollution: Types and major sources of soil pollutants, effects of soil pollutants on environment, remedial measures for soil pollution.

Unit– 2	**Number of lectures=13**	**Solid waste and its management**

Solid waste: Sources, classification & composition. Solid Waste Management-Sanitary land-filling, Recycling, Composting, Vermi-composting, Incineration, Energy recovery from organic waste-Gasification, Liquification and Pyrolysis, Waste minimization technologies, HazardousWasteand its

Management		
Unit– 3	**Number of lectures=13**	**Water properties and resources**
Physico-chemical and biological properties of fresh water, Hydrological cycle, Solubility of gases in water, carbonate system, Water management strategies: Rain water harvesting, Recharging of ground water, Water quality standards.		
Unit– 4	**Number of lectures=13**	**Water pollution**
Water pollution: Sources, causes and effects, Characteristics of domestic, industrial and agricultural waste water, Marine pollution, Thermal pollution. Primary, secondary, tertiary & advance treatment of waste water, Wastewater treatment technologies, Bioremediation, Water borne diseases.		
12. Brief Description of self learning/E-learning component		
1. https://www.environmentalpollutioncenters.org/soil/ 2. https://www.springer.com/journal/11270 3. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000280/M026065/ET/1520505536paper10_module25_etext.pdf		
13. Books Suggested:		
1. Introduction to Soil Microbiology by. Alexander, M., Publisher: John Wiley & Sons, ISBN-13 : 978-0471021797 2. Fundamentals of Soil Ecology by Coleman and Crossley, Academic Press, ISBN 9780121797263. 3. Soil Ecology, Killham, K.,Cambridge University Press, ISBN: 9780511623363 4. Environmental chemistry by G.S.Sodhi, ISBN-13 : 978-1842650127 5. Introduction to environmental engineering and science - Gilbert Masters, Publisher: Pearson, ISBN-10:0134830660 6. Water supply engineering by S.K. Garg, Publisher: Khanna, ISBN-13 : 978-8174091208		

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1.Name of the Department: Environmental Science						
2. Course Name	**Soil and water pollution -Lab**		**L**	**T**	**P**	**Credits**
3. Course Code	17030814		0	0	4	2
4. Type of Course (use tick mark)		**Core()**	**DSE(✓)**		**SEC()**	
5. Pre-requisite(if any)	10+2.	**6.Frequency(use tick marks)**	Even (✓)	Odd()	Either Sem()	Every Sem()
7. TotalNumberofLectures,Tutorials,Practical(assuming15weeksofonesemester)						
Lectures=Nil		**Tutorials=Nil**		**Practical=52**		

8. Course Description:

This Course will introduce the students to the basic concept of water pollution and chemistry. This course will also give a platform to develop different methods to study to various samples of water from various sources. This Course will also introduce the students to understand the basic chemistry of the soil. To know the methodology for analysis of basic physico-chemical properties of soil. To understand the solid waste and its environmental implications.

9. Course Objectives:

The objectives of this course are:

1. To explain the process of composting/ Vermi-composting/landfill.
2. To determine DO, BOD, COD of wastewater.
3. To compare physio-chemical properties of polluted and non-polluted soil.
4. To measure specific gravity and moisture content of soil.

10. Course Outcomes(COs):

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

1. To understand the physio-chemical properties of soil.
2. To understand the physio-chemical properties of water.
3. To be familiar with composting/vermicomposting/landfill sites.
4. To understand the process of waste water treatment.

11.List of Experiments

1. A visit to composting/vermicomposting/sanitary landfill site and report writing.
2. A visit to nearby STP/ETP to understand operation and report writing on process of water/effluent treatment.
3. To study the Soil profile and determination of moisture content of the soil.
4. Determination of pH and Electrical Conductivity of Soil and Water sample.
5. Determination of hardness of water sample.
6. Determination of the alkalinity of water sample.
7. Estimation of Dissolved Oxygen of water sample.
8. Estimation of Biological oxygen Demand of wastewater.
9. Estimation of Chemical oxygen demand of wastewater.
10. To determine organic carbon content in soil sample.

Brief Description of self learning/E-learning component
1. https://www.environmentalpollutioncenters.org/soil/ 2. https://www.springer.com/journal/11270 3. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000280/M026065/ET/1520505536paper10_module25_etext.pdf
Books Suggested:
1. Introduction to Soil Microbiology by.Alexander, M., Publisher: John Wiley & Sons, ISBN-13 : 978-0471021797 2. Fundamentals of Soil Ecology by Coleman and Crossley, Academic Press, ISBN 9780121797263. 3. Soil Ecology, Killham, K.,Cambridge University Press, ISBN: 9780511623363 4. Environmental chemistry by G.S.Sodhi, ISBN-13 : 978-1842650127 5. Introduction to environmental engineering and science - Gilbert Masters, Publisher: Pearson, ISBN-10:0134830660 Water supply engineering by S.K. Garg, Publisher: Khanna, ISBN-13 : 978-8174091208

1. Name of the Department: Environmental Science						
2. Course Name	EIA and Sustainable development		**L**	**T**	**P**	**Credits**
3. Course Code	17030815		4	0	0	4
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5. Pre-requisite(if any)	10+2	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 15 weeks)						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This course will introduce students to the concept of environmental impacts assessment and its importance. It also help students in understanding the various methodologies and guidelines of EIA in details. This course also covers the different stages of EIA, criteria and standards for the environmental impact assessment and provides the alternates and mitigation measures to reduce the adverse impacts of developmental projects on environment. Last two units of this course covers the topics such as Principles and emergence of the concept of Sustainable Development, Resource degradation, social insecurity, and Role of developed countries in the sustainable development of developing countries.

9. Course Objectives:

The objectives of this course are:

1. To acquaint students about the concept and basic process of environmental impact assessment.
2. To develop critical awareness among students about the factors affecting the EIA process.
3. To describe the EIA methodologies and risk assessment process.
4. To know the principle of sustainable development.
5. To understand the future aspect of sustainability.

10. Course Outcomes (COs):

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

1. To identify the environmental attributes to be considered for the EIA study.
2. To formulate objectives of the EIA studies.
3. To identify the methodology to prepare rapid EIA.
4. To prepare EIA reports and environmental management plans.
5. To get basic knowledge about concept of sustainable development.

Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Introduction to EIA Concept**

Nature and purpose of Environment impact assessment, Environmental impact statement and Environmental management plan, EIA notification 1994, 2006 & 2020. EIA checklist, ISO14000 and Life cycles Assessment. Environmental clearance, Composition of EAC & SEAC.

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Unit – 2	Number of lectures = 13	Process and Methods of EIA:
EIA methodology: Screening, Scoping, Alternatives, Base-line data, Impact Identification, Impact prediction, evaluation and mitigation. Criteria and standards for assessing significant Impact. Cost- Benefit Analysis and evaluation of Environmental Impacts. Public Participation, presentation and review. EIA monitoring and auditing.		
Unit – 3	**Number of lectures = 13**	**Concept of Sustainability**
Sustainable Development: Concept, principles and indicators, SDGs, Agenda for Future Global Sustainable Development: Role of developed countries in the sustainable development of developing countries, Demographic dynamics and sustainability, Integrated approach for resource protection and management.		
Unit – 4	**Number of lectures = 13**	**Approaches for Sustainable Development**
Environmental accounting for sustainable development, Clean development mechanism and carbon trading, Green building concept, Linkages between population, poverty and environment, Role of public in sustainable development, National Environment Policy 2006, Recent initiatives of renewable energy by Government of India,		

11. Brief Description of self-learning / E-learning component

1. https://www.iitr.ac.in/wfw/web_ua_water_for_welfare/education/Teachers_Manual/Teacher_manual_master_EIA.pdf
2. https://www.iitr.ac.in
3. https://www.sdgindex.org/reports/sustainable-development-report-2021/
4. https://www.un.org/sustainabledevelopment/progress-report/

12. Books Recommended

1. Environmental Impact Assessment by John Glasson, Publisher: Routledge, ISBN 9781138600744.
2. Methods of Environmental Impact Assessment by Morris and the rivel. Publisher: Routledge, ISBN: 9781134107988
3. Environmental Impact Assessment by L. W. Canter, Publisher: McGraw-Hill Higher Education; 2nd edition, ISBN-13 : 978-0070097674
4. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R., Publishers: New Society, ISBN-13 : 978-0865715318
5. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.
6. Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development.

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1-6-22

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1. Name of the Department: Environmental Sciences						
2. Course Name	EIA and Sustainable Development-Lab	**L**	**T**	**P**	**Credits**	
3. Course Code	17030816	0	0	4	2	
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**SEC ()**			
5. Pre-requisite (if any)	10+2	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = Nil	**Tutorials = Nil**	**Practical = 52**				

8. Course Description:

This Course will introduce the students to the basic concept of EIA, EIS, regulatory authorities in India related to projects. The part of Sustainable Development will enable students to understand the importance of natural resources and the need for their conservation. This course will also give a platform to develop knowledge about the requirements, check lists, process and time need for decision making in proceedings of any projects.

9. Course Objectives:

The objectives of this course are:

1. To study EIA notifications and amendments time to time.
2. To learn concepts of EIA and the process.
3. To understand the concept of Sustainable Development
4. To acquaint students about the process of EIA through Case studies.

10. Course Outcomes (COs):

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

1. Identify the factors affecting the EIA Process.
2. Prepare the EIA report of different projects.
3. Demonstrate the methods for carrying out impact assessment method
4. Develop the strategies to conserve natural resources

11. List of Experiments

1. EIA case study of Mining Project
2. EIA case study of Thermal Power Project
3. EIA case study of Township Project
4. Public Hearing of EIA- Documents and Process
5. United Nations and Sustainable Development
6. Sustainable Development- Case Study
7. To study the star rating of electronic appliances and energy conservation.
8. To make the energy audit of a residential building.
9. To determine the carbon footprint of a project.
10. To determine the carbon sequestration by trees.

12. Books Recommended

1. Environmental Impact Assessment by John Glasson, Publisher: Routledge, ISBN 9781138600744.
2. Methods of Environmental Impact Assessment by Morris and the rivel. Publisher: Routledge, ISBN: 9781134107988
3. Environmental Impact Assessment by L. W. Canter, Publisher: McGraw-Hill Higher Education; 2nd edition, ISBN-13 : 978-0070097674
4. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R., Publishers: New Society, ISBN-13 : 978-0865715318

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

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

8. Course Description:

This course introduces the basic concepts of LaTeX. Participants taking this course will be able to create and design documents in LaTeX and presentations in Beamer with confidence.

9. Course Objectives:

This course aims to introduce students to use the typesetting software Latex to write Mathematical research articles, books etc. It further explains how to write complex mathematical formulae, tables in a document.

10. Course Outcomes (COs):

After completing this course students will be able to:

1. Use the beamer package to create presentations.
2. Use BibTex to maintain bibliography information and to generate a bibliography for a particular document.
3. Handle different types of documents.
4. Write complex mathematical formulae.

11. Unit wise detailed content

1. To create the first document using LaTeX.
2. To use different classes like article, book, report and amsarticle.
3. To organize content into sections using article and book class.
4. To use different mathematical packages.
5. To change the formatting of a latex document like header, footer, margins, multiple columns.
6. To change formatting of a text such as style, size, color, alignment.
7. To add bullets and numbering.
8. To add images, explore different properties like rotate, scale etc.
9. To create different types of tables, arrays.
10. To define a new environment in a LateX document.
11. To write complex mathematical structures.
12. To write mathematical equations in different environments.
13. To add references and citations.
14. To create a presentation using the Beamer package.

12. Brief Description of self learning / E-learning component

1. **https://www.youtube.com/watch?v=0ivLZh9xK1Q&list=PL1D4EAB31D3EBC449**
2. https://www.youtube.com/watch?v=bCumVPGR4ts&list=PL1D4EAB31D3EBC449&index=2
3. https://www.youtube.com/watch?v=kefvRACdXHs&list=PL1D4EAB31D3EBC449&index=3

13. Books Recommended

1. LaTex Tutorial: A primary by Indian Tex users group
2. Stefan Kottwitz: LaTeX Beginner's Guide: Create visually appealing texts, articles, and books for business and science using LaTeX (2nd edition), 2021.
3. Leslie Lamport: LaTeX: A Document Preparation System, Addison- Wesley, 1994.