Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Botany

(Faculty of Science & Technology)

T.Y.B. Sc Botany

Choice Based Credit System Syllabus

To be implemented from Academic Year 2021- 2022

Title of the Course: B. Sc Botany

1. Structure of Course:

Structure B.Sc. Botany syllabus					
Year	Semester	Course Type	Course code	Course Name	Credits
1	1	Compulsory Course	BO 111	Plant life and utilization I	2
			BO 112	Plant morphology and Anatomy	2
			BO 113	Practical based on BO 111 & BO 112	1.5
	2	Compulsory Course	BO 121	Plant life and utilization II	2
			BO 122	Principles of plant science	2
			BO 123	Practical based on BO 121 & BO 122	1.5
2	3	Compulsory Course	BO 231	Taxonomy of Angiosperms and Plant Ecology	2
			BO 232	Plant Physiology	2
			BO 233	Practical based on BO 231 & BO 232	2
	4	Compulsory Course	BO 241	Plant Anatomy and Embryology	2
			BO 242	Plant Biotechnology	2
			BO 243	Practical based on BO 241 & BO 242	2
3	5	Discipline Specific Elective Course	BO 351	**Algae and Fungi**	2
			BO 352	**Archegoniate**	2
			BO 353	**Spermatophyta and Paleobotany**	2
			BO 354	**Plant Ecology**	2
			BO 355	**Cell and Molecular Biology**	2
			BO 356	**Genetics**	2
			BO 357	**Practical based on BO 351 & BO 352**	2
			BO 358	**Practical based on BO 353 & BO 354**	2
			BO 359	**Practical based on BO 355 & BO 356**	2
		Skill Enhancement course	BO 3510	**Medicinal Botany**	2
			BO 3511	**Plant Diversity and Human Health**	2
3	6	Discipline Specific Elective Course	BO 361	**Plant Physiology**	2
			BO 362	**Biochemistry**	2
			BO 363	**Plant Pathology**	2
			BO 364	**Evolution and Population genetics**	2
			BO 365	**Advanced Plant Biotechnology**	2
			BO 366	**Plant Breeding and Seed Technology**	2
			BO 367	**Practical based on BO 361 & BO 362**	2

			BO 368	**Practical based on BO 363 & BO 364**	2
			BO 369	**Practical based on BO 365 & BO 366**	2
		Skill Enhancement course	BO 3610	**Nursery and Gardening Management**	2
			BO 3611	**Biofertilizers**	2

2. Equivalence of Previous Syllabus:

Old Course (2015 Pattern)	**New Course (2020 CBCS Pattern)**
Semester V	**Semester V**
BO. 331 Cryptogamic Botany	BO 351 Algae and Fungi
BO. 332 Cell and Molecular Biology	BO 352 Archegoniate
BO. 333 Genetics and Evolution	BO 353 Spermatophyta and Paleobotany
BO. 334 Spermatophyta and Palaeoboatny	BO 354 Plant Ecology
BO. 335 Horticulture and Floriculture	BO 355 Cell and Molecular Biology
BO. 336 Computational Botany	BO 356 Genetics
--	BO 3510 Medicinal Botany
--	BO 3511 Plant Diversity and Human Health
Semester VI	**Semester VI**
BO.341 Plant Physiology and Biochemistry	BO 361 Plant Physiology and Metabolism
BO.342 Plant Ecology and Biodiversity	BO 362 Biochemistry
BO.34 Plant Pathology	BO 363 Plant Pathology
BO.344 Medicinal and Economic Botany	BO 364 Evolution and population genetics
BO.345 Plant Biotechnology	BO 365 Advanced Plant Biotechnology
BO.346 Plant Breeding and Seed Technology	BO 366 Plant Breeding and Seed Technology
--	BO 3610 Nursery and Gardening Management
--	BO 3611 Biofertilizers

T.Y.B.Sc. Botany CBCS Pattern

(Semester V, Paper I) 2020-2021

BO 351: Cryptogamic Botany (Algae and Fungi)- 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I Alagae	**15**
1.	Introduction: Cryptogams- meaning. Types- Lower Cryptogams, brief Review with examples	**01**
2.	Algae: General characters, distribution, Thallus organization, habit and Habitat reproduction and Classification (G.M.Smith 1955) up to classes.	**04**
3.	Study of life cycle of algae with reference to taxonomic position, Occurrence, Thallus structure, and reproduction of *Nostoc, Oedogonium Chara, Sargassum* and *Batrachospermum*.	**08**
4	Economic importance of algae- Role in industry, agriculture, fodder and medicine.	**02**
	Credit-II Fungi	**15**
5	Fungi: General characters, Habit and habitats, thallus organization, cell wall composition, nutrition and Classification. (Alexopoulos and Mims 1979) up to classes.	**03**
6.	Study of life cycle of fungi with reference to taxonomic position, thallus structure, and reproduction of *Mucor (Zygomycotina), Saccharomyces (Ascomycotina), Puccinia (Basidiomycotina), Penecillium and Cercospore (Deuteromycotina) [Two members of Deutero.]*	**08**
7.	Symbiotic Associations - Lichens, Mycorrhiza and their significance	**04**

Suggested readings:

1. Vashistha B. R. et al., Botany for degree students-Algae
2. Das, Datta and Gangulee-College Botany Vol. I
3. Sharma, O.P. –Algae
4. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd New Delhi.
5. Vashishta B.R. et al., Botany for degree students- Fungi
6. Sharma, P.D.-The Fungi

7. Sharma, O.P.-Fungi Economic importance of fungi

8. Alexopoulus C. J , Mims C.W. and Blacwel M.I 1996. Introductory Mycology. John Wiley and Sons Inc.

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper II) 2020-2021
BO 352: Archegoniate- 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I Bryophytes	**15**
1.	Introduction to Archegoniate	**01**
2.	Introduction, general characters, distribution of Bryophytes to land habit, classification of Bryophytes according to G.M. Smith (1955) up to classes with reasons	**02**
3.	Range of thallus organisation, origin of Bryophytes - Pteridophytes and Algal hypothesis, evolution of sporophyte	**02**
4	Study of Life Cycle of Bryophytes with respect to Taxonomic position, Morphology, Anatomy, Reproduction, Gametophytes and sporophytes of *Marchantia, Anthoceros and Funaria*	**09**
5	Ecological and economic importance of Bryophyte	**01**
	Credit-II Pteridophytes	**15**
6	Introduction, Vascular Cryptogams, General characteristics, Classification according to K.R. Sporne (1975) up to classes with reasons, Diversity and Distribution of Pteridophytes.	**02**
7.	Resemblances of Pteridophytes with Bryophytes, Differences between Pteridophytes and Bryophytes, Origin of Pteridophytes -Algal and Bryophytes, Evolution of Pteridophytes- Telome Theory and Enation Theory.	**03**
8.	Study of Life Cycle of Pteridophytes with respect to Taxonomic position, Morphology, Anatomy, Reproduction, Sporophytes and Gametophytes of *Psilotum, Selaginella* and *Equisetum*	**09**
09	Ecological and Economical Importance of Pteridophytes	**01**

Note:development of sex organs and Sporophytes is not expected.)

Suggested readings:

1. Chopra G.L. and Yadav D.L. A Text book of Bryophytes.
2. Das, Datta and Gangulee-College Botany Vol I
3. Parihar, N.S. An introduction to Embryophyta: Bryophyte-I
4. Puri Prem. Brayophytes, Atmaram and Sons. Delhi.
5. Parihar N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
6. Sporne K.R. 1991. The Morphology of Pteridophytes. B.I Publishing Pvt. LtdBombay.
7. Vashishta B.R. Botany for degree students Bryophytes- Vol-III
8. Vashishta B.R. Botany for degree students Pteridophytes.

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper III) 2020-2021
BO 353: Spermatophyta and Paleobotany - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I ANGIOSPERMS	**15**
1.	**Origin of angiosperms:** with reference to time, place and ancestry- 1) Pseudanthial theory 2) Transitional-Combinational Theory	**02**
2.	**Speciation & Endemism** Species concept (Biological, Taxonomic & Phylogenetic Species Concept), Speciation (Allopatric, Sympatric & Parapatric), Endemism and its types (Palaeoendemism, Holoendemism and Neoendemism)	**04**
3.	**Classification:** Outline, Merit and Demerits of Cronquist's System and APG IV system of classification. Study of following families with reference to systematic position (As per Bentham & Hooker), Diagnostic characters, floral formula, floral diagram and any five examples with their economic importance – Nymphaeaceae, Oleaceae, Amaranthaceae, Cannaceae	**06**
4	**Herbaria and Botanical Gardens** Functions of Herbarium, Important herbaria (World: Kew herbarium; India: Central National Herbarium, Kolkata). Botanic gardens of the world (Royal Botanic Garden, Kew) and India	**03**
	Credit-II GYMNOSPERMS and PALEOBOTANY	**15**

6	Introduction, general characters, economic importance and classification according to Chamberlain (1934).	**02**
7.	Study of life cycle of Pinus and Gnetum with reference to distribution, morphology, anatomy, reproduction, gametophyte, sporophyte, seed structure and alternation of generations.	**10**
8.	Fossil- Definition, process of fossil formation, types of fossils.-Impression, Compression, Petrifaction, Pith cast and Coal ball.	**03**

Suggested readings:

1. Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Thomas Nel and Sons, Ltd. London.
2. Lawrence, G.H.M 1951. Taxonomy of Vascular Plants.
3. Singh V. and D.K Jain, 1981 Taxonomy of Angiosperms. Rastogi Publication, Meerut.
4. Swingle D.B. 1946. A Text book of Systematic Botany. Mc Graw Hill Book Co. New York.
5. Takhtajan A. 1969. Flowering Plants; Origin and Disposal.
6. Pande B.P 1997. Taxonomy of Angiosperms. S.Chand.
7. Gurucharan Singh 2005- Plant systematics
8. Naik V.N. - Taxonomy of Angiosperms.
9. Shivrajan V.V. -Introduction to Principles plant taxonomy
10. V. V. Sivarajan, N. K. P. Robson 1991. Introduction to the Principles of Plant Taxonomy IInd Edi.
11. Sharma O.P. Plant Taxonomy Tata McGraw-Hill
12. Botanical Journal of the Linnean Society, 2009, 161, 105–121.
13. http://www.mobot.org/MOBOT/research/APweb/

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper IV) 2020-2021
BO 354: Plant Ecology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	Introduction, interrelationship between the living world and the environment, levels of organization, components and dynamism of ecosystem, homeostasis, niche concept, concept of limiting factors	**03**
2.	**Biogeography:** Floristic realms, speciation and its types, biogeographic regions of India,Plant indicators	**03**

3.	**Population ecology:**Definition, characteristics, population growth form, r and k selection	**03**
4.	**Community ecology:** Introduction and Definition, community structure, physiognomy, Raunkiaer's life form classification, keystone species, edge and ecotone	**04**
5.	**Biogeochemical cycles:** The carbon cycle, Nitrogen cycle, Phosphorus cycle, and Hydrologic cycle	**02**
	Credit-II	**15**
6.	**Ecological Impact Assessment (EIA)** Introduction, Historical Review of EIA, Objectives of EIA, Stages of EIA process: Screening; Scoping; Baseline study; Impact prediction and assessment; Mitigation; Producing Environmental Impact Statement (EIS); EIS review; Decision making; Monitoring, Compliance and Enforcement; Benefits of EIA.	**05**
7.	**Environmental Audit** Meaning and concept, need, objectives, benefits, types, audit protocol, process, certification, personnel environmental audit	**04**
8.	**Remote Sensing** Definition, basic principles, process of ecological data acquisition and interpretation, global positioning system,application of remote sensing in ecology.	**04**
9.	**Ecological management:** Concepts, sustainable development, sustainability indicators	**2**

References:

1. Current sciences special issue remote sensing for national development Volume 61 numbers 3 and 4 August 1991
2. DaubenmireR.F. 1974. Plants and Environment- A Text Book of Plant Ecology (3rd edition). John Wiley & Sons. New York.
3. E.P. Odum. 1996. Fundamentals of Ecology. Natraj Publishing, Dehradun.
4. G.J. Rau and C.D. Weeten, "Environmental Impact Analysis Hand book, McGraw Hill, 1980.
5. George Joseph Fundamentals of remote sensing (Second edition, 2005) by Universities press (India) Private Ltd., Hyderabad.
6. John R. Jensen (2000)Remote sensing of the environment, Dorling Kindersley India Pvt. Ltd,
7. KendeighS.C. 1980. Ecology with Special Reference to Animals and Man. Prentice Hall of India Pvt. Ltd., New Delhi.
8. KermondyF.J. 1996. Concepts of Ecology.Prentice Hall of India Pvt. Ltd. New Delhi.
9. Kumar H.D. 1996. Modern Concepts of Ecology (3rd edition). Vikas Publishing House Pvt., Ltd. Delhi.

10. Kumar H.D. 1997. General Ecology. Vikas Publishing Pvt. Ltd., Delhi.
11. Larry W. Canter," Environment Impact Assessment", McGraw-Hill Book Company, New York
12. M. Anji Reddy Textbook of Remote sensing and GIS (Third edition, 2006) by BS Publication, Hyderabad
13. Singh JS, Singh SP, & Gupta SR, (2006) Ecology, Environment and Resource Conservation. Anamayapubl, New Delhi
14. Smith L.R. 1996. Ecology and Field Biology (5th edition). Harper Collns College Publishers, USA.
15. Smith L.R. and Mith T.M. 1998. Elements of Ecology. (4th edition). An imprint of Addison Wesley, Longman ink., California
16. Weaver. J.E. and Clements. S.E. 1966. Plant Ecology. Tata McGraw Publishing Co. Ltd. Bombay.

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper V) 2020-2021
BO 355: Cell and Molecular Biology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I Cell Biology	**15**
1.	**Introduction to Cell Biology:** Definition, Brief history of Cell Biology, Units of measurement for cell, Interdisciplinary nature of Cell Biology	**01**
2	**Cell organelles**: Ultrastructure, components and functions of Cell wall and cell membranes, mitochondria and Chloroplast, endoplasmic Reticulum, Golgi apparatus, Lysosomes, Vacuoles, Peroxisomes & Glyoxysomes	**06**
3.	**Nucleus:** Morphology and ultrastructure of nucleus, nucleolus and nucleolar organizer Nuclear envelope – structure of nuclear pore complex, transport of molecules across nuclear envelope.	**03**
4.	Chromosomes: Euchromatin and heterochromatin Histones, Packing of DNA into chromosomes in eukaryotes, Karyotype and ideogram, Polytene chromosomes and lampbrush chromosomes.	**03**
5	**Cell signaling:** Introduction and definition, Signaling molecules and receptors, Calcium signaling pathway in plants	**02**
	Credit-II Molecular Biology	**15**
5	**Genetic material** DNA: historical perspective from 1953 to 2020, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment.	**02**

6.	**DNA replication (Prokaryotes and Eukaryotes):** Molecular mechanism of DNA replication. Enzymes involved in both prokaryotic and eukaryotic DNA replication and their inhibitors (antibiotics).	**03**
7.	**Gene expression:Transcription (Prokaryotes in details and passing remarks on Eukaryotes)** Types of RNA: mRNA, tRNA, rRNA; types of promoters; types of RNA polymerase enzymes in eukaryotes; molecular mechanism of transcription.	**04**
8	**Translation (Prokaryotes and Eukaryotes):** Definition, concept and properties of genetic code; molecular mechanism of translation.	**03**
9	**Regulation of gene expression:** Concept of operon, *lac* operon and *trp* operon, positive and negative control, one gene one enzyme hypothesis.	**03**

Suggested readings:

1. Cell and Molecular Biology , S. C. Rastogi
2. Cytology, T. S. Verma and V. K. Agarwal 3. Cell Biology, C. B. Pawar
4. Cell and Molecular Biology, P. K. Gupta
5. Fundamentals of Molecular Biology, Veer Bala Rastogi
6. Fundamentals of Molecular Biology, G. K. Pal and Ghaskadabi
7. Cell Biology, Molecular Biology, Genetic, Evolution and Ecology, Verma and Agarwal
8. Cell and Molecular Biology, Robertis and DeRobertis
9. Molecular Cell Biology, 4th Edition, Lodish S. Baltimore
10.Molecular Biology of Gene, Watson J. D.
11.Biochemistry and Molecular Biology of Plants, Buchanan B. B.
12. Molecular and Cell Biology, Wolfe S.L.

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper VI) 2020-2021
BO 356: Genetics - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Introduction to Genetics.** History, Definition, Concept, branches and applications of Genetics.	**01**
2	**Mendelism** Genetical terminology, Monohybrid cross, Law of dominance, Incomplete dominance, Law of segregation, Dihybrid cross, Dihybrid ratio, Law of	**04**

	independent assortment, Back cross and Test cross.	
3.	**Neo Mendelism (Gene Interaction)** Genetic interaction, Epistatic interactions –supplementary gene (recessive epistasis 9:3:4), Inhibitory genes (13:3), Masking genes (12:3:1), Non-Epistatic inter-allelic genetic interactions-Complementary genes (9:7), Duplicate genes (15:1)	**03**
4.	**Multiple alleles** Definition, Concept, Characters of multiple alleles, Examples of multiple alleles – Blood group in human and self-incompatibility in Nicotiana.	**02**
5	**Linkage, Recombination and Crossing Over** Linkage- Definition and Types, Crossing over: Definition and Types, Construction of a linkage map by two point test cross and three point test cross, Recombination: Concept, definition and types	**04**
6	**Mutation:** Concept, definition and types	**01**
	Credit-II	**15**
5	**Numerical alterations of chromosomes.:** Euploidy, Aneuploidy-Concept and Types, Aneuploidy in Plants and Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy	**03**
6.	**Structural alterations of chromosomes.:**Types, cytology and genetic effects of Deletion, Duplication Inversion and Translocation with examples.	**04**
7.	**Cytoplasmic & Quantitative Inheritance:** Concept of quantitative inheritance, Inheritance of quantitative trait in Maize (Cob length), Cytoplasmic inheritance Definition and concept, Chloroplast- Varigation in Four O'clock plants, Mitochondria- Petite mutants in yeast.	**04**
8	**Sex Linked Inheritance:** Concept of Sex chromosomes and autosomes, Inheritance of X- linked genes –Inheritance of colour blindness in humans, Inheritance of Y-linked (Holandric genes) in humans, Sex influenced genes, Sex-limited genes.	**04**

Suggested readings:

1. Atherly, A.G., Girton, J.R. and McDonald, J.F 1999. The Science of Genetics Saunders College Publishing, Frot Worth, USA.

2. Hartle D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.

3. Khush, G.S 1973. Cytogenetics of Aneuploids. Academic Press, New York, Lewis, R. 1997. Human Genetics: Concepts and Application (Second Edition). WCB McGraw Hill, USA.

4. Russel, P.J. 1998. Genetics (Fifth Edition). The Benjamin/Cummings Publishing Company IND., USA.

5. Snustad, D.P and Simmons, M.J 2000. Principles of Genetics (Second Edition). John Wiley and Sons Inc., USA.

6.Gardner and Simmons Snustad 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.

7. Sarin C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.

8.Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.

9.Burus and Bottino 1989. (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).

10.Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai.

11. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
12. Allard R.W 1995. Priniples of Plant Breeding. John Wiley and Sons, Ice., Singapore.

13. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.

14.Verma and Agarwal, Genetics, S. Chand Co, New Delhi.

15. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana.

16. Gupta P.K Genetics and Cytogenetics, Rastogi Publications.

17.Gupta P. K. Genetics Rastogi Publications.

18. Phundan Singh Genetics, Kalyani Publications.

19. Verma P.S and Agarwal V.K. (2006) Cell Biology, Genetics, Molecular Biology, Evolution, Ecology. S.Chand and Company, New Delhi.

20.Shukla R.S. & Chandel P.S. Cytogenetics, Evolution & Biostatistics. S.Chand Publications.

21. Tomar & Singh Evolutionary Biology, Rastogi Publications.

22. Darbeshwar Roy Crop Evolution & Genetic Resources.

T.Y.B.Sc. Botany CBCS Pattern
Practical (Semester V Paper VII) 2020-2021
BO 357: Practical based on BO351 and BO352 (2 Credits)

Sr. No.	Title	No. of Practical
1.	Study of Algae with respect to systematic position, thallus structure and reproduction of *Nostoc*, *Oedogonium*, *Chara*, *Sargassum*, *Palmaria/Chondrus.*	**04**
2	Study of Fungi respect to systematic position, thallus structure and reproduction of *Mucor, Saccharomyces, Penicillium, Puccinia* and *Cercospora***.**	**04**
3.	Study of *Marchantia* with respect to systematic position,morphology of thallus –rhizoids and scales,Gemma Cup, structure of sporophyte, reproduction.	**01**
4.	Study of *Anthoceros* with respect to systematic position, structure of gametophyte, anatomy of thallus, structure of Sporophytes, reproduction.	**01**
5	Study of *Funaria* with respect to systematic position, morphology of thallus- leaf, rhizoids, operculum, Anatomy of axis, leaf, reproduction	**01**
6	Study of Sporophyte evolution in Bryophytes with the help of permanent slides.	**01**
7	Study of *Psilotum* with respect to Taxonomic position, Morphology of sporophyte, anatomy and reproductive structure	**01**
8	Study of *Selaginella* with respect to Taxonomic position, Morphology of sporophyte, Anatomy and reproductive structures.	**01**
9	Study of *Equisetum*with respect to taxonomic position, Morphology of Sporophyte, anatomy and reproductive structure	**01**
10	Study of Stelar evolution in Pteridophytes with the help of permanent slides	**01**

Note: Botanical Excursion and submission of Tour Report with Photograps is compulsory.

T.Y.B.Sc. Botany CBCS Pattern
Practical (Semester V Paper VIII) 2020-2021
BO 358: Practical based on BO353 and BO354 (2 Credits)

Sr. No.	Title	No. of Practical
1.	Study of following families with reference to systematic position (following Bentham & Hooker), Diagnostic characters, floral formula, floral diagram of Nymphaeaceae, Oleaceae, Amaranthaceae, Cannaceae	**04**
2	Preparation of Botanical keys: Indented and bracketed keys by using vegetative and reproductive characters	**01**
3	Study of internal and external morphology of Gnetum	**01**
4.	Study of internal and external morphology of Pinus	**01**
5.	Study of the following with the help of slides and/ or specimens. i) Impression ii) Compression iii) Petrifaction	**01**
6	Study of polluted water body with ref. to BOD (D zero day and D fifth day).	**02**
7	Study of physicochemical properties of water body by using Sacchi disc, pH meter and electric conductivity meter	**02**
8	Acquisition of ecological data of particular locality by using GPS/ altimeter/geographicloa maps etc	**02**
9	Study of suitable ecosystem by line/belt transect method/ nested quadrate method	**02**

Note: Excursion tours of long and short duration are compulsory

T.Y.B.Sc. Botany CBCS Pattern
Practical (Semester V Paper IX) 2020-2021
BO 359: Practical based on BO355 and BO356 (2 Credits)

Sr. No.	Title	No. of Practical

1.	Cytological techniques-preparation of Fixatives, preparation of stains (Aceto carmine and Aceto-orcein).	01
2	Isolation of nuclei and characterization	01
3	Study of various stages of mitosis and meiosis	01
4	Induction of C metaphase in suitable plant material	01
4	Study of Chromosomes Morphology (from colchicines pretreated Onion root tip cells)	01
6	Isolation of plant genomic DNA by suitable method.	01
7	Estimation of Plant DNA by DPA method	01
8	Extraction and estimation of RNA by Orcinol Method	01
9	To study the monohybrid and dihybrid crosses with suitable data and its analysis by Chi-Square test.	01
10	Induction of tetraploidy in onion root cells and preparation of squash for observation of tetraploid cells.	01
11	Preparation of salivary gland chromosomes in *Chironomous* larvae.	01
12	Study of human genetic traits viz. PTC taste sensitivity, earlobe and rolling tongue, height, Skin colour, Hair colour, Eye colour in known population.	01
13	Genetic problems on gene mapping using three point test cross data.	01
14	Study of structural heterozygotes (multiple translocations) in *Rhoeo*.	01
15	Problems on quantitative inheritence. (Cob length in Maize)	01
16	Problems on Multiple Alleles. (Blood group in Human)	01

Skill Enhancement course

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper X) 2020-2021
BO 3510: Medicinal Botany - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Medicinal Plants**: History, Scope and Importance	**01**
2	**Indigenous Medicinal Sciences**; Definition and Scope	**01**
3.	**Ayurveda**: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments	**04**
4.	**Siddha**: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine.	**02**
5	**Unani**: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.	**02**
6	**Conservation of endangered and endemic medicinal plants:** Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens.	**05**
	Credit-II	**15**
5	**Propagation of Medicinal Plants:** Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.	**05**
6.	**Ethnobotany and Folk medicines**: Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany.	**05**
7.	**Folk medicines** of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.	**05**

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

Skill Enhancement course

T.Y.B.Sc. Botany CBCS Pattern
(Semester V, Paper XI) 2020-2021
BO 3511: Plant Diversity and Human Health - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Plant diversity** and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level,	**03**
2	**Agrobiodiversity** and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.	**05**
3.	**Loss of Biodiversity**: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss,	**04**
4.	Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations.	**03**
	Credit-II	**15**
5	**Conservation of Biodiversity:** Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.	**08**
6.	Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses.	**07**

Suggested Readings

Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper I) 2020-2021
BO 361: Plant Physiology and Metabolism - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Mineral nutrition**: Classification of mineral elements, macro and micronutrients; Role of essential elements; Transport of ions across cell membrane, Ionophores , Carriers and Channels	**03**
3.	**Photosynthesis**: Mechanism of photosynthesis- Electromagnetic spectrum Ultra-Structure of Chloroplast, Organization of Light-Absorbing Antenna Systems, Light Reaction: (Cyclic and Non-cyclic photophosphorylation), Dark Reaction: Calvin–Benson Cycle, Photorespiration, C4 cycle and CAM pathway of carbon fixation).	**07**
4.	**Respiration:** Types of respiration (Aerobic and anaerobic), Mechanism of aerobic respiration (Glycolysis, TCA cycle, Terminal oxidation and phosphorylation in respiratory chain); Pentose Phosphate Pathway.	**05**
	Credit-II	**15**
5	**Stomatal Biology:** Light-dependent Stomatal Opening, Mediation of Blue-light Photoreception in Guard Cells by Zeaxanthin, Reversal of Blue Light–Stimulated Opening by Green Light, The Resolving Power of Photophysiology (Overview).	**04**
6.	**Translocation in phloem**: Composition of phloem sap, girdling experiment; Pressure flow model.	**03**
7.	**Plant growth regulators**: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.	**05**
8	**Photomorphogenesis**: Red and far red light responses on photomorphogenesis; Phytochrome (discovery and mode of action).	**03**

Suggested Readings:

1. Lincoln Taiz, Eduardo Zeiger, Ian Max Moller and Angus Murphy 2015. Plant Physiology and Development (Sixth Edition) Sinauer Associates, Inc Publishers Sunderland, Massachusetts U.S.A.

2. Epstein, E., and Bloom, A. J. (2005) Mineral Nutrition of Plants: Principles and Perspectives, 2nd ed. Sinauer Asso ciates, Sunderland, MA.
3. Salisbury F.B and Ross C.W (1992). Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.
4. V. K. Jain (2017) Fundamentals of Plant Physiology S. Chand Publications.

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper II) 2020-2021
BO 362: Biochemistry - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Foundation of Biochemistry:** From molecules to the first cell (origin of a cell), Miller and Urey experiment. Biomolecules of a cell, functional groups in biomolecules, conformations and configurations of biomolecules.	**03**
2	**Water: The solvent of life:** Physical properties of water, structure of water molecule, polarity of water molecule, weak interactions in aqueous solutions.	**02**
3.	**Amino acids and proteins:** Structure, classification, properties and functions of amino acids. Structure (primary, secondary, tertiary and quaternary), properties and functions of proteins. Biological disorders of amino acid metabolism. Commercial applications.	**05**
4.	**Enzymes:** Definition, nature of enzymes and co-factors, classification and properties of enzymes, active site. Mechanism of enzyme action: free energy, activation energy, binding energy, transition state, lock and key hypothesis, induced fit theory. Factors affecting enzyme activity: pH, temperature, substrate concentration, enzyme concentration. Enzyme inhibition: Competitive, uncompetitive, non-competitive.Reversible and irreversible inhibition, feedback inhibition.	**05**
	Credit-II	**15**
5	Carbohydrates: Definition, classification of carbohydrates- Monosaccharides: aldoses and ketoses, configurations, linear to ring structure; Oligosaccharides: glycosidic bond, reducing and non-reducing sugars; Polysaccharides: homopolysaccharides, heteropolysaccharides,	**08**

	examples, their structures, locations and role. Properties and functions of carbohydrates. Commercial applications.	
6.	**Lipids:** Definition, classification of lipids: simple, conjugate and derived lipids, properties and functions of lipids. Biological disorders of lipid metabolism. Commercial applications.	**05**
7.	**Vitamins:** Definition, classification of vitamins. source and functions of vitamins.	**02**

Suggested Readings:

1. **Nelson, D. L., & Cox, M. M.** (2017). *Lehninger principles of biochemistry* (7th ed.). W.H. Freeman.
2. **Buchanan, B. B., Gruissem, W., & Jones, R. L.** (2000). *Biochemistry & molecular biology of plants.* Rockville, Md.: American Society of Plant Physiologists.
3. **Taiz, L. Zeiger, E., Moller, I.M. and Murphy, A.** (2015) *Plant Physiology and Development*. 6th Edition, Sinauer Associates, Sunderland, CT.
4. **Jain, J. L., Jain, S. & Jain, N.** (2020) *Fundamentals* of *Biochemistry,* Revised edition, S. Chand Publishing
5. **Verma S.K. and Verma M. (**2007) *A text book of Plant Physiology, Biochemistry and Biotechnology*, S. Chand Publishing.

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper III) 2020-2021
BO 363: Plant Pathology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Fundamentals of Plant Pathology**: Introduction, Important terminology- Incitants, Host, Symptoms, Parasite, Pathogen, Inoculum, Penetration, Infection, Incubation, Disease. Economic importance of plant diseases, History of plant pathology, Introduction to Indian Agriculture Research Institute (IARI),International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Contribution of Anton De Bary and Prof. B.B. Mundkur.	**02**
2	Disease Development: Concept of disease cycle, Inoculation, Prepenetration, Penetration, Infection, Dissemination. Epidemics-Forms,	**02**

	Decline, Exponential model.	
3.	**Defense Mechanisms**: Concept and Definition, Types-Preexisting-Structural and chemical, Induced- Structural and Biochemical.	**02**
4.	**Methods of Studying Plant Diseases.** Macroscopic study, Microscopic study, Koch"s postulates. Types of culture Media, Pure culture methods-Streak plate, Pour plate, Spread plate.	**02**
5	**Fungal Plant Diseases** Introduction to fungi as plant pathogens. Study of Diseases- Downy mildew of Grapes, Head smut of Jowar, Tikka diseases of Groundnut with reference to causal organism, symptoms and disease management.	**04**
6	**Bacterial Plant Diseases.** Introduction to bacteria as plant pathogens, Study of Diseases- Citrus Canker, Black arm of Cotton with reference to causal organism, symptoms and disease management.	**03**
	Credit-II	**15**
5	**Mycoplasma Plant Diseases:** Introduction to Mycoplasma as plant pathogens, Study of Diseases- Grassy shoot disease of sugarcane, Little leaf of brinjal with reference to causal organism,symptoms and disease management.	**03**
6.	**Nematodal Plant Diseases:** Introduction to Nematodes as plant pathogens. Study of Diseases- Root knot diseases of vegetables, Soyabean cyst Nematodes with reference to causal organism,symptoms, Integrated management of Nematodal diseases.	**02**
7.	**Viral Plant Diseases**: Introduction of Virus as plant pathogens. Study of Diseases- Papaya Mosaic Disease, Bunchy top of Banana with reference to causal organism, symptoms and causal organism	**02**
8	**Non-Parasitic Diseases.** The impact and abiotic causes- Temperature, Soil moisture and relative humidity, Poor oxygen, Poor light, Air pollutants, mineral deficiencies. Herbicidal injury, Study of Mango necrosis, Black Heart of Potato.	**04**
9	**Principles of plant diseases control:** General account, Quarantine,	**04**

	Eradication, cultural control practices, Biological control. Curative measures, chemical control, Use of Effective Microorganism solution (EMS), Microbial Pesticides.	

Suggested Readings:

1. Singh R. S. (2019) Introduction to Principles of Plant Pathology 4Ed (PB2019) Paperback.
2. Plant Pathology 2/e PB....Sharma PD Paperback – 1 January 2016
3. A.V.S.S. Sambamurty (2010) Principles of plant pathology, Wiley distributor
4. George Agrios (2004)Plant Pathology 5th Edition, Academic Press

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper IV) 2020-2021
BO 364: Evolution and Population genetics- 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1	**Organic Evolution**: Distinction between Origin of life and Organic Evolution, Historical account of Origin of life, Origin of Earth Vs Origin of life: Gaia Hypothesis, Earliest Fossils, Prebiotic Evolution, Abiotic synthesis of organic matter, Primordial soup, origin of membranes, Oparin's Coacervate model, Theory of Panspermia, Early life and RNA and Origin of genetic code	**06**
2	**Organic Evolution:**The concept of organic evolution, Theories of Evolution, Pre-Darwinian period, Theory of Inheritance of acquired characters (Lamark's), Darwinism- Theory of Natural Selection, Post-Darwinian period- Modern synthetic theory	**05**
2	**Evidences of Evolution** Direct evidences and conclusions from fossil records, Indirect evidences, Evidences from Genetics, Evidences from bio-geographical relations	**04**
	Credit-II	**15**
4	**Evolution Through Ages**: Fossils and Geological Time scale: Fossils and	**05**

	Fossilization, Conditions of fossilization, Dating of fossils: Uranium Lead method, Radio-carbon method, U-series and ESR method, Geological Time scale: Eras, Periods, epochs, and duration in millions of years and plant life.	
5.	**Population Genetics and Evolution**: Concept of Mendelian population, Gene Pool and its models, Hardy-Weinberg law of gene frequencies, Factors affecting allelic frequency, Genetic polymorphism	**04**
5.	**Speciation and Isolating Mechanisms:** Introduction, Morphological Criteria for Species and Races, Allopatric and Sympatric Populations, Isolating Mechanisms: Pre zygotic Isolation mechanisms: Concept, Spatial & Ecological;, Seasonal Isolation, Ethological Isolation, Mechanical Isolation, Post zygotic Isolation mechanisms: Concept, Hybrid in viability, Hybrid sterility & Hybrid breakdown.	**06**

Suggested readings:

1. P. K Gupta, Cytology, Genetics and Evolution , Rastogi Publications
2. Verma P.S and Agarwal V.K. (2006) Cell Biology, Genetics, Molecular Biology, Evolution, Ecology. S. Chand and Company, New Delhi
3. Shukla R.S. & Chandel P.S. Cytogenetics, Evolution & Biostatistics. S. Chand Publications,
4. Tomar & Singh, Evolutionary Biology, Rastogi Publications
5. Suryaprakash Mishra. A textbook of Cell Biology, Genetics and Evolution, Kalyani Publication
6. N Shukla, Population Genetics, DISCOVERY PUBLISHING, PVT. LTD.
7. Veer Bala Rastogi .Organic Evolution (Evolutionary Biology), Scientific Inernational Pvt. Ltd.
8. N. Anurgam, Evolution, Saras Publications
9. N. Anurgam, Organic Evolution, Saras Publications

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper V) 2020-2021
BO 365: Advanced Plant Biotechnology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1	**Biotechnology:**	**02**

	Introduction, Traditional and modern Biotechnology. Impact of Biotechnology on Health care, Agriculture, and Environment	
2	**Plant Tissue Culture:** Concepts of Cell theory & Cellular totipotency, Landmarks in plant tissue culture. Pluripotency, Differentiation, dedifferentiation, redifferentiation, Hormones used in PTC, 'Explant' for plant tissue culture and Response of explants in vitro– callus formation, organogenesis (direct and indirect) and embryogenesis (direct and indirect)**.** Micro propagation of Banana (in detail from Selection of explant to hardening and marketing)	**06**
3.	**Techniques of Genetic Engineering and Methods of gene transfer in Plants-** Introduction to Molecular tools: Definition and role of Nucleases, Polymerases, Ligases, Polynucleotide kinases, Alkaline Phosphatases. Types of vectors- Definition and characters (2-4) of Plasmids, Phages, Cosmids, BAC, YAC, Plant viruses, Animal viruses. Methods of gene transfer in Plants – Direct gene transfer – Definition and concept of Electroporation, Microinjection, and Gene gun Indirect gene transfer- Agrobacterium mediated gene transfer method, Ti-plasmid: structure and functions, T-DNA Gene amplification technique -Polymerase chain reaction DNA finger printing	**07**
	Credit-II	**15**
4	**Cryopreservation and Germplasm Conservation** Definition and concept, techniques of cryopreservation, cold storage, long term and short term storage, applications. **Germplasm Conservation:** Preservation of Cell, tissue, organ, whole organism. Concept of Gene Bank, DNA Bank, Seed Bank, Pollen Bank etc.	**03**
5.	**Biotechnology and Society**	**05**

	Biotechnology- Benefits, GM foods and its safety, Recombinant foods and religious beliefs, Recombinant therapeutic product for human health care. Patenting of biotechnological inventions and Intellectual property rights.	
5.	**Microbial Biotechnology:** Biochemistry of fermentation, Microorganism used in fermentation, fermentable substrate, Ethanol fermentation methods, Distilleries producing alcohols. Commercial production: Alcoholic beverages, organic acids, citric acids. Advantages of fermentation. **Transgenic Plants as Bioreactors:** Metabolic engineering of starch, cyclodextrins, fructans, Bioplastics, Genetically engineered plants as protein factories, Production of therapeutic proteins from plants.	**06**
6	**Nano-biotechnology** Definition and concept, Applications of nanotechnology in agriculture (fertilizers and pesticides).	**01**

Suggested readings:

1. R. C. Dube (2008) - A Text Book of Biotechnology, S. Chand

2. P.K. Gupta-Elements of Biotechnology

3. Satyanarayana-Biotechnology

4. Kalyan Kumar De-Plant tissue culture

5. Pal J.K. and Ghaskadabi S.S. (2008) Fundamentals of Molecular Biology.

6. Verma and Agrawal- Molecular Biology

7. Devi P.2008-Principle and Methods of plant Molecular Biology, Biochemistry and Genetics Agrobios, Jodhpur, India.

8. Glick B.R. and Tompson J.E. 1993 Methods in Plant Molecular Biology and Biotechnology CRC Press Boca Raton, Florida.

9. Hall R.D. (Ed.) 1999 Plant cell culture Protocol human press Inc., New Jersey, USA

10. Kumar H.D. 2002 A Text Book of Biotechnology 2nd Edn. Affiliated Easyt West Press Private Ltd New Delhi.

11. Ramawat K.G. 2003 Plant Biotechnology, S. Chand & Co. Ltd . Ramnagar New Delhi. 110055

12. Trivedi P.C.2000 Plant Biotechnology, Panima Publishing Carpation, New Delhi.

13. Rajdan- Plant tissue culture.

13. Kalyan Kumar De-Plant tissue culture

14. Pal J.K. and Ghaskadabi S.S. (2008) Fundamentals of Molecular Biology.

15. .Razdan M.K. - Introduction to Plant Tissue culture (Oxford & IBH Publ, New Delhi)

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper VI) 2020-2021
BO 366: Plant Breeding and Seed Technology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I –Plant Breeding	**15**
1	**Introduction:** Definition, Scope and objectives and History of Plant breeding in India	**01**
2	**Techniques and practices of plant breeding** **A. Plant Introduction** • Definition • Types (Primary and Secondary) • Procedure • Merits and Demerits • Important Achievements	**02**
	B. Selection methods • Concept, • Types of selections –mass selection, pure line selection and clonal selection. • Advantage and disadvantages of selection • Achievements of selection breeding	**03**
	C. Hybridization • Definition, Concept and Objectives • Precaution to be taken during hybridization • Types: Intervarietal and Distant • General procedure of hybridization • Methods of hybridization: Pdigree and bulk • Hybrid vigour and heterosis	**04**
3	**Advanced techniques in Plant breeding** **A. Mutation breeding**	**03**

	• Definition and concept • Mutagens (Physical and Chemical) • Mutants • Types of mutation (Spontaneous and Induced) • Application of mutation breeding • Limitations of mutation breeding	
	B. Tissue Culture • Definition and concept • Totipotency • Application of tissue, embryo and anther culture in seed production	**02**
	Credit-II - SEED TECHNOLOGY	**15**
4	**Introduction to Seed Technology** • Seed as a basic input in agriculture • Classes of seed 1. Nucleus 2. Breeder 3. Foundation 4. Certified Role of seed technology	**02**
5.	**Seed legislation** • Introduction • Seed legislation in India (Seed Act)	**01**
6	**Seed Production** • Introduction • National Seed Corporation (NSC) and its objectives • State Seed Corporation (SSC) and its objectives • General procedure for Seed Production o Location and Season o Land requirement o Importance of soil and water testing o Cultural practices o Isolation distance o Plant protection o Weed Control o Rouging o Harvesting o Threshing o Seed Processing	**03**
7	**Seed Certification** • Definition, Objectives and Concept • Phases of Seed Certification • General procedure of seed certification • Field inspection • Duties of seed inspector	**02**
8	**Seed Testing**	**03**

	A. **Physical Purity Analysis** • Definition of purity components • Physical Purity Work Board • Procedure B. **Moisture Testing** • Concept • Air oven method • Digital Moisture Meter C. **Germination testing** • Definition and objectives • Procedure and methods for germination testing (Paper, Sand and Soil) • Seedling evaluation (Normal Seedlings, Abnormal Seedlings, Multigerm Seed Units and Non-germinated Seeds)	
9	**Seed Pathology and Entomology** • Definition • Seed Borne pathogens o Fungi o Bacteria o Viruses • Influence of seed borne pathogens on seed production • Common insect pest and its impact on seed production	**02**
10	**Seed Storage** • Definition and Concept • Seed treatment • Management of seed storage structures o Sanitization o Dehumidification o Fumigation	**02**

Suggested readings:

1. Laxmi lal somani and Devidas patel (2020) Textbook of seed science and technology, Agrotech publishing co.
2. Vijay Pal Singh Panghal and Axay Bhuker (2020) Seed Science and Technology. Kalyani publisher
3. Gardner and Simmons Snustad 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
4. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw Hill Publishers Company Ltd., New Delhi.
5. Singh B.D 1996 Plant Breeding – Principles and methods. Kalyani Publications, Ludhiana.
6. Allard R.W 1995. Priniples of Plant Breeding. John Wiley and Sons, Ice., Singapore.
7. Agarwal R.L. --- Seed Technology, Oxford & IBH Publishing Co Pvt.Ltd

8. TNAU (ICAR) Principles of Seed technology (2020)

T.Y.B.Sc. Botany CBCS Pattern
Practical (Semester V Paper VII) 2020-2021
BO 367: Practical based on BO361 and BO362 (2 Credits)

Sr. No.	Title	No. of Practical
1.	Determination of osmotic potential of plant cell sap by plasmolysis method	01
2	Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.	01
3	Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.	01
4	To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.	01
5	Comparison of the rate of respiration in any two parts of a plant.	01
6	Separation of amino acids by paper chromatography.	02
7	Demonstration experiments (any four) i). Bolting. ii). Effect of auxins on rooting. iii). Suction due to transpiration. iv). R.Q. v). Respiration in roots.	01
8	Estimation of total free amino acids by spectrophotometry	01
9	Separation of amino acids by paper chromatography.	01
10	Estimation of soluble proteins by Lowery *et. al.* method.	01
11	Demonstration of Enzyme activity: Amylase /invertase /catalase	01

12	Estimation of reducing sugars by DNSA method.	01
13	Estimation of Vitamin C (Ascorbic acid) from plants.	01
14	Qualitative tests for starch, lipids and proteins.	01
15	Determination of the iodine number of lipids using Hanus method.	01

T.Y.B.Sc. Botany CBCS Pattern
Practical (Semester V Paper VIII) 2020-2021
BO 368: Practical based on BO363 and BO364 (2 Credits)

Sr. No.	Title	No. of Practical
1.	Preparation of any one culture media for isolation of plant pathogens.	01
2	Culture technique- Streak plate methods, pour plate methods, Spread plate methods.	01
3	Study of any two of fungal (Downy mildew of Grapes, Head smut of Jowar, Tikka diseases of Groundnut) diseases	01
4	Study of any two of each bacterial and mycoplasma diseases	01
5	Study of any two of each viral and non-parasitic diseases of plants.	01
6	Preparation of 1% Bordeaux mixture and Bordeaux paste 10%.	01
7	Preparation of Jivamruta.	01
8	Study of Koch's Postulates.	01
9	Study of Fungicides and Microbial pesticides.	01
9	Study of Geological time scale	01
10	Study of types of Fossils : i) Coal ball ii) Rhynia vii) Lyginopteris iii) Pentoxylon iv) Nipaniophyllum v) Lepidodendron	01
11	Demonstration of any three evidences of Organic Evolution	01
12	Numerical Problems based on Allele frequency and Genotype frequency	01
13	Numerical Problem based on Hardy-Weinberg Equilibrium	01

14	Study of Sympatric and Allopatric speciation with suitable example	01
15	Study of Isolation mechanism : Prezygotic & Postzygotic(Any one example from each)	01
16	Submission of Report on Visit to Paleobotany Laboratory/Museum/Fossil Garden	01

T.Y.B.Sc. Botany CBCS Pattern
Practical (Semester V Paper IX) 2020-2021
BO 369: Practical based on BO365 and BO366 (2 Credits)

Sr. No.	Title	No. of Practical
1.	Preparation and sterilization of MS Medium and Callus Induction using leaf primordia	01
2	Production of secondary metabolites in any suitable plant material	01
3	Artificial seed production by Sodium Alginate method encapsulation (somatic embryogenesis)	01
4	Demonstration to equipments used in genetic engineering like gene gun, PCR, gel doc, microcentrifuge, electrophoresis, micropipettes, incubator, shaker etc. (live/videos/photographs/visit to research labs)	01
5	Study of Transgenic plants- Arabidopsis thaliana as a model plant, Bt-Brinjal, Flr-svr Tomato, and other GM crops like soybean, maize, tobacco as a pharmaceuticals, banana as a edible vaccine etc. (live/videos/photographs/visit to research labs)	01
6	Preparation of plant based nano-particles	01
7	Demonstration to Fermentation of fruit juice and wine production from grapes/pomegranate/jamun/ apple/ber (live/videos/photographs/visit to research labs)	01
8	Problems on genetic engineering (set of problems will be given on restriction enzymes, vectors etc.)	01

9	Demonstration of Hybridization Techniques (Emasculation, Hand Pollination, Bagging and Tagging) in cotton and tomato.	01
9	Effect of chemical mutagens on seed germination and seedling growth.	01
10	Study of pollen viability and floral morphology of crops	01
11	To test seed moisture by hot air oven method	01
12	To study germination methods (Paper, Sand and Soil)	01
13	Physical purity analysis of seed sample	01
14	Visual examination of dry seeds for disease symptoms	01
15	To study any one common seed insect pest w.r.t to their life cycle, way of infestation/damage, symptoms and control measures.	01
16	Visit to a Plant Breeding Research Centre/ Seed Industry and report submission	01

Note: Submission of minimum 10 seed samples along with their botanical names, family, variety etc. to the department at the time of final practical examination

Skill Enhancement course

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper X) 2020-2021
BO 3610: Nursery and Gardening Management- 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I Nursery Managment	**15**
1	**Nursery:** definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.	**03**
2	**Seed:** Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion –Seed production technology - seed testing and certification.	**03**
3.	**Vegetative propagation**: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants– greenhouse - mist chamber, shed root, shade house and glass house.	**09**

	Credit-II Gardening Management	15
4	Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design -computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.	08
5.	Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes,and carrots - Storage and marketing procedures.	07

Suggested Readings

1. Bose T.K. & Mukherjee, D., Gardening in India, Oxford & IBH Publishing Co., New Delhi.1972.
2. Sandhu, M.K., Plant Propagation, Wile Eastern Ltd., Bangalore, Madras. 1989.
3. Kumar, N., Introduction to Horticulture, Rajalakshmi Publications, Nagercoil. 1997.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. Hand Book of Seed Technology, Dept. of Agriculture and Cooperation,National Seed Corporation Ltd., New Delhi. 1993.
6. Janick Jules. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.1979.

T.Y.B.Sc. Botany CBCS Pattern
(Semester VI, Paper X) 2020-2021
BO 3611: Biofertilizers- 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1	**Introduction**: 1.1 Introduction, Scope and importance of Biofertilizers 1.2 General account of the microbes used as Biofertilizers	02
2	**Bacterial Biofertilizers** 2.1.Isolation of Rhizobium, Identification, Mass multiplication, Carrier based inoculants. 2.2.Azospirillum isolation and mass multiplication, carrier based	09

	inoculants and associative effect of different organisms 2.3. Azotobacter, classification and characteristics 2.4. Crop response to Azotobacter inoculums, Mass multiplication of Azotobacter 2.5. Applications of Azospirillum 2.6. Phosphate solubilizing Bacteria	
3.	**Algal Biofertilizers** 3:1. Cyanobacteria (Blue Green Algae): Isolation of Anabaena from Azolla, Mass Multiplication of Anabaena 3.2. Azolla - Anabaena relationship 3.3. Biological Nitrogen fixation 3.4. Blue Green algae in a rice cultivation. 3.5. Applications of BGA	**04**
	Credit-II	**15**
4	**Fungal Biofertilizers** 4.1. Introduction, Occurrence and Distribution of Mycorrhizal association. 4:2. Types of Mycorrhizal association, growth and yield - colonization of VAM - Vesicular Arbuscular Mycorrhiza 4.3. Mycorrhizal applications in agriculture	**09**
5.	**Compost and Manure** 5.1. Organic Farming, green manuring, organic manures and their uses 5.2. Recycling by composting method of biodegradable, municipal, agricultural and industrial wastes 5.3. Biocompost making methods, Types and methods of vermicomposting 5.4. Benefits of vermicompost, field applications	**06**

Suggested readings

1. Dubey, R. C. (2005). A text book of Biotechnology. S. Chand & Co. New Delhi, India.

2. Kumaresan, V. (2005). Biotechnology. Saras Publication, New Delhi, India.

3. Sathe, T. V. (2004). Vermiculture and Organic Farming. Daya Publishers, Delhi, India.

4. Jshon, Jothi Prakash, E. (2004). Outline of Plant Biotechnology. Emkay Publication, New Delhi, India.

5. Subha Rao, N. S. (2000). Soil Microbiology. Oxford and IBH Publishers, New Delhi, India.

6. Vayas, S. C., Vayas S. and Modi, H. (1990). Biofertilizers and Organic Farming. Ekta Publication, Nanded, India.

Webliography

1. Production of various Biofertilizers.www.biology discussion.com

2. Biofertilizers vikaspedia.in

3. www.solverchem.com

CBCS: 2020-2021 T. Y. B. Sc.Mathematics

SavitribaiPhule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Mathematics

(Faculty of Science and Technology)

T.Y.B.Sc. (Mathematics)

Choice Based Credit System Syllabus

(With effect from June 2021)

To be implemented from Academic Year 2021-2022

Title of the Course: B. Sc. (Mathematics)

Preamble:

University of Pune has decided to change the syllabi of various faculties from June, 2019. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects, Board of Studies in Mathematics with concern of the teachers of Mathematics from different colleges affiliated to University of Pune has prepared the syllabus of T.Y.B.Sc. Mathematics. To develop the syllabus the U.G.C. Model curriculum is followed.

Programme Specific Outcome (PSO)

i) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling,solving and interpreting.

ii) To equip the students sufficiently in both analytical and computational skills in Mathematical Sciences.

iii) To develop a competitive attitude for building a strong academic - industrial collaboration, with focus on continuous learning skills.

iv) Enhancing students overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

v) Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

vi) Enabling students to Gauge the hypothesis, theories, techniques and proofs provisionally.

Programme Outcome:(PO)

A graduate of this program are expected to:

i) Gain sound knowledge on fundamental principles and concepts of Mathematics and computing with their applications related to Industrial, Engineering, Biological and Ecological problems.

ii) Exhibit in depth the analytical and critical thinking to identify, formulate and solve real world problems of science and engineering.

iii) Get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning.

iv) A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.

v) Apply their skills and knowledge,that is, translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

vi) Be capable of undertaking suitable experiments/research methods while solving the real-life problem and would arrive at valid conclusions based on appropriate interpretations of data and experimental results.

vii) Develop written and oral communications skills in order to effectively communicate design, analysis and research results.

viii) Demonstrate appropriate inter-personal skills to function effectively as an individual, as a member or as a leader of a team and in a multi-disciplinary setting.

ix) Acquire competent positions in industry and academia as well.

Eligibility:

S.Y.B.Sc. (with Mathematics)or T.Y.B.Sc. Computer Science as per University rules.

Medium of Instruction: English

Structure of the Course:

Semester –V		**Semester-VI**	
DSE-1A	**MT 351: Metric Spaces**	**DSE-4A**	**MT 361: Complex Analysis**
DSE-1 B	**MT 352: Real Analysis-I**	**DSE-4 B**	**MT 362: Real Analysis-II**
DSE-2 A	**MT 353: Group Theory**	**DSE-5 A**	**MT 363: Ring Theory**
DSE-2 B	**MT 354: Ordinary Differential Equations**	**DSE-5 B**	**MT 364: Partial Differential Equations**
Select any one out of three		**Select any one out of three**	
DSE-3A	**MT 355(A):Operations Research** **MT 355(B): Differential Geometry** **MT 355(C):C- Programming**	**DSE-6A**	**MT 365(A): Optimization Techniques** **MT 365(B):Calculus of Variation and Classical Mechanics** **MT 365(C): Financial Mathematics**
Select any one out of three		**Select any one out of three**	
DSE-3B	**MT 356(A): Machine Learning-I** **MT 356(B): Number Theory** **MT 356(C): Laplace Transform and Fourier Series**	**DSE-6B**	**MT 366(A): Machine Learning-II** **MT 36 (B): Computational Geometry** **MT 366(C): LebesgueIntegration**
Practical Lab		**Practical Lab**	
DSE-1	**MT 357: Practical Course Lab-1 (on Metric Space and Real Analysis-I)**	**DSE-4**	**MT 367: Practical Course Lab-1 (on Complex Analysis and Real Analysis-II)**
DSE-2	**MT 358: Practical Course Lab-II (on Group Theory and Ordinary Differential equations)**	**DSE-5**	**MT 368: Practical Course Lab-II (on Ring Theory and Partial Differential Equations)**
DSE-3	**MT 359: Practical Course Lab-III (on DSE-3A and DSE-3B)**	**DSE-6**	**MT 369: Practical Course Lab-III (on DSE-6A and DSE-6B)**
SEC-I	**MT -3510: Programming in Python-I**	**SEC-III**	**MT 3610: Programming in Python-II**
SEC-II	**MT-3511: LaTeX for Scientific Writing**	**SEC-IV**	**MT 3611: Mathematics into LaTeX**

Note.

i) Papers MT-351 to MT-354 are compulsory, a student can opt one paper from MT-355(A) to MT-355 (C) and opt one paper from MT-356(A) to MT-356 (C) in fifth semester.

ii) Papers MT-361 to MT-364 are compulsory, a student can opt one paper from MT-365(A) to MT-365 (C) and opt one paper from MT-366(A) to MT-366 (C) insixth semester.

iii) For MT-351 to MT-359 and MT-361 to MT-369 each course is of 50 marks (35 marks external examination and 15 marks internal examination).

iv) For SEC: MT-3510, MT-3511, MT-3610 and MT-3611 each course is of 50 marks (15 marks internal evaluation: assignments/ tutorial/seminar/test and 35 marks external theory and practical examination).

Examination:

A) Pattern of examination: **Semester wise**.

B) Standard of passing: 20 Marks out of 50 marks for each paper. (But for passing a student should obtain minimum 14 marks out of 35 in the externalUniversity examination and should obtain minimum 06 marks out of 15 in the internal examination). For Skill enhancement courses a student should obtain minimum 06 marks out of 15 in internal examination and theory/practical external examination 14 marksout of 35 in the external University examination.

C)Pattern of question papers: For MT-351 to MT-354 and MT-361 to MT-364.

Q.1. Attempt any 05 out of 07 questions each of 01 marks. [05 Marks]

Q.2. Attempt any 02 out of 04 questions each of 05 marks. [10 Marks].

Q.3. Attempt any 02 out of 04 questions each of 05 marks. [10 Marks].

Q.4. Attempt any 02 out of 04 questions each of 10 marks. [10 Marks].

D) External Students: **Not allowed**.

E) Verification / Revaluation: **Allowed for Theory papers only.**

F) Qualifications for Teacher: **M.Sc. Mathematics (with NET /SET as per UGC existing rules).**

Equivalence of Previous syllabus along with new syllabus:

New Course	**Old Course**	**New Course**	**Old Course**
Semester-V	**Semester-III**	**Semester-VI**	**Semester-IV**
MT-351: Metric Spaces	MT 331 : Metric Spaces	MT 361: Complex Analysis	MT 341: Complex Analysis
MT-352: Real Analysis-I	MT 332: Real Analysis-I	MT 362 : Real Analysis-II	MT 342: Real Analysis-II

MT 353:Group Theory	MT 334 : Group Theory	MT 363 : Ring Theory	MT 344: Ring Theory
MT 354 : Ordinary Differential Equations	MT 335 : Ordinary Differential Equations	MT 364 : Partial Differential Equations	MT 345: Partial Differential Equations
MT 355 (A): Operations Research	MT 337 A. Operations Research	MT 365 (A): Optimization Techniques	MT 347 A : Optimization Techniques
MT 355 (B): Differential Geometry	MT 337 D: Lattice Theory	MT 365 (B): Calculus of Variation and Classical Mechanics	MT 347 B : Differential Geometry
MT 355 (C): C-Programming	MT 337 B. Dynamical System	MT 365(C): Financial Mathematics	MT 347 E: Lebesgue Integration
MT 356 (A): Machine Learning-I	MT 347D. Graph theory	MT 366 (A): Machine Learning-II	MT 347 C: C-Programming-II
MT 356 (B): Number Theory	MT 337 F. Number Theory	MT 366 (B): Computational Geometry	MT 347F : Computational Geometry
MT 356 (C): Laplace Transform and Fourier Series	MT 337 C. C- Programming I	MT 366(C): Lebesgue Integration	MT 337 E. Financial Mathematics
MT 357: Practical CourseLab-I: Metric Spaces and Real Analysis-I	MT 333 : Problem Course on MT 331 and MT 332	MT 367: Practical CourseLab-I: Complex Analysis and Real Analysis-II	MT 343 : Problem Course on MT 341 and MT 342
MT 358: Practical CourseLab-II: Group Theory and Ordinary Differential Equations	MT 336 : Problem Course on MT 334 and MT 334	MT 368: Practical CourseLab-II: Ring Theory and Partial Differential Equations	MT 346 : Problem Course on MT 344 and MT 345
MT 359: Practical Course Lab-III: DSE-3A and DSE-3B	MT 338: Practical based on papers selected from 337 A to 337 F	MT 369:Practical CourseLab-III: DSE-6A and DSE-6B	MT 348: Practical based on papers selected from 347 A to 347 F
MT 3510: Programming in Python-I		MT 3610: Programming in Python -II	
MT 3511: LaTeX for Scientific Writing		MT 3611: Mathematics IntoLatex	

Details of Syllabus:

Semester-V

DSE-1A: MT 351: Metric Spaces (2 credits)

Course Objectives: The course aims at providing the basic knowledge pertaining to metric spaces such as neighborhood, interior, closure, open and closed balls, continuity, completeness, compactness and connectedness etc.

Course Learning Outcomes: The course will enable the students to:

i) understand the introductory concepts of metric spaces;
ii) correlate these concepts to their counter parts in modern analysis by studying examples;
iii) learn to analyze mappings between spaces.
iv) attain background for advanced courses in real analysis, functional analysis, and topology.
v) appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.

Course Contents:

Unit 1: Basic Notions **[09 Lectures]**

1.1 Definition and examples
1.2 Open Balls and Open Sets

Unit 2: Convergence **[09 Lectures]**

2.1 Convergent Sequences
2.2 Limit and Cluster points
2.3 Cauchy Sequences and Completeness
2.4 Bounded Sets
2.5 Dense Sets
2.6 Boundary of a set

Unit 3: Continuity **[08 Lectures]**

3.1 Continuous Functions
3.2 Equivalent Definitions of Continuity
3.3 Topological Property
3.4 Uniform Continuity
3.5 Limit of **a** Function
3.6 Open and closed maps

Unit 4:CompactnessandConnectedness **[10 Lectures]**

4.1 Compact Spaces and their Properties
4.2 Connected Spaces

Text Book:

1. **Topology of Metric Spaces, S. Kumaresan, Narosa Publishing House (2nd edition), 2011.**

Unit 1: Chapter-1: Sec. 1.1; 1.1.14(only Statement) (Except- 1.1.9 to 1.1.12, 1.1.15 to 1.1.27, 1.1.33 to 1.1.37), Sec. 1.2; 1.2.40(only Statement), 1.2.42 (only Statement) (Except - 1.2.9 to 1.2.17, 1.2.41, 1.2.49 to 1.2.55, 1.2.57 to 1.2.60, 1.2.65, 1.2.66, 1.2.70 to 1.2.73, 1.2.76, 1.2.77, 1.2.87, 1.2.88, 1.2.107).

Unit 2: Chapter -2: Sec. 2.1 (Except 2.1.7, 2.1.8, 2.1.11 to 2.1.13, 2.1.15 to 2.1.19), Sec. 2.2; 2.2.7 (on metric space), 2.2.19(on metric space) (Except- 2.2.11, 2.2.21, 2.2.31), Sec. 2.3; 2.3.12(only statement) (Except - 2.3.4, 2.3.19, 2.3.20), Sec. 2.4 (Except 2.4.8 to 2.4.13, 2.4.16), Sec. 2.5 (Except 2.5.3, 2.5.4, 2.5.15), Sec. 2.7.

Unit 3: Chapter – 3: Sec. 3.1 (Except 3.1.9, 3.1.10, 3.1.12, 3.1.14, 3.1.21to 3.1.24), Sec. 3.2; 3.2.35 (only statement), 3.2.53 (only statement), (Except- 3.2.3, 3.2.4, 3.2.6, 3.2.8, 3.2.12 to 3.2.15, 3.2.19, 3.2.29, 3.2.37 to 3.2.43, 3.2.51, 3.2.52), Sec. 3.3 (Except 3.3.5, 3.3.6, 3.3.10), Sec. 3.4 (Except 3.4.4, 3.4.5, 3.4.12 to 3.4.14, 3.4.16), Sec. 3.5, Sec. 3.6.

Unit 4: Chapter -4: Sec. 4.1; 4.1.15(only statement) (Except - 4.1.27 to 4.1.31, 4.1.35, 4.1.36), Sec. 4.2 (Except- 4.2.2, 4.2.6, 4.2.9, 4.2.12 to 4.2.14), Sec. 4.3; 4.3.1(only statement) (Except 4.3.16. 4.3.25, 4.3.26, 4.3.27).
Chapter -5: Sec. 5.1; 5.1.6(on metric space), 5.1.7(only statement) (Except - 5.1.12, 5.1.15 to 5.1.17, 5.1.23, 5.1.24, 5.1.27, 5.1.33, 5.1.34, 5.1.36,5.1.48).

Reference Books:

1. Metric Spaces, Q.H. Ansari: Narosa Publishing House, New Delhi, Chapters 1 – 5.
2. Metric Spaces, SatishShirali, H. Vasudeva, Springer.
3. First Course in Metric Spaces, B. K. Tyagi, Cambridge University Press
4. M. O. Searcoid: Metric spaces, Springer, 2007.
5. Metric Spaces, E.T.Copson, University Press, Cambridge, 2nd edition, Mumbai, 1978.

DSE-1B: MT: 352 Real Analysis-I (2 credits)

Course Objectives: The course will provide students with a thorough understanding of real lines and distinguishing concepts in order to prove convergence and divergence of real number sequences and series. These principles have a wide variety of real-world applications.

Course Learning Outcomes: This course will enable the students to:

i) learn the basic facts in logic and set theory
ii) learn to define sequence in terms of functions from N to a subset of R and to understand several properties of the real line.
iii) recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
iv) use the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Course Contents:

Unit 1: Logic and Set Theory **[10 Lectures]**

1.1 Introduction
1.2 "And" and "Or"
1.3 "Not" and "If-Then"

1.4 Contrapositive, Converse, and Iff
1.5 Quantifiers
1.6 Set Theory and Venn Diagrams
1.7 Relations and Functions
1.8 Countable and Uncountable Sets

Unit 2: Sequences of Real Numbers **[07 Lectures]**

2.1 Definition of sequence and subsequence
2.2. Limit of a sequence
2.3 Convergent sequences
2.4 Divergent sequences
2.5 Bounded sequences
2.6 Monotone sequences

Unit 3:Operations on convergent sequences and Limit Superior, Limit Inferior **[07 Lectures]**

3.1 Operations on convergent sequences
3.2 Operations on divergent sequences
3.3 Limit superior and limit inferior
3.4 Cauchy sequences

Unit 4: Series of Real Numbers **[12 Lectures]**

4.1 Convergence and divergence
4.2 Series with nonnegative terms
4.3 Alternating series
4.4 Conditional convergence and absolute convergence
4.5 Rearrangements of series
4.6 Tests for absolute convergence
4.7 Series whose terms form a non-increasing sequence
4.8 The class l^2.

Text Books: -

1. **Real Analysis and Foundations, Second Edition, Steven G. Krantz, Chapman and Hall/CRC.**
   Unit 1: Chapt. 1- Sec.: 1.1, 1.2,1. 3, 1.4, 1.5, 1.6, 1.7, 1.8
2. **Methods of Real Analysis, Second Edition, Richard R. Goldberg, John Wiley & Sons, Inc.**
   Unit 2: Chapt.-2: Sec.: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6,
   Unit3: Chapt.-2 Sec.: 2.7, 2.8, 2.9, 2.10,
   Unit 4: Capt.- 3: Sec.: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10

Reference Books: -

1. Real Analysis, N.L. Carothers, Cambridge University Press
2. Introduction to Real Analysis, Third edition, Robert, G. Bartle, Donald Sherbert , John Wiley and Sons.

3. A Basic Course in Real Analysis, Ajit Kumar and S.Kumaresan ,CRC Press, Second Indian, , CRC Press (Chapman and Hall)
4. A course of Mathematical Analysis, Revised edition, Shantinarayan and Mittal - S. Chand and Co. (2002).
5. Mathematical Analysis, third Edition, S.C. Malik and Savita Arora - New Age International Publications.

DSE-2A: MT-353: Group Theory(2 credits)

Course Objectives: The course objective is to introduce students to the fundamental theory of groups and their homomorphisms. Symmetric groups and symmetries in groups, Lagrange's theorem are also studied in depth.

Course Learning Outcomes: The course will enable the students to:

i) recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc;
ii) analyze consequences of Lagrange's theorem
iii) learn about structure preserving maps between groups and their consequences.
iv) explain the significance of the notion of cosets, normal subgroups, and factor groups.

Course Contents:

Unit 1. Groups **[06 lectures]**
1.1 Binary Operation
1.2 Isomorphic Binary Structures
1.3 Groups

Unit 2. Subgroups **[06 lectures]**
2.1 Subgroups
2.2 Cyclic Groups

Unit 3. Permutations[12 lectures]
3.1 Groups of Permutations
3.2 Orbits
3.3 Cycles
3.4 Alternating Groups
3.5Cosets and the Theorem of Lagrange
3.6 Direct Products

Unit 4.Homomorphisms and Factor Group **[12 lectures]**
4.1 Homomorphisms
4.2 Factor Groups
4.3 Factor Group Computations and Simple Groups

Text book:

1. **John B. Fraleigh, A First Course in Abstract Algebra, Seventh Edition, Pearson. Sections:** 2,3,4,5,6,8,9,10, 11(only Direct Product), 13,14,15.

Reference Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra, Second Ed., Foundation Books, New Delhi, 1995.

2. I. N. Herstien, Topics in Algebra, John Wiely and Sons.
3. N.S. Gopalakrishnan, University Algebra, Second Edition, New Age International, New Delhi, 1986.
4. Joseph. A. Gallian, Contemporary Abstract Algebra,(4th Edition), Narosa Publishing House.

DSE-2B: MT-354- Ordinary Differential Equations (2 credits)

Course Objectives: The main objectives of this course are to introduce the students to the exciting world of differential equations, system of differential equationsand their applications.

Course Learning Outcomes: The course will enable the students to:

i) understand the genesis of ordinary differential equations.
ii) learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
iii) grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

Course Contents:

Unit 1. Linear Differential Equations with constant coefficients [12 lectures]

1.1 Constant coefficient homogeneous equations
1.2 Characteristic equations
- 1.2.1 distinct real roots
- 1.2.2 repeated roots
- 1.2.3 complex roots

1.3 Particular solution
1.4 Initial value problem
1.5 The operator $\frac{1}{f(D)}$ and its evaluation for the functions x^m, e^{ax} , $e^{ax}v$, xv and the operator $\frac{1}{D^2+a^2}$ acting on $\sin ax$ and $\cos ax$ with proofs.

Unit 2. Non -Homogeneous Linear Equations [08 lectures]

2.1 Principle of superposition
2.2 Method of undetermined coefficients
2.3 Method of reduction of order
2.4 Method of variation of parameters.

Unit 3. Series Solutions of Linear Second Order Equations [06 lectures]

3.1 Review the properties of power series
3.2 Series solution near an ordinary point
3.3Regular singular points
3.4 Euler equations

Unit 4. System of Equations [10 lectures]

4.1 Introduction to system of differential equations
4.2 Linear systems: basic theory of homogeneous linear systems, constant coefficient
4.3 Homogeneous systems.

Text Books:

1. **William F Trench , Elementary Differential Equations with Boundary Value Problems ,** E book (Free download)

Unit 1 : Chapter 5: Sections 2 to 3 . Unit 2 : Chapter 5: Sections 4 to 7 .
Unit 3: Chapter 7: sections 1 to 4. Unit 4 : Chapter 10 : sections 1 to 6.

2. **Frank Ayres JR, Theory and Problems on Differential Equations, Schaum's outline Series, SI (metric) edition.** Unit 1 Chapter 16 Short methods

Reference Books:

1. M. D. Raisinghania , Ordinary and Partial Differential Equations , S. Chand and Company LTD 2009.
2. Elementary Differential Equations seventh edition by Earl D. Rainville and Philip E Bedient.
3. George F. Simmons and Stevan G. Krantz , Differential Equations, Tata McGraw-Hill.
4. W. R. Derrick and S. I. Grossman, A First Course in Differential Equations with Applications . CBS Publishers and Distributors , Delhi 110032, Third Edition.
5. Daniel Murray, Introductory Course in Differential Equations, Orient Longman.

DSE-3A: MT 355(A): Operations Research (2 credits)

Course Objectives: This course develops the ideas underlying the Simplex method for Linear programming problem, as an important branch of operations research. The course covers Linear programming with applications to Transportation and Assignment problem. Such problems arise in manufacturing resource planning and financial sectors.

Course Learning Outcomes: This course will enable the students to learn:

i) Analyze and solve linear programming models of real-life situations.
ii) The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
iii) The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

Course Contents:

Unit 1. Modeling with Linear Programming **[08 Lectures]**

1.1Two variable LP Model
1.2 Solution of LP Model by Graphical Method
1.3 Selected LP Model Applications
1.4 Graphical Sensitivityanalysis.

Unit 2. TheSimplex Method and Duality **[12 Lectures]**

2.1 LP Model in equation form
2.2 Transition from graphical to algebraic solutions
2.3 The Simplex method.
2.4 Definition of the dual problem
2.5 Primal dual relationship
2.6 Economic interpretation of Duality.

Unit 3. Transportation Model **[10 Lectures]**

3.1 Definition of the Transportation model
3.2 The Transportation algorithm.

Unit 4. The Assignment Model **[06 Lectures]**

4.1 The Hungarian method
4.2 Simplex explanation of the Hungarian method.

Text Book:

1. **Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.**

Unit 1: Chapter-2: 2.1,2.2,2.3(2.3.4, 2.3.5, 2.3.6).

Unit 2:**Chapter-3**: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 (3.6.1), Chapter-4: 4.2, 4.3

Unit 3:Chapter -5: 5.1,5.3 (5.3.1, 5.3.2, 5.3.3), **Unit 4:Chapter-5**: 5.4(5.4.1, 5.4.2).

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, Introduction toOperation Research (Eighth Edition) Tata McGrawHill.
2. J K Sharma, Operations Research (Theory and Applications,second edition, 2006), Macmillan IndiaLtd.
3. Hira and Gupta, Operation Research.

DSE-3A: MT-355(B): Differential Geometry (2 credits)

Course Objectives: This course enables the students to understand differential geometry of curves, their fundamental properties like torsion, curvature etc. along with their different forms. Also, to make understand different forms of curves and surfaces, along with their diverse properties through the use of differential calculus.

Course Learning Outcomes: The course will enable the students to:

i) Gain an understanding to solve problems with the use of differential geometry to diverse situations in mathematical contexts.
ii) Develop different properties associated with curves and surfaces.
iii) Demonstrate a depth of understanding in advanced mathematical topics in relation to geometry of curves and surfaces Learn to analyze mappings between spaces.
iv) Apply the theory of differential geometry to specific research problems in mathematics or other fields.

Course Contents:

Unit 1: Curves in the plane and in space [04 Lecture]

1.1 What is a curve?
1.2 Arc-length
1.3 Reparameterization
1.4 Level Curves vs. Parameterized Curves

Unit 2 : How much does a curve? [06 Lecture]

2.1 Curvature
2.2 Plane Curves
2.3 Space Curves

Unit 3 : Global Properties of curves [06 Lecture]

3.1 Simple Closed Curves
3.2 The Isoperimetric Inequality
3.3 The Four Vertex Theorem

Unit 4 : Surfaces in three dimensions [06 Lecture]

4.1 What is a Surface?
4.2 Smooth Surfaces
4.3 Tangents, Normal and Orientability

4.4 Examples of surfaces
4.5 Quadratic Surfaces
4.6 Triply orthogonal Systems
4.7 Applications of the Inverse Function Theorem

Unit 5 : The first fundamental form [07 Lecture]

5.1 Lengths of Curves on Surfaces
5.2 Isometries of Surfaces
5.3 Conformal Mappings of Surfaces
5.4 Surface Area
5.5 Equiareal Maps and Theorem of Archimedes

Unit 6 : Curvature of surfaces [07 Lecture]

6.1 The Second Fundamental Theorem
6.2 The Curvature of Curves on a Surface
6.3 The Normal and Principal Curvatures
6.4 Geometric Interpretation of Principal Curvatures.

Text book:

1. **Andrew Pressley: Elementary Differential Geometry, Springer International Edition, Indian Reprint 2004.**
   Unit 1: Chapter 1: Section 1.1 to 1.4, Unit 2: Chapter 2: Section 2.1 to 2.3,
   Unit 3: Chapter 3: Section 3.1 to 3.3, Unit 4: Chapter 4: Section 4.1 to 4.7,
   Unit 5: Chapter 5: Section 5.1 to 5.5, Unit 6: Chapter 6: Section 6.1 to 4.4.

Reference Books:

1. John A. Thorpe, Differential Geometry, Springer International Edition, Indian Reprint 2004.
2. M. DoCarmo, Diffrential geometry of Curves and surfaces, Prentice Hall, 1976.

DSE-3A: MT 355(C): C-Programming (2 credits)

Course Objectives: The **course** is designed to provide complete knowledge of **C-language**. Students will be able to develop logics which will help them to create **programs**, applications in **C**. Also, by **learning** the basic **programming** constructs they can easily switch over to any other **language** in future.

Course Learning Outcomes: After the completion of this course, the students will be able to develop applications.

Course Contents:

Unit 1. Fundamentals of C – programming: [06 Lectures]

1.1 Introduction to C, The character set. Identifier and keywords. Data types, Constants.
1.2 Variables and arrays.
1.3 Declarations. Expressions., Statements, Symbolic constants, Operators and Expressions.

Unit 2. Data Input and Output: [06 Lectures]

2.1 Preliminaries. Single character input- the getchar() function.
2.2 Single character output-the putchar() function.
2.3 Entering input data- the scanf() function.
2.4 Writing output data- the printf function.
2.5 The gets and puts functions.

Unit 3. Preparing, running a complete C Program and Control Statements: [10 Lectures]

3.1Preliminaries.The while statement.The do-while statement.

3.2 The for statement, Nested loops. The if-else statement.The switch statement.

3.3. The break statement. The continue statement. The comma operator.The goto statement.

Unit 4. Functions and Arrays: [14 Lectures]

4.1 Introduction to a function. Defining a function. Accessing a function.

4.2 Passing arguments to a function. Function prototypes, Recursion, Defining an array.

4.3 Processing an array. Passing arrays to functions. Multidimensional arrays. Arrays and strings.

Text Book:

1. **Programming with C. By Byron S. Gottfried. Schaum's Outline series.**
   Unit-1: Chapters: 1, 2, 3, Unit-2: Chapter: 4, Unit-3: Chapters: 5, 6.
   Unit-4: Chapters: 7, 9.

Reference Books:

1. The C Programming Language. By Brian W. Kernighan, Dennis M. Ritchie, 2nd Edition.
2. Spirit of C: An Introduction to Modern Programming. By Henry Mullish and Herbert L. Cooper, Jaico Publishers.

DSE-3B: MT-356(A): Machine Learning-I (2 credits)

Course Objectives:

Students will try to learn:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with **introduction to NumPy Array and Matrices**.
3. To become familiar with discover and visualize data to gain insights.
4. To become familiar with Fine-tuning the model - Grid Search, Randomized Search.
5. To develop the ability to write database applications in Python.

Course Learning Outcomes:

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

1. Gain knowledge about basic concepts of Machine Learning.
2. Identify machine learning techniques suitable for a given problem.
3. Solve the problems using various machine learning techniques.

Course Contents:

Unit 1: Introduction to Machine Learning [08 Lectures]

1.1 What & why behind machine learning

1.2 Types of Machine Learning - Supervised vs Unsupervised

1.3 Model Based Training

1.4 Main challenges of Machine Learning

1.5. Testing and Validating

Unit 2: Introduction to Python [08 Lectures]

2.1 The Way Of The Program

2.2 Variables, Expressions and Statements

2.3 Functions
2.4 Conditionals and Recursion
2.5 Strings
2.6 Lists

Unit 3: Understanding ML related Python Packages [10 Lectures]

3.1 Numpy Basics: Arrays and Vectorized Computation
1. The NumPyndarray: A Multidimensional Array Object
2. Universal Functions: Fast Element-wise Array Functions
3. Data Processing Using Arrays
4. Linear Algebra

3.2 Getting Started with Pandas
1. Introduction to pandas Data Structures
2. Essential Functionality
3. Summarizing and Computing Descriptive Statistics
4. Handling Missing Data
5. Hierarchical Indexing

3.3 Plotting and Visualization
1. A Brief matplotlib API Primer
2. Plotting Functions in Pandas
3. Plotting Maps: Visualizing Haiti Earthquake Crisis Data

Unit 4: End to End Machine Learning Project [10 Lectures]

4.1 Get the data
4.2 Discover &Visualize the data to gain insights
4.3 Preparing the data for machine learning - Cleaning, Handling categorical values, Feature scaling
4.5 Select and Train a model - Training and Evaluating on the Training Set
4.4 Fine-tuning the model - Grid Search, Randomized Search

Text Books:-

1. **Hands-on Machine Learning with Scikit-Learn, Keras and Tensorflow–AurelienHeron, Sections: 1, 2**
2. **Python for Data Analysis by Wes McKinney (O' Reilly publication)Chapter -4:4.1, 4.2, 4.3, 4.5, Chapter -5: 5.1, 5.2, 5.3, 5.4, 5.5, Chapter-8:8.1, 8.2, 8.3**
3. **Allen Downey,Think Python,How to Think Like a Computer Scientist, Green Tea Press Needham, Massachusetts, 2015, Sections - 1, 2, 3, 5, 8, 10**

Reference Book:-

1. Introduction to Machine Learning With Python - Andreas C. Muller & Sarah Guide
2. Head first Python by Paul Barry (O Reilly publication)
3. Jason Brownlee - Basics of Linear Algebra for Machine Learning, 2018
4. M. P. Deisenroth, A. A. Faisal, C. S. Ong - Mathematics for Machine Learning, Cambridge University Press, 2019
5. DipanjanSarkar, Raghav Bali, Tushar Sharma - Practical Machine Learning with Python, 2018.
6. **Extra Reference Resources -**
   geeksforgeeks.org/machine-learning
   https://towardsdatascience.com/search?q=machine%20learningwww.kaggle.com

DSE-3B: MT-356(B): Number Theory (2 credits)

Course Objectives: There are difficult open problems in number theory that are understandable at the undergraduate level; this course is designed to develop a micro aptitude for understanding the aesthetic aspect of mathematical instructions and to prepare young minds to ponder such problems. Another goal is to familiarise students with basic number theoretic techniques that can be used in data protection.

Course Learning Outcomes: This course will enable the students to learn:

i) some of the open problems related to prime numbers.
ii) about number theoretic functions and modular arithmetic.
iii) the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.

Course Contents:

Unit 1. Divisibility **[06 Lectures]**

1.1 Introduction
1.2 Divisibility
1.3 Prime

Unit 2.Congruences **[08 Lectures]**

2.1 Congruences
2.2 Solution of Congruences
2.3 The Chinese Remainder Theorem

Unit 3. Greatest integer function **[08 Lectures]**

3.1 Greatest integer function
3.2 Arithmetic functions
3.3 The Mobius Inversion formula

Unit 4.Quadratic Reciprocity **[08 Lectures]**

4.1 Quadratic residues
4.2 Quadratic reciprocity
4.3 The Jacobi Symbol

Unit 5. Diophantine Equations **[06 Lectures]**

5.1 Diophantine equations $ax + by = c$
5.2 Pythagorean triplets.

Text Book:

1. **I. Niven, H. Zuckerman and H.L. Montgomery, An Introduction to Theory of Numbers, 5th Edition, John Wiley and Sons.**
   Unit 1 : Chapter 1 Section 1.1- 1.3, Unit 2 : Chapter 2 Section 2.1- 2.3,
   Unit 3 : Chapter 3 Section 3.1- 3.3, Unit 4 : Chapter 4 Section 4.1 -4.3,
   Unit 5 : Chapter 5 Section 5.1 and 5.3

Reference Book:

1. David M. Burton, Elementary Number Theory (Second Ed.), Universal Book Stall, New Delhi, 1991.

DSE-3B: MT-356 (C): Laplace Transform and Fourier Series (2 credits)

Course Objectives: The main objective of this course is to determine properties of Laplace Transform and Fourier series which may be solved by application of special functions.

Course Learning Outcomes: This course will enable the students to learn:

i) Students will be able to know the use of Laplace transform in system modeling, digital signal processing, process control.
ii) Solve an initial value problem for an nth order ordinary differential equation using the Laplace transform.
iii) Find the Fourier series representation of a function of one variable

Course Contents:

Unit 1: The Laplace Transform [10Lectures]

1.1 Definition, Laplace Transform of some elementary functions.
1.2 Sufficient condition for existence of Laplace Transform
1.3 Some important properties of Laplace Transform.
1.4 Methods of finding Laplace Transform: Direct Method, Series Method
1.5 Evaluation of Integration
1.6 Some Special Functions

Unit2: The Inverse Laplace Transform [10Lectures]

2.1 Definition, Some inverse Laplace Transform.
2.2 Some important properties of Inverse Laplace Transform.
2.3 Methods of finding inverse Laplace Transforms: Partial Fraction Method and Series Method.
2.4 The Heaviside's Expansion formula.
2.5 Beta function, Evaluation of Integration.

Unit3: Applications to Differential Equations [10Lectures]

3.1 Ordinary Differential Equations with constant coefficients.
3.2 Ordinary Differential Equations with variable coefficients.
3.3 Simultaneous Ordinary Differential Equations.

Unit 4: Fourier series [06Lectures]

4.1 Even and Odd functions, Its properties.
4.2 Fourier series and its Examples.

Text Book:

1. **Schaum's Outline Series-Theory and Problems of Laplace Transform by Murray R. Spiegel.**
   Unit1:Chapter-1, Unit2:Chapter-2, Unit3:Chapter-3 (Excluding Applications to Mechanics, Electrical circuits, Beam and PDE).
2. **Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co.Pvt.Ltd.(1970).**
   Unit4: Chapter-12(only12.1)

ReferenceBooks:

1. Phil Dyke, An Introduction to Laplace Transforms and Fourier Series, Second Edition, Indian Reprint 2014.
2. Joel L. Schiff, The Laplace Transforms- Theory and Applications, Springer Verlag New York 1999.
3. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications, Third Edition, CRC Press.

DSE-1: MT 357: Practical Course Lab-I (Metric Spaces and Real Analysis-I)(2 credits)

Section-I: Metric Spaces Practical

Practical 1: Definition and examples of Metric Spaces (Unit-1; 1.1)

Practical 2: Open and Closed sets in metric spaces (Unit-1; 1.2)

Practical 3: Convergences (Unit 2)

Practical 4: Continuity (Unit 3)

Practical 5: Compactness (Unit 4)

Practical 6: Connectedness (Unit 4)

Section-II: Real Analysis-I Practical

Practical 1: Logic, Set Theory, Functions and Cardinality (Unit-1)

Practical 2: Convergent and Divergent Sequences of Real Numbers (Unit-2)

Practical 3: Monotone Sequences and Algebra of Convergent Sequences (Unit-2)

Practical 4: Limit Superior, Inferior and Cauchy Sequences (Unit-3)

Practical 5: Series of Real Numbers, Alternating Series and Conditional/Absolute Convergence (Unit-4)

Practical 6: Convergent and Divergent Series of Real Numbers (Unit-4)

DSE-2: MT 358: Practical Course Lab-II (Group Theory and Ordinary Differential Equations)(2 credits)

Section-I: Group Theory Practical

Practical 1: Isomorphic Binary Structures and Groups (Unit-1)

Practical 2: Subgroups and Cyclic Groups (Unit-2)

Practical 3: Groups of Permutations, Orbits and Cycles (Unit-3)

Practical 4: Alternating Groups, Cosets and the Theorem of Lagrange (Unit-3)

Practical 5: Direct Productsand Homomorphisms (Unit-4)

Practical 6: Factor Groups, Factor Group Computations and Simple Groups (Unit-4)

Section-II: Ordinary Differential Equations Practical

Practical 1: Linear differential equations with constant coefficients (Unit 1.1 to 1.4)

Practical 2: Inverse differential operators (Short methods) (Unit 1.5)

Practical 3: Non homogeneous linear equations Part I (Unit 2.1 to 2.2)

Practical 4: Non homogeneous linear equations Part II (Unit 2.3 to 2.4)

Practical 5: Series solution of linear second order equations (Unit 3)

Practical 6: System of equations (Unit 4).

DSE-3: MT 359: Practical Course Lab-III (Based on DSE-3A and DSE-3B)(2 credits)

Section-I: Operations Research/ Differential Geometry/C-Programming

Section-I (A): Operations Research Practical

Practical 1: Modeling withLinearProgramming (Unit-1)

Practical 2: TheSimplex Method-I (Unit-2)

Practical 3: TheSimplex Method-II (Unit-2)

Practical 4: Duality (Unit-2)

Practical 5: TransportationModel (Unit-3)

Practical 6: TheAssignmentModel (Unit-4)

OR

Section-I (B): Differential GeometryPractical

Practical 1: Curves in the plane and in space (Unit 1)

Practical 2: How much does a curve? (Unit 2)

Practical 3: Global Properties of curves (Unit 3)

Practical 4: Surfaces in three dimensions (Unit 4)

Practical 5: The first fundamental form (Unit 5)

Practical 6: Curvature of surfaces (Unit 6)

OR

Section-I(C): C- Programming Practical

Practical-1: Operators and expressions-I (Unit 1)

Practical-2: Operators and expressions-II (Unit 2)

Practical-3: Control statements-I (Unit 3)

Practical-4: Control statements-II (Unit 3)

Practical-5: Arrays (Unit 4)

Practical-6: Functions (Unit 4)

Section-II: Machine Learning-I/ Number Theory/Laplace Transform and Fourier Series

Section-II(A): Machine Learning-I Practical

Practical 1: Introduction to Python, Python Data Types-I (Unit 2)

Practical 2: Python Data Types- II (Unit 2)

Practical 3: Control statements in Python-I (Unit 2)

Practical 4: Control statements in Python-II (Unit 2)

Practical 5: Python collection type - List (Unit 2)

Practical 6: Data handling with Panda - 1 (Unit 3)

Practical 7: Data handling with Panda - 2 (Unit 3)

Practical 8: Data visualization with Matplotlib (Unit 3)

Practical 9: Introduction to scikit-learn (Unit 3)

Practical 10: End to end model implementation - 1 (Unit 4)

Practical 11: End to end model implementation - 2 (Unit 4)

Practical 12: End to end model implementation - 3 (Unit 4)

OR

Section-II(B): Number TheoryPractical

Practical 1: Divisibility and GCD – I (Unit 1)

Practical 2: Divisibility and GCD – II (Unit 1)

Practical 3: Congruences (Unit 2)

Practical 4: Quadratic Reciprocity (Unit 3)

Practical 5: Number Theoretic Functions (Unit 4)

Practical 6: Linear Diophantine Equations, Pythagorean Triplets (Unit 5)

OR

Section-II(C): LaplaceTransformsandFourierSeries Practical

Practical1:The Laplace Transform(Unit1:1.1,1.2,1.3,1.4)

Practical2:Special Functions(Unit1:1.5,1.6)

Practical3:The Inverse Laplace Transform-I(Unit2:2.1,2.2,2.3,2.4)

Practical4:The Inverse Laplace Transform-II(Unit2:2.4, 2.5)

Practical5:Applications to Differential Equations(Unit3)

Practical6:Fourier Series(Unit4)

SEC-I: MT -3510: Programming in Python–I (2 credits)

Course Objectives:

1. To understand why **Python** is a useful scripting language for developers.
2. To learn how to use lists, tuples, and dictionaries in **Python** programs.

3. To learn and understand python looping, control statements and string manipulations.
4. To acquire programming skills in core Python.

Course Learning Outcomes: At the end of the course:

1. The student will be able to explain basic principles of Python programming language.
2. The student will implement object oriented concepts.

Course Contents:

Unit 1: Introduction to Python [06 Lectures]

1.1 Installation of Python
1.2 Values and types: int, float and str,
1.3 The Print Function: Print basics
1.4 Variables: assignment statements, printing variable values, types of variables.
1.5 Mathematical Operators, operands and precedence:+, -, /, *, **, % PEMDAS (Rules of precedence)
1.6 String operations: + : Concatenation, * : Repetition
1.7 Boolean operator:
1.7.1 Comparison operators: ==, !=, >, =, <=
1.7.2 Logical operators: and, or, not
1.8 Mathematical functions from math, cmath modules, random module
1.9 Keyboard input: input() statement
1.10 Calculus: Differentiation, Integration, Limit and Series

Unit 2: String, list, tuple [06 Lectures]

2.1 Strings:
2.1.1 Length (Len function)
2.1.2 String traversal: Using while statement, Using for statement
2.1.3 String slice
2.1.4 Comparison operators (>, <, ==)
2.2 Lists:
2.2.1 List operations
2.2.2 Use of range function
2.2.3 Accessing list elements
2.2.4 List membership and for loop
2.2.5 List operations
2.2.6 Updating list: addition, removal or updating of elements of a list
2.3 Tuples:
2.3.1 Defining a tuple,
2.3.2 Index operator,
2.3.3 Slice operator,
2.3.4 Tuple assignment,
2.3.5 Tuple as a return value

Unit 3: Iterations and Conditional statements [10 Lectures]

3.1 Conditional and alternative statements, Chained and Nested Conditionals: if, if-else, if-elif-else, nested if, nested if-else
3.2 Looping statements such as while, for etc, Tables using while.
3.3 Functions:

3.3.1 Calling functions: type, id
3.3.2 Type conversion: int, float, str
3.3.3 Composition of functions, Returning values from functions
3.3.4 User defined functions, Parameters and arguments

Unit 4: Linear Algebra [04 Lectures]

4.1 Matrix construct, eye(n), zeros(n,m) matrices
4.2 Addition, Subtraction, Multiplication of matrices, powers and invers of a matrix.
4.3 Accessing Rows and Columns, Deleting and Inserting Rows and Columns
4.4 Determinant, reduced row echelon form, nullspace, columnspace, Rank
4.5 Solving systems of linear equations (Gauss Elimination Method, Gauss Jordan Method, LU- decomposition Method)
4.6 Eigenvalues, Eigenvectors, and Diagonalization

Unit 5: Numerical methods in Python [06 Lectures]

5.1 Roots of Equations
5.2 Newton-Raphson Method
5.3 False Position (RegulaFalsi) Mehtod
5.4 Numerical Integration:
5.4.1 Trapezoidal Rule,
5.4.2 Simpson's $1/3^{rd}$ Rule,
5.4.3 Simpson's $3/8^{th}$ Rule

Unit 6: 2D and 3D Graphs [04 Lectures]

6.1 Installation of numpy, matplotlib packages
6.2 Graphs plotting of functions
6.3 Different formats of graphs, PyDotPlus (Scalable Vector Graphics), PyGraphviz.
Decorate Graphs with Plot Styles and Types: Markers and line styles, Control colors, Specifying styles in multiline plots, Control linestyles, Control marker styles.
Polar charts: Navigation Toolbar with polar plots, Control radial and angular grids.
6.4 Three-dimensional Points and Lines
6.5 Three-dimensional Contour Plots, Wireframes and Surface Plots.

Practicals:

Practical 1: Introduction to Python, Python Data Types-I (Unit 1)

Practical 2: Python Data Types- II (Unit 2)

Practical 3: Control statements in Python-I (Unit 3- 3.1, 3.2)

Practical 4: Control statements in Python-II (Unit 3- 3.3)

Practical 5: Application: Matrices (Unit 4 – 4.1-4.3)

Practical 6: Application: Determinants, system of Linear Equations (Unit 4- 4.4, 4.5)

Practical 7: Application: System of equations (Unit 4- 4.5)

Practical 8: Application: Eigenvalues, Eigenvectors (Unit 4 – 4.6)

Practical 9: Application: Eigenvalues, Eigenvectors (Unit 4 – 4.6)

Practical 10: Application: Roots of equations (Unit 5 – 5.1)

Practical 11: Application: Numerical integration (Unit 5 – 5.2, 5.3,5.4)

Practical 12: Graph Plotting (Unit 6)

Text Books:-

1. **Allen Downey,Think Python, How to Think Like a Computer Scientist, Green Tea Press Needham, Massachusetts, 2015,**
   Unit1-1: Chapter-1:1.1-1.5, Capter-2: 2.1-2.6, Chapter-3: 3.1-3.6, Chapter-5: 5.1-5.3
   Unit1-2: Chapter-8: 8.1-1.5, Capter-10: 10.12, Chapter-12: 12.1.- 12.6
   Unit-3: Chapter 5:5.4 -5.7, Chapter 7: 7.1-7-7.5
2. **Robert Johansson, Introduction to Scientific Computing in Python, 2016**
   Unit-1: 6.5-6.8
   Unit- 4: Chapter-4: 4.6 (4.6.1 - 4.6.6), Chapter-6: 6.9-6.10, Unit-5: Chapter-4: 4.8, Unit-6: Chapter-5
3. **Hans-PetterHalvorsen,Python for Scientific engineering, 2020 Unit-5: Chapter-31**

Reference Books:-

1. Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India, 2015.
2. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
3. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015.Zelle, J., Python Programming: An Introduction to Computer Science, Franklin,Beedle and Assiciatesn Inc.
4. SandroTosi, Matplotlib for Python Developers, Packt Publishing Ltd. (2009) BIRMINGHAM – MUMBAI. (Use for 2D and 3D plots and also use Lambert K. A book).
5. Python: Notes for Professionals, Goalkicker.com, Free Programming books.

SEC-II: MT-3511: LaTeX for Scientific Writing (2 credits)

Course Objectives: The purpose of this course is

i) To provide an understanding of the basicmechanisms of LaTeX, using plain text as a vehicle
ii) To acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting.

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

i) Write a simple LaTeX input document based on the article class.
ii) Turn the input document into pdf with the pdflatex program.
iii) Format Words, Lines, and Paragraphs.
iv) Understand how to present data using tables.

Course Contents:

Unit 1. Introduction to LaTeX [06 Lectures]

1.1 Definition and application of LaTeX
1.2 Preparation and Compilation of LaTeX input file
1.3 LaTeX Syntax
1.4 Keyboard Characters in LaTeX

Unit 2.Formatting Words, Lines, and Paragraphs [09 Lectures]

2.1 Text and Math Mode Fonts.
2.2 Emphasized and Colored Fonts

2.3 Sectional Units
2.4 Labeling and Referring Numbered Items
2.5 Texts Alignment and Quoted text
2.6 New Lines and Paragraphs
2.7 Creating and Filling Blank Space
2.8 Producing Dashes Within Texts

Unit 3.Listing and Tabbing Texts [09 Lectures]

3.1 Listing Texts
3.2 Tabbing Texts Through the tabbing Environment

Unit 4.Table Preparation [12 Lectures]

4.1Table Through the tabular Environment
4.2 Table Through the tabularx Environment
4.3 Vertical Positioning of Tables
4.4 Sideways (Rotated) Texts in Tables
4.5 Adjusting Column Width in Tables
4.6 Additional Provisions for Customizing Columns of Tables
4.7 Merging Rows and Columns of Tables.

Practicals:

Practical 1: Introduction to LaTeX (Unit-1; 1.1, 1.2)

Practical 2: Syntax and Keyboard Characters in LaTeX (Unit-1; 1.3, 1.4)

Practical 3: Fonts in LaTeX (Unit -2; 2.1, 2.2)

Practical 4: Sections, Labelling and Text Alignment in LaTeX (Unit-2; 2.3, 2.4, 2.5)

Practical 5: New Lines, Paragraphs, Blank Space and Dashes in LaTeX (Unit-2; 2.6-2.8)

Practical 6: Listing Texts -I (Unit-3; 3.1[Chapter 6, 6.1.1, 6.1.2])

Practical 7: Listing Texts -II (Unit-3; 3.1[Chapter 6, 6.1.3, 6.1.4, 6.1.5])

Practical 8: Tabbing Texts (Unit-3; 3.2)

Practical 9: Table Through the tabular Environment (Unit-4; 4.1)

Practical 10: Table Through the tabularx Environment (Unit-4; 4.2)

Practical 11: Positioning and Texts in Tables (Unit-4; 4.3, 4.4)

Practical 12: Customizing Tables in LaTeX (Unit-4; 4.5, 4.6, 4.7)

Text Book:

1. **LaTeX in 24 Hours, A Practical Guide for Scientific Writing, Dilip Datta, Springer International Publishing AG, 2017.**
   Unit 1: Chapter 1; 1.1 to 1.6, Unit 2: Chapter 2; 2.1 to 2.4, Chapter 3; 3.1 to 3.7
   Unit 3: Chapter 6; 6.1, 6.2, Unit 4: Chapter 7; 7.1 to 7.7

Reference Books:

1. LaTeX, A Document Preparation System, User's Guide and Reference Manual, Leslie Lamport, Addison-Wesley Publishing Company, Inc., 1994.
2. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing Ltd, 2011.

3. LaTeX and Friends, M.R.C. van Dongen, Springer-Verlag Berlin Heidelberg ,2012.

Semester-VI

DSE-4A: MT - 361: Complex Analysis (2 Credits)

Course Objectives: This course aims to introduce the basic ideas of analysis for complex functions in complex variables with visualization through relevant Practicals. Particular emphasis has been laid on Cauchy's theorems, series expansions and calculation of residues.

Course Learning Outcomes: The completion of the course will enable the students to:

i) Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
ii) Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
iii) Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.
iv) Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

Course Contents:

Unit 1: Analytic functions [09 Lectures]

1.1 Functions of a Complex Variables
1.2 Limits, Theorems on limits (Without Proof), Limitsinvolving the point at infinity, Continuity, Derivatives, Differentiation formulas (WithoutProof)
1.3 Cauchy- Riemann Equations, Sufficient Conditions for differentiability (OnlyStatement and Examples)
1.4 Polar coordinates, Analytic functions, Harmonic functions.

Unit 2: Elementary Functions [07 Lectures]

2.1 The Exponential functions
2.2 The Logarithmic function, Branches and derivatives oflogarithms, Some identities involvinglogarithms
2.3 Complex exponents, Trigonometricfunctions.

Unit 3. Integrals [11 Lectures]

3.1 Derivatives of functions, Definite integrals of functions
3.2 Contours, Contour integral,Examples
3.3 Upper bounds for Moduli of contour integrals, Anti-derivatives (Only Examples)
3.4 Cauchy-GoursatTheorem (without proof), Simply and multiply Connected domains.Cauchy integral formula, Derivatives of analytic functions. Liouville's Theorem andFundamental Theorem of Algebra (Without Proof).

Unit 4. Series [04 Lectures]

4.1 Convergence of sequences and series (Theorems without proof)
4.2 Taylor's series (without proof), Laurent series (withoutproof), examples only.

Unit 5. Residues and Poles [05 Lectures]

5.1 Isolated singular points, Residues
5.2 Cauchy residue theorem (Without Proof), residue atinfinity, types of isolated singular points,residues at poles
5.3 Zeros of analytic functions, zerosand poles.

Text Book:

1. **J.W. Brown and R.V. Churchill, Complex Variables and Applications, International StudentEdition, 2009. (Eighth Edition).**
   Unit -1: Chapter 1: Sec.11, 12, 15 to 26. Unit-2: Chapter 3: Sec.29 to 34.
   Unit -3: Chapter 4: Sec. 37 to 44, 46 and48 to53.
   Unit -4: Chapter 5:Sec. 55 to 60 and 62. Unit – 5: Chapter 6: Sec.68 to 76.

Reference Books:

1. S. Ponnusamy, Complex Analysis, Second Edition (Narosa).
2. S. Lang, Complex Analysis, (Springer Verlag).
3. A.R. Shastri, An Introduction to Complex Analysis, (MacMillan).
4. L.V.Ahlfors, Complex Analysis, 3rd edition, McGraw Hill, 2000.
5. H.A.Priestley, Introduction to Complex Analysis, 2nd edition (Indian), Oxford, 2006.

DSE-4B: MT: 362 Real Analysis-II(2 Credits)

Course Objectives: To comprehend bounded function integration on a closed and bounded interval, as well as its extension to situations where either the integration interval is infinite or the integrand has infinite limits at a finite number of points on the integration interval. The sequence and series of real-valued functions.

Course Learning Outcomes: The course will enable the students to learn about:

i) some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
ii) beta and gamma functions and their properties.
iii) recognize the difference between pointwise and uniform convergence of a sequence of functions.
iv) illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.

Course Contents:

Unit 1: Riemann Integration **[12 Lectures]**

1.1 Sets of Measure zero
1.2 Definition of the Riemann Integral
1.3 Existence of the Riemann Integral
1.4 Properties of the Riemann Integral
1.5 Fundamental Theorems of Calculus

Unit 2: Improper Integrals **[10 Lectures]**

2.1 Improper Integrals on Closed and Bounded Intervals
2.2 Tests for Convergence of Positive Integrands
2.3 Improper Integrals on Unbounded Intervals and Tests for their Convergence
2.4 Tests for Convergence of the Integral of Product

Unit 3: Sequences of Functions **[07 Lectures]**

3.1 Pointwise convergence of sequences of functions
3.2 Uniform convergence of sequences of functions
3.3 Consequences of uniform convergence

Unit 4: Series of Functions **[07 Lectures]**

4.1 Convergence and uniform convergence of series of functions
4.2 Integration and differentiation of series of functions

Text Books:

1. **Methods of Real Analysis, Second Edition, Richard R. Goldberg, John Wiley and amp; Sons, Inc.**
   Unit -1:Sec.: 7.1,7.2,7.3,7.4,7.8, Unit -3: Sec.: 9.1, 9.2, 9.3, Unit-4: Sec.9.4, 9.5
2. **Introduction to Real Analysis, Eighth Edition, S.K. Mapa, Sarat Book House**
   Unit-2: Sections: 12.1, 12.2, 12.3, 12.4,12.5, 12.6, 12.7, 12.8, 12.9, 12.10

Reference Books:

1. Real Analysis, N.L. Carothers, Cambridge University Press
2. Introduction to Real Analysis, Third edition, Robert, G. Bartle, Donald Sherbert, John Wiley and Sons.
3. A Basic Course in Real Analysis, Ajit Kumar and S.Kumaresan,CRC Press, SecondIndian, CRC Press (Chapman and Hall)
4. A course of Mathematical Analysis, Revised edition, Shanti Narayan and Mittal - S.Chand and Co.(2002).
5. Mathematical Analysis, third Editions'. Malik and Savita Arora - New AgeInternational Publications

DSE-5A: MT: 363 Ring Theory (2 Credits)

Course Objectives: The objective of this course is to introduce the fundamental theory of rings and their corresponding homomorphisms. The basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers.

Course Learning Outcomes: The course will enable the students to learn about:

i) The fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms.
ii) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.
iii) Appreciate the significance of unique factorization in rings and integral domains.

Course Contents:

Unit 1: Rings and Fields [08 lectures]

1.1 Ring, Subring, Fields.
1.2 Divisors of zero, Integral Domain, The Characteristics of a Ring.
1.3 The Field of Quotients of an Integral Domain.

Unit 2: Rings of Polynomials & Factorization [08 lectures]

2.1 Polynomials in an determinate,
2.2 The Evaluation Homomorphism Zeros.
2.3 Factorization of a Polynomial over a Field: The Division Algorithm in F[x]
2.4 Irreducible Polynomials, Uniqueness of Factorization in F[x].

Unit 3: Ideals and Factor Rings [08 lectures]

3.1 Homomorphism, Properties of Homomorphism
3.2 Ideals, Factor Ring, Fundamental Homomorphism Theorem.
3.3 Maximal Ideal, Prime Ideal, Ideal Structure in F[x].

Unit 4: Factorization [12 Lectures]

4.1 Unique Factorization Domain, Principal Ideal Domain, Gauss Lemma, D[x] is a UFD.
4.2 Euclidean Norm, Euclidean Domain, Euclidean Algorithm (Without Proof).
4.3 Gaussian Integers, Multiplicative Norm.

Text Book:

1. **John B. Fraleigh, A First Course In Abstract Algebra, 7th Edition, Pearson.**
   Unit 1: Section 18, 19, 21. Unit 2: Section 22 and 23.
   Unit 3: Section 26 and 27. Unit 4: Section 45, 46 and 47 (except theorem 47.10).

Reference Books:

1. Josheph A. Gallian, Contemporary Abstract Algebra, 7th Edition, Narosa Publishing House.
2. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Edition, Jonh Wiley and Sons, Inc.
3. I.N. Herstein, Abstract Algebra, 3rd Edition, Prentice Hall of India.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra, 2nd Edition, Cambridge University Press.

DSE-5B: MT 364: Partial Differential Equations (2 credits)

Course Objectives: The main goals of this course are to teach students how to form, solve, and apply partial differential equations to solve physical problems. Also, to introduce first and second order partial differential equations and their classifications and methods of finding solutions of these partial differential equations.

Course Learning Outcomes: The course will enable the students to:

i) formulate, classify and transform partial differential equations into canonical form.
ii) solve linear partial differential equations using various methodsand apply these methods in solving some physical problems.
iii) solve Laplace equations using various analytical methods demonstrate uniqueness of solutions of certain kinds of these equations.

Course Contents:

Unit 1: Introduction to Ordinary and Partial Differential Equations [10 Lectures]

1.1 Surfaces and Curves in Three Dimensions
1.2 Simultaneous Differential Equations of the First Order and the First Degree in Three Variables.
1.3 Methods of solution of $dx/P = dy/Q = dz/R$
1.4 Pfaffian Differential Forms and Equations.
1.5 Solution of Pfaffian Differential Equations in Three Variables

Unit 2: Partial Differential Equations [08 Lectures]

2.1 Introduction to Partial Differential Equations
2.2 Origin of first order Partial Differential Equations
2.3 Linear Equations of First order equations
2.4 Integral surfaces passing through given curve

Unit 3: Second Order Partial Differential Equations [10 lectures]

3.1 The Origin of Second Order Partial Differential Equations.
3.2 Linear Partial Differential Equations with constant coefficients.
3.3 Methods of solving Linear Partial Differential Equations
   3.3.1. Solution of reducible equations
   3.3.2. Solution of irreducible equations with constant coefficients

3.3.3. Rules of finding complementary functions

3.3.4. Rule of finding particular integrals

Unit 4 :Classification of Partial Differential Equations [08 lectures]

4.1 Classification of second order partial differential equations, canonical forms

4.2 Solution of Laplace equations by separation variables methods

4.3 Solution of periodic differential equations by separation variables method

4.4 Solution of wave equation by separation variables method.

Text Books:

1. **Ian Sneddon, Element of Partial Differential Equations, McGraw-Hill Book Company, McGraw-Hill Book Company.**

Unit-1: Chapter-1 : 1,2,3,5 , Unit-2: Chapter-2 :1,2,4,5, Unit-3:Chapter-3: 1,4,5

2. **J.N. Sharma, Kehar Singh, Partial Differential equations for Engineers and Scientists, second Edition, Narasa Publications.**

Unit-4: Chapter No.3: 3.3, Chapter No.4: 4.3 ,Chapter No.5: 5.5

Reference Books:

1. T. Amaranath, An Elementary Course in Partial Differential Equations, Narosa Publishing, House 2nd Edition, 2003 (Reprint, 2006).
2. K. Sankara Rao, Introduction to Partial Differential Equations, Third Edition, PHI.

DSE-6A: MT365 (A): Optimization Techniques(2 Credits)

Course Objectives: This course enables the students to get an idea about the

i) Network and basic components, Determination of critical path: Critical Path Method (CPM),Project Evaluation and Review Techniques(PERT).Time-cost optimization Algorithm.

ii) Problem of Sequencing, Processing n Jobs through Two Machines, Processing n Jobs through 3 Machines and Processing n Jobs through k Machines.

Course Learning Outcomes: The course will enable the students to:

i) understand fundamentals of Network Analysis using CPM and PERT.

ii) solve a sequencing Problem for various jobs and machines.

Course Contents:

Unit 1: Network Models [10 Lectures]

1.1 CPM and PERT, Network representation, Critical Path Computations

1.2 Construction of the time schedule, PERT networks.

Unit 2: Game Theory [08 Lectures]

2.1 Game theory, Some basic terminologies

2.2 Optimal solution of two person zero sum game

2.3 Solution of mixed strategy games (Graphical solution of gamesonly).

Unit 3: Replacement and Maintenance Models [08 Lectures]

3.1 Introduction, Types of failure

3.2 Replacement of items whose efficiencydeteriorates with time.

Unit 4: Sequencing Problems [05 Lectures]

4.1 Introduction, Notation, terminology and assumptions

4.2 processing n jobs throughtwo machines, processing n jobs through three machines.

Unit 5: Classical Optimization Theory [05 Lectures]

5.1 Unconstrained problems, Necessary and sufficient conditions

5.2 Newton Raphsonmethod, Constrained problems, Equality constraints (Lagrangian Method Only).

Text Books:

1. **Hamdy A. Taha, Operation Research (Eighth Edition, 2009), PrenticeHall of India Pvt. Ltd, New Delhi.**
   Unit-11: Ch.6: 6.5 (6.5.1 to 6.5.3 & 6.5.5), Unit-2: Ch.13: 13.4(13.4.1,13.4.2,13.4.3), Unit-4:Ch.18: 18.1(18.1.1, 18.1.2), 18.2 (18.2.1).
2. **J K Sharma, Operations Research (Theory and Applications, secondedition, 2006), Macmilan India Ltd.**
   Unit-5: Ch.17: 17.1,17.2, 17.3, Ch.20: 20.1, 20.2, 20.3, 20.4.

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, Introduction to OperationResearch (Eighth Edition) Tata McGraw Hill.
2. Hira and Gupta, Operation Research

DSE-6A: MT 365(B): Calculus of Variation and Classical Mechanics (2 credits)

Course Objectives: Using mathematical methods, the course seeks to comprehend various definitions of physical quantities and their effects on various bodies. It stresses the acquisition of knowledge in order to apply mathematics to the real world.

Course Learning Outcomes: The course will enable the students to:

i) understand problems, methods and techniques of calculus of variations.

ii) understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.

iii) deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.

iv) determine the center of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.

Course Contents:

Unit 1: Variational Problems with Fixed Boundaries [06 Lectures]

1.1 Necessary condition of extremum of functionals

1.2 Euler equation

1.3 Euler-Poisson equation

1.4 Euler-ostrogradsky equation

1.5 Euler equation in parametric form

1.6 Isoperimetric problems

1.7 Principle of reciprocity

Unit 2: Variational Problems with Moving Boundaries [06 Lectures]

2.1 Moving boundaries in explicit form

2.2 Moving boundaries in implicit form

2.3 One sided variation

2.4 Functional in parametric form

Unit 3: Sufficient Conditions of Extremum [03 Lectures]

3.1Higher order variations

3.2 Sufficient condition for extremum

3.3 Jacobi equation and Jacobi equation

Unit 4: Mechanics of a Particle and System of Particles [06 Lectures]

4.1 Conservation principles (laws)

4.2 Conservation of linear momentum

4.3 Conservation of angular momentum

4.4 Conservation of energy, Constrained motion, constraints, degrees of freedom

4.5 Generalized co-ordinates

4.6 Limitations of Newton's laws

Unit 5: Variational Principle and Lagrangian Formulation [15 Lectures]

5.1 Hamilton's variational principle

5.2 Deduction of Lagrange's equations of motion fromHamilton's principle

5.3 Deduction of Lagrange's equations by D'Alembert's Principle

5.4 Lagrangian for charged particle in an electromagnetic field, gyroscopic forces,nonconservative forces.

5.5 Deduction of Hamilton's principle form D'Alembert's Principle

5.6 Deduction of Newton's second law of motion from Hamilton's principle

5.7 Deduction of Lagrange's equations of motion using variational principle for non-conservative systems

5.8 Applications of Lagrange's equations of motion

5.9 Non -holonomic systems

5.10 Conservation theorems

5.11 Worked Examples

Text Books:

1. Classical Mechanics by SL Gupta, V. Kumar and H.V. Sharma PragatiPrakashan.
   Unit-4: Chapter 1: 1.1 to 1.6, Unit-5: Chapter-2: 2.1 to 2.12
2. An elementary course on variational problems in Calculus, Naveen Kumar Narosa Publishing House.
   Unit-1: Chapter 1: 1.1 to 1.9, Unit-2: Chapter-2: 2.1 to 2.4, Unit-3: Chapter-3: 3.1 to 3.3.

Reference Books:

1. Classical Mechanics by Herbert Goldstein, Pearson Publication.
2. Introduction to classical Mechanics: with problems and solutions by David J. Morrin Cambridge University Press.
3. Mathematical Methods of Classical Mechanics by V.I. Arnold. Springer Publication.

DSE-6A: MT 365 (C): Financial Mathematics (2 credits)

Course Objectives:

This course enables the students to understand the basic securities, organization of financial markets, the concept of interest rates, present and future value of cash flow.

Course Learning Outcomes: The course will enable the students to:

i) describe and explain the fundamental features of a financial instruments.
ii) demonstrate a clear understanding of financial research planning, methodology and implementation.
iii) demonstrate understanding of basic concepts in linear algebra, relating to linear equations, matrices, and optimization.
iv) demonstrate understanding of concepts relating to functions and annuities.

Course Contents:

Unit 1: Mathematical models in economics, recurrences, and the elements of finance [08 Lectures]

1.1 Introduction, a model of the market, market equilibrium and excise tax.
1.2 The first-order recurrence, limits, special cases, continuous compounding of interest.
1.3 Interest and capital growth, income generation, the interval of compounding.

Unit 2: The Cobweb model, and Introduction to optimization [10 Lectures]

2.1 Stability of market equilibrium, the general linear case and economic interpretation.
2.2 Marginal cost as a derivative, Profit maximization, critical points, optimization in an interval and infinite intervals.

Unit 3: The derivative in economics [08 Lectures]

3.1 Elasticity of demand, profit maximization again.
3.2 Competition versus monopoly, the efficient small firm, startup and break-even points.

Unit 4: Linear equations and the input-output model [10 Lectures]

4.1 Making money with matrices, a two-industry 'economy', arbitrage portfolios and state prices and IS-LM analysis.
4.2 An economy with many industries and the technology matrix.

Text Book:

1. **Martin Anthony and Norman Biggs, Mathematics for Economics and Finance Methods and Modeling, Cambridge University Press, Reprint 2012.**
   Unit-1: Chapters-3: 3.2, 3.3, 3.4 and Chapter-4,
   Unit-2: Chapter-5, Chapter-6: 6.3, Chapter-8
   Unit-3: Chapter-9, Chapter-10,
   Unit-4: Chapter-15:15.3, Chapter-16:16.1, Chapter-17:17.4, Chapter-18:18.5, Chapter- 19.

Reference Books:

1. Edward T. Dowling, Mathematical Economics, Second Edition, Schaum's Outline Series, McGraw Hill International Edition.
2. AswathDamodaran, Corporate Finance- Theory and Practice, John Wiley and Sons, Inc.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.

DSE-6B: MT-366(A): Machine Learning-II (2 Credits)

Course Objectives:

The main goal of this course is to help students learn, understand, and practice machine learning approaches, which include the study of modern computing big data technologies and scaling up machine learning techniques focusing on industry applications.

Course Learning Outcomes:

The students learning outcomes are designed to specify what the students will be able to perform after completion of the course: Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.

Course Contents:

Unit 1: Classification of MNIST dataset [10 Lectures]

1.1 MNIST
1.2 Training a Binary Classifier
1.3 Performance Measures - Measuring accuracy using Cross Validation, Confusion Matrix, Precision and Recall
1.4 Multiclass Classification
1.5 Multilabel Classification

Unit 2: Linear Regression [10 Lectures]

2.1 Linear Regression
1. The Normal Equation
2.2 Gradient Descent
1. Batch Gradient Descent
2. Stochastic Gradient Descent
3. Mini-batch Gradient Descent
2.3 Polynomail Regression

Unit 3: Logistic Regression [06 Lectures]

3.1 Estimating Probabilities
3.2 Training and Cost Function
3.3 Decision Boundary
3.4 Softmax Regression

Unit 4: Other Supervised Algorithms [10 Lectures]

4.1 K Nearest Neighbors
4.2 Decision Trees
4.3 Ensembles of Decision Trees - Random Forest
4.4 Support Vector Machines

Text Books:-

1. **Hands-on Machine Learning with Scikit-Learn, Keras and Tensorflow – Aurelien Geron. Chapter-3:** Sections: 3.1, 3.2, 3.3, 3.4, 3.6, Chapter-4: 4.1, 4.2, 4.3, 4.6
2. **Introduction to Machine Learning With Python - Andreas C. Muller & Sarah Guido,** Chapter-2: Sections: 2.2.2, 2.2.5, 2.2.6, 2.2.7

Reference Book:-

1. Introduction to Machine Learning With Python - Andreas C. Muller & Sarah Guide.
2. Head first Python by Paul Barry (O Reilly publication).
3. Jason Brownlee - Basics of Linear Algebra for Machine Learning, 2018.
4. M. P. Deisenroth, A. A. Faisal, C. S. Ong - Mathematics for Machine Learning, Cambridge University Press, 2019.

5. DipanjanSarkar, Raghav Bali, Tushar Sharma - Practical Machine Learning with Python, 2018.
6. Andrew Ng Playlist - https://www.youtube.com/playlist?list=PLLssT5z_DsK-h9vYZkQkYNWcItqhlRJLN **(First 4 Lectures (till 4.6))**

geeksforgeeks.org/machine-learning
https://towardsdatascience.com/search?q=machine%20learningwww.kaggle.com

DSE-6B: MT- 366(B): Computational Geometry(2 credits)

Course Objectives: This course enables the students to gain detailed knowledge of the fundamental problems within computation geometry and general techniques for solving problems within computational geometry and practical experience with implementation issues involved in converting computation geometry algorithms into running programs.

Course Learning Outcomes: The course will enable the students to:

v) construct algorithms for simple geometrical problems.
vi) characterize invariance properties of Euclidean geometry by groups of transformations.
vii) describe and construct basic geometric shapes and concepts by computational means.

Course Contents:

Unit 1: Two Dimensional Transformations [12 Lectures]

1.1 Introduction.
1.2 Representation of points.
1.3 Transformations and matrices.
1.4 Transformation of – points, straight lines.
1.5 Midpoint Transformation.
1.6 Transformation of – parallel lines, intersecting lines.
1.7 Transformation: rotations, reflections, scaling.
1.8 Combined transformations.
1.9 Transformation of a unit square.
1.10 Solid body transformations.
1.11 Translations and homogeneous coordinates.
1.12 Rotation about an arbitrary point.
1.13 Reflection through an arbitrary line.
1.14 Projection – A Geometric Interpretation of Homogeneous Coordinates.
1.15 Overall Scaling.
1.16 Points at Infinity.

Unit 2: Three Dimensional Transformations [08 Lectures]

2.1 Introduction.
2.2 Three dimensional – Scaling, shearing, rotation, reflection, translation.
2.3 Multiple transformations.
2.4 Rotation about – an axis parallel to coordinate axes, an arbitrary axis in space.
2.5 Reflection through an arbitrary plane.

Unit 3: Projection [08 Lectures]

3.1 Orthographic projections.
3.2 Axonometric projections.

3.3 Oblique projections.
3.4 Perspective Transformations.

Unit 4: Plane and Space Curves [08 Lectures]

4.1 Introduction.
4.2 Curve representation.
4.3 Parametric curves.
4.4 Parametric representation of a circle.
4.5 Bezier Curves – Introduction, definition, properties (without proof), Curve fitting (up to n = 3), equation of the curve in matrix form (up to n = 3).

Text Book:

1. **D. F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics,Tata McGraw Hill, Second Edition.**

Unit 1: Chapter 2: Sec. 2.1 to 2.20, Unit 2: Chapter 3: Sec. 3.1 to 3.10.
Unit 3: Chapter 3: Sec. 3.12 to 3.15, Unit 4: Chapter 4: Sec. 4.1, 4.2, 4.4, 4.5,
Chapter 5: Sec. 5.1, 5.8.

Reference Books:

1. Computer Graphics with OpenGL, Donald Hearn, M. Pauline Baker, WarrenCarithers, Pearson (4th Edition).
2. Schaum Series, Computer Graphics by Zhigang Xiang and Roy A. Plastock.

DSE-6B: MT-366(C): Lebesgue Integration (2 Credits)

Course Objectives: To develop skills and to acquire knowledge on basic concepts of Lebesgue Measure, The Lebesgue Integral, Measurable Functions, Convergence and completeness.

Course Learning Outcomes: The course will enable the students:

i) To understand the concept of measure and properties of Lebesgue measure.
ii)To study the properties of Lebesgue integral and compare it with Riemann integral.

Course Contents:

Unit 1.Measurable Sets: [08 Lectures]

1.4 Length of open sets and closed sets
1.5 Inner and outer measure
1.6 Measurable sets
1.7 Properties of measurable sets.

Unit 2. Measurable Functions: [08 Lectures]

1.4 Definition of measurable functions and other criteria for measurability equivalent
1.5 Sums, Products, and limits of a measurable functions
1.6 Sequences of a measurable function

Unit 3. The Lebesgue integral for bounded function [10 Lectures]

3.1 Measurable partition, lower sum, upper sum,
3.2 Lebesgue integral for bounded measurable function
3.3 Properties of Lebesgue integrals for bounded measurable functions

Unit 4. The Lebesgue integral for unbounded function [10 lectures]

4.1 The Lebesgue integral for non-negative valued function
4.2 The Lebesgue integral for real valued function
4.3 Properties of Lebesgue integrals for unbounded functions
4.4 Some fundamental theorems

Text-Book:

1. **Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. (1970).**

Unit 1: Chapter 11: Sec 11.1 to 11.3. (Theorem No. 11.1B and 11.1C Statements only).
Unit 2: Chapter 11: Sec 11.4. Unit 3: Chapter 11: Sec 11.5 to 11.4.
Unit 4: Chapter 11: Sec. 11.5 to 11.8 (Theorem 11.8 D statement only)

Reference Books:

1. Tom M. Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House.
2. D. Somasundaram and B. Choudhari, A first course in Mathematical Analysis,Narosa Publishing House.
3. R.G. Bartle and D.R. Scherbert, Introduction to real analysis Fourth Edition, Wiley India Edition.
4. Inder K. Rana, An Introduction to Measure and Integration Second Edition, NarosaPublishing House.
5. G. de Barra, Measure Theory and Integration, New Age International (P) Limited, Publishers.

MT 367: Practical Course Lab-I (Complex Analysis and Real Analysis-II) (2 Credits)

Section-I: Complex Analysis Practical

Practical No. 1: Analytic Functions (Unit 1)

Practical No. 2: Elementary Functions (Unit 2)

Practical No. 3: Integrals - I (Unit 3 upto and including Anti-derivatives)

Practical No. 4: Integrals – II(Unit 3 from Cauchy-Groursat's Theoremonwards)

Practical No. 5: Series (Unit 4)

Practical No. 6: Residues and Poles (Unit 5)

Section-II: Real Analysis-IIPractical

Practical 1: Definition and Existence of Riemann Integral (Unit 1)

Practical 2: Properties of Riemann Integrals and Applications (Unit 1)

Practical 3: Improper Integrals (Unit 2)

Practical 4: Pointwise Convergence of Sequences of Functions (Unit 3)

Practical 5: Uniform Convergence of Sequences of Functions (Unit 3)

Practical 6: Series of Functions: Convergence and Divergence (Unit 4)

MT 368: Practical Course Lab-II (Ring Theory and Partial Differential equations) (2 credits)

Section-I: Ring Theory Practical

Practical 1: Rings and Fields (Unit 1)

Practical 2: Rings of Polynomials (Unit 2)

Practical 3: Homomorphism and Factor Ring (Unit 3: 3.1)

Practical 4: Ideals in a Ring (Unit 3: 3.2)

Practical 5: Unique Factorization Domain (Unit 4: 4.1)

Practical 6: Euclidean Domain and Gaussian Integers (Unit 4: 4.2, 4.3)

Section-II: Partial Differential Equations Practical

Practical 1: Simultaneous Differential Equations of the First Order and the First Degree in Three Variables (Unit 1: 1.1, 1.2, 1.3)

Practical 2: Pfaffian Differential Equations and their Solution (Unit 1: 1.4, 1.5)

Practical 3: Solution of First order Partial Differential Equations (Unit 2: 2.1, 2.2, 2.3)

Practical 4: Linear Equations of First order equations and Integral surfaces passing through given curve (Unit 2: 2.3, 2.4)

Practical 5: Solution of Second order Partial Differential Equations (Unit 3)

Practical 6: Canonical Forms and Solution of Second order Partial Differential Equations by Separation Variables Method (Unit 4)

MT 369: Practical Course Lab-III (Based on DSE-6A and DSE-6B) (2 credits)

Section-I: Optimization Techniques/Calculus of Variation and Classical Mechanics/Financial Mathematics

Section-I(A): Optimization Techniques Practical

Practical 1: Network Models (Unit 1)

Practical 2: Game Theory (Unit 2)

Practical 3: Network Models and Game Theory (Unit 1, Unit 2)

Practical 4: Replacement Theory (Unit 3)

Practical 5: Sequencing (Unit 4)

Practical 6: Classical Optimization Theory (Unit 5)

OR

Section-I(B): Calculus of variation and classical Mechanics Practical

Practical 1: Applications of Euler -Lagrange's equation (Unit 1)

Practical 2: Isoperimetric Problems and Variational Problems with Moving Boundaries (Unit 1 and Unit 2)

Practical 3: Degrees of freedom and Generalized coordinates (Unit 3)

Practical 4: Problems on Conservation laws (Unit 4)

Practical 5: Lagrangian Formulation and worked examples-I (Unit 5)

Practical 6: Lagrangian Formulation and worked examples-II (Unit 5)

OR

Section-I (C): Financial Mathematics Practical

Practical 1: Mathematical Models in Economics (Unit 1)

Practical 2: Rrecurrences and the elements of finances (Unit 1)

Practical 3: The Cobweb model (Unit 2)

Practical 4: Introduction to Optimization (Unit 2)

Practical 5: The derivative in Economics (Unit 3)

Practical 6: Linear Equations and the Input Output Model (Unit 4)

Section-II(A): Machine Learning-II Practical

Practical 1: Revision of python and scikit learn (Unit 1)

Practical 2: MNIST classification with python - 1 (Unit 1)

Practical 3: MNIST classification with python - 1 (Unit 1)

Practical 4: Linear Regression Implementation - 1 (Unit 2)

Practical 5: Linear Regression Implementation - 2 (Unit 2)

Practical 6: LogisticRegressionImplementation 1 (Unit 3)

Practical 7: LogisticRegressionImplementation 2 (Unit 3)

Practical 8: Dealingwith Data (Unit 4)

Practical 9: KNN Implementation (Unit 4)

Practical 10: Decision Tree Implementation 4 (Unit 4)

Practical 11: Random Forest Implementation 4 (Unit 4)

Practical 12: Support Vector Machine Implementation 4 (Unit 4)

OR

Section-II (B): Computational Geometry Practical

Practical 1: Two Dimensional Transformation-I (Unit 1)

Practical 2: Two Dimensional Transformation-II (Unit 1)

Practical 3: Two and three Dimensional Transformation-I (Unit 1, Unit 2)

Practical 4: Three Dimensional Transformation-II (Unit 2)

Practical 5: Projection (Unit 3)

Practical 6: Plane and Space Curve (Unit 4)

OR

Section-II(C): Lebesgue Integration Practical

Practical 1: Length of Open and closed sets (Unit 1:1.1, 1.2)

Practical 2: Measurable Sets (Unit 1: 1.2, 1.3)

Practical 3: Measurable functions (Unit 2)

Practical 4: Lebesgue Integral - I (Unit 3: 3.1, 3.2, 3.3)

Practical 5: Lebesgue Integral - II (Unit 3: 3.3, 3.4)

Practical 6: Fourier Series(Unit 4: 4.1, 4.2)

SEC-III: MT-3610: Programming in Python –II(2 Credits)

Course Objectives:

1. To acquire Object Oriented Skills in Python.
2. To develop the skill of designing Graphical user Interfaces in Python.
3. To learn and understand Python programming basics and paradigm.
4. To learn the concepts of visualization of data and database connectivity.
5. To develop the ability to write database applications in Python.

Course Learning Outcomes:

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

1. Demonstrate the use of Python in Mathematics such as operations research and computational Geometry etc.
2. Study graphics and design and implement a program to solve a real world problem.
3. The students will implement the concepts of data with python and database connectivity.

Course Contents:

Unit 1: Graphics [06 Lectures]

1.1 Turtle Graphics: Overview of Turtle Graphics , Turtle Operations, Object Instantiation and the turtle graphics Module.
1.2 Drawing Two-Dimensional Shapes
1.3 Taking a Random Walk
1.4 Colors and the RGB System
1.5 Drawing with Random Colors
1.6 Using the str Function with Objects.

Unit 2: Data Visualization with Python [04 Lectures]

2.1 Seaborn
2.2 Matplotlib
2.3 Plotly
2.4 MayaVI

Unit 3: Dictionary and Sorting, Minimum and Maximum: [08 Lectures]

3.1 Introduction to Dictionary , Avoiding Key Error Exceptions, Iterating Over a Dictionary,

3.2 Dictionary with default values, Merging dictionaries, Accessing keys and values,Accessing values of a dictionary, Creating dictionary, Creating an ordered dictionary,Unpacking dictionaries using the ** operator.

3.3 Sorting, Minimum and Maximum:Special case: dictionaries, Using the key argument, Default Argument to max, min,Getting a sorted sequence, Extracting N largest or N smallest items from an iterable,Getting the minimum or maximum of several values, Minimum and Maximum of asequence.

Unit 4: Computational Geometry [10 Lectures]

4.1 Points: The distance between two points, Lists of Points - the PointList class, Integer point lists, Ordered Point sets, Extreme Points of a PointList, Random sets of Points not in general position.

4.2 Points: Displaying Points and other geometrical objects, Lines, rays, and line segments, The geometry of line segments, Displaying lines, rays and line segments.

4.3 Polygon: Representing polygons in Python, Triangles, Signed area of a triangle, Triangles and the relationships of points to lines, is Collinear, is Left, is Left On, is Right, is Right On, Between

4.4 Two dimensional rotation and reflection

4.5 Three dimensional rotation and reflection

4.6 Generation of Bezier curve with given control points

Unit 5: Study of Operational Research in Python [08 Lectures]

5.1 Linear Programming in Python

5.2 Introduction to Simplex Method in Python

Practicals:

Practical 1: Turtle Graphics (Unit 1)

Practical 2: Data Visualization (Unit 2)

Practical 3: Dictionary and Sorting, Minimum and Maximum (Unit 3)

Practical 4: Application to Computational Geometry-I (Unit 4)

Practical 5: Application to Computational Geometry-II (Unit 4)

Practical 6: Application to Computational Geometry-II (Unit 4)

Practical 7: Study of Graphical aspects of Two dimensional transformation matrix using Matplotlib (Unit 4)

Practical 8: Study of Graphical aspects of Three dimensional transformation matrix using Matplotlib (Unit 4)

Practical 9: Study of Graphical aspects of Three dimensional transformation matrix using Matplotlib and Study of effect of concatenation of Two dimensional and Three dimensional transformations(Unit 4)

Practical 10: Generation of Bezier curve using given control points (Unit 4)

Practical 11: Study of Operational Research in Python (Unit 5-5.1)

Practical 12: Study of Operational Research in Python (Unit 5-5.2)

Text Books:

1. **Kenneth A. Lambert, Fundamentals of Python:From First Programs to DataStructure, Martin Osborne, 2010, Course Technology, Cengage Learning.** Unit-1: Chapter-7: Sec-7.1.1 to 7.1.8
2. **Python: Notes for Professionals, Goalkicker.com, Free Programming books.** Unit-2: Chapter-108, Unit-3: Chapter-19 Section:19.1 to 19.10 and Chapter-72:Section:72.1 to 72.8
3. **Jim Arlow, Interactive Computational Geometry in Python.** Unit-4: Chapter-1: Sec.-1 to 7, Chapter-2: Sec.-1 to 2, Chapter-3: Sec.-1, 3 to 11, Chapter-4: Sec.-1 to 3, :Chapter-5: Sec.-3 to 7.
4. **Operations Research: Unit-5:** https://pypi.org/project/PuLP/

Reference Books:

1. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
2. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015.
3. Zelle, J., Python Programming: An Introduction to Computer Science, Franklin,Beedle and Associates Inc.
4. Jim Arlow, Interactive Computational Geometry in Python.
5. Robert Johansson, Introduction to Scientific Computing in Python.
6. Jason Brownlee, Basics of Linear Algebra for Machine Learning, Discover the Mathematical Language of Data in Python.
7. JaanKiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press, (2005).

SEC-IV: MT-3611: Mathematics into LaTeX(2 Credits)

Course Objectives: The purpose of this course is to acquaint students with typesetting basic Mathematics in LaTeX.

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

i) typeset mathematical formulas, use nested list, tabular and array environments.

ii) import figures and pictures that are stored in external files.

Course Contents:

Unit 1. Figure Insertion **[06 Lectures]**

1.1 Commands and Environment for Inserting Figures
1.2 Inserting a Simple Figure
1.3 Side-by-Side Figures
1.4 Sub-numbering a Group of Figures
1.5 Figures in Tables

Unit 2. Equation Writing -I **[12 Lectures]**

2.1 Basic Mathematical Notations and Delimiters.
2.2 Mathematical Operators
2.3 Mathematical Expressions in Text-Mode

2.4 Simple Equations
2.5 Array of Equations
2.6 Left Aligning an Equation
2.7 Sub-numbering a Set of Equations

Unit 3.Equation Writing -II **[12 Lectures]**

3.1 Texts and Blank Space in Math-Mode
3.2 Conditional Expression
3.3 Evaluation of Functional Values
3.4 Splitting an Equation into Multiple Lines
3.5 Vector and Matrix
3.6 Overlining and Underlining
3.7 Stacking Terms
3.8 Side-by-Side Equations

Unit 4. User-Defined Macros **[06 Lectures]**

4.1 Defining New Commands
4.2 Defining New Environments

Practicals:

Practical 1: Commands and Environment for Inserting Figures (Unit 1: 1.1, 1.2)

Practical 2: More about Figure Insertion (Unit-1; 1.3, 1.4, 1.5)

Practical 3: Mathematical Notations, Operators and Expression in LaTeX (Unit 2: 2.1- 2.3)

Practical 4: Simple Equations (Unit-2: 2.4)

Practical 5: Array of Equations (Unit-2: 2.5)

Practical 6: Alignment and numbering a Set of Equations (Unit-2: 2.6, 2.7)

Practical 7: Texts, Blank Space and Conditional Expression in Math mode (Unit-3: 3.1, 3.2)

Practical 8: Evaluation of Functional Values and Splitting an Equation (Unit-3: 3.3, 3.4)

Practical 9: Vector and Matrix (Unit-3; 3.5)

Practical 10: More about equation writing in LaTeX (Unit-3: 3.6, 3.7, 3.8)

Practical 11: New Commands in LaTeX (Unit-4: 4.1)

Practical 12: New Environments in LaTeX (Unit-4: 4.2)

Text Book:

1. **LaTeX in 24 Hours, A Practical Guide for Scientific Writing, Dilip Datta, Springer International Publishing AG 2017.**
   Unit 1: Chapter 9; 9.1 to 9.4, 9.8, Unit 2: Chapter 11; 11.1 to 11.7
   Unit 3: Chapter 12; 12.1 to 12.8 , Unit 4: Chapter 13; 13.1, 13.3 (13.3.1, 13.3.2, 13.3.3)

Reference Books:

1. LaTeX, A Document Preparation System, User's Guide and Reference Manual, Leslie Lamport, Addison-Wesley Publishing Company, Inc., 1994.
2. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing Ltd, 2011.
3. LATEX and Friends, M.R.C. van Dongen, Springer-Verlag Berlin Heidelberg ,2012.
4. Math into LaTeX, George Gratzer, Springer Science Business Media New York, 1996.

Modalities For Conducting The Practical and The Practical Examination:

1. There will be one 4 hours and 20 minutes (260 minutes) practical session for each batch of 15 students per week for each practical course.
2. The College will conduct the Practical Examination at least 15 days before the commencement of the Main Theory Examination. The University practical examination will consist of written examination of 30 marks and oral examination of 05 marks.
3. There will be external examiner; the practical exam will be of the duration of 3hours. The teacher will set a question paper at the time of paper setting meeting conducted by SavitribaiPhule Pune University, Pune based on respective papers I and II given in **Practical Lab-I, Practical Lab-II and Practical Lab-III**,and the pattern is as follows

Q1. Any 3 out of 5 each question of 5 marks on paper – I (from Practical Lab-I,

Practical Lab-II and Practical Lab-III).

Q2. Any 3 out of 5 each question of 5 marks on paper – II(fromPractical Lab-I,

Practical Lab-II and Practical Lab-III).

4. **SEC:MT -3510, MT -3511, MT -3610**, **MT -3611 University practical writtenexaminationof 30 marks, oral examination 05 marks and internal examination of 15 marks.**
5. **The courses MT-356(A): Machine Learning-I, MT-366(A): Machine Learning-II, MT -3510: Programming in Python -I, MT -3610: Programming in Python –II, MT-3511: LaTeX for Scientific Writing and MT 3611: Mathematics into LaTeX**will teach in Computer Laboratory with live sessions for better understanding of students.
6. Each student will maintain a journal to be provided by the college.The internal 15 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.**Methods of assessment for Internal exams:** Seminars, Viva-voce, Projects, Surveys, Field visits, Tutorials, Assignment, Group Discussion.
7. It is recommended that concept may be illustrated using computer software (Python, Maxima etc.) and graphing calculators wherever possible.
8. Study tours may be arranged at places having important mathematical institutes or historical places.
9. **Special Instruction:**
   a) There should be well equipped mathematics practical laboratory of size 20x20 sq. fts containing at least 20 computers because there are six papers based on Software's (**like Machine Learning-I & II, Programming in Python –I & II, LaTeX Software for Scientific Writing and Mathematics into LaTeX**).
   b) Examiners should set separate question papers, solutions and scheme of marking for each batch and claim the remuneration as per University rule.
   c) Before starting each practical necessary introduction, basic definitions, intuitive inspiring ideas and prerequisites must be discussed**.**

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Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Physics

(Faculty of Science & Technology)

T.Y.B.Sc. (Physics)

Choice Based Credit System

To be implemented from Academic Year 2021-2022

Savitribai Phule Pune University, Pune

Revised syllabus for T.Y.B.Sc. (Physics) (CBCS Pattern-2021-22)

To be implemented from Academic Year 2021-22

Salient Features of Revised Syllabi in Physics

As far as possible to promote:

1) Physics Education through Master Texts:
It helps in understanding the theoretical and mathematical development of the subject and to create interest in the subject.

2) Physics Education through Experimentation:
It helps in general to improve scientific attitude. So emphasis is given on the development of experimental skills, data analysis, calculations, and also on the limitations of the experimental method and data and, results obtained.

3) Physics Education through Problem Solving: It helps in understanding the concepts of physics. It underline the strength of equations, formulae, graphs, mathematical tools to tackle the problems. So accordingly, we have introduced compulsory problem part in the question paper.

4) Physics Education through History and Philosophy:
It helps in understanding the conceptual development of the subject and thereby increase the interest in the subject. A topic on this is introduced in the Physics Course.

5) Physics Education through Awareness of Misconceptions:
It improves the scientific awareness among the students. A discussion on different subjects are encouraged.

6) Physics Education through Proto-research:
It creates interest in the subject and improves technological aspect. Accordingly, mini projects, hands-on activities, projects, models and demonstrations etc. is included in the syllabi.

7) Physics Education through Qualitative Overview:
It creates interest in the subject to continue to work in the field of science in general and physics in particular. Accordingly future directions and frontiers of the subject are included in the syllabi.

8) **Structure of Question paper:**
Existing structure shall continue.

9) **ATKT Rules:**
Existing rules shall apply.

10) **Structure of the Course:**

Semester	Course Type	Course Code	Course Name	Credit
V	Discipline Specific Elective Course	PHY-351	Mathematical Methods in Physics-II	2
		PHY-352	Electrodynamics	2
		PHY-353	Classical Mechanics	2
		PHY-354	Atomic and Molecular Physics	2
		PHY-355	Computational Physics	2
		PHY-356: Elective-I (Select any One)		2
		PHY-356(**A**)	Astronomy and Astrophysics-I	
		PHY-356(**B**)	Elements of Materials Science	
		PHY-356(**C**)	Biophysics	
		PHY-356(**D**)	Renewable Energy Sources-I	
		PHY-356(**E**)	Applied Optics	
		PHY-356(**F**)	C# programming	
		PHY-356(**G**)	Acoustics-I	
		PHY-357	Physics Laboratory-3A	2
		PHY-358	Physics Laboratory-3B	2
		PHY-359	Project-I	2
	Skill Enhancement Course	**PHY-3510: Skill Enhancement Course-I (Select any One)**		2
		PHY-3510(**H**)	Python Programming	
		PHY-3510(**I**)	Energy studies	
		PHY-3510(**J**)	Introduction to Arduino	
		PHY-3510(**K**)	Sensors and Transducer	
		PHY- 3511: Skill Enhancement Course-II (Select any One)		2
		PHY-3511(**L**)	Physics Workshop Skill	
		PHY-3511(**M**)	Biomedical Instrumentation	
		PHY-3511(**N**)	Non-destructive Testing Techniques	
		PHY- 3511(**O**)	Acoustics Applications	
VI	Discipline Specific Elective Course	PHY-361	Solid State Physics	2
		PHY-362	Quantum Mechanics	2
		PHY-363	Thermodynamics and Statistical Physics	2
		PHY-364	Nuclear Physics	2
		PHY-365	**(A)** Electronics-II **OR**	2

			(B) Advanced Electronics	
		PHY-366: Elective-II (Select any One)		
		PHY-366(**P**)	Medical Electronics	2
		PHY-366(**Q**)	Physics of Nanomaterials	
		PHY-366(**R**)	Microcontrollers	
		PHY-366(**S**)	Lasers	
		PHY-366(**T**)	Astronomy and Astrophysics-II	
		PHY-366(**U**)	Renewable Energy Sources-II	
		PHY-366(**V**)	Acoustics-II	
		PHY-367	Physics Laboratory-4A	2
		PHY-368	Physics Laboratory-4B	2
		PHY-369	Project-II	2
	Skill Enhancement Course	**PHY-3610: Skill Enhancement Course-III (Select any One)**		
		PHY-3610(**W**)	Scientific Data Analysis using Python	2
		PHY-3610(**X**)	Solar PV System: Installation, Repairing and Maintenance	
		PHY-3610(**Y**)	Applications of Internet of things (IOT)	
		PHY-3610(**Z**)	Calibration Techniques	
		PHY- 3611: Skill Enhancement Course-IV (Select any One)		
		PHY- 3611(**AA**)	Microcontrollers	2
		PHY- 3611(**AB**)	Instrumentation for Agriculture	
		PHY- 3611(**AC**)	Radiation Physics	
		PHY- 3611(**AD**)	Photography	

Semester-V

T.Y.B.Sc. (Physics) (Sem-V)
PHY-351: Mathematical Methods in Physics-II

Lectures: 36 **(Credits-02)**

1: Curvilinear Co-ordinates **(10L)**

Review of Cartesian, spherical and cylindrical co-ordinate, transformation equation, General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear co-ordinate system.

Orthogonal curvilinear co-ordinate system, expressions for gradient, divergence, Laplacian, and curl, special case for gradient, divergence and curl in Cartesian, spherical polar and cylindrical co-ordinate system, Problems.

2: The Special Theory of Relativity **(10L)**

Introduction, Newtonian relativity, Galilean transformation equation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformations, Kinematic effects of Lorentz transformation, Length contraction, Proper time, Problems.

3: Partial Differential Equations **(8L)**

Introduction to Partial differential equations (PDE), General methods for solving second order PDE, Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (two dimensional Laplace's equation, one dimensional Wave equation), Singular points ($x = x_0$), Solution of differential equation-Statement of Fuch's theorem, Frobenius method of series solution.

4: Special Functions **(8L)**

Introduction, generating function for Legendre Polynomials: $P_n(x)$, Properties of Legendre Polynomials, Generating function for Hermite Polynomials: $H_n(x)$, Properties of Hermite Polynomials, Bessel function of first kind: $J_n(x)$, Properties of Bessel function of first kind, Problems.

Reference books:

1. Mathematical methods for physicists, Arfken and Weber, Acadmic press Newyork, 7th Edition.
2. Mathematical physics, Rajput, Pragati prakashan-1997.
3. Mathematical methods in the physical sciences – Marry L. Boas, John Willy & Sons publication, 3rd Edition-2005.
4. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc.-1968.
5. Mathematical physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010.
6. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition-2014
7. The Special Theory of Relativity: A Mathematical Approach-Farook Rahaman, Springer Publication -2014.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-352: Electrodynamics

Lectures: 36 **(Credits-02)**

1: Electrostatics **(12 L)**

- **a.** Revision of Coulomb's law, Gauss law, Electric field, Electrostatic Potential.
- **b.** Potential energy of system of charges.
- **c.** Statement of Poisson's and Laplace's equation, Boundary Value problems in electrostatics-**S**olution of Laplace equation in Cartesian system, Boundary conditions.
- **d.** Polarization **P**, Electric displacement **D**, Electric susceptibility and dielectric constant, bound volume and surface charge densities.
- **e.** Electric field at an exterior and interior point of dielectric.

2: Magnetostatics **(12 L)**

- a. Concepts of magnetic induction, magnetic flux and magnetic field.
- b. Magnetic induction due to straight current carrying conductor, magnetization of matter, relationship between **B, H** and **M.**
- c. Boundary conditions at the interface of two magnetic media (Normal and tangential components).
- d. Biot-Savart's law, Ampere's force law, Magnetic force between two current carrying loops, Ampere's circuital law.
- e. Equation of continuity, Magnetic vector potential **A,** Magnetic susceptibility and permeability.

3: Electrodynamics **(12 L)**

- **a.** Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law.
- **b.** Maxwell's equations (Differential and Integral form) and their physical significance.
- **c.** Polarization, reflection & refraction of electromagnetic waves through media.
- **d.** Wave equation and plane waves in free space.
- **e.** Poynting theorem & Poynting vector.

Reference Books:

1. Introduction to Electrodynamics; D. J. Griffith; Cambridge India; Fourth edition (2020)
2. Classical Electrodynamics; J. D. Jackson; Wiley; Third edition (2007)
3. Introduction to Electrodynamics; A. Z. Capri, Panat P. V.; Alpha science international ltd; Illustrated edition(2002)
4. Foundations of electromagnetic theory; Reitz, Milford and Christy; Pearson education India; Fourth edition (2010)
5. Electrodynamics; Gupta, Kumar, Singh; Pragati Prakashan; Ninteenth edition (2011)
6. Electromagnetic field and waves; Paul-Lorrain, D. R. Corson; W.H. Freeman & co. Ltd; Second edition (1970)
7. Electricity and magnetism; Murugeshan; S. Chand; (2020)
8. Electromagnetic theory and electrodynamics; Satya Prakash; Kedar Nath Ram Nath; (2020)

T.Y.B.Sc. (Physics) (Sem-V)
PHY-353: Classical Mechanics

Lectures: 36 **(Credits-02)**

1: Motion of Particles **(8L)**

a. Charged Particles: Motion of a charged particle in constant electric, magnetic and electromagnetic field,
b. System of particles: Concept of Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles.(statements only)
c. Problems

2: Central force Field **(8L)**

a. Central force Field: Definition and Properties of central force field. Reduction of two body problem to an equivalent one body problem
b. Motion in central force field,
c. Kepler's laws of planetary motion and their proof
d. Artificial satellite and its orbit
e. Problems.

3: Scattering of particles **(10L)**

a. Elastic and inelastic scattering: Definition and properties,
b. Elastic scattering - Laboratory and center of mass system.
c. Scattering: Scattering angles in laboratory and center of mass system.
d. Differential cross-section, impact Parameter, total cross-section in brief.
e. Problems

4: Langrangian and Hamiltonian formulation **(10L)**

a. Limitations of Newton's Law of Motion,
b. Constraints and Their Classification, Example of Constrains, degrees of freedom, generalized coordinate, configuration space,
c. Principle of Virtual work done,
d. D'Almeberts Principle of virtual work,
e. Langrangian equation from D' Alembert's principle, cyclic coordinates,
f. Phase space, Hamiltonian's equations
g. Problems

Reference books:

1. **Classical Mechanics**, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition of 2005.
2. **Introduction to Classical Mechanics,** R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. **Classical Mechanics,** NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, 1991.
4. **Classical Mechanics** by P.V.Panat.
5. **Classical Mechanics,** Herbert Goldstein, Narosa Publishing House.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-354: Atomic and Molecular Physics

Lectures: 36 **(Credits-02)**

1: Atomic structure **(6 L)**

1. Revision of various atomic models
2. Vector atom model (Concepts of space quantization and electron spin)
3. Pauli Exclusion Principle and electron configuration, Quantum states, Spectral notations of quantum states.
4. Problems

2: One and Two Valence electron systems **(12 L)**

1. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na-atom, Selection rules, Spectra of sodium atom, Sodium doublet.
2. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ-coupling schemes.
3. Singlet-Triplet separations for interaction energy of LS coupling, Lande's interval rule, Spectra of Helium atom.
4. Problems

3: Zeeman Effect **(4 L)**

1. Zeeman Effect
2. Experimental arrangement
3. Normal and anomalous Zeeman Effect
4. Stark effect (Qualitative discussion)
5. Applications of Zeeman effects
6. Problems

4: Molecular spectroscopy **(8 L)**

1. Introduction of molecular spectra and its types
2. Rotational energy levels, Rotational spectra of rigid diatomic molecule
3. Vibrational energy levels
4. Rotational and Vibrational spectra
5. Electronic spectra of molecules
6. Applications of UV-Vis spectroscopy
7. Problems

5: Raman spectroscopy **(6 L)**

1. History of Raman effect, Molecular polarizability
2. Classical theory and Quantum theory of Raman Effect
3. Characteristics Raman Lines and Applications of Raman spectroscopy
4. Problems

Reference books:

1) R. Murugeshan, Er. K. Sivaprasath, Modern Physics, S. Chand, 2014, Revised edition
2) Robert Eiseberg, Robert Resnik, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley, 2016, 2nd edition
3) G. Aruldhas, Molecular structure and Spectroscopy, PHI, 2015, 2nd edition
4) Colin Banwell, Elaine McCash, Fundamentals of Molecular Spectroscopy, TMH, 4th ed
5) Arthur Baiser, Concepts of Modern Physics , McGraw Hill International, 4th edition
6) White H. E, Introduction to Atomic spectra, McGraw Hill International

T.Y.B.Sc. (Physics) (Sem-V)
PHY-355: Computational Physics

Lectures: 36 **(Credits-02)**

1: Concepts of Programming and Introduction to C-programming: (14 L)

a) Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts.
b) Introduction and Structure of C-program, 'C' Character set, key words, Constants and variables, Variable names, Data types, qualifiers and their declarations, Symbolic Constants.
c) Input/output functions: scanf( ), printf( ), getchar(), putchar(), gets(), puts().
d) Operators and Expressions: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Conditional Operator.
e) Control statements: if, if else, while, do while, for loop, nested control structures (nested if, nested loops), break, continue, switch- case statement, goto statement.
f) Use of Library functions: e.g. mathematical, trigonometric, graphics.

2: Arrays, Pointers and user defined function in C-Language (8 L)

a) Arrays: 1-D, 2-D: Arranging numbers in descending and ascending order, Sum of matrices, multiplication of matrices.
b) Concept of pointers with suitable illustrative examples.
c) User defined functions: Definitions and declaration of function, function prototype, passing arguments (Call by value, Call by reference). Simple illustrative examples.

3: Graphics in C-Language: (3 L)

Concepts of graphics in C, Some simple graphic commands- Point, Line, Circle, Arc, Ellipse, Bar with suitable illustrative examples.

4: Computational Physics: (11 L)

Numerical Methods to solve the Physics Problems

a) **Iterative methods:** Bisection method and Newton-Raphson Method– Algorithm, Flowchart and writing C- program for finding the roots of the equation, problems
b) **Integration:** Trapezoidal rule, Simpson's $1/3^{rd}$ rule – Algorithm, Flowchart and C-program, problems

Reference Books:

1. Programming in C- (Schaum's series), Gottfreid, TMH
2. Programming in C- Balgurusami, Prentice Hall publications
3. Let us C- Yashwant Kanetkar, BPB publications
4. Programming with C- K.R. Venugopal, S. R. Prasad, TMH.
5. Introductory methods of numerical analysis-S. Sastry, Prentice Hall
6. Computer oriented numerical methods – V. Rajaraman.

PHY-356: Elective-I

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (A): Astronomy and Astrophysics-I

Lectures: 36 **(Credits-02)**

1: Fundamentals of Astronomy: **(10 L)**

Introduction: Components of the Universe; Stars, Planets, Asteroids, Meteors, Comets, Galaxies. Solar System: Age, Origin Basic measurements: Planetary orbits, distances, physical size, mass, density, temperature, rotation period determination, Co-ordinate system, Celestial hemisphere,

2: Astronomical Instruments: **(8 L)**

Optical telescopes, mounts, light gathering power, magnification, Resolution. Spectroscopes, CCD camera, photometer, filters Radio telescopes, Interferometry (only introduction)

3: Star Systems and basic observations: **(10 L)**

Stars life cycle, Stellar processes (Nuclear). Neutron stars, black holes, Chandrasekhar limit. Spectral classification of stars, O, B, A, F, G, K, M. Star Systems: Binaries / Cepheids / RR Lyrae, Observation of Sun: Eclipses, Moon, planets, meteor showers, transits, occultations.

4: Galaxies, Dark Matter and Dark Energy **(8 L)**

A) Galaxies, types, their formation, Hubble's tuning fork diagram, Open and Globular clusters, Dark Matter / Energy (evidence for both), Cosmology: Theories: BBT, Steady State, Oscillating Universe Theory.

B) Observational Astronomy: Concept of time, Magnitudes: apparent and absolute, introduction to Constellations, Star dial.

Reference books:

1. Astronomy structure of the Universe. A.E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Structure of the Universe, J.V. Narlikar
6. Astrophysics, Baidyanath Basu.
7. Astrophysical Techniques, third Edition, C. R. Kitchin
8. Fundamentals of Astronomy, Michael Seed
9. Telescopes and techniques, C. R. Kitchin (Springer)

List of experiments: (Any 2)

1. Study of Binocular, refracting and reflecting telescopes and their mounts.
2. To determine the diameter of the Moon.
3. Measurement of Solar Constant.
4. Observation of emission, continuous and absorption spectra. (Mercury, sodium or iodine spectra could be obtained.)
5. Study of Construction and working of CCD.
6. Study of Solar Eclipse and Lunar Eclipse.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-356 Elective-I (B): Elements of Material Science

Lectures: 36 **(Credits-02)**

1: Defects in Solids **(7 L)**

1. Material Properties – Mechanical, Electrical, and thermal
2. Impurities in solids.
3. Solid solutions in metals.
4. Rules of solid solubility.
5. Imperfection in crystals.
6. Defects in solids point, line, surface, and volume.
7. Atomic diffusions definition, mechanism, Fick's laws.

2: Single Phase Metals **(6 L)**

1. Single phase alloys
2. Deformation
3. Elastic Deformation and Plastic Deformation
4. Mechanism of plastic Deformation by slip
5. Critical resolved shear stress (CRSS)
6. Plastic deformation in poly crystalline materials

3: Ceramic Materials **(10 L)**

1. Ceramic Phases, Classification of ceramic materials
2. Ceramic crystals (AX)
3. Mechanical behavior of ceramics
4. Electromagnetic behavior of ceramics –
   a) Electric properties dielectrics, semiconductors, piezoelectric
   b) Magnetic Properties Magnetic Ceramics, hard and soft ferrites

4: Phase Diagrams **(9 L)**

1. Basic terms System, Surrounding, Component, Coordinates, Phase, Equilibrium.
2. Phase Diagram definition, importance, and objective
3. Lever rule
4. Gibb's phase rule
5. Phase diagram of a) Sugar water b) NaCl water
6. Types of phase diagrams with construction
   a) Type I Lens type CuNi phase diagram
   b) Type II Only introduction
   c) Type III Eutectic type PbSn phase diagram
7. Isothermal cuts

5: Introduction to smart materials **(4 L)**

1. Definition of smart materials
2. Types and structure of smart materials,
3. Properties of smart materials
4. Applications of smart materials.

Reference books :

1. Elements of Materials Science and Engineering I. H. Vanvlach (4^{th} Edition)
2. Materials Science and Engineering - V. Raghavan

List of experiments : (Any 2)

1. To determine the dipole moment of a given liquid
2. To determine magnetic susceptibility of $FeCl_3$
3. To determine the specific heat of graphite
4. Determination of the yield point and the breaking point of an elastic material
5. Ionic conductivity of NaCl/ NaI
6. Grain size and grain boundary measurement using optical microscope.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (C): Biophysics

Lectures: 36 **(Credits-02)**

1: Introduction of Biophysics **(13L)**

1.1 History of Biophysics, Concept of Biophysics and Physical properties applied to biology- Surface tension, Viscosity, adsorption, diffusion, osmosis, Definition for Biostatistics and Biometry

1.2 Cell: Animal and plant cell, types of cell, Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria and chloroplast

1.3 Protein structure (Primary and Secondary), amino acid structure, Genetic code- symmetry, DNA structure

1.4 Photosynthesis process:- electron transport, Gibbs's free energy, Redox couple, Redox potential, Oxidation and reduction, Examples of redox potential in biological system.

2: Bio-potentials **(9L)**

2.1 Bioelectric signals: structure of neuron, resting potential, action Potential, Nernst equation

2.2 Bioelectrodes- Half-cell potential, polarizable and non-polarizable electrodes, Microelectrode- metal and glass electrodes

2.2 Study of Cardiovascular system, Compound action potential of human body-ECG (Electrocardiography), Electrodes for ECG

3: Bio-instruments **(6L)**

3.1 Basic principle, Construction and working of colorimeter, spectrophotometer, PH meter and Centrifuge measurement.

3.2 Electron Microscope: SEM, TEM.

4: Radiation Biophysics **(8L)**

4.1 Definition, Units of Radioactivity and radiation doses, Types of radiation (Ionizing and non- ionizing), radioimmunoassays.

4.2 Applications: PET (Positron Emission Tomography), NMR (Nuclear Magnetic Resonance), MRI (Magnetic Resonance Imaging Techniques), Ultrasonography, CT (Computed Tomography) Scan.

Reference books:

1. Introduction to Biophysics - by P. Narayanan.New Age P.
2. Medical Instrumentation - by Khandpur, TMH
3. Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4. Biophysics -by Vatsala Piramal, Dominant Publisher and Distributors, New Delhi-110002
5. Textbook of Biophysics - by R.N. Roy
6. Photosynthesis - by Hall and Rao.
7. Introduction to Biomedical Equipment Technology (Fourth Edition) by-Joseph J.Carr
8. Text Book of Bio-medical Electronics-by S.S. Agrawal

List of Experiments : (Any 2)

1. Recording and analysis of ECG signals
2. Verification of Beer's and Lambert's Law
3. Absorption spectrum of Blood/Chlorophyll.
4. pH value of Amino acids.
5. Bimolecular model building using standard kits.
6. Separation of components of Milk/Chlorophyll using centrifuge machine.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (D): Renewable Energy Sources-I

Lectures: 36 **(Credits-02)**

1: An Introduction to Energy Sources: **(10L)**

1. Energy: Definition, Classifications of energy sources
2. Conventional and non-conventional energy sources.
3. Sun: The source of energy (Structure, Characteristics and Composition)
4. Solar Constant
5. Electromagnetic Energy Spectrum.
6. Solar radiations outside earth atmosphere.
7. Solar radiation at the earth surface.
8. Problems.

Ref.1- page no. 1 to 11 and 15 to 37
Ref.3- 3.1, 3.2, 3.3, 3.4, 3.5

2: Photothermal Applications: **(10L)**

1. Photothermal devices: Solar Insolation, Selective Coating, Glass Cover, Heat Conductor and Heat Insulation.
2. Solar water heating systems: Types, construction and working of Liquid Flat Plate Collector (FPC) and Evacuated Tube Collector (ETC)
3. Energy Balance Equation (without thermal Analysis).
4. Concentrating collectors: Flat plate collector with plane reflector, Cylindrical parabolic, Compound parabolic, Collector with fixed circular concentrators and moving receiver, paraboloid concentrator.
5. Comparative study between flat plate collector and solar concentrators.
6. Solar distillation, Solar dryer, Solar cooker (box type)

Ref. 1: 3.3, 3.3(A), 3.5, 3.7, 3.8, 5.2, 5.8, 5.11.
Ref. 2: 2.2.6

3: Photovoltaic systems: **(10L)**

1. Introduction to Photovoltaic effect and Photovoltaic Conversion.
2. Basic photovoltaic system for power generation
3. Basics of Solar Cell, PV modules, Arrays,
4. Solar Cell: I-V characteristics, Power output and conversion efficiency.
5. Factors affecting on photovoltaic efficiency. (Change in amount of input light, solar cell area, Change in angle, Change in operating Temperature etc.)
6. Types of solar cells: p-n junction solar cell, p-i-n diode solar cell, cadmium sulphide solar cell, Gallium arsenide solar cell, Indium phosphide solar cell, nano-crystalline solar cell.
7. Application of solar photovoltaic systems.

Ref.3 -15.1, 15.3, 15.4, 15.5, 15.7, 15.8, 15.10.
Ref.8 – 3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5

4: Energy Storage: **(06L)**

1. Importance and Needs of Energy storage in Conventional and Nonconventional Energy Systems.
2. Various forms of Energy Storage
3. Electrical Energy: Super capacitors
4. Electrochemical Energy: Battery
5. Chemical Energy: Hydrogen Production and storage

Ref.4 - Ref.5 - Ref.6 - Ref.7 -

Reference books:

1. Non-conventional Energy sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc. Graw Hill Ltd, New Delhi.
3. Solar Energy Utilizations**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer
5. Chemical and Electrochemical Energy System by R. Narayan and B. Viswanathan, University Press.
6. Battery Systems Engineering by C. D. Rahn and C. Wang, Wiley Pub.
7. Electrochemical Energy Storage for Renewable sources and grid balancing by P. T. Moseley and J. Garche, Elsevier Science.
8. Solar Photovoltaic Technology and Systems by C S Solanki

List of Experiments: (Any 2)

1. To calculate the thermal efficiency of liquid flat plate collector.
2. To study the box type solar cooker.
3. To determine an instantaneous thermal efficiency of parabolic collector.
4. To calculate an efficiency and fill factor of PN junction solar cell.
5. To study I-V characteristic of various types of solar cells.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (E): Applied Optics

Lectures: 36 **(Credits-02)**

1: Fermat's Principle and Matrix Methods in Paraxial Optics: (9L)

1.1 Introduction to Fermat's Principle and its Applications.
1.2 Laws of Reflection and Refraction from Fermat's Principle.
1.3 Ray paths in an Inhomogeneous Medium.
1.4 Introduction to Matrix methods in Paraxial Optics.
1.5 The matrix method, Unit planes and Nodal planes.
1.6 A System of two thin lenses.
1.7 Problems.

2: Multiple-Beam Interferometry and Diffraction: (9L)

2.1 Introduction to Multiple-Beam Interferometry.
2.2 Michelson Interferometer
2.3 The Fabry-Perot Etalon.
2.4 The Fabry-Perot Interferometer.
2.5 Introduction and revision of diffraction.
2.6 Two slit and N-Slit Fraunhofer diffraction pattern.
2.7 Fresnel half period zones, the zone plate and Fresnel Diffraction.
2.8 Problems.

3: Polarization and Holography: (9L)

3.1 Introduction and Revision of Polarization.
3.2 Malus law, Double refraction,
3.3 Phase retarded plate, Quarter wave plate and half wave plate
3.4 Optical activity and Polarimeter
3.5 Introduction and Theory of Holography.
3.6 Importance of coherence and Principle of holography.
3.7 Characteristics, recording and reconstruction of Holography
3.8 Applications of Holography.
3.9 Problems.

4: Fibre Optics: (9L)

4.1 Introduction to Fibre Optics.
4.2 The Optical Fibre: Principle and Structure.
4.3 Fibre Optics: Numerical aperture and Acceptance angle, Pulse dispersion and Calculation of pulse dispersion.
4.4 Types of Optical Fibres: Concept of Mode, Multimode and Single mode fibre.
4.5 Attenuation in optical fibers, single mode and multimode fibers.
4.6 Fibre Optic communication system: Fiber optical telecommunication system.
4.7 Advantages of Fibre Optics.
4.8 Applications of Fibre Optics.
4.9 Problems.

Reference Books:

(1) Ghatak Ajoy, Optics 3rd Edition, The McGraw Hill companies.
(2) N. Subrahmanyam, A textbook of Optics, S. Chand publications.
(3) Optical Fiber and Fiber Optic communication System, S.K Sarkar S. Chand.
(4) Practical Optics, Naftaly Menn, Academic press (2004)
(5) M. Born and E. Wolf, Principles of Optics, Cambridge University Press
(6) F. A. Jenkins, H.E White, Fundamental of Optics, McGraw companies

List of Experiments : (Any 2)

(1) Determination of the numerical aperture of the given optical fibre.
(2) Determination of the optical power loss in attenuators.
(3) Fabry Perot Etalon
(4) To study the nature of polarization of laser light using photo cell and quarter wave plate.
(5)To determine the Brewster's angle for glass using a polarized monochromatic light source.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (F): C# Programming

Lectures: 36 **(Credits-02)**

1: MS.NET Framework Introduction **(8L)**

• The .NET Framework - an Overview • Framework Components • Framework Versions • Types of Applications which can be developed using MS.NET • MS.NET Base Class Library • MS.NET Namespaces • The Common Language Runtime (CLR), Common Type System (CTS) • Common Language Specification (CLS) . Installing Required Software – SQL Server and Management studio

2: C # Language Syntax **(8L)**

• Datatypes • Global, Stack and Heap Memory • Common Type System • Reference Type and Value Type • Datatypes and Variables Declaration • Implicit and Explicit Casting • Checked and Unchecked Blocks – Overflow Checks • Casting between other datatypes • Boxing and Unboxing • Enum and Constant • Operators • Control Statements • Working with Arrays • Working with Methods • Pass by value and by reference and out parameters• Writing, testing and execution of program to understand general syntax and functions available in C#.

3: Database Programming Using ADO.NET **(8L)**

• Prerequisite - Knowledge of SQL Queries • Introduction and Evolution of ADO.NET • Understanding the Role of Managed Provider and ADO.NET Objects • connecting to Database and Connection Pooling • Performing Insert, Update and Delete Operations • Fetching Data from database - Executing Select Statements • How to implement Login facility with database

4: Interactive methods **(6L)**

Preparing flowchart, algorithm for interactive methods, Bisection Methods, Newton Rapson Method, Numerical integration by Trapezoidal rule, Simpson 1/3rd rule.

5: Hands on training: **(6L)**

Hands on training to execute numerical problems for interactive methods, Bisection Methods, Newton Rapson Method, Numerical integration by Trapezoidal rule, Simpson 1/3rd rule.

Reference Books:

1. C# 8.0 Pocket Reference: Instant Help for C# 8.0 Programmers
2. Programming in C# by E Balagurusamy
3. Beginning C# Object-Oriented Programming (English, Paperback, Clark Dan)
4. Pro C# 9 with .NET 5: Foundational Principles and Practices in Programming by Troelsen, Andrew, Japikse, Philip

Web References:

1. https://dotnet.microsoft.com/learn/csharp
2. https://docs.microsoft.com/en-us/dotnet/csharp/programming-guide/
3. https://www.pragimtech.com/courses/c-sharp-tutorial-for-beginners/
4. https://www.tutorialspoint.com/csharp/csharp_tutorial.pdf

List of Experiments: (Any 2)

1. Write a program that converts 1 lower case letter ("a" - "z") to its corresponding upper case letter ("A" - "Z"). For example if the user enters "c" then the program will show "C" on the screen.
2. Write a program using a switch statement that takes one value from the user and asks about the type of conversion and then performs a conversion depending on the type of conversion. If user enters:
3. Write a program using conditional operators to determine whether a year entered through the keyboard is a leap year or not.
4. Write a program using a for loop that prints the following output (you need to find a pattern to print letters in this order): A B D H P
5. Write a program using a loop that prints the following output. 1 2 2 3 3 3 4 4 4 4 5 5 5 5 5 6 6 6 6 6 6 . . . nth iteration.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (G): Acoustics-I

Lectures: 36 **(Credits-02)**

1: Fundamentals of Sound:

Velocity of sound in fluids; Acoustic standards and reference conditions; Decibel scales: Intensity level (IL), Sound pressure Level (SPL), Sound Power Level (PWL); Problem-solving; Sound fields: Near, far, reverberant, and free. (6L)

2: Speech, Hearing and Community Noise Criteria:

Voice mechanism, acoustic power output of speech; Mechanism of hearing, thresholds of the ear; Equivalent continuous sound pressure level (L_{Aeq}); Perceived noise level (L_{EPN}); Audiometry (6L)

3: Architectural Acoustics and Audio Rooms:

Reverberation time: Concept and measurement, problem-solving relating to reverberation time; Management of sound absorption: porous absorbers, effect of density, thickness, airspace, acoustic tiles, foam board insulation, carpet absorption; Anechoic chamber; Haas effect and delay; Room modes: concept and room mode calculation; Room acoustics: Sound Transmission Class (STC), high-loss acoustic frame walls, acoustic floor, and ceiling systems (10L)

4: Resonators, Filters and Active Noise Control:

Helmholtz resonator; Acoustic, electrical, and mechanical analogues; Expansion chamber muffler, Active noise control: Noise Cancellation, Pros and cons of headphones, earphones, earbuds (8L)

5: Bioacoustics and Music:

Animal sounds: Bird songs, whale sounds - FFT and Wavelet Analysis (introductory) with examples; Pitch and timbre; Characteristics of musical notes: Vibrato, Tremolo, Portamento; Musical Instruments Digital Interface (MIDI) (6L)

Reference Books:

1. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
2. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
3. Acoustics, W.W. Seto, Schaum's Outline Series, McGraw Hill, 1970
4. Handbook of Sound Engineers, G.M. Ballou, Academic Press
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Design for good Acoustics and Noise Control, J. E. Moore, Univ. Press
7. Acoustics of Ducts and Mufflers, M. L. Munjal, John Wiley & sons

List of Experiments (Any two):

1. Transmission loss of an expansion chamber muffler.
2. Reverberation time measurement using a storage oscilloscope.
3. Calculation of room modes for a typical room and verification using an online mode calculator
4. Sound mapping using localized SPL measurement.
5. FFT: Square wave, animal sound recording

T.Y.B.Sc. (Physics) (Sem-V)
PHY-357: Physics Laboratory-3A

Lectures: 36 **(Credits-02)**

(General Laboratory, Electromagnetism, Atomic and Molecular Physics, and Optics)

(Any Eight)

GROUP-I: GENERAL PHYSICS (any FOUR)

1. Kater's pendulum
2. Moment of Inertia by Bifilar suspension
3. Young's modulus by Koeing method
4. Surface tension of mercury by ripple method
5. Surface tension liquid by Fergusson method
6. Surface tension of mercury by Quincke's method
7. 'Y' by vibration of wooden scale
8. Young's modulus by Newton's rings
9. Determination of wavelength of light by Michelson's interferometer
10. Study of damped oscillations of physical pendulum and finding log decrement

GROUP-II: ELECTROMAGNETISM (any TWO)

1. Study of forced oscillations by electromagnetically driven simple pendulum
2. Self-Inductance by Anderson's bridge
3. Core losses in transformers
4. Electromagnetic pendulum
5. Self-Inductance by Maxwell's bridge

GROUP-III: ATOMIC AND MOLECULAR PHYSICS AND OPTICS (any TWO)

1. Determination of Rydberg's constant
2. Zeeman Effect
3. Llyod's mirror
4. Determination of Resolving Power of grating
5. Determination of wavelength by Constant deviation spectrometer

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-V)
PHY-358: Physics Laboratory-3B

Lectures: 36 **(Credits-02)**

GROUP-I: EXPERIMENTS USING CRO/INSTRUMENTATION (any TWO)

1. Charging and discharging of capacitor and RC time constant
2. Measurement of g using simple pendulum
3. Velocity of sound
4. Radiation detection
5. IV Characteristics of diode
6. Measuring a value of a capacitor using CRO.
7. Temperature controller using AD590
8. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter.

GROUP-II: C-PROGRAMMING (any TWO)

1. Factorial of a number by simple and recursive method.
2. To find out the first 100 prime numbers
3. Matrix multiplication
4. Position time data using kinematic equations
5. Finding pressure using Van-der-Waals' equation of state

GROUP-III: COMPUTATIONAL PHYSICS (NUMERICAL BASED) (any TWO)

1. Roots of an algebraic equation (Bisection)
2. Roots of polynomial (Newton Raphson)
3. Numerical Integration by Trapezoidal rule
4. Numerical Integration by Simpson's 1/3 rule

GROUP-IV: PRACTICAL FROM OPTIONAL COURSE (Any TWO)

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-V)
PHY-359: Physics Project-I

Lectures: 36 **(Credits-02)**

Guidelines:

It is expected that,

1. The student does work equivalent to about ten (10) laboratory experiments throughout the semester in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the final presentation at the time of viva voce.
6. It is also recommended that a teacher will look after Four (4) projects at one time.
7. Practical examination will be conducted semester wise.
8. The student can perform an Experimental/Theoretical/Computational Project in Physics or interdisciplinary areas under the supervision of one or more guides.
9. The student can learn the basics of the topic chosen for project, to learn how to do literature survey and set up the basic experimental/theoretical and computational techniques needed for the project.
10. The department encourage to students for projects both in experimental and theoretical areas of Physics in collaboration with other institutes and industry.

The Project work shall consist of the following Criterions.

1. Project work is mandatory for all the T. Y .B. Sc. students.
2. All the T. Y. B. Sc. students will be have to complete the Project work prescribed by the Board of Studies in Physics of Savitribai Phule Pune University during the V^{th} Semester.
3. The Project work shall consist of the following Criterions.
    - It is expected that students must finalize the Title of Project, Aim and objective, Significance, Literature survey, Materials required, Method and Application etc.
    - Introduction to foundations of Project Work.
    - Introduction of Project Research Methodology.
    - Study of Data Collection Methods.
    - Project Problem Writing and Presentation Skills.

Evaluation weightage:

- Project-I: Semester End University Examination : 35 Marks
- Internal Examination: 15 Marks

Skill Enhancement Courses

Skill Enhancement Courses (SEC)

a) Selection of Skill enhancement courses

There are two skill enhancement courses (SEC) in 5th semester (PHY-3510 and PHY-3511). For 5th semester, there are four options available. The college has to select any one from the given four options. It is advised that college should not offer elective and skill enhancement course of same theme.

b) Teaching Learning process for Skill Enhancement Courses

Skill base courses are intended to explore the applications of physics knowledge. Learning in skill enhancement courses is largely experience based. The skill enhancement courses may be categorized as knowledge skill or technical skill. For knowledge skill courses one can use the conventional method for teaching along with problem solving, assignments seminars etc. For acquiring the technical skill, the students will get adequate 'hands-on' experience. The teachers may use demonstrations and activity-based learning techniques. On field visits, study tour and mini projects will enrich the learning experience of the students.

c) Assessment methods for skill enhancement courses

Continuous evaluation will be the best method for assessment of skill enhancement courses.

One can use tools like assignments, mini projects or activities, problems, etc and grade the students according to their performance. The internal assessment should have 50 % weightage.

The University examination may be conducted for the remaining 50%.

The University examination question paper should have adequate proportion of objective and subjective question.

d) List of Skill Enhancement Courses:

Semester-Vth	**Semester-Vth**
PHY-3510	**PHY-3511**
PHY-3510(H): Python Programming	PHY-3511(L): Physics Workshop Skill
PHY-3510(I): Energy studies	PHY-3511(M): Biomedical Instrumentation
PHY-3510(J): Introduction to Arduino	PHY-3511(N): Non-destructive Testing Techniques
PHY-3510(K): Sensors and Transducer	PHY-3511(O): Acoustics Applications

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (H): Python Programming

Lectures: 36 **(Credits-02)**

Pre-requisite : Basic mathematics (XII-Science)
Version of python : 3.4
Proposed IDE : Spider, Py Charm or Jupyter

Python Programming:

Python is one of the top ten popular programming languages. Python is a general purpose and high level programming language. You can use Python for developing desktop GUI applications, websites and web applications. Also, Python, as a high level programming language, allows you to focus on core functionality of the application by taking care of common programming tasks. The simple syntax rules of the programming language further makes it easier for you to keep the code base readable and application maintainable. There are also a number of reasons why you should prefer Python to other programming languages.

Advantages of Python Programming

i.) Readable and Maintainable Code
ii.) Multiple Programming Paradigms
iii.) Compatible with Major Platforms and Systems
iv.) Robust Standard Library
v.) Many Open Source Frameworks and Tools
vi.) Simplify Complex Software Development
vii.) Adopt Test Driven Development

Objectives:

i.) To build foundation for understanding Python environment to enhance computational skills.
ii.) Understand variables, input and output functions in python and To Apply computational skill in problem solving approach of Physics
iii.) Get exposure to arithmetic, assignment, relational, logical and Boolean operators.
iv.) Be familiar with Python modules and Libraries

Course outcomes:

After completion of this course student will be able

i.) To write code for complex scientific computational requirement.
ii.) Use Libraries like NumPy for numeric computation
iii.) Use Library SciPy for scientific and technological calculations
iv.) Use Library Matplotlib for plotting of graph and its visualization.
v.) Develop own functions for Physics or mathematics.

Syllabus

a) Python Programming:

Unit No.	Topic	Lectures
1	**Introduction to Python Programming Language**: Introduction to Python Language, • Strengths and Weaknesses, • IDLE, Dynamic Types, • Naming Conventions, • String Values, • String Operations, • String Slices, • String Operators, • Numeric Data Types, • Conversions, • Built In Functions	03
2	**Data Collections and Language Component:** • Introduction, • Control Flow and Syntax, • Indenting, • The if Statement, • Relational Operators, • Logical, • Operators, • True or False, • Bit Wise Operators, • The while Loop, break and continue, • The for Loop, Lists, • Tuples, • Sets, • Dictionaries, • Sorting Dictionaries, • Copying Collections.	05
3	**Functions and Modules :** • Introduction • Defining Your Own Functions Parameters • Function Keyword and Optional Parameters • Passing Collections to a Function • Variable Number of Arguments Scope • Functions Passing Functions to a Function • Mapping Functions in a Dictionary	05

	• Modules • Standard Modules – sys • Standard Modules – math • Standard Modules – time • The dir Function	
5	**Modules and packages in Python :** • NumPy, SciPy • MathPlot etc	**05**

a) Demonstrations :

Sr. No.	Practical Demonstration to Communicate Concepts and Application in Physics, Electronics, Statistics and Mathematics
1	Write python program to use basic math and string operations.
2	Write python program to find roots of quadratic equation, prime numbers etc
3	Write python program to store data in list and perform matrix operation
4	Write python program to do numerical methods
5	Write python program involving tuples, dictionaries in problems related to physics or mathematical concepts
6	Write python program to use random number generator as probability density to show expected value is 0.5 to explain quantum mechanical behaviour of particle in one dimensional well.
7	Write python program to use NumPy library for more complex arithmetic operations
8	Write python program to use complex numbers and complex algebra
9	Write python program to use bitwise operation
10	Write python program to plot graphs using mathplotlib or similar library

Reference books:

- Python Programming: Using Problem Solving Approach. By Reema Thareja.
- Think Python By Allen Downey
- Problem Solving and Python Programming By Balguruswami McGrow Hill
- Let Us Python By Aditya Kanetkar
- Learning with Python By Allen Downey
- Data Analytics By Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (I): Energy Studies

Lectures: 36 **(Credits-02)**

Course Objectives:

1. Students understand the comparative aspects, advantages and disadvantages of various sources of energy. They understand the facts and myths regarding the energy sources.
2. Students learn the basic principles involved and technologies developed in the uses of solar energy, biomass energy, wind energy, fuel cells.
3. Students understand the challenges and opportunities in conversion of energy from one form to another, generation of electricity and mechanical work using different energy sources.
4. Students get acquainted with challenges and recent trends in energy storage devices and they learn more about super-capacitors and batteries, electrical vehicles. They can imagine about future road maps in the fields of energy conversion and storage technologies.

Course Outcomes:

1. Students become capable of conducting energy audits and give consultancy in that field.
2. Students can design different types of solar heaters for small domestic as well as large scale community level applications.
3. Students acquire skills to implement solar P-V systems at domestic levels as well as for office premises and educational institutions. Students become able to start their own enterprise in net metering.
4. Students get ideas and hence become self-employed in the field of design , production, commissioning and implementation of bio-mass energy sources , bio-gas plants, gasifiers, wind mills, hybrid systems etc.
5. Students can go for research in the fields of super-capacitors, battery technologies, fuel cells and material synthesis for implementation of these technologies.
6. Students become successful entrepreneurs in the energy field.

Students strive to make the regions where they live and work self-sufficient in generating and fulfilling their own energy needs using different energy solutions.

Unit No.	Topic	Lectures
1	**An Introduction to Energy Sources:** Classification and comparison of energy sources (hydro, thermal, nuclear, solar, wind, biomass, and fossil fuels) considering environmental, safety, economy, production and distribution aspects. Facts and Myths about various sources of energy, thermal, nuclear sources of energy, Hybrid sources. Energy audit. Activity: 1. Energy audit of college campus/public campus/home/building 2. Comparison of energy sources. Visits to energy generation/distribution sites.	6
2	**Solar thermal Applications:** Sun as a source of energy, Solar Constant, Liquid flat plate collector, construction and working, Concentrating collectors, Solar drying, Solar water heating systems. Activity:	6

	1. Study of solar water heaters 2. Study of large scale solar heaters for industrial/cooking/water heating applications. 3. Study of flat plate, parabolic solar concentrators	
3	**Solar Photovoltaic systems Applications:** Photovoltaic principle, Power output and conversion efficiency, Limitation to photovoltaic efficiency, Basic photovoltaic system for power Generation, Application of solar photovoltaic systems, Advantages and disadvantages of Solar PV Systems. Configurations of Solar Photovoltaic Systems: Off-grid, Grid-Tied and Grid-Storage, Net metering and steps in installation of a rooftop solar PV System design. Activity: 1. Efficiency measurement of PV systems using I-V characteristics of Amorphous Si, Mono-crystalline Si, Polycrystalline Si in individual, series and parallel combinations. 2. Effect of intensity of incident light, incident angle and shading on Solar PV Module on Output power. 3. Study of design of solar lanterns, street lights using solar systems 4. Study of Installation and commissioning of roof top solar PV systems **5.** Study of net metering systems	8
5	**Biomass and wind energy:** Bio-mass conversion technologies, Bio-gas generation, Working of biogas plant, Bio-gas from plant wastes, Methods for obtaining energy from biomass, Thermal gasification of biomass, Introduction to wind energy, Classification and description of wind machines, Wind energy, Wind data. Activity 1. Visit to bio gas plant 2. Visit to bio diesel plants 3. Study of modified bio mass plants 4. Design and implementation of domestic/small scale biogas plants. 5. Study of different types of gasifiers 6. Study of wind mill / visit to wind mill	8
	Energy storage devices and electrical Vehicles : Recent trends in batteries, super-capacitors, fuel cells. Applications of storage devices: Electrical Vehicles (EV), Converter, Inverter, Controls & Controllers in EV, Future Trends in Electric Cars. Activity 1. Preparation and testing of fuel cell on Laboratory scale 2. Preparation and testing of super capacitors on Laboratory scale 3. Preparation and testing of paper batteries and other types of batteries on Laboratory scale. 4. Design and implementation of battery-operated toys using green technology	8

Reference books:

1. Non-conventional Energy sources- G. D. RAI (4th edition), Khanna Publishers, Delhi
2. Solar Energy - S. P. Sukhatme (Second Edition), Tata Mc Graw Hill Ltd., New Delhi.
3. Solar Energy Utilisation - G. D. RAI (5th edition), Khanna Publishers, Delhi.

4. Renewable Energy Technology: A practical guides of beginners, Chetan Singh Solanki, PHI Learning Private-Ltd., New Delhi.
5. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki, PHI Learning Private-Ltd., New Delhi

Note :

1. It is expected that students should undertake at least 1 activity from each unit and total 6 activities amounting to 18 lectures time.
2. Out of the total time allotted to each unit, half the time should be utilized for classroom teaching and remaining half for the activity.
3. Students should be encouraged to study this course by using Case–Study approach.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (J): Introduction to Arduino

Lectures: 36 **(Credits-02)**

Introduction:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino board designs use a variety of microcontrollers. Boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various circuits. It has USB that is used for loading programs. Microcontrollers can be programmed using C / Python programming languages. This course will focus on creative thinking and on hands-on project development using Arduino Boards.

Objectives:

- To create general awareness and interest in Arduino Boards.
- To provide knowledge of different Arduino boards and various sensors and actuators.
- The course enables student to understand the basics of interfacing with Arduino Boards.
- To familiarize students with Arduino as IDE, programming language & platform and to Program basic Arduino examples.
- To provide knowledge of different Smart System applications.
- Develop skills to design and implement various smart system application.

Course Outcomes: After successful completion of this course, student will be able to

- Students will be able to understand and use various Arduino Boards, and its various components, Input / Output Pins, Input / Output Devices.
- Understand general concepts of Programming Arduino Boards.
- Apply the knowledge gain to design applications using Arduino in different domains.
- To analyze and evaluate the performance of various Arduino based devices.
- Learn and understand about any new IDE, compiler, and MCU chip in Arduino compatible boards or similar types.

Instructions: This course consists of two parts

- Part I: Theory and Part II: Practical / Project.
- Out of which 1 Credit is for Theory and 1 credit is for Practical work.
- Part II has two sub parts:
- Part II(A) : Practical / Demonstration & Part II(B) : Project. The A or B parts are optional, students can opt any one for 1 credit

Part I: Theory

Unit	Topics	Lectures
I : Introduction to Microcontrollers	• Introduction to Embedded Systems, Block Diagram, Single Board Computers (SBC) and System on Chip (SoC), Single Board Microcontroller (SBM), microprocessor vs microcontrollers, Basic system with microcontroller such as Arduino (SBM), Raspberry Pi (SoC) etc.	04

II : Introduction to Arduino and Arduino Programming	• **Arduino Basics:** What is Arduino, Advantages of Arduino, Arduino Types, Arduino Components, Arduino Uno Architecture • **Arduino Hardware:** Types of Arduino boards, Various components on Arduino Board, Various sensors and actuators: Overview of Sensors working, Analog and Digital Sensors	**06**
III : Introduction to Programming for Arduino	• **Arduino Software:** Integrated Simulation Environment (IDE), Setup the IDE, Arduino Libraries, What is Sketch, Writing Arduino Sketches, Serial Monitor, **Introduction to programming:** Fuctions, Variables & Basic Structure of Arduino (C++) Code, Basics Programs (Hello Word, Blinking of LED), Loading program through USB and Test performance of the System, Integration of Sensors and Actuators with Arduino	08

Part II (A): Arduino Programming (Practical / Demonstration) : Any 6 [18 L]

Simple Practical using Arduino Uno Board (Software + Hardware): Choose any-3 Practical from group-1 and any-3 practical from group-2. (Total = 6 practical)

Sr No	List of Practical's
	Group 1 : Any-3
1	Demonstration of Arduino Uno Board, Its Various Components, Pins
2	Installation Arduino Software (IDE) on computer, Introduction to Sketch, Loading of Program from computer, Simple programs: Hello Word, Blinking of LED on Arduino board etc.
3	Interfacing external LED (ON & OFF); Fading of LED
4	Analog Read Serial: 1. Read a potentiometer, print its state out to the Arduino Serial Monitor. 2. Read an analog input and prints the voltage to the Serial Monitor.
5	Digital Read Serial: Interfacing a switch, Read a switch, print the state out to the Arduino Serial Monitor.
6	Digital: Interfacing push Button: Use a push button to control an LED or Buzzer
7	Digital : State Change Detection: Count the number of button pushes.
8	Analog In Out Serial: Read an analog input pin, map the result, and then use that data to dim or brighten an LED.
	Group 2 : Any 3
9	Knock: Detect knocks with a piezo element.
10	Interfacing of Ultrasonic Sensor, Detect objects with an ultrasonic range finder.
11	Interfacing of Proximity Sensor

12	Interfacing of Temperature & Humidity Sensor : To interface DHT11 sensor for recording temperature and humidity readings with Arduino.
13	Interfacing LCD display with Arduino
14	Interfacing of Relay Switch and Servo Motor with Arduino
15	Interfacing Bluetooth Module to Arduino
16	Interfacing of Motion (PIR Sensor) or Light Sensor using (LDR & LED) or Gas Sensor (MQ-2) with Arduino

OR

Part II (B): Arduino Programming (Practical / Demonstration)

Project : any-1 Simple Projects Using Arduino Uno Board [18 L]

Sr No	List of Simple Projects
1	Line Following Robot with Arduino
2	Obstacle Avoiding Robot with Arduino
3	Weather Station using Arduino
4	Home Automation using Arduino
5	Android Based Air quality Monitor
6	Intelligent automatic irrigation system

References:

1. www.arduino.cc
2. https://www.arduino.cc/en/Tutorial/BuiltInExamples
3. https://create.arduino.cc/projecthub

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3510 SEC (K): Smart Sensors and Transducer Technology

Lectures: 36 **(Credits-02)**

Course Objectives:

- To make students familiar with the constructions and working principle of different types of sensors and transducers.
- To make students aware about the measuring instruments and the methods of measurement and the use of different transducers.

Course Outcomes: At the end of the course, a student will be able to:

- Use concepts in common methods for converting a physical parameter into an electrical quantity
- Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
- Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
- Predict correctly the expected performance of various sensors
- Locate different type of sensors used in real life applications and paraphrase their importance
- Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers and develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.

Syllabus: **[18 L]**

1) **Mechanical and Electromechanical sensor:**
   Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes. LVDT: Construction, material, output input relationship, I/O curve, discussion.
2) **Capacitive sensors:**
   Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics..
3) **Thermal sensors**:
   Material expansion type: solid, liquid, gas & vapor Resistance change type: RTD materials, tip sensitive & stem sensitive type. Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type.
4) **Magnetic sensors:** Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics. Radiation sensors: LDR.

Activity: Any-6 **[18 L]**

Based on chapter I

1) Linear displacement measurement using potentiometric sensor.

2) Displacement/pressure measurement using strain gauge sensor.
3) Linear displacement measurement using LVDT.

Based on chapter II

1) Capacitive type transducer measure small displacement/force varying plate area/distance of plate/dielectric constant.
2) Displacement/pressure measurement using microphone.
3) Liquid pressure measurement using pressure sensor

Based on chapter III

1) Measurement of temperature using RTD .
2) Measurement of temperature using Thermocouple transducer.
3) Silicon diode as temperature sensor

Based on chapter IV

1) Magnetic sensor/Hall effect/proximity sensor based measurement magnetic susceptibility magnetisation
2) LDR based measurement light intensity etc.

Reference books:

1) R Sensor & transducers, D. Patranabis, 2nd edition, PHI
2) Instrument transducers, H.K.P. Neubert, Oxford University press.
3) Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill
4) Sensor & transducers, D. Patranabis, 2nd edition, PHI
5) Instrument transducers, H.K.P. Neubert, Oxford University press.
6) Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (L): Physics Workshop Skill

Lectures: 36 **(Credits-02)**

Objectives:

This course is to get exposure with various aspects of instruments and their usage through hands-on mode.

Course outcomes:-

After completion of this course students will able to handle and test various instruments.

Syllabus:

Unit-1. Basic of Measurement: 4L

- Accuracy, precision, sensitivity, resolution, range etc.
- Errors in measurements and loading effects.
- Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter.

Multimeter:

- Block diagram and working of a digital multimeter.
- Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance.
- Specifications of a multimeter and their significance.

Unit-2. Electronic Voltmeter: 4L

- Principles of voltmeter, Construction (block diagram only).
- Specifications of an electronic Voltmeter and their significance.
- AC Milli Voltmeter: Type of AC Milli Voltmeters
- Block diagram ac Milli Voltmeter,
- Specifications and their significance.

Unit-3. Cathode Ray Oscilloscope: 5L

- Block diagram of basic CRO.
- Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only-no mathematical treatment),
- Brief discussion on screen phosphor, visual persistence & chemical composition.
- Time base operation, synchronization. Front panel controls.
- Specifications of a CRO and their significance.
- Use of CRO for the measurement of voltage (dc and ac frequency, time period.
- Special featuresof dual trace oscilloscope.
- Introduction to digital oscilloscope, Block diagram and principle and working.

Unit-4. Signal Generators and Analysis Instruments: 2L

- Block diagram, explanation and specificationsof low frequency signal generators.
- Pulse generator, and function generator.

- Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Unit-5. Impedance Bridges and Q-Meters: 3L

- Block diagram of bridge.
- Working principles of basic (balancing type) RLC bridge.
- Specifications of RLC bridge. Block diagram & working principles of a Q- Meter.
- Digital LCR bridges.

Activity: (Complete any activity of 18 L) (18 L)

1. Use of Digital multimeter.(3L)
2. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance. (3L)
3. To observe the limitations of a multimeter for measuring high frequency voltage and currents. (3L)
4. Measurement of voltage, frequency, time period and phase angle using CRO. (3L)
5. Measurement of rise, fall and delay times using a CRO. (3L)
6. To measure Q of a coil and its dependence on frequency, using a Q- meter. (3L)
7. Measurement of distortion of a RF signal generator using distortion factor meter. (3L)
8. Measurement of R, L and C using a LCR bridge/ universal bridge. (3L)

Reference Books:

1) A text book in Electrical Technology - B L Theraja - S Chand and Co.
2) Performance and design of AC machines - M G Say ELBS Edn.
3) Digital Circuits and systems, Venugopal, 2011, Tata Mc Graw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
4) Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3, 2012, Tata Mc-Graw Hill
5) Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (M): Biomedical Instruments

Lectures: 36 **(Credits-02)**

Objectives

- Introduction to various bio-signals and their origin
- Understanding of electrode theory
- Use of transducers in biomedical instrumentation
- Patient safety while using biomedical instrumentation
- Instruments handling and analysis of the recorded data

Course Outcomes

- Students will acquire basic knowledge of biomedical instrumentation.
- Students can handle and operate different equipment's like ECG, Oxymeter, and Glucometer.
- Students will be able to record the different health parameters using it.
- Student will also able to analyze and interpret the recorded data.

Syllabus:

Unit-I: Physiological transducers **(7L)**

- Introduction to physiological transducers
- Classification of Transducer
- Performance characteristic of transducer.
- Displacement, position and motion transducer.
- Pressure transducer for blood pressure measurement
- Transducer for Body temperature measurement
- Biosensors

Unit-II: Bioelectric signals and cardiovascular system: **(7L)**

- Basics of signal measuring system
- Basic and essentials of biomedical instrumentation system.
- Heart and Cardiovascular system
- Resting and action potential, propagation of action potential, Passive and active conduction.
- Electro-conduction system of heart
- Blood Pressure measurement
- Heart Sounds, Phonocardiography
- Pulse oximetry

Unit-III: Electrocardiography: **(4L)**

- Introduction and Principle
- Interpretation of Electrocardiogram
- Block diagram of electrocardiograph, ECG machine maintenance and trouble shooting
- The ECG leads
- Effect of artifacts on ECG recording

- Types of ECG recorders

Activities: (Any 6: 3 Lecture hours each) (18L)

1. Study of ECG machine(Voltage gain , chart speed etc) and EEG placement of electrodes
2. ECG recording and analysis (Calculation of heart rate, measurement of peak amplitude and period of waves)
3. Study of anolog sphygmomanometer and digital BP monitor – Measurement of SBP, DBP and pulse rate
4. Measurement of pulse parameter using pulse oxymetry /pulse measuring instrument
5. Use of biosensor (sugar level measurement / skin resistance).
6. To study Infrared sensor/ temperature gun and measuring values
7. Study of BMI/ body composition monitor and measurement of physiological parameters (BMI, % Body fat,
8. First aid for heart patient – study and practice
9. Study of Spirometer and practice for increasing lung capacity
10. Visit to established hospital

Reference Books:

1. Biomedical Instrumentation and Measurements (Second edition) - Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson education.
2. Handbook of Biomedical Instrumentation (Second Edition) - R. S. Khandpur (Tata McGraw Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.
4. Biomedical instruments and measurements (Second edition) - R. Ananda Natarajan Eastern economy edition
5. A textbook of Biomedical engineering edited - R.M. Kenedi, blackie (Glasgow & London)
6. Medical instrumentation: Application and design (Third edition)- John G. Webster, Willey India Education

Required Equipment with Probable cost:

1. Electro Cardiogram- ECG machine- analog- Rs. 30000/-
2. SPO_2 meter- Analog- Rs. 3000/-
3. Fat Meter- Digital- Rs. 4000/-
4. Sphygmomanometer – Digital and analog: Rs. 3000/- each
5. Glucometer- Digital: Rs.2000 each.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (N): Nondestructive Testing Techniques

Lectures: 36 **(Credits-02)**

Objective:

- To study and understand the various non-destructive testing (NDT) methods, and their industrial and scientific applications.

Outcomes:

- After completion of this course the students will be able to use NDT methods for defects and characterization of industrial components.

Unit No.	Topics	Lectures
I	Definition and objectives of NDT, introduction to materials testing, purpose of testing and properties of materials, classification of material testing, destructive testing and its examples only, Definition, Characteristics detected, principle, advantages, limitation and applications of various methods like Visual inspection, liquid penetrant testing, magnetic particle testing, thermography testing, eddy current testing, ultrasonic testing, acoustic emission testing, radiography testing,	6
II	What are the discontinuities, Types of discontinuities in materials? Processing the discontinuity, service induced discontinuity, factors for selection of NDT method in different cases of discontinuity, brief description of equipment used in visual testing method, Principles of liquid penetrant method, stages of liquid penetrant process, liquid penetrant process flow chart, chemical and solvent cleaning methods of surface preparation, how to apply and removal of excess penetrant?, application of developer, and observation of defects, penetrant, their types and properties, role of developer, their types, Magnetic particle testing method, procedure of Magnetic particle testing methods, portable magnetization equipment and stationary magnetization equipment, dry and wet particle inspection techniques and stages involved in it and its applications	6
III	Thermography testing, basics of infrared theory, range characteristics, wavelength, frequency, emission, convection, conduction, reflection, transmission, emissivity of infrared, basic principles of thermography testing, elements of infrared detection system, thermography testing active and passive approach, basics of eddy current testing, working principles of eddy current testing, stages in eddy current testing, factors influencing in eddy current testing, Ultrasonic testing and its methods (transmission and pulse echo method), Acoustic emission testing, factors influencing acoustic wave propagation and data acquisition, instrumentation of acoustic emission testing, Radiography testing, principle, various stages in testing, gamma ray radiography testing, SWSI and DWSI techniques in X ray testing, Fluoroscopy testing arrangement and working principle, Computed tomography in NDT	6

Activity: Any-6 demonstration activities from the followings (each activity will be equivalent to 3-hrs)

1. Video demonstration of any two NDT techniques
2. Study of different X ray photograph and MRI scan photographs in medicine
3. Study of NDT by acoustic method
4. Surface visual study of defects of various objects provided
5. Study of surface defects by liquid penetration method
6. Study of surface defects by liquid leak method
7. Study of surface defects by liquid spray method
8. Study of surface defects by using UV light and fluorescent liquid method
9. Visit to any industry and observing NDT method live (equivalent to two demonstrations)
10. Audio visual expert lecture of industrialist who is using NDT method for quality control.

Reference Books:

1. Non- destructive testing of materials, Dr V. Jaykumar, Dr. K. Elangovan, Lakshmi Publications, Tamilnadu, India.
2. Practical non-destructive testings, Baldev Raj, T. Jaykumar, M. Thavasimuthu, Narosa Publications
3. Basics of non-destructive testings, Lari and Kumar, S.K. Kataria& Sons publications
4. Non-destructive testing techniques, Ravi Prakash, New Age International Private Limited
5. Non-destructive test and evaluation of materials, J. Prasad, C.G.K. Nair, McGraw Hill Education

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3511 SEC (O): Acoustics Applications

Lectures: 36 **(Credits-02)**

Objective:

To study and understand about sound physics, properties and their applications.

Outcomes:

After completion of this course the students will be able to use sound detection and characterization of sounds.

Syllabus:

Unit-1. Environmental Acoustics (3 L)

1.1 Environmental Noise: sonic boom, aircraft flyover, foot-fall noise, slammed door

1.2 Weighted sound levels: Sound level meters, A-weighted & C-weighted sound level, Phon, Sone,

1.3 Noise rating: Community noise: Highway noise, Aircraft noise

1.4 Noise induced hearing loss: Chronic, Trauma.

1.5 Mufflers: Automobile, Silencers, Transmission loss,

Unit-2. Sound Reinforcement Systems (5 L)

2.1 Microphones- Types, selection criteria, Professional grade, sensitivity, FM microphones

2.2 Loudspeakers- Direct Radiator type, Horn- Folded and Flared horn, Woofer, Squawker, Tweeter, Loudspeaker Cabinets- Enclosed cabinet, Open Cabinet, Bass Reflex Cabinet,

2.3 Amplifiers: Public Address systems, Gain and Bandwidth

2.4 Headphones- Noise cancellation features

2.5 Acoustic Delays

2.6 Synthesizers, Graphic equalizers, mixers

2.8 Basics of Audio Signal Processing

2.9 Monophonic and Stereophonic Systems

Unit-3. Musical Acoustics **(**4 L)

3.1 Pitch, timbre, rhythm, intensity, loudness, consonance, dissonance, Bass, Treble, Harmonics and Overtones

3.2 Standing waves, interference, beats, harmony, melody

3.3 Octave: Musical Scales

3.4 Types of Musial Instruments: String - violin, guitar, Wind - Brass, Reed instruments, organ, Percussion - Drums, Tabla

3.5 MIDI - Musical Instruments Digital Interface

3.6 Audio file formats: MP 3 and MP 4 systems

Unit-4. Room Acoustics (2 L)

4.1 Growth and decay of sound in live rooms

4.2 Sabine Equation, Reverberation time measurement methods

4.3 Room modes, Sound absorption materials

4.2 Speech Intelligibility: Articulation Test, Articulation Score

Unit-5. Acoustics in Medicine & Ultrasound (2 L)

5.1 Audiometry and Hearing loss

5.2 Ultrasonography
5.3 Ultrasonic Transducers
5.4 Ultrasonic cleaning, Non Destructive Testing (NDT)

Unit-6. Underwater Acoustics (2 L)

6.1 Speed of sound in sea water, Transmission loss
6.2 Sonar: Active and Passive Sonar

Activities: Any-6 **[18L]**

1. Frequency response of loudspeaker
2. Polar characteristics of a microphone
3. Study of Graphic Equalizer
4. Estimation and measurement of reverberation time
5. Expansion chamber mufflers Transmission Loss (TL)
6. Online calculators for Room Modes

Reference Books:

8. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
9. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
10. Acoustics, W.W. Seto, Schaum's Outline
11. Handbook of Sound Engineers, G.M. Ballou, Academic Press
12. Basic Acoustics, D.E. Hall, Oxford University Press
13. Design for good Acoustics and Noise Control, J.E. Moore, University Press

Semester-VI

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-361: Solid State Physics

Lectures: 36 **(Credits-02)**

1: The Crystalline Structures **(10 L)**

Lattice, Basis, Translational Vectors, Primitive Unit Cell, Symmetry Operations, Different types of lattices: 2D and 3D (Bravais lattices) Miller indices, Inter Planer Distances, SC, BCC and FCC structures, Packing Fraction, Crystal structures NaCl, diamond, CsCl, ZnS, HCP, Concept of Reciprocal Lattice and its properties, Problems

2: X ray Diffraction and Experimental Methods **(9 L)**

Bragg's Diffraction, Bragg's Law, Experimental X-ray diffraction Methods: The Laue Method, Bragg's Spectrometer, The Powder Crystal Method, Analysis of cubic structure by Powder Method, Ewald's Construction, Bragg's Diffraction condition in direct and reciprocal lattice, Problems

3: Free Electron and Band Theory of Metals **(9L)**

Assumptions of Classical and Somerfield Free Electron model, Energy levels and Density of States (One and Three Dimensions), Nearly free electron model, Fermi energy, Fermi level, Hall Effect, Mobility, Hall Angle

Band Theory of Solids: Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator, Problems

4: Magnetism **(8L)**

Diamagnetism, Langevin theory of Diamagnetism, Paramagnetism, Langevin theory of Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferromagnetic Domains, Hysteresis, Curie temperature, Neel temperature, **Superconductivity**, Problems

Reference books:

1. Solid State Physics S.O.Pillai, 6th Edition, New Age International (P) Ltd, Publisher, (2010).
2. Solid State Physics – Kakani S.L. and Hemrajani C, 4th Edition, S. Chand Publication (2005).
3. Fundamentals of Solid State Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena, Pragati Prakashan, Meerut , Uttar Pradesh
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Elementary Solid State Physics Principles and Applications, M Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.(2006)
8. Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
9. Solid State Physics, P.K. Palanisamy, Scitech Publications(India) Pvt Ltd, Chennei, 1st Edition (2004)
10. Solid State Physics: Essential Concepts, David W. Snoke, 2nd Edition, Cambridge University Press

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-362: Quantum Mechanics

Lectures: 36 **(Credits-02)**

1: Origin of Quantum Mechanics (08 L)

1. Historical Background: Black body radiation, photoelectric effects.
2. Matter waves - De Broglie hypothesis. Davisson and Germer experiment.
3. Wave particle duality
4. Concept of wave function, wave packet, phase velocity, group velocity and relation between them
5. Heisenberg's uncertainty principle with Electron diffraction experiment, different forms of uncertainty.
6. Different fields of applications of quantum mechanics
7. Problems

2: The Schrodinger equation (10 L)

1. Physical interpretation of wave function
2. Schrodinger time dependent equation.
3. Schrodinger time independent equation.(Steady state equation).
4. Requirements of wave function.
5. Probability current density, equation of continuity, and its physical significance.
6. An operator in Quantum mechanics, Eigen function and Eigen values.
7. Expectation value, Ehrenfest's theorem (Only statements)
8. Problems

3: Applications of Schrodinger Steady state equation (14 L)

1. Free particle.
2. Step potential.
3. Potential barrier. (Qualitative discussion). Barrier penetration and tunnelling effect.
4. Particle in infinitely deep potential well (one - dimension).
5. Schrodinger's equation in spherical polar co-ordinate system.
6. Rigid rotator (free axis).
7. Problems

4: Operators in Quantum Mechanics (4 L)

1. Hermitian operator.
2. Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian).
3. Commutator brackets- Simultaneous Eigen functions.
4. Commutator Algebra
5. Commutator bracket using position, momentum and angular momentum operator
6. Concept of parity according to quantum mechanics, parity operator and its Eigen values.
7. Problems

Reference books:

1. Eisberg, Robert M., and Robert Resnick. *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*. Wiley, 1985. ISBN: 9780471873730.
2. Liboff, Richard L. *Introductory Quantum Mechanics*. Addison Wesley, 2002. ISBN: 9780805387148.
3. Griffiths, David J. *Introduction to Quantum Mechanics*. Upper Saddle River, Pearson Prentice Hall, 2005. ISBN: 9780131118928
4. Feynman, Richard P., Robert B. Leighton, and Matthew L. Sands. *The Feynman Lectures on Physics*. Addison Wesley, 1989. ISBN: 9780201500646.
5. P M Mathews and K Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill publication, *ISBN*. : 9780070146174
6. N. Zettili, *Quantum Mechanics- Concepts and applications*, Wiley publication, *ISBN*: 978-0-470-02679-3
7. Ajoy Ghatak, S. Lokanathan, *Quantum Mechanics: Theory and Applications*, Springer Publication, *ISBN* 978-1-4020-2130-5
8. G Aruldhas, *Quantum Mechanics*, Phi Learning Private Ltd., *ISBN* : 97881203363
9. Shankar, Ramamurti. *Principles of Quantum Mechanics*. Springer, 2008. ISBN: 9780306447907.
10. Gupta, Kumar & Sharma, *Quantum Mechanics*, Jai Prakash Nath Publications.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-363: Thermodynamics and Statistical Physics

Lectures: 36 **(Credits-02)**

1: **Transport phenomenon and Maxwell's relations:** **(9L)**

Mean free path, Transport phenomenon, Viscosity, Thermal conductivity and diffusion.
Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function,
Derivation of Maxwell Relations, Specific heat and latent heat equations, Joule Thomson effect (Throttling Process), Problems

2: Elementary Concepts of Statistics: **(9L)**

Probability, distribution functions, Random Walk and Binomial distribution, Simple random walk problem, Calculation of mean values, Probability distribution for large-scale N, Gaussian probability distributions, Problems

3: Statistical Distribution of System of Particles and Ensembles: **(12L)**

Specification of state of system, Statistical ensembles, Basic Postulates, Probability calculations, Behaviors of density of states, Thermal, Mechanical and general interactions
Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble, Molecules in Ideal gas, Calculation of mean values in canonical ensemble.
Problems.

4: **Introduction to Quantum Statistics**: **(6L)**

Quantum distribution function, Maxwell-Boltzmann's statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics, Comparison of the distributions. Problems.

Reference books:

1) Lokanathan, R.S. Gambhir, Statistical and Thermal physics
2) F. Reif, Fundamentals of statistical and thermal physics
3) A. Beiser, Perspectives of modern physics
4) B.B. Laud, Fundamental of Statistical Mechanics
5) R.B. Singh, A primer of Statistical Mechanics
6) Gupta, Kumar, Statistical Mechanics

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-364: Nuclear Physics

Lectures: 36 **(Credits-02)**

1: Nuclear Structure, Properties and Radioactivity: (12 L)

Basic Concept of Nucleus:

- Composition, charge, size, density of nucleus(Revision)
- Nuclear Angular momentum,
- Nuclear magnetic dipole moment
- Electric quadrupole moment, Parity & symmetry,
- Mass defect and Binding energy, packing fraction,
- Classification of nuclei,
- Stability of nuclei (N Vs Z Curve) and problems.

Radioactivity:

- Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Specific activity and its units (Revision)
- Successive disintegration and equilibriums and radioisotopes.
- Radiocarbon dating
- Application of radioactivity (Agricultural, Medical, Industrial, Archaeological).
- Problems

Ref.(1) Ch.(2,3), Ref.(3) Ch.(3, 6)

2: Particle Accelerator and Radiation Detectors: (06 L)

Particle Accelerators:

- Introduction and Classification
- Linear Accelerator (electron/proton LINAC)
- Cyclic Accelerator (Cyclotron)
- Particle Accelerators In India (Discussion only)

Ref.(1) Ch.(12)

Nuclear Detector:

- Classification of Nuclear Detectors
- Gas filled Detectors (G. M. counter)
- Solid state detectors (scintillation counter)
- Problems:

Ref.(2) Ch.(4), Ref.(3) Ch.(7, 15)

3: Nuclear forces and Nuclear Models: (09 L)

Nuclear Forces:

- Classification of Nuclear Forces
- Meson theory of nuclear forces,
- Properties Of nuclear forces, properties of deuteron system,

- Elementary particles,
- Quarks model for elementary particles
- Shell Model: Assumptions, Evidences, and Spin and Parity limitations.
- Liquid drop model: Assumptions
- Semi-empirical B.E. formula
- Problems:

Ref.(1) Ch.(9, 17, 18), Ref.(3) Ch.(18)

4: Nuclear Reactions and Reactor Theory: (09 L)

Introduction to Nuclear reactions:

- Nuclear Reaction, Conservation laws (Revision)
- The Q-value equation, Exothermic and Endothermic reaction
- Compound nucleus
- Threshold energy
- Nuclear cross-section
- Nuclear fission , nuclear fusion stellar energy, chain reaction and critical mass,
- Nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeders
- Nuclear Reactors In India (Discussion only)
- Problems.

Ref.(1) Ch.(14, 15), Ref.(3) Ch.(11, 13, 14)

Reference books:

1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014
2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.
3. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988
4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill
5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-365 (A): Electronics-II

Lectures: 36 **(Credits-02)**

1: Semiconductor Devices: **(9L)**

a. LED and Photodiode, Optocoupler. (Working Principles) Problems. Ref. 1.
b. BJT: Transistor amplifier classifications - Class A, B, C and AB (working only), Differential amplifier (transistorized), Problems. Ref. 1.
c. Field Effect Transistor: JFET (Introduction, classification, principle, working and IV characteristics) MOSFETs (DE-MOSFET and E only MOSFET). Problems. Ref. 1

2: Applications of Semiconductor Devices: **(9L)**

a. Three Pin Regulators: Block diagram of 3-pin IC regulator, study of IC-78XX, 79XX. Dual Power Supply using IC-78XX, 79XX. Ref. 1
b. Switching Regulators (SMPS): Introduction, Block diagram, Advantages and Disadvantages. Ref. 4
c. Modulation and Demodulation : Concept of Carrier Wave, Need of Modulation and Demodulation, Methods of Modulation like AM, FM, PM (Concepts Only),
d. Concept of Modulation Index, Upper and Lower Side Band Frequencies in AM. Problems, Ref.3

3: Integrated Circuits: **(9L)**

a. Integrated Circuits: Introduction, Scale of Integration, Advantages and drawbacks of IC Ref.4
b. OP-AMP Applications as Integrator, Differentiator, Comparator. Ref. 1
c. Timer IC-555: Block diagram, Astable, monostable multivibrator (working and design). Problems, Ref. 1

4: Combinational and Sequential Circuits: **(9L)**

a. Combinational Circuits: Introduction to SOP and POS equation. Concept of Standard SOP and POS equation. Concept of K-map and their use in reduction of Boolean expressions, design of half adder, full adder, half subtract, Study of binary to gray and gray to binary code conversion. Problems. Ref. 2
b. Sequential Circuits: RS flip flop using NAND/NOR, clocked RS, D, JK and T-flip flops. Application of flip flops in Sequential Circuits as Counters and Registers. Asynchronous and Synchronous Counters. (3-bit Counter), Shift Registers and their types of operation -SISO, SIPO, PISO, PIPO (Concepts only). Ref. 2

Reference books:

1. Malvino, Electronic Principles (6th Ed.), Tata McGraw Hill, New Delhi
2. R. P. Jain, Modern Digital Electronics (3rd Ed.), Tata McGraw Hill, New Delhi
3. B. L. Theraja, Basic Electronics - Solid State, S. Chand and Company, New Delhi
4. K. R. Botkar, Integrated Circuits, Khanna Publishers, Delhi

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-365 (B): Advanced Electronics

Lectures: 36 **(Credits-02)**

(Important Note: This course is designed for the student who has offered Electronics as one of the subjects at S.Y.B.Sc. level**)**

1: Sensors: **(9L)**

Introduction to Sensors: Revision of temperature measurement and Pressure Measurement.

Motion sensors: Types of motions, Accelerometers' principles, Types of accelerometers, applications.

Optical sensors:

Photo detectors, Photo detector characteristics, photoconductive detectors, photo voltaic detectors, Photodiode detectors, photo emissive detectors.

Pyrometry: Thermal radiation, Broadband pyrometers, Narrowband pyrometers.

Optical sources: Conventional light sources, Laser light sources and principles.

Applications: Label inspection, Turbidity, Ranging.

2: Analog Signal Conditioning: **(11L)**

Introduction to analog and digital signals: Analog Multiplexer and De-Multiplexer using Ic-4051, Ideal & Practical characteristics of Low Pass, High Pass, band pass and band reject filters. 2nd order active low pass and high pass filter using op-amp. Instrumentation amplifier using 3-OP-AMP, Application of Instrumentation Amplifier as thermocouple signal conditioning. Interpretation of integrator and differentiator as low pass and high pass filters respectively.

3: Digital signal conditioning: **(10L)**

Digital Multiplexer and De-Multiplexer using NAND gate, Priority encoder using Ic-74148, Decoders: 2 to 4 decoder and 3 to 8 Decoder.

Signal Converters:

DAC: R-2R ladder type DAC, Binary weighted DAC.

ADC: Single slope ADC, Successive Approximation ADC, Flash ADC.

Data Acquisition System using 3-channels

4: Introduction to Process Control: **(6L)**

Block diagram of Process control, Process control using ON-OFF controller, Op-amp and temperature sensor, Process control using Proportional Control Logic, Definition of Process LAG, and Problems.

Reference books:

1. C.D. Johnson, Process Control Instrumentation Technology, Pearson Education, 8th edition.
2. Krishna Kant, Computer Based Industrial Control, Eastern Economic Edition
3. Rangan, Mani, Sharma, Instrument of Device System
4. B. C. Nakra, K. K. Chaudhari, Instrument measurement and analysis

PHY-356: Elective-II

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (P): Medical Electronics

Lectures: 36 **(Credits-02)**

1: Introduction: **(9L)**

1. 1 Terminology of medical instrumentation,
1.2 Physiological system of body
1.3 Sources of bioelectric signals,
1. 4 Origin of bioelectric signals,
1.5 Analysis of ECG pattern
1.6 Nernst equation
1.7 Various types of bioelectric signals,
1.8 Basic medical instrumentation system,
Problems
Ref: 1

2: Bio potential Electrodes and sensors: **(9L)**

2.1 Electrode-electrolyte interface,
2.2 Polarizable and non-polarizable electrodes,
2.3 Electrodes for ECG, EEG, EMG,
2.4 Resistive sensor
2.5 Capacitive sensor
2.6 Inductive sensor
2.7 Piezoelectric sensor
2.8 Temperature sensor
Problems
Ref: 2

3: Amplifiers and Signal Processing: **(9L)**

3.1 Introduction
3.2 Basic amplifier requirements
3.3 The Differential amplifier
3.4 Common mode rejection
3.5 Instrumentation amplifier
3.6 Isolation amplifier
3.7 Pateint safety
3.8 Cardiac monitor
Problems
Ref: 2

4: Measurements of Pressure and Volume Flow of Blood: **(9L)**

4.1 Direct measurements of blood pressure,
4.2 Indirect measurements of BP.
4.3 Heart sounds,

4.4 Phonocardiography,

5.4 Ultrasonic blood flow meter

5.5 Laser Doppler blood flow meter

Ref: 1

Reference books :

1. Handbook of Biomedical Instrumentation, R.S. Khandpur
2. Medical Instrumentation application design, John G Webster, Houghon Mifflin Co.
3. Clinical Biophysics, P. Narayanan
4. Introduction to biomedical equipment technology J. Carr and John M. Brown
5. Introduction to Biomedical Electronics, Joseph DfuBovy, Mc Graw Hill.

List of Experiments: (Any Two)

1. Measurement of BP using Mercury sphygmomanometer and digital BP monitor
2. Study of ECG machine. Gain, chart speed arrangements and positioning electrodes
3. Recording of ECG and its analysis.
4. Absorbance using calorimeter/ Absorption spectra using Spectrophotometer.
5. Pulse oximetry. Measurement of SpO2
6. Use of thermal scanner/Thermal gun
7. Study of glucometer as a sensor and measurement of BSL

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (Q): Physics of Nanomaterials

Lectures: 36 **(Credits-02)**

1: Introduction to nanomaterials: **(10 L)**

- Introduction to Nano-sized materials and Structures
- Significance of Nano-size
- Properties of Nanomaterials: Mechanical, Electrical, Thermal and Optical properties
- Classification of nanostructured materials

2: Methods for Synthesis of Nanomaterials: **(08 L)**

- Bottom-up and Top-down approaches
- Classification of Synthesis Techniques: Vapour phase and Liquid phase approach.
- Synthesis Methods: Thermal Evaporation, Sputter deposition, Colloidal method, Sol-gel Method, Chemical Vapour deposition and Electrochemical Deposition.

3: Characterization techniques: **(08 L)**

- Over view of structural characterization of nanomaterials by XRD
- Microstructural characterization and elemental analysis of nanomaterials using Scanning electron microscopy (SEM)and Energy Dispersive Spectroscopy (EDS)
- Structural characterization of nanomaterials using Transmission electron microscopy (TEM)
- Optical characterization of nanomaterials using UV- visible spectroscopy

4: Special nanomaterials: **(04 L)**

- Carbon nanotubes, their types and properties
- Quantum dots and their properties

5: Applications: **(06L)**

- Nanomaterials for application in Nano-electronics, Cosmetics, Medical, Biosensors Automobiles, Space, Sports, Cloth industry etc.
- Nanomaterials for environmental pollution monitoring and reduction etc.
- Nanomaterials for energy generation and storage

Reference books :

1. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
2. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
3. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
4. Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials College Press, London.
5. The chemistry of nanomaterials: Synthesis, properties and applications, C. N. R. Rao, A. Muller, A. K. Cheetham (Eds) Wiley VCH Verlag Gmbh& Co, Weinheim, 2004.

List of experiments: (Any Two)

1. Synthesis of metallic nanoparticles by wet chemical method.
2. Synthesis of Metal Oxide Nanoparticle using different techniques.
3. Synthesis of silver nanoparticles from silver nitrate by colloidal solution method.
4. Study of optical absorption of nanoparticles.
5. Determination of crystallite size from X-ray diffraction spectra.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (R): Microcontrollers

Lectures: 36 **(Credits-02)**

1: ARCHITECTURE OF 8051: **[10L]**

1.1 Comparison of Microprocessor and Microcontroller,

1.2 Intel 8051 Microcontroller: Block Diagram and Functions of each block, Pinout details, A and B CPU registers, Program status word (PSW) register, Program Counter, Data Pointer, Stack and Stack Pointer.

1.3 Memory Organization of 8051, Internal RAM, Register Banks, Special function registers, Internal ROM, I/O Ports and their functions, Oscillator and Clock.

2: 8051 ASSEMBLY LANGUAGE PROGRAMMING: **[16L]**

2.1 Introduction to 8051 Assembly programming, 8051 data types and assembler directives, Different Addressing modes, Concept of Unsigned and Signed numbers.

2.2 Instruction Set of 8051 microcontroller: Data Transfer instructions, Arithmetic Instructions, Logic and compare instructions, rotate instructions, Branch (Jump, Call RET) instructions.

2.3 Use of Instruction Set in Assembly Language Programming.

3: 8051 INTERRUPTS, TIMERS/COUNTERS AND SERIAL COMMUNICATION: **[10L]**

3.1 Interrupts and their vector structure, IE register, Interrupt priority in the 8051

3.2 Timers and Counters: Use of Basic Registers in Programming 8051 timers, Timer/ Counter Operation modes. Problems on Timer clock frequency and its Period.

3.3 Basics of Serial Data Communication, Types of Serial Data Communication, Concept of Baud Rate, RS 232 Standards, 8051 connection to RS 232, Functions of SBUF and SCON Registers.

Reference Books:

1. 8051 Microcontroller by Kenneth J. Ayala.
2. 8051 Microcontroller and Embedded Systems using Assembly and C by Mazidi and D Mac Kinlay, 2006 Pearson Education Low Price Edition.
3. 8051 Microcontroller – Hardware, Software and Applications by V Udayashankara, M S Mallikarjunaswamy, McGraw Hill Education (India) Pvt.Ltd, New Delhi.
4. Microprocessor and Microcontroller by R. Theagarajan, Sci Tech Publication, Chennai
5. Programming customizing the 8051 Microcontroller by Myke Predko, Tata McGraw Hill

List of Experiments : (Any Two)

Use Keil / Pinacle software for:

1. Addition of two 16 bit numbers
2. Multiplication of two 8 bit numbers.
3. Write a program to find largest/smallest number of N numbers in given block.
4. Memory block transfer from one location to another.
5. Find one's and two's complement of given number.
6. Subtraction two 8 bit numbers using two's complement method.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (S): Lasers

Lectures: 36 **(Credits-02)**

1: Introduction to Lasers: **(8 L)**

Brief history of Lasers, Interaction of radiation with matter, Energy levels, Population density, Boltzmann distribution, Stimulated Absorption, Spontaneous Emission and Stimulated Emission, Einstein's Coefficients, Einstein's relations.

Characteristics of Laser: Directionality, Mono-chromaticity, Coherence,

2: Laser Action: **(6 L)**

Population inversion, Condition for light amplification, Gain coefficient, Active medium, metastable states.

Pumping schemes: three level and four level

3: Laser Oscillator: **(6 L)**

Optical feedback, round trip gain, critical population inversion, Optical resonator, condition for steady state oscillations, cavity resonance frequencies.

4: Laser Output: **(3 L)**

Line-shape broadening: Lifetime broadening, Collision broadening

5: Types of Lasers: **(7 L)**

Solid State Lasers – Ruby Laser, Diode Laser, Gas Lasers – HeNe Laser, CO_2 Laser

6: Applications of Lasers: **(6 L)**

Industrial: welding, cutting, drilling

Nuclear Science: laser isotope separation, laser fusion,

Medical: eye surgery

Reference books :

1. An introduction to Lasers - Theory and applications, M.N. Avadhanulu, S. Chand and Co. New Delhi
2. Experiments with He-Ne Laser by Sirohi
3. Optical fibre and Laser - Principle and applications, Anuradha De, New Age International Publishers,

List of Experiments: (Any Two)

1. Determination of wavelength of He-Ne Laser by transmission grating
2. Determination of Angle of prism (Pin and drawing paper)
3. Study of Lissajous figures using diode Laser and mirrors
4. Beam divergence of a Diode Laser.
5. Determination of the diameter of a thin wire using a laser.
6. Measurement of wavelength of Laser beam using Michelson Interferometer.
7. To study the interference of light using optical fibers
8. Measurement of the focal length of a given convex lens using a laser.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-366 Elective-II (T): Astronomy and Astrophysics-II

Lectures: 36 **(Credits-02)**

1: Astronomical Scales: **(10 L)**

Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Coordinate system (only introduction)

2: The Milky Way and Universe: **(8 L)**

Basic Structure and Properties of the Milky Way, Active Galaxies, Quasars and Radio Galaxies, Hubble's law with equation, its significance, Concept of space time, fate of our universe, Multiverse (only introduction)

3: The Stellar Phenomenon: **(10 L)**

Basic Composition of Interstellar Medium, Sun: Solar Cycle, Activity, Butterfly diagram, Photospheric phenomenon, Stars as distance estimators, Hydrostatic Equilibrium of a Star, Stellar models (only introduction).

4: Non-optical Astronomy: **(8 L)**

Basic parameters of an antenna, various types of antennas. UV, IR, X-ray and Gamma ray Telescopes, Detectors for optical and infrared regions. Orbiting space based telescopes: HST, Chandra.

List of Reference Books:

1. Astronomy structure of the Universe, A. E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Structure of the Universe, J.V. Narlikar
6. Astrophysics, Baidyanath Basu.
7. Astrophysical Techniques, third Edition, C. R. Kitchin
8. Fundamentals of Astronomy, Michael Seed
9. Telescopes and techniques, C. R. Kitchin (Springer)

List of experiments: (Any Two)

1. To determine the temperature of an artificial star.
2. To observe the Fraunhofer lines in sunlight and determine the elements present.
3. To obtain the solar image on the screen and trace out the existing sunspots.
4. To locate and observe the various stars, constellation, planets. (At least 2 observation of each)
5. To polar Align an astronomical telescope.
6. To study the solar limb darkening effect.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-366 Elective-II (U): Renewable Energy Sources-II

Lectures: 36 **(Credits-02)**

1: Bioenergy and Biofuels: **(10L)**

Bioenergy:

1. Introduction to Bioenergy
2. Basic Routs: Biochemical, Thermochemical, Transesterification
3. Biochemical- Biogas generation/methanation
4. Biogas plant: Floating gas holder and fixed dome type biogas plant, construction and working
5. Factors affecting on bio-digestion (list of factors).
6. Thermochemical: Pyrolysis, Gasification, Carbonization
7. Transesterification:
8. Comparative study of floating gas holder and fixed dome type biogas plant.
9. Working of downdraft gasifier.
10. Various methods to obtain energy from biomass.

Biofuel:

1. Introduction to Biofuels
2. Production of Biofuels (Jatropa and Sugar cane bagasse)

Ref 1: 7.1, 7.2, 7.2.1, 7.2.2, 7.4, 7.5, 7.6, 7.7, 7.8, 7.11, 7.23, 7.24.1

Ref 2: 10.3 (page no 374 to 380)

2: Wind Energy **(08L)**

1. Introduction to wind energy.
2. Principles and components of wind energy conversion system.
3. Classification of wind machines: Horizontal axial machine and vertical axial machine.
4. Advantages and disadvantages of wind energy.
5. Wind data

Ref -1: 6.1, 6.2, 6.3, 6.5, 6.7, 6.8

3: Other Energy Sources: **(08L)**

1. Introduction to tidal and geothermal energy.
2. Tidal energy: methods of utilization of tidal energy.
3. Advantages and disadvantages of tidal power generation.
4. Geothermal energy: Geothermal sources and energy conversion.
5. Advantages and disadvantages of geothermal energy.
6. Introduction to Thermocell

Ref -1 (9.3), pages from 510-532),

Ref -1 (8), pages from 443, 470-476, 477) Ref -1 (11), pages from 609-657)

4: Energy Management: **(10L)**

1. Introduction to Energy Management (Definition, Principles etc)
2. Need of Energy Saving and Management
3. Different strategies of Energy Management
4. Role of Energy Managers and Auditors,

5. Energy Audit Measurements and Instruments, and Preparation of Energy Audit Report (in brief).
6. Case studies of Energy Audit & Management (e.g. Industries & Green Buildings, Boilers, Furnaces, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery, Electric motors, Pumping systems, Fans and blowers, Cooling Towers,
   Industrial/Commercial Lighting system, BEE Star rated equipment) any one.

Ref- 4 to 12 - Use any book for reference

Reference books:

1. Non-conventional Energy Sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc Graw Hill Ltd, New Delhi.
3. Solar Energy Utilisation**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
5. Energy Management Principles: C.B.Smith (Pergamon Press).
6. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
7. Energy Economics -A.V.Desai (Wieley Eastern)
8. Industrial Energy Conservation: D.A. Reay (Pergammon Press)
9. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Inter science publication)
10. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
11. Hand book of Energy Audit by Sonal Desai (Publisher Tata McGraw Hill.)
12. Energy Management and Conservation Handbook, Frank Kreith and Yogi Goswami, (CRC Press)

List of Experiments: (Any Two)

1. Fuel value of wood/charcoal.
2. Study of sensible heat storage using liquid.
3. Selective and Non-selective coatings – Determination of Selectivity ratio.
4. To do energy audit of home/society/college/industry and prepare a detail audit report.
5. Study and analysis of home Electricity Bill
6. Study of Power consumption of conventional tube light vs LED fitting

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (V): Acoustics-II

Lectures: 36 **(Credits-02)**

1: Microphones:

Carbon, Moving Coil and Condenser microphones: construction, equivalent circuit, expression for sensitivity (no derivation), constant pressure frequency response and sensitivity related problem-solving (6L)

2: Loudspeakers:

Direct radiator loudspeaker: construction, equivalent circuit, expression for efficiency (no derivation), acoustic power radiated; problem-solving relating to efficiency and acoustic power; Woofer, tweeter and squawker; Bass-reflex cabinet; Horn Loudspeakers: types, wave equation, cut-off frequency, folded horns, problem-solving relating to exponential horns and cut-off frequency (8L)

3: Sound systems, Recording and Reproduction:

Amplifier power specifications for auditoria: Power required for various applications, expression for power calculation; problem-solving related to power; Audio file formats: Lossy compressed (MP3, WMA), uncompressed (WAV, AIFF, AU); Dynamic range; Volume compressors, expanders, and limiters; Graphic equalizer; Monophonic and Stereophonic sound reproducing systems; Dolby Noise Reduction, Dolby Atmos (12L)

4: Environmental Acoustics:

Community noise criteria: Highway noise, aircraft flyover noise, sonic boom; Weighted sound levels: A-weighted sound level, C-weighting, Phon, Sone, Noise induced hearing loss: Trauma and chronic Hearing aids (6L)

5: Ultrasound: Ultrasound Transducers, Medical Ultrasound, Ultrasonography, Distance Measurement, NDT (4L)

Reference Books:

1. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
2. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
3. Acoustics, W.W. Seto, Schaum's Outline Series, McGraw Hill 1970
4. Handbook of Sound Engineers, G.M. Ballou, Academic Press
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Design for good Acoustics and Noise Control, J.E. Moore, Univ. Press
7. Consumer Electronics, S. P. Bali
8. Modern Electronics, A. B. Gupta, Books and Allied (P) Ltd

List of experiments (Any two):

1. Polar response of a microphone
2. Speaker response of a direct radiator loudspeaker
3. Graphic equalizer
4. Acoustic power of direct radiator loudspeaker using hemispherical array
5. Distance measurement using ultrasound transducer

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-367: Physics Laboratory-4A

Lectures: 36 **(Credits-02)**

(General Physics, Thermodynamics and Statistical Physics, Nuclear Physics and Quantum Mechanics)

(Any Eight)

GROUP-I: GENERAL PHYSICS (any FOUR)

1. Surface Tension of Mercury by method of Ripples.
2. Viscosity of Liquid by rotating cylinder method.
3. Coefficient of sound absorption
4. 'Y' by Cornu's Method
5. Hall Effect: To measure the Hall coefficient
6. Energy gap of a semiconductor
7. Study of XRD spectrum of any material.
8. Resistivity by Four probe method
9. Platinum resistance thermometer

GROUP-II: THERMODYNAMICS AND STATISTICAL PHYSICS (any TWO)

1. Determination of pressure coefficient of air by constant volume thermometer.
2. Verification of Stefan's fourth power law by bulb filament
3. Thermal conductivity by Forbes Method.
4. Thermal conductivity of rubber tube.
5. Thermal diffusivity of Brass.
6. Thermal and Electrical conductivity of Cu.

GROUP-III: NUCLEAR PHYSICS AND QUANTUM MECHANICS (any TWO)

1. Characteristics of G.M. tube
2. Inverse square law (γ-rays)
3. e/m by Thomson method
4. Determination of Planck's constant
5. Study of Gaussian distribution by G. M. tube.

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-368: Physics Laboratory-4B

Lectures: 36 **(Credits-02)**

(Electronics (Essential) or Advanced Electronics, acoustics and Lasers, Optional Courses)

(Any Eight)

GROUP-I: ELECTRONICS (ESSENTIAL) (any TWO)

(For the students not offering advance electronics in theory courses)

1. Characteristics of JFET
2. Design and built astable multivibrator using IC 555/IC 741
3. Half adder /Full adder
4. Integrator and differentiator using IC 741
5. IC 723 as regulated power supply

GROUP-I: ADVANCED ELECTRONICS (any TWO)

(For the students offering advance electronics in theory courses)

1. Instrumental amplifier using three op-amps
2. Temperature controller using PT 100 / thermocouple /thermistor temperature sensors
3. Object counter (two digit)
4. Schmitt trigger
5. Study of LVDT

GROUP-II: ACOUSTICS AND LASERS (any FOUR)

1. Frequency response of loudspeaker (twitter, woofer, mid-range)
2. Study of interference by Quinck's method
3. Use of Ultrasonic interferometer to measure velocity of sound in liquids
4. Transmission loss using expansion chamber muffler.
5. Study of diffraction using a transmission/reflection grating (metal ruler)
6. Study of the characteristics of a laser beam.
7. Determination of the diameter of a thin wire using a laser beam.
8. 'μ' By total internal reflection of light

GROUP-III: PRACTICAL FROM OPTIONAL COURSE (Any-2)

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)

  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-369: Physics Project-II

Lectures: 36 **(Credits-02)**

Guidelines:

It is expected that,

1. The student does work equivalent to about 10 laboratory experiments throughout the semesters in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the presentation of the final report at the time of viva voce.
6. The viva voce should be conducted at the time of evaluation of project work at least for twenty minutes per student. Extra care must be taken in the evaluation of projects done in a pair or group. Delegation of the work done by individuals must be sought from the students in such cases.
7. Any ready-made material used in the report (such as downloaded pages from the web) must be clearly referred to and acknowledged.
8. It is also recommended that a teacher will look after 4 projects at one time.
9. Any non-adherence to this norm should attract a penalty by way of deduction in the marks awarded to a student. It is recommended that the College will provide consumables/contingencies for every project, to the tune of Rs. 750 /- each. (*If the students paid extra fee other than laboratory fee then college will provide financial assistance for the Project work.)

The Project work shall consist of the following Criterions.

1) Working model (Experimental or Concept based simulation/Demonstration Related to Physics).
2) Understanding of the project.
3) Experimental Details.
4) Data collection and Data Analysis.
5) Innovation.
6) Outcomes/Result.
7) Conclusion.

Note: At the time of project practical examination, the candidate must submit the certified project report by the project in-charge and HOD. A candidate will be allowed to appear for the Project practical examination only if the candidate submits a project completion report duly certified by the project in-charge and Head of the department.

The Project work shall include:

Models based / Demonstrated Applications / Review articles / Simulation on PC on any concept in Physics / Comparative & differentiative study / Improvement in the existing experiment (Design and fabrication concept) / Extension of any regular experiments / Attempt to make experiment open-ended / Thorough survey of existing active components / devices, ICs, methods, means, technologies, generations, applications etc. / any innovative projects using the concept of Physics / Interdisciplinary areas.

Evaluation weightage:

- Semester End University Examination : 35 Marks
- Internal Examination: 15 Marks

Skill Enhancement Courses

Skill Enhancement Courses (SEC)

a) Selection of Skill enhancement courses

There are two skill enhancement courses (SEC) in 6th semester (PHY-3610 and PHY-3611). For 6th semester, there are four options available. The college has to select any one from the given four options. It is advised that college should not offer elective and skill enhancement course of same theme.

b) Teaching Learning process for Skill Enhancement Courses

Skill base courses are intended to explore the applications of physics knowledge. Learning in skill enhancement courses is largely experience based. The skill enhancement courses may be categorized as knowledge skill or technical skill. For knowledge skill courses one can use the conventional method for teaching along with problem solving, assignments seminars etc. For acquiring the technical skill, the students will get adequate 'hands-on' experience. The teachers may use demonstrations and activity-based learning techniques. On field visits, study tour and mini projects will enrich the learning experience of the students.

c) Assessment methods for skill enhancement courses

Continuous evaluation will be the best method for assessment of skill enhancement courses.

One can use tools like assignments, mini projects or activities, problems, etc and grade the students according to their performance. The internal assessment should have 50 % weightage.

The University examination may be conducted for the remaining 50%.

The University examination question paper should have adequate proportion of objective and subjective question.

d) List of Skill Enhancement Courses:

Semester-VIth	**Semester-VIth**
PHY-3610	**PHY-3611**
PHY-3610(W): Scientific Data Analysis using Python	PHY-3611(AA): Microcontrollers
PHY-3610(X): Solar PV System: Installation, Repairing and Maintenance	PHY-3611(AB): Instrumentation for Agriculture
PHY-3610(Y): Applications of Internet of things (IOT)	PHY-3611(AC): Radiation Physics
PHY-3610(Z): Calibration Techniques	PHY-3611(AD): Photography

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (W): Scientific Data Analysis using Python

Lectures: 36 **(Credits-02)**

Pre-requisite	: Basic knowledge of computer programming (Python/c)
Mode of internal Assessment	: A small project analysing scientific data for visualization
Data sets may include	: Pollution Data, Rain data, Astronomical data, any scientific data Related to Physics or science in general
Sources of Data sets	: MERI, Nashik, AIUCAA Pune, NASA or similar 1. Website for competition: https://www.kaggle.com/ 2. Google dataset: https://datasetsearch.research.google.com/ 3. Data for visualization and dataset resources: https://dev.to/aspittel/my-favorite-data-visualization-and-dataset-resources-35kp Other potentially useful searches: 1. https://bigdata-madesimple.com/70-amazing-and-free-data-sources-for-data-visualization/ 2. https://eduinpro.com/blog/data-sets-for-data-visualization-projects-datascience/

Learn how to analyses data using Python. This course will take you from the basics of Python to exploring many different types of data. You will learn how to prepare data for analysis, perform simple statistical analyses, create meaningful data visualizations, predict future trends from data, and more

Student will learn how to:

- Import data sets, access different elements of data frames.
- Understand the functions available in existing Python modules.
- Understand the utility of functions available in NumPy and Pandas library.
- Clean and prepare data for analysis
- Manipulate pandas Data Frame
- Understand awareness with different types of basic charts and functions in matplotlib library
- Get exposure to visualization techniques from seaborn library
- Build data pipelines

  Data Analysis with Python is delivered through lecture, hands-on labs, and assignments. It includes following parts:
- Data Analysis libraries: will learn to use Pandas Data Frames, Numpy multi-dimensional arrays, and SciPy libraries to work with a various datasets. We will introduce you to pandas, an open-source library, and we will use it to load, manipulate, analyze, and visualize cool datasets. Then we will introduce you to another open-source library, scikit-learn, and we will use some of its machine learning algorithms to build smart models and make cool predictions.

Outcome of the course

- Know basic notions and definitions in data analysis.
- Know standard methods of data analysis and information retrieval.
- Be able to formulate the problem of knowledge extraction as combinations of data filtration, analysis and exploration methods.
- Be able to translate a real-world problem into mathematical terms.

Syllabus:

Unit No.	Topics	Lectures
I	**Data Structures, modules and Importing Datasets** Lists: Creating list, accessing list elements, functions for lists, programming with lists Tuples: Creating Tuples, accessing list elements, functions for Tuples, programming with Tuples Dictionary: Creating Dictionary, accessing list elements, functions for Dictionary, programming with Dictionary. In Built modules : Math module, random Module, Array module, string Module etc	6
II	**Core libraries in Python** NumPy Library for Arrays Pandas Library for Data Processing Basics of data frames, create, adding/ deleting of rows, columns to data frames Import of data, functions of data frames Data Normalization Sets, data extraction using relational, logical operators. Group by functionality, missing values	6
III	**Summarizing the Data Frame and visualization** Matplotlib Library for visualization: Pie chart, violin plot, scatter plot, histogram, bar chart, area plot. Seaborn Library for Visualization: Box plot, point plot, line plot, count plot, bar plot, strip plot, scatter plot and Regression Plot	6

Activity: Hands on data Analysis and Visualization with Pandas [18L]

Note: For Internal assessment students will either do 8 activities related to data analysis and visualization on particular dataset or will carry out small project on analysis or visualization using science (preferably physics) related dataset.

Reference Books:

- Python Programming: Using Problem Solving Approach- Reema Thareja.
- Let us Python - Aditya Kanetkar
- Learning with Pythob - Allen Downey
- Data Analytics - Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (X): Solar PV System: Installation, Repairing and Maintenance

Lectures: 36 **(Credits-02)**

Objectives:

1. In this skill oriented course, student will study basics of solar photovoltaic (PV) cells, modules, and system components.
2. Design and sizing of off-grid PV system for homes, apartments as well as commercial offices.
3. Understanding energy conversion from sunlight to electricity, and working with solar conversion equipment.
4. This Course will hands on experience needed to become self-employed.

Outcomes:

1. Learn basics of light conversion in electricity.
2. Hands on training will motivate to use Solar PV system.
3. Become entrepreneur / self-employed.
4. Analyzed of MSEB electricity bill and design and sizing of off-grid PV system
5. Participants will learn about solar PV module and batteries used in solar PV plant.

Syllabus:

Unit-1: Introduction **(6L)**

The Sun, Earth, and Renewable Energy, Photovoltaic Effect, Working of Solar cell, Types of Solar cell, PV Modules and Arrays, Module Parameters, Sunshine and Shadow, tracking mechanism, Aligning the Array.

Unit-2: Solar Radiations and Measurement **(6L)**

Introduction, Solar Constant, Solar Radiation at the Earth Surface, Need of Solar Radiation Measurement, Instruments For The Measurement of Solar Radiation, Pyrheliometer, Pyranometer, Sunshine Recorder, Sun Meter or Lux Meter

Unit-3: Basics Solar PV Systems **(6L)**

Basics types of PV Systems On grid and off grid, DC to AC Conversion, Building-integrated Photovoltaics, Engineering and Architecture, Balancing of PV system. System Components, Batteries, Charge Controllers, Inverters, Hybrid Systems, System Sizing, Applications of off grid PV System.

Activity: **(18L)**

1. Estimate the value of the Solar Constant.
2. Study of intensity variation on the performance of PV module.
3. Study of series and parallel combination of the PV modules.
4. Measurement of Solar radiation measurement using Sunmeter and Pyranometer.
5. Analysis of MSEB electricity bill.
6. Energy Farm/PV Plant visit report.

Reference books:

1. Solar Energy, S.P. Sukhatme (second edition), Tata Mc.Graw Hill Ltd, New Delhi.
2. Solar Energy Utilisation, G. D. RAI (5th edition), Khanna Publishers,Delhi.
3. Electricity from Sunlight, An Introduction to Photovoltaics, Paul A. Lynn, John Wiley & Sons, Ltd.
4. Solar Electricity, 2nd edition, T. Markvart, John Wiley & Sons, Ltd.
5. Solar Photovoltaic Basics, White Sean, Taylor & Francis Ltd.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (Y): Applications of Internet of Things (IOT)

Lectures: 36 **(Credits-02)**

Objectives:

- To introduce the terminology, technology and its applications
- To introduce the concept of M2M (machine to machine) with necessary protocols
- To introduce the C# Language which is used in many IoT devices
- To introduce the Raspberry PI platform, that is widely used in IoT applications
- To introduce the implementation of web based services on IoT devices

Learning Outcomes :

a) IOT concepts
b) IOT Standards
c) Components of IOT System.
d) Relevance of IOT for the future.
e) IOT Applications.
f) IOT for smart cities (Case study Smart city Barcelona)
g) IOT in Indian Scenario
h) Challenges in IOT implementation.

This subject does not have the intention of being a comprehensive course about the technologies involved in IOT. The focus will be more on the possibilities offered by the different technologies, and on the creative thinking techniques to find innovative applications of combinations of such technologies in real-life scenarios. Some presentations will also be scheduled in which people from industry will make presentations about selected topics related to the IoT. The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The course will focus on creative thinking and on hands-on project development. The duration of the course is 30 hours. Will be a mix of 75 minutes session and 2 hours session. Lab will be for 5 hours.

Future Scope:

It is a system of interrelated computing devices, digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Internet of Things

What Internet of Things can do?

3. Medical Check-up Health Devices Operational Efficiency Medical Report Health Sector
4. Advanced Kitchen Automatic Parking Remote Home Control Security System Smart Home
5. Wi-Fi Connectivity Traffic Control Security System Advanced Parking System Smart City
6. Advanced Power Supply Manufacturing Bill Payment Planning Industrial Automation
7. Let's Take an Example of Internet of Things

● Renewal Energy Source. ● Automatic wearing suit. ● Next Gen way to fly. ● Speech Recognition. ● Perfect example of AI. ● Advanced GPS.

Syllabus:

Unit-1: Introduction to Internet of Things **[4L]**

Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols,

Unit-2: IOT Concepts and introduction **[5L]**

i) Technologies that led to evolution of IOT
ii) IOT and SCADA
iii) IOT and M2M
iv) IOT and Big Data
v) Requirement of international standard (case study)
vi) IOT standards in practice.
vii) Operating platforms /systems

Unit-3: IOT Applications. **[4L]**

i) Lighting as a service (case study)
ii) Intelligent Traffic systems (case study)
iii) Smart Parking (case study)
iv) Smart water management (case study)
vi) IOT in Indian Scenario

Unit-4: Introduction to C# **[5L]**

Language features, commands , functions of C#, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling.

Activity: Case Studies (Any two) **[18 L]**

i) Lighting as a service (case study)
ii) Intelligent Traffic systems (case study)
iii) Smart Parking (case study)
iv) Smart water management (case study)
v) IoT for smart cities (Case study Smart city Barcelona)

Reference books:

1. Internet of Things – A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World Paperback – 26 March 2015 by Michael Miller.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3610 SEC (Z): Calibration Techniques

Lectures: 36 **(Credits-02)**

Objective:

- To make students familiar with the constructions and working principle of different types of Instruments
- To make students aware about the measuring instruments and Calibration of Instrument

Course Outcomes: At the end of the course, a student will be able to:

- Calibrate hydraulic, pneumatic and mechanical measuring and control equipment: setting, adjustment, validation or verification of mechanical, pneumatic, hydraulic, measuring and control instruments using reference standards in accordance with predetermined procedures.
- Calibrate electrical and electronic measuring and control equipment: setting, adjustment, validation or verification of electrical, electronic measuring and control instruments using reference standards in accordance with predetermined procedures.
- Carryout maintenance activities on instrumentation and control panel.

Syllabus:

Unit-1: Principles of Calibration [4 L]

1. Introduction and Importance of Calibration
2. Traceability in Calibration
3. Calibration Uncertainty
4. Various Calibration Methods
5. Factors Affect Calibration
6. Instrument Classification and Instrument Identification

Unit-2: Pressure Calibration [6L]

1. Introduction to pressure calibration
2. Pressure unit conversion standards
3. Types of Pressure Gauges
4. Calibration of Pressure Gauges
   a. Accuracy
   b. Pressure Media
   c. Contamination
   d. Height Difference
   e. Leak test of Piping
   f. Adiabatic Effect
   g. Torque Force
   h. Calibration Position
   i. Generating Pressure
   j. Pressurizing the Gauge
   k. Reading the Pressure Value
   l. Number of Calibration Points
   m. Hysteresis (deviation of calibration points)
   n. Number of Calibration cycles
5. Instruments required for calibration:
   a. Pressure comparator
   b. Master Gauge
6. Pressure Calibration with Example

Unit-3: Calibration of Electronic Instruments [4L]

1. Identification of Components
2. Equipment required for calibration
3. Procedure of Calibration
   a. Read operational Specifications
   b. Sequence of events
   c. Identification of common Faults
4. Electronic Calibration with Examples (Oscilloscopes, Multimeters, Function Generators, Signal Generators)

Unit-4: Temperature Calibration [4L]

1. Temperature units and Conversions
2. Temperature Sensors
3. Calibration of temperature sensors
   a. Handling temperature sensor
   b. Preparations
   c. Temperature sources
   d. Reference Temperature Sensor
   e. Immersion Depth
   f. Stabilization
   g. Temperature sensor handle
   h. Calibrated temperature range
   i. Calibration Points
   j. Adjusting/trimming a temperature sensor
4. Examples:

Activity: Any-6 [18L]

Calibration of a dial thermometer

1) RTD calibration check
2) Temperature controller loop
3) Calibration of pressure Transmitters
4) Calibration of pressure switch
5) Level calibration Instrument
6) Liquid head measurement
7) Calibrating a differential pressure level transmitter
8) Calibration of top pan balance
9) Calibration of digital balance
10) Calibration of PH/Conductivity meter
11) Calibration of Volt meter
12) Calibration of Current meter
13) Calibration of Oscilloscopes
14) Calibration of Function Generators

Reference Books :

1) **Calibration:** A Technician's Guide - Mike Cable
2) Measurement and Control Basics -Thomas A. Hughes
3) Measurement and Control of Liquid Level - Chun H. Cho
4) A Practical Book On Calibration Of Analytical Instruments - Dr S Jain ,
5) Calibration Handbook of Measuring Instruments - Alessandro Brunelli

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AA): Microcontroller

Lectures: 36 **(Credits-02)**

Objective:

- To make students familiar with the constructions and working principle of microprocessor
- To make students aware about microprocessor

Outcome: After successful completion of this course students are supposed to develop their own applications/ mini/ tiny projects using microcontroller.

Syllabus:

Unit-1. ARCHITECTURE OF 8051: **[05]**

Microprocessor and Microcontrollers a short comparison, Overview of the 8051 family, Block diagram of Microcontroller, Functions of each block, Pin details of 8051, A and B CPU registers, Flags and Program status word (PSW), Program Counter (PC) and Data Pointer register (DPTR), Internal RAM, Stack and Stack Pointer, Special function registers, Memory Organization of 8051, Internal ROM, I/O Ports, Oscillator and Clock

Unit-2. 8051 ASSEMBLY LANGUAGE PROGRAMMING: **[05]**

Introduction to 8051 Assembly programming, Assembling and running an 8051 program, 8051 data types and directives, Jump, loop, and call instructions, 8051 I/O programming, Addressing modes, arithmetic and logical instructions and programs, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instructions, BCD, ASCII, and other application programs.

Unit-3. Timers/ Counters and Interrupt programming: **[04]**

Timers of 8051, TMOD and TCON registers, Programming timers 0 and 1 in 8051, counter programming**,** 8051 interrupts, Interrupt priority in the 8051, and Application programs using interrupts.

Unit-4. INTERFACING TECHNIQUES **[04]**

Key/ keyboard (push button) interfacing, interfacing a LCD display, interfacing an ADC and LM35 temperature sensor.

Activity: any-3 **[18L]**

1. Use of Kiel/ Pinnacle/AVR (Atmel processor family) Studio/IDE (Integrated development environment) or any other suitable IDE.
2. Use of IDE/Software the students are supposed to run basic programs of their own. (Arithmetic, logical, Data manipulation, Data transfer/I-O Port related etc.)
3. Single key / Keyboard Interfacing.
4. ADC/DAC Interfacing.
5. Mini Project (Water level controller, Electronic Thermometer etc.)

Reference Books:

1. 8051 Microcontroller by Kenneth J. Ayala.
2. 8051 Microcontroller and Embedded Systems using Assembly and C - Mazidi, Mazidi and D MacKinlay, 2006 Pearson Education Low Price Edition.
3. Microprocessor and Microcontroller by R.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AB): Instrumentation for Agriculture

Lectures: 36 **(Credits-02)**

Objectives:

After completion of this course students can

1. Get knowledge of sensors used in agriculture field
2. Learn continuous and batch process
3. Learn greenhouse automation schemes
4. Learn Instrumentation in Irrigation

Course Outcomes:

After completion of this course student will

1. Able to test soil and water parameters.
2. Able to develop their own juice extract plant.
3. Able to developed their own green house

Syllabus:

Unit-1: Introduction **[02L]**

Necessity of instrumentation and control for agriculture, sensor requirement, remote sensing, bio sensors in agriculture.

Unit-2: Soil Properties & Sensing **[04L]**

Properties of soil: fundamentals definitions and relationship, index properties of soil, permeability & seepage analysis, shear strength, Mohr's circle of stress, active & passive earth pressures, stability & slopes,

Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples, open & close path gas analyzers

Unit-3: Instrumentation in Continuous & Batch process **[04L]**

Flow diagram of sugar plant, sensors & instrumentation setup, Flow diagram of fermenter & control (batch process), flow diagram of dairy industry & instrumentation setup for it, Juice extraction control process & instrumentation setup.

Unit-4: Instrumentation in Irrigation **[04L]**

Water distribution and management control, Auto drip and sprinkler irrigation system, upstream & downstream control concept, SCADA for DAM parameters &control.

Unit-5: Greenhouse Parameters & Instrumentation **[04L]**

Greenhouse effect, Concept and construction of greenhouse, merits & demerits, ventilation, cooling & heating, wind speed, temperature & humidity, soil moisture, rain gauge, carbon dioxide enrichment measurement & control, Leaf area length *evapotranspiration*, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis.

Activity : any-6 **[18L]**

1) Measurement of water holding capacity of soil.
2) Measurement of soil texture.
3) Measurement of moisture contain in soil.
4) Micronutrients analysis of soil.
5) Measurement of physical properties of soil. (Color, odder, texture etc.)
6) Measurement of Chemical properties of soil (pH, chloride, Oxygen, Sulphur etc. contain in soil)
7) Measurement of Biological properties of soil (Fungi, Bacteria)
8) Air quality measurement.

9) Analysis of Residues in fruits.
10) Visit to green house.
11) Visit to Sugar industry/Juice extract plant/ dairy industry

Reference books:

1. Industrial instrumentation, "Patranabis", TMH.
2. Instrumentation handbook-process control, "B.G. Liptak", Chilton.
3. Process control and instrumentation technology, "C.D. Johnson", PHI
4. Wills B.A., " Mineral Processing Technology", 4th Ed., Pergamon Press
5. Principle of Farm Machinery, R.A Kepner, Roy Bainer;: CBS Publication
6. Agricultural Engineering; Radhey Lal: Saroj Publication
7. Environmental Engineering, Peary. II. S. and others

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AC): Radiation Physics

Lectures: 36 **(Credits-02)**

Course Objectives:

1. Students should understand the mechanism of interaction of various types of radiations with matter.
2. Students should get acquainted with principles of Measurement radiation levels, design principles and and actual implementation of variety of radiation detectors.
3. Students should learn about standards regarding safety levels laid down by National and International agencies, methods adapted to maintain safety standards in various places and methods of shielding.
4. Students should study the applications of radiations in various fields.

Course outcomes:

1. Students can use the knowledge in the applications of Radiation Physics in the fields like radio carbon dating, medical diagnostic tools.
2. Students acquire skill in operating different types of radiation detectors to detect and measure radiation levels in different places.
3. Students can work as advisers in maintenance of radiation safety standards and following of strict protocols at various places like Hospitals, Industry, and Laboratories etc.
4. Students become able to employ their skills to develop applications of radio activity in the fields like agriculture, industry, hospitals etc.

Syllabus:

Unit No.	Title and Contents	Lectures
I	**Interaction of Radiation with Matter** Interaction of different types of radiation with matter-Ionizing & Nonionizing radiations, excitation, ionization, radioactive losses-Energy loss by collision, range energy relation, Bethe-Bloch formula collision stopping power, radiation stopping power, Straggling.	3
II	**Radiation Detectors** Characteristic curve of Gas-filled detectors. Ionization chamber, Proportional counter, Gas filled detectors (G. M. counter), Characteristics of organic and inorganic scintillation detectors, Scintillator detector, Semiconductor detector.	3
III	**Radiation units and Measurement of radiation exposure** Units for radiation exposure- Roentgen, Becquerel, Gray, Sievert, RAD, REM, KERMA. Radiation exposure, Absorbed Dose, Equivalent Dose, Effective Dose, Ambient and directional equivalent dose, Relative biological effective dose, Quality factor, Personal dosimeters, Film badge dosimeters, Thermo luminescent dosimeter.	3
IV	**Radiation Sources and Radiation Shielding** Natural & Artificial radioactive sources, Alpha, Beta, Gamma Sources, Basic concept of radiation shielding, linear and mass absorption coefficient, stopping power, materials for shielding of gamma and neutron, shielding interaction cross section.	3

V	**Radiation Protection:** Time, Distance, Shielding, Radiation Protection and Safety rules as per the regulatory guidelines of the Government of India, Safety codes for handling radioactive sources. Monitoring of radiation levels around an open radioactive source, ICRP, NCRP, AERB recommended limit.	3
VI	**Radiation Applications:** Radioactive pharmaceuticals and labelled compounds. Radioactive nuclei used in diagnostic applications. Applications of gamma-rays in sterilization of medical instruments, medication items and preservation of food.	3

Activity: any-6 [18L]

1. Study the different types of radio isotopes and their applications in medical field.
2. Study use of isotopes in radiocarbon dating.
3. Study of working of G. M. Counter.
4. Study of G. M. Counter characteristics – Dead Time and End point energy.
5. Study of commercially available portable, handy radiation detectors.
6. Survey of various places to measure radiation levels
7. Visit to hospitals and other such locations for measuring radiation exposure.
8. Visit to industrial areas to measure radiation exposure levels
9. Study of various shielding materials and their stopping power.
10. Study of dependence of radiation stopping power of materials on physical properties of materials
11. Study of protocols followed by various units to follow safety measures
12. Visit to food industry using preservation techniques using nuclear radiations.
13. Visit to pharmacy industry producing radioactive compounds.
14. Visit to diagnostic centres which employ radiation sources

Reference books:

1. Nuclear and Radiation Physics in Medicine. Tony Key. World Scientific. 2014
2. Introduction to Radiological Physics and Radiation dosimetry. Frank H. Attix. Wiley. 1986
3. Medical Physics by Glasser O, Vol 1, 2, 3 Year Book Publisher Inc Chicago.
4. Radiation Protection and Health Science. Marilyn E. Noz. World Scientific. 2007.
5. Introduction to Radiation Protection. Grupen C. Springer. 2008.
6. Radiation Physics for Medical Physicists. Podgorsak Ervin B. Springer. 2005.
7. Techniques for Nuclear and Particle Physics experiments. Leo. W. R. Springer. 2005.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AD): Photography

Lectures: 36 **(Credits-02)**

Objectives:

- To create general awareness and interest in photography process.
- To make students familiar with the Photographic equipment and handling techniques.
- To help students to learn basic photographic and image processing skills.

Course Outcomes: After successful completion of this course, student will be able to

- Understand the basic principle, structure and handling techniques in digital photography.
- Students will be able to develop and apply photographic skills using digital photography tools including digital editing, saving, sizing, and posting of the images
- Student gets proficient at the technical aspect of photographing with a digital camera.
- Students can identify and apply appropriate business practices specific to the self-employed professional photographer

Syllabus:

Unit No.	Topics	Lectures
I	**Introduction of Photography:** **Introduction:** History & Development of photography, Principles, functions and structure of camera, Indoor and outdoor lighting techniques; Background selection; Flash and its features. Black & White v/s Digital camera (Limitation & advantages) **Types of Camera:** Pinhole camera, Box camera, SLR camera, Studio camera, Digital camera.	6
II	**Camera Control and Exposure:** **Camera Controls:** Need for camera controls. Apertures, Depth of field and depth of focus. Shutters (Ideal, leaf and focal plane shutter). Shutter speed (slow and fast). Auto focus, Manual focus and Image stabilization **Camera lenses & Exposure:** Normal, Wide angle, Telephoto and Zoom range, Incident and reflected light, Exposure triangle, Exposure and equivalent exposures, Brief idea of exposure meter (TTL and Flash meter).	6
III	**Colour Theory & Digital Camera:** **Colour Theory:** Classification and use of colours in photography, Construction of colour enlarger, Colour Head, sources of light and filters used in a colour enlarger **Digital Camera:** Types of Digital Camera and its features, Memory Chip card, Creative shots, Settings in the Digital Camera - Handling methods; White balance, Maintenance of camera. Digital camera sensors and its types.	6

Activity: any-6 (Practical/Demonstration) **[18L]**

Sr No	List of Practical's
1	To study the effect of aperture on depth of field
2	To study and recognize the use of slow and fast shutter speed
3	To study the effect of Exposure for different colour temperatures
4	To identify and determine the focal length of the different types of lenses
5	To study the Image Mixing, Image Cutting and Text Building Effect
6	To study Blurr Effect and Transformation Tools
7	To understand the effect of clip mask, photo filter and stamping Tool
8	To study the effect of natural light, tungsten light and fluorescent light on Photograph.
9	Lighting for still life (Earthen ware, Metal ware, Glass ware, Fruits, Crockery, Jewelry, Flowers, Food etc.)
10	Indoor shooting using three point lighting set up
11	Image processing 1: (Light room techniques 1): Brightness, saturation etc
12	Image processing 2: (Light room techniques 2): Exporting, contact sheet, print
13	Nature photography
14	Wild life photography
15	Night photography
16	Event Photography
17	News photography and preparing a photo story
18	Cover page design for a magazine

Reference books:

1. Basic Photography- M.J. Langford, Focal Press.
2. The basic book of Photography – Fifth edition – by Tom Gri
3. Beginner's guide to photographic lighting: Techniques studio or on Location-Dom Marr
4. Photography its principles & practice: A manual of the photography – Carroll.
5. Photography for the 21st century by Katic Millar
6. Advanced Photography (Vol.-I & Vol.-II) - M.J. Langford, Focal Press.
7. Applied Photographic Optics- Sidney F. Ray; Focal Press
8. The Practical Guide to Photographic Lighting, John Tarrant, Focal Press

Savitribai Phule Pune University, Pune
T.Y.B.Sc. Chemistry Syllabus

To be implemented from June 2015
(Academic Year 2015-16)
Preamble of the Course

1. T.Y.B.Sc. Chemistry is consisting of six theory and three practical courses.
2. Each theory course is of 48 lectures; 4 lectures per course per week should be conducted in every semester.

3. Out of five optional courses recommended for CH-336 and CH-346, only one option should be taught and the same course should be implemented for the next semester.

4. Each practical course is of 4 lectures per week per batch. Practical batch for each course should comprise of 12 students only.

5. Each theory paper will carry 50 Marks out of which 10 Marks will be allotted for Internal assessment and University Examination will be conducted for 40 Marks at the end of each semester.

6. The practical examination of six hours for each practical course will be conducted at the end of Semester-IV. Each practical course will carry 100 Marks out of which 20 Marks will be allotted for Internal assessment and University Examination will be conducted for 80 Marks.

7. **Marks for internal assessment of Practical courses will be allotted as follows.**
   a. Completed and Certified journal and regularity of the student 10 Marks
   b. Oral Examination and Internal Test 10 Marks

8. Internal assessment for theory courses will be done on the basis of the performance of the student in tests. Minimum two tests should be arranged for each course in a Semester.

9. Visit to a chemical industry may be organized during the academic year.

Savitribai Phule Pune University
Board of Studies in Chemistry
T.Y.B.Sc. Chemistry Syllabus

Structure to be implemented from June 2015 (i.e. from Academic Year 2015-16)

Semester	Course Code and Title	Number of Lectures	Marks
Semester III	CH-331: Physical Chemistry	48	50
	CH-332: Inorganic Chemistry	48	50
	CH-333: Organic Chemistry	48	50
	CH-334: Analytical Chemistry	48	50
	CH-335: Industrial Chemistry	48	50
	OPTIONAL COURSE CH-336-A Nuclear Chemistry**OR** CH-336-B Polymer Chemistry**OR** CH-336-C Introduction to Biochemistry and Molecular Biology **OR** CH-336-D Environmental and Green Chemistry**OR** CH-336-E Agriculture Chemistry	48	50
Semester IV	CH-341: Physical Chemistry	48	50
	CH-342: Inorganic Chemistry	48	50
	CH-343: Organic Chemistry	48	50
	CH-344: Analytical Chemistry	48	50
	CH-345: Industrial Chemistry	48	50
	OPTIONAL COURSE CH-346-A Nuclear Chemistry**OR** CH-346-B Polymer Chemistry**OR** CH-346-C Introduction to Biochemistry and Molecular Biology **OR** CH-346-D Environmental and Green Chemistry**OR** CH-346-E Dairy Chemistry	48	50
	PRACTICAL COURSES		
	CH-347: Physical Chemistry Practicals		100
	CH-348: Inorganic Chemistry Practicals		100
	CH-349: Organic Chemistry Practicals		100

NOTE

1. Each theory paper will carry 50 Marks out of which 10 Marks will be allotted forinternal assessment and University Examination will be conducted for 40 Marks atthe end of each semester.

2. The practical examination will be conducted at the end of Semester-IV. Each practicalcourse will carry 100 Marks out of which 20 Marks will be allotted for internalassessment and University Examination will be conducted for 80 Marks.

3. Marks for internal assessment of Practical courses will be allotted as follows.

a. Completed and certified journal 10 Marks

b. Overall performance and regularity of the student during whole academic year 10 Marks

4. Internal assessment for theory courses will be done on the basis of the performance ofthe student in tests. Minimum two tests should be arranged for each course in aSemester.

Date: 29/04/2015

Dr. B. R. Khot
Chairman,
BOS in Chemistry

Savitribai Phule Pune University

Board of Studies in Chemistry

T.Y.B.Sc. Chemistry Syllabus

To be implemented from June 2015 (i.e. from Academic Year 2015-16)

Equivalenceof the Courses

Semester	Course Code and Title (Old)	Course Code and Title (New)
Semester III	CH-331: Physical Chemistry	CH-331: Physical Chemistry
	CH-332: Inorganic Chemistry	CH-332: Inorganic Chemistry
	CH-333: Organic Chemistry	CH-333: Organic Chemistry
	CH-334: Analytical Chemistry	CH-334: Analytical Chemistry
	CH-335: Industrial Chemistry	CH-335: Industrial Chemistry
	OPTIONAL COURSE CH-336-A Nuclear Chemistry CH-336-B Polymer Chemistry CH-336-C Introduction to Biochemistry and Molecular Biology CH-336-D Environmental Chemistry CH-336-E Agriculture Chemistry	**OPTIONAL COURSE** CH-336-A Nuclear Chemistry CH-336-B Polymer Chemistry CH-336-C Introduction to Biochemistry and Molecular Biology CH-336-D Environmental and Green Chemistry CH-336-E Agriculture Chemistry
Semester IV	CH-341: Physical Chemistry	CH-341: Physical Chemistry
	CH-342: Inorganic Chemistry	CH-342: Inorganic Chemistry
	CH-343: Organic Chemistry	CH-343: Organic Chemistry
	CH-344: Analytical Chemistry	CH-344: Analytical Chemistry
	CH-345: Industrial Chemistry	CH-345: Industrial Chemistry
	OPTIONAL COURSE CH-346-A Nuclear Chemistry CH-346-B Polymer Chemistry CH-346-C Introduction to Biochemistry and Molecular Biology CH-346-D Environmental Chemistry CH-346-E Dairy Chemistry	**OPTIONAL COURSE** CH-346-A Nuclear Chemistry CH-346-B Polymer Chemistry CH-346-C Introduction to Biochemistry and Molecular Biology CH-346-D Environmental and Green Chemistry CH-346-E Dairy Chemistry
	PRACTICAL COURSES	**PRACTICAL COURSES**
	CH-347: Physical Chemistry Practicals	CH-347: Physical Chemistry Practicals
	CH-348: Inorganic Chemistry Practicals	CH-348: Inorganic Chemistry Practicals
	CH-349: Organic Chemistry Practicals	CH-349: Organic Chemistry Practicals

Date: 29/04/2015

Dr. B. R. Khot
Chairman,BOS in Chemistry

Semester-III
Course: Physical Chemistry (CH-331)

Topic	No. of Lectures
1. Chemical Kinetics	10
2. Electrolytic Conductance	14
3. Investigation of Molecular Structure	16
4. Phase Rule	08
Total Lectures	**48**

1. Chemical Kinetics : [10 L]

Recapitulation of Chemical Kinetics, Third order reaction, Derivation of integrated rate law for third order reaction with equal initial concentration, characteristics of third order reaction, examples of third order reaction, Methods to determine order of reaction using Integrated rate equation method, Graphical method, Half-life method, Differential method. Effect of temperature on reaction rate, Arrhenius equation, related numerical.

[Ref. 1 : Pages 567-574, Ref. 2: Pages 600-612]

2. Electrolytic Conductance: [14 L]

Recapitulation of Electrolytic conductance,Specific and equivalent conductance,Variation of equivalent conductance with concentration,

Kohlrausch's law and its applications to determine

a. Equivalent conductance at infinite dilution of a weak electrolyte,
b. The ionic product of water,
c. Solubility of sparingly soluble salts,

Migration of ions and ionic mobilities, absolute velocity of ions, Transport number determination by Hittorf's method and moving boundary method, Relation between ionic mobility, ionic conductance and transport number, Ionic theory of conductance, Debye-Huckel –Onsager equation and its validity, Activity in solution, fugacity and activity coefficient of strong electrolyte.

[Ref. 1 : Pages 398-437, Ref. 2 : Pages 686-703]

3. Investigations of Molecular Structure: [16 L]

Molar refraction, Electrical polarization of molecules, Permanent dipole moment, Determination of dipole moment, Molecular spectra - Rotational, vibrational and Raman spectra Reference

[Ref. 1 : pages 691-710 Ref. 2 : Pages 398-424]

4. Phase Rule: [08 L]

Definitions, Gibb's phase rule, one component system (moderate pressure only) for sulphur and water system, two component system for silver-lead and zinc-cadmium.

[Ref. 1 : Pages 344-350, 350-354; Ref. 2 Pages 558-575]

AIMS AND OBJECTIVES:

1. **Chemical Kinetics :** After studying this topic students are expected to know-
   i. Expression for rate constant k for third order reaction
   ii. Examples of third order reaction
   iii. Characteristics of third order rate constant k
   iv. Derivation for half-life period of third order reaction and to show that half-life is inversely proportional to square of initial concentration of reactants.
   v. Experimental determination of order of reaction by Integrated rate equation method, Graphical method, Half-life method and Differential method.
   vi. Explain the term energy of activation with the help of energy diagram
   vii. Explain the term temperature coefficient.
   viii. Effect of temperature on rate constant k
   ix. Derivation of Arrhenius equation
   x. Graphical evaluation of energy of activation
   xi. Solve the numerical problems based on this topic.

2. **Electrolytic Conductance :** After studying this topic students are expected to know-
   i. Ohm's law and electrical units such as coulomb, Ampere, Ohm and Volt.
   ii. Meaning of specific resistance, specific conductance, cell constant and their units.
   iii. Cell constant, its theoretical and experimental determination.
   iv. Preparation of conductivity water.
   v. Experimental determination of conductance.
   vi. Variation of specific and equivalent conductance of strong and weak electrolyte with dilution
   vii. Meaning of infinitely dilute solution.
   viii. Kohlrausch's law of independent migration of ions and its applications such equivalent conductance of weak electrolyte at zero conc., degree of dissociation (α),ionic product of water.
   ix. Transport number of an ion
   x. Hittorf's rule
   xi. Experimental determination of transport number by Hittorf's and moving boundary method.
   xii. Drawbacks of Arrhenius theory, Debye-Huckel-Onsager Interionic Attraction theory
   xiii. Asymmetry /Relaxation effect
   xiv. Electrophoretic effect
   xv. Validity of Onsager equation
   xvi. Fugacity and activity concept
   xvii. Activity and activity coefficient of strong electrolyte.
   xviii. Solve the numerical problems based on this topic.
   xix.
3. **Investigation of molecular structure :** After studying this topic students are expected to know-
   i. Understand the term additive and constitutive properties
   ii. Understand the term specific volume, molar volume and molar refraction.
   iii. Understand the meaning of electrical polarization of molecule.

iv. Understand the meaning of induced and orientation polarization
v. Dipole moment and its experimental determination by temperature variation method.
vi. Application of dipole moment for structure determination.
vii. Nature of wave and its characteristics such as wavelength, wave number, frequency and velocity.
viii. Rotational / Microwave spectroscopy
ix. Derivation for rotational spectra for the transition from J to J+1
x. Limitations of Rotational Spectra.
xi. Vibrational Spectra
xii. Vibrational rotational Spectra
xiii. Raman Spectroscopy
xiv. Solve the numerical problems based on this topic.

4. **Phase Rule :** After studying this topic students are expected to know-
   i. Meaning and Types of equilibrium such as true or static, metastable and Unstable equilibrium.
   ii. Meaning of phase, component and degree of freedom.
   iii. Derivation of phase rule.
   iv. Explanation of water system : Description of the curve, Phase rule relationship and typical features.
   v. Explanation of sulphur system : Description of the curve, Phase rule relationship and typical features.
   vi. Explanation of two component system curve : for silver-lead and Zinc-cadmium.

References:

1. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton

2. Essentials of Physical Chemistry by B.S. Bahl, G.D.Tuli and ArunBahl Edition 2000 S. Chand and Company Ltd.

2. Essentials of Physical chemistry by BahlTuli-Revised Multicolor Edition 2009

3. Essentials of Nuclear Chemistry, H.J.Arnikar Second edition

4. Nuclear and Radiation Chemistry, Third edition

5. Quantum Chemistry second edition by Manas Chandra

6. Physical Chemistry a molecular approach by Donald A. McQuarrie , John D. Simon

Semester-IV
Course: Physical Chemistry (CH-341)

Topic	No. of Lectures
1. Electrochemical Cells	14
2. Nuclear Chemistry	12
3. Crystal Structure	12
4. Quantum Chemistry	10
Total Lectures	**48**

1. Electrochemical Cells [14 L]

Reversible and irreversible cells,EMF and its measurements,Standard cells, cell reaction and EMF,Single electrode potential and its calculation,Calculation of cellEMF,Thermodynamics of cell EMF,Types of electrodes,Classification of electrochemical cells with and without transference,Applications of EMFmeasurement-i)Solubility product of sparingly soluble salt,ii)Determination of pH,iii)Potentiometric titration

[Ref. 1 : Pages: 471-486, 492-519]

2. Nuclear Chemistry [12 L]

The atom, nucleus and outer sphere, classification of nuclides, nuclear stability and binding energy.Discovery of radioactivity, types of radioactivity, general characteristics of radioactive decay and decay kinetics,Measurements radioactivity, gaseous ion collection method, proportional and G.M. counter.

Applications of radioactivity-

Radiochemical principles in the use of tracers,

Typical applications of radioisotopes as a tracer-

i) Chemical investigations- reaction mechanism,

ii)Structure determination- phosphorus pentachloride and thiosulphate ion

iii)Age determination- by Carbon-14 dating and Uranium-Lead/ Thorium-Lead Ratio

iv) Medical applications-Assess the volume of blood in patients body, Goiter

[Ref. 3 : Pages 1, 4-15, 117-119,121-125,371-378,Ref. 4:.Pages 243-245,247-251]

3. Crystal structure [12 L]

Crystallization and fusion process,Crystallography, Crystal systems,-Properties of crystals, Crystal lattice and unit cell,-Crystal structure analysis by X ray - The Laue method and Braggs method,

- X-ray analysis of NaCl crystal system,
- Calculation of d and λ for a crystal system.

[Ref. 1 : Pages 67-85]

4. Quantum Chemistry **[10 L]**

Concept of quantization, atomic spectra (no derivation), wave particle duality, uncertainty principle, wavefunction and its interpretation, well-behaved function, Hamiltonian (energy) operator, formulation of Schrodinger equation, particle in box (1D, 2D and 3D box) (no derivations), sketching of wavefunction and probability densities for 1D box, correspondence principle, degeneracy(lifting of degeneracy), applications to conjugated systems, harmonic oscillator, wavefunction and probability densities (no derivation), zero point energy and quantum tunneling.

[Ref. 5.Quantum Chemistry second edition by Manas Chandra- Relevant pages
Ref. 6.Physical Chemistry a molecular approach by Donald A. Mc.Quarrie, John D. Simon- Relevant pages]

AIMS AND OBJECTIVES:

1. ElectrochemicalCell : After studying this topic students are expected to know-

i. What is mean by Electrochemical cell with specific example
ii. Origin of EMF of electrochemical cell.
iii. Conventions used to represent electrochemical cell.
iv. Thermodynamic conditions of reversible cell
v. Explanations of reversible and irreversible electrochemical cell with suitable example.
vi. What is mean by reference electrode?
vii. Primary and secondary reference electrode
viii. Construction, representation, working and limitation of Standard hydrogen Electrode
ix. Construction, representation and working of Calomel and Silver –Silver Chloride electrode
x. Types of electrodes
xi. Conditions of Standard Cell
xii. Construction, representation and working of Weston Standard Cell.
xiii. Measurement of EMF of electrochemical cell
xiv. Nernst Equation for theoretical determination of EMF.
xv. Thermodynamics and EMF: Relation of EMF with ΔG, ΔG°,ΔH, ΔS and equilibrium constant K of the cell reaction.
xvi. Explanation of the term liquid junction potential
xvii. Classification of electrochemical cell
xviii. Chemical cell with and without transfer
xix. Electrode and electrolytic concentration cell
xx. Concentration cell with and without transfer.
xxi. Application of EMF measurement such as pH determination, Determination of solubility and solubility product.
xxii. Potentiometric titrations: Weak acid against strong base, Titration of polybasic acids, Precipitation and Redox titrations.
xxiii. Solve the numerical problems based on this topic.

2. Nuclear Chemistry: After studying this topic students are expected to know-

i. The atom its nucleus and outer sphere.
ii. Classification of nuclides with suitable examples such as isotope, isobar, isotone and isomers
iii. Explanation of stability of nucleus through neutron to proton ratio, odd and even nature of proton and neutron, Mean binding energy.
iv. Conversion of mass into energy
v. Mass defect, Total and mean binding energy
vi. Explanation of binding energy curve.
vii. Types of decay
viii. Discovery of radioactivity
ix. Decay kinetics
x. Relation of half-life with decay constant.
xi. Unit of Radioactivity : Curie Bq
xii. Measurement of radioactivity by G.M. and proportional counter
xiii. Principle, construction and working of G.M. / Proportional counter.
xiv. Application of radioisotopes as a tracer
xv. Chemical investigation : Reaction mechanism and structure determination w.r.t PCl_5 and thiosulphate ion
xvi. Age determination- by Carbon-14 dating and Uranium-Lead/ Thorium-Lead Ratio
xvii. Medical applications-Assess the volume of blood in patients body, Goitre
xviii. Solve the numerical problems based on this topic.

3. Crystal Structure: After studying this topic students are expected to know-

i. Distinguish between crystalline and amorphous solids / anisotropic and isotropic solid
ii. Explain the term crystallography and laws of crystallography
iii. Weiss and Millers Indices
iv. Crystal system and their characteristics
v. Explain the term polymorphism /allotrophism
vi. Distance between the planes for 100, 110 and 111 type of simple, body centred and face centred cubic crystals
vii. Bragg's experiment and Derivation of ($n\lambda = 2d\sin\theta$)Bragg's equation
viii. Explanation: Structure of NaCl can be ascertained with the help of X-ray analysis.
ix. Laue's and Bragg's method.

4.Quantum Chemistry: After studying this topic students are expected to know-

i. Concept of quantization
ii. Atomic spectra
iii. Wave particle duality
iv. Uncertainty principle and its physical significance
v. Derivation of time independent Schrodinger wave equation.
vi. Wave function and its Interpretation
vii. Well behaved function
viii. Hamiltonian Operator
ix. Particle in a box (1 and 3 dimensional)
x. Degeneracy

xi. Application to conjugated systems
xii. Harmonic oscillator
xiii. Solve the numerical problems based on this topic.

References:

1.Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton

2. Essentials of Physical Chemistry by B.S. Bahl, G.D.Tuli and ArunBahl Edition 2000 S. Chand and Company Ltd.

2. Essentials of Physical chemistry by BahlTuli-Revised Multicolor Edition 2009

3.Essentials of Nuclear Chemistry, H.J.Arnikar Second edition

4.Nuclear and Radiation Chemistry, Third edition

5.Quantum Chemistry second editionby Manas Chandra

6.Physical Chemistry a molecular approachby Donald A. McQuarrie , John D. Simon

Physical Chemistry Practicals:CH- 347

Group A:

1. Chemical Kinetics: (Any Five):

1.To study the effect of concentration of the reactants on the rate of hydrolysis of an ester.

2.To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of hydrolysis of an ester.

3.To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of Inversion of cane sugar using Polarimeter.

4.To study the kinetics of iodination of acetone

5.To determine the first order velocity constant of the decomposition of hydrogen peroxide by volume determination of oxygen.

6.To determine the energy of activation of the reaction between potassium iodide and potassium persulphate.

7.To determine the order of reaction between $K_2S_2O_8$ and KI by half-life method.

2. Viscosity:

To determine the molecular weight of a high polymer by using solutions of different concentrations.

3.Adsorption

To investigate the adsorption of oxalic acid /acetic acid by activated charcoal and test the validity of Freundlich / Langmuir isotherm

4. Phenol-water system

To study the effect of addition of salt on critical solution temperature of phenol water System

5. Transport number

To determine the transport number of cation by moving boundary method.

6. Refractometry (any two)

i)To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C.

ii) To determine the molecular refractivity of the given liquids A, B, C and D.

iii)To determine the molar refraction of homologues methyl, ethyl and propyl alcoholand show the constancy contribution to the molar refraction by $-CH_2$ group.

Group B

1. Colorimetry (any two)

i)Determination of λ_{max} and concentration of unknown solution of $KMnO_4$ in 2 N $H2SO_4$

ii)Determination of λ_{max} and concentration of unknown solution of $CuSO_4$.

iii)To titrate Cu^{2+} ions with EDTA photometrically.

iv)To determine the indicator constant of methyl red indicator

2. Potentiometry(any three)

i)To prepare standard 0.2 M Na_2HPO and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pka value of these and unknown solutions.

ii)To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base.

iii)To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentriometrically

iv)To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.

3.pH metry (any two)

i)To determine the degree of hydrolysis of aniline hydrochloride
ii)To determine pka value of given weak acid by pH-metric titration with strong base.
iii)To determine the dissociation constant of oxalic acid by pH-metric titration with strong base
iv)To determine pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence to find the dissociation of acetic acid.

4.Radioactivity (any one)

i)To determine plateau voltage of the given G M counter.
ii)To determine the resolving time of GM counter
iii)To determine E_{max} of beta particle

5.Conductrometry (any two)

i)To determine the cell constant of the given cell using 0.01 M KCl solution and hence determine dissociation constant of a given monobasic weak acid.
ii)To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate.
iii)To investigate the conductometric titration of any one of the following
a)Strong acid against strong base
b)Strong acid against weak base
c)Strong base against weak acid
d)Weak acid against weak base

STRUCTURE OF PRACTICAL EXAMINATION

	Experiment	**Marks**
1.	One Experiment from Group – A	35
2.	One Experiment from Group-B	35
3.	Oral	10

References:

1. Practical Physical Chemistry, 3rd Edn. A. M. James and F. E. Prichard, Longman publication.
2. Experiments in Physical Chemistry, R. C. Das and B. Behra, Tata McGraw Hill.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House.
4. Advanced Experimental Chemistry, Vol-I, J. N. Gurtu and R. Kapoor, S. Chand and Company.
5. Physical Chemistry Experiments, Raghvan and Vishwanathan.

Semester-III

Course: Inorganic Chemistry (CH-332)

Topic	No. of Lectures
1. Molecular Orbital Theory	15
2. Coordination Chemistry	33
Total Lectures	**48**

1. Molecular Orbital Theory **15 L**

Limitations of Valence Bond theory(VBT), Need of Molecular orbital theory (MOT), Features of MOT, Formation of molecular orbitals(MO's) by LCAO principle, Rules of LCAO combination, Different types of combination of Atomic orbital(AO's): S-S, S-P, P-P and d-d, Non-bonding combination orbitals(formation of NBMO), M.O. Energy level diagram for homonuclear diatomic molecules, Bond order and existence of molecule from bond order, Energy (β) and magnetic behavior for following molecules or ions: H_2, H_2^+, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2, O_2^+, O_2^-, O_2^{2-}, F_2, Ne_2,

M.O. energy level diagram, for heteronuclear diatomic molecule like CO, NO, HCl, HF.

M.O. energy level diagram, for heteronuclear triatomic molecule like CO_2, NO_2

Ref. 2 Pages 89-112, 106-117
Ref. 4 Pages 55-72

Aims and objective:

A student should:

i. Know the theories of covalent bond formation
ii. Know the assumptions and limitations of VBT
iii. Understand the need of concept of MOT
iv. Know LCAO principal and its approximation
v. Understand and show the formation of bonding and antibonding MO's
vi. Draw the shapes of s, p, d orbital
vii. Draw combinations of s-s, s-p, p-p and d-d orbital to form σ and π molecular orbitals.
viii. Give the comparison of
   a) Atomic orbital and molecular orbital
   b) BMO and ABMO
   c) Sigma and pi MO's
   d) VBT and MOT
   e) Comparison between BMO, ABMO and NBMO
ix. Draw the MO energy level diagrams for homonuclear diatomic molecules having interactions between 2s and 2p orbitals and having no interactions between 2s and 2p orbitals : H_2, H_2^+, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2, O_2^+, O_2^-, O_2^{2-}, F_2, Ne_2,
x. Draw the shapes of molecular orbitals.
xi. Give the calculations of bond order, energy and explanation on stability of the above molecule and ions
xii. Draw the MO energy level diagrams for heteronuclear diatomic molecules: CO, NO, HCl, HF and calculations of bond order, energy and explain the stability of the molecules.

xiii. Understand the formation of BMO, ABMO and NBMO in CO_2 or NO_2 molecule and construct MO energy level diagrams for them.

2. Coordination Chemistry 33L

I. INTRODUCTION TO COORDINATION CHEMISTRY (03 L)

1. General account and meaning of the terms involved in coordination chemistry:
Coordinate bond, central metal atom or ions, ligand, double salt, complex compound, coordination number, charge on the complex ion, oxidation number of Metal ion, first and second coordination sphere.
2. Ligands: Definition, Classification, Chelates and chelating agents.
3. Formation Constant, inert and labile complexes.
4. IUPAC nomenclature of coordination compounds
5. Different geometries of coordination compounds with C.N.= 4 to C.N.=10 and examples of each geometry.

II. WERNER'S THEORY OF COORDINATION COMPOUNDS (02 L)

Assumptions of Werner's coordination theory, Werner's formulation of Coordination compounds, Physical and chemical test to support his formulation of ionizable and non-ionizable complexes, Stereoisomerism in complexes with C.N.4 and C.N. 6 to identify the correct geometrical arrangement of the complexes.

III. ISOMERISM IN COORDINATION COMPLEXES (04 L)

Definition of isomerism in complexes-Structural Isomerism and stereoisomerism,
1. Structural isomerism (ionization, hydrate, linkage, ligand, coordination position and polymerization isomers)
2. Stereoisomerism and its types-Geometrical isomerism and optical isomerism.

IV. SIDGWICK THEORY (02 L)

Concept of Sidgwick's model, Scheme of arrow indication for M-L bond suggested by Sidgwick, Effective Atomic Number rule (EAN), Calculations of EAN value for different complexes and stability of complexes, Advantages and Drawbacks of Sidgwick's theory.

V. PAULING'S VALENCE BOND THEORY (06 L)

Introduction of Valence Bond Theory (VBT), Need of concept of hybridization, Aspects of VBT, Assumptions, VB representation of tetrahedral, square planer, trigonalbipyramidal and octahedral complexes with examples, Inner and outer orbital complexes, Electro neutrality principle, Multiple bonding(dπ-pπ and dπ-dπ), Limitations of VBT.

VI. CRYSTAL FIELD THEORY (10 L)

Introduction and need of Crystal Field Theory(CFT), Assumptions, Shapes and degeneracy of d orbital, Splitting of d-orbitals, Application of CFT to octahedral complexes, pairing energy(P) and distribution of electrons in e_g and t_{2g} level, calculation of magnetic moment using spin-only formula, Crystal Field Stabilization Energy (CFSE), calculation of CFSE in weak oh field and strong oh field complexes, Evidence for CFSE, Interpretation of spectra of complexes, calculation of 10 Dq and factors affecting magnitude of 10Dq, d-d transitions and colour of the complexes, Jahn-Teller distortion theorem for octahedral complexes and its illustration, CFT of tetrahedral and square planar

complexes, calculations of CFSE, Spectrochemical series, Nephelauxatic effect and Nephelauxetic series, Limitations of CFT, modified CFT (LFT), Problems related to calculation of 10 Dq, CFSE and spin only magnetic moment for octahedral, tetrahedral & square planar complexes. (i.e. for high spin & low spin complexes)

VII. MOLECULAR ORBITAL THEORY OF COORDINATION COMPLEX (06 L)

Introduction, Assumptions, MO treatment to octahedral complexes with sigma bonding, Formation of MO's from metal orbitals and Composite Ligand Orbitals (CLO), MO correlation diagram for octahedral complexes with sigma bonding, effect of π bonding, Charge transfer spectra, Comparison of VBT, CFT, and MOT.

Ref. 2 Pages 194 -236
Ref. 8 Relevant Pages
Ref. 9 Relevant Pages

Aims and objective

A student should:

i. Know the meaning of various terms involved in coordination chemistry.
ii. Know the different types of Ligands.
iii. Understand the chelating agents, chelate and stability of chelates and complexes.
iv. Calculate the charge on complex ion and the oxidation number.
v. Be able to give the IUPAC name the co-ordination compound.
vi. Know the application of co- ordination compounds in biology and chemistry.
vii. Be able to understand the Werner's formulation of complexes and identify the ionizable ions.
viii. Be able to distinguish between ionizable and non-ionizablevalencies with suitable examples.
ix. Give the suitable physical and chemical test for identification of number and types of ionizable ions.
x. Be able to draw the geometrical and optical isomerism of complexes.
xi. Choose the correct geometry for complexes with C.N. 4 and C.N. 6 with the help of stereoisomerism.
xii. Be able to define and explain isomerism in complexes.
xiii. Be able to explain various types of isomerism.
xiv. Comment on the stereoisomerism in complexes with C.N. 4 and C. N. 6.
xv. Define EAN rule and calculate EAN value of the complexes.
xvi. Comment on EAN value and stability of complexes.
xvii. Know the merits and the demerits of Sidgwick's theory.
xviii. Be able to explain the need of concept of hybridization.
xix. Explain the VB representation of tetrahedral, square planar, trigonalbipyramidal and octahedral complexes.
xx. Be able to identify which d-orbitals are involved in hybridization during formation of complexes with different geometries such as tetrahedral, square planar, trigonalbipyramidal and octahedral.
xxi. Be able to explain structure and magnetic behaviour of the complexes.
xxii. Be able to identify the high spin and low spin complexes.
xxiii. Be able to identify inner orbital and outer orbital complexes.
xxiv. Explain elctroneutrality principle and different types of pi bonding.
xxv. Know the limitations of VBT.
xxvi. Know the shapes of d-orbitals and degeneracy of d-orbitals.

xxvii. Know the assumptions of CFT.
xxviii. Understand how splitting of d-orbitals occurs when ligand approaches.
xxix. Be able to draw crystal filled splitting diagrams of d orbital of metal ion in octahedral, tetrahedral, square planer of tetragonal ligand field.
xxx. Interpret the spectra of complexes and calculate the 10 Dq.
xxxi. Understand the factors affecting magnitude of 10 Dq.
xxxii. Be able to find high spin and low spin complexes when 10 Dq and pairing energy are given.
xxxiii. Be able to explain d-d transitions and colour of the complexes.
xxxiv. Know the conditions under which Jahn-Teller distortion occurs.
xxxv. Explain, why Jahn-Teller distortion should occur in Oh complexes?
xxxvi. Be able to explain Nephelauxetic effect towards covalent bonding.
xxxvii. Explain MOT of Octahedral complexes with sigma bonding.
xxxviii. Be able to explain Charge Transfer Spectra.
xxxix. Be able to compare the different approaches to bonding in Coordination compounds.

Reference Books:

Ref. 1 Introduction to Electrochemistry by Glasstone - 2nd edition.
Ref. 2 Concise Inorganic Chemistry by J.D. Lee - 5th edition.
Ref. 3 Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H.Longford ELBS - 2nd edition.
Ref. 4 Basic Inorganic Chemistry, - F.A. Cotton and G. Wilkinson, Wiley Eastern Ltd 1992.
Ref .5 Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels - 3rd edition.
Ref. 6 Chemistry by Raymond Chang - 5th edition
Ref. 7 New Guide to Modern Valence Theory by G.I. Brown - 3rd edition
Ref. 8 Co-ordination Compounds by Baselo and Pearson.
Ref. 9 Theoretical Inorganic Chemistry by Day and Selbin.
Ref.10 Inorganic Chemistry by A. G. Sharpe - 3rd Edition.
Ref.11 Coordination Chemistry by A. K. De.

Semester-IV
Course: Inorganic Chemistry (CH-342)

Topic	No. of Lectures
1. Chemistry of f-block element	08
2. Metals Semiconductors and Superconductors	10
3. Ionic Solids	10
4. Homogeneous Catalysis	06
5. Heterogeneous Catalysis	08
6. Bioinorganic Chemistry	06
Total Lectures	**48**

1. Chemistry of f- block elements (08 L)

Introduction of f-block elements- on the basis of electronic configurations, occurrence and reactivity, F-block elements as Lanthanide and Actinide series

I. Lanthanides

Position in periodic table, Name and electronic configuration of lanthanides, Oxidation States, Occurrence and separation (Group/ Individual) by modern methods (ion exchange and solvent extraction method), Lanthanide contraction & its effect on chemistry of Lanthanides and post-lanthanide elements, applications of lanthanides

II. Actinides

Position in periodic table, Name and electronic Configuration of actinides, Oxidation States, Occurrence, and general methods of preparation of transuranic elements [viz., a) Neutron Bombardment, b) Accelerated projectile bombardment and c) Heavy ion bombardment], Nuclear Fuels-Nuclear Fusion fuels & nuclear fission fuels, IUPAC nomenclature system for super heavy elements with atomic no. (z) greater than100, Comparison between Lanthanides and Actinides.

Ref. 2 Pages 859-863, 865-866, 874 – 875, 879-886, 891-893, 898-900

Aims and objective

A student should know:

a. The meaning of term f-block elements, Inner transition elements, lanthanides, actinides.
b. Electronic configuration of lanthanides and actinides.
c. Oxidation states of lanthanides and actinides and common oxidation states.
d. Separation lanthanides by modern methods.
e. Lanthanide contraction and effects of lanthanide contraction on post-lanthanides.
f. Use of lanthanide elements in different industries.
g. Transuranic elements.
h. Preparation methods of transuranic elements.
i. Nuclear fuels and their applications.
j. Why transuranic elements are called as the synthetic elements?
k. IUPAC nomenclature for super heavy elements with atomic no. 100 onwards.

2. Metals, semiconductors and Super conductors (10 L)

Introduction, Metallic bonding, Band theory in metals with respect to Na along with n (E) and N(E) diagrams, Electrical conductivity of metals (Na, Mg, Al), Valence electrons and conductivity of

metals, Effect of temperature and impurity on electrical conductivity of metals, Semiconductors – types of Semiconductors: I. Intrinsic II. Extrinsic, effect of temperature and impurity on semiconductivity, N & P type semiconductors ZnO and NiO, Super conductivity- Discovery, Property, Models structure and superconductivity, Applications of superconductors,

Ref. 7 Pages 209-221
Ref. 6 Related Pages

Aims and objective
A student should know:

a. The meaning of metal & semiconductor.
b. The difference between metal, semiconductor and insulator.
c. Metallic bond on the basis of band theory.
d. The energy band and energy curve.
e. Draw n (E) & N (E) curves.
f. Explain the electrical conductivity of metals with respect to valence electrons.
g. Explain the effect of temperature and impurity on conductivity of metals and semiconductors.
h. Intrinsic and extrinsic semiconductor.
i. The term valance band and conduction band.
j. n and p type of semiconductors.
k. Non-stoichiometry and semi conductivity.
l. Insulators on the basis of band theory.
m. The difference between Na, Mg, and Al in terms of valence electrons and conductivity.
n. Meaning of super conductors and their structure.
o. Discovery and applications of superconductors.

3. Ionic Solids (06 L)

Crystalline and amorphous solids, crystal structures simple cubic, body centered cubic and face centered cubic, Properties of ionic solids, packing arrangements of anions in an ionic solids, Voids in crystal structure- tetrahedral and octahedral, Ionic radius, Palings univalent and crystal radii, Conversion of univalent radii to crystal radii, problems based on conversion of radii, Radius ratio effect, Lattice energy, Born-Lande equation, Born Haber cycle and its applications, Schottky and Frenkel defect.

Ref. 2 Pages 32-61
Ref. 5 Pages 102-127
Ref. 7 Pages 55-62

Aims and objectives
A student should:

i. Know the nature of solids.
ii. Know the crystal structures of solids.
iii. Draw the simple cubic, BCC and FCC structures.
iv. Identify the C.N. of an ion in ionic solid.
v. Identify the type of void.
vi. Know the effect of radius ratio in determining the crystal structure.
vii. Be able to define Pauling's univalent radius and crystal radius.

viii. Be able to solve simple problems based on Pauling's univalent radii and crystal radii.
ix. Know how to draw Born-Haber cycle.
x. Be able to solve simple problems based on Born- Haber cycle.
xi. Know the defects in Ionic solids.
xii. Be able to differentiate between the defects.

4. Homogeneous Catalysis (06 L)

Definition, types of homogeneous catalysts, Essential properties of homogeneous catalysts, Catalytic Reactions such as:

a. Wilkinson's Catalysis
b. Zeigler Natta Catalysis
c. Monsanto acetic acid synthesis

Ref. 3 Related Pages
Ref. 6 Related Pages
Ref. 13 Pages 650-652 and 656-661

Aims and objectives

A student should:

i. Define the homogeneous catalysis.
ii. Give examples of homogeneous catalysts.
iii. Understand the essential properties of homogeneous catalysts-Give the catalytic reactions for Wilkinson's Catalysis, Zeigler Natta Catalysis, Monsanto acetic acid synthesis
iv. Give the brief account of homogeneous catalysis.

5. Heterogeneous Catalysis (08 L)

Definition, types of heterogeneous catalysts-metals, semiconductors, solid acid catalysts and supported catalysts, Essential properties of heterogeneous catalysts, Catalytic Reactions such as:

a. Oxidation- i. Synthesis of terephthalic acid from xylene using ZSM-5
   ii. Synthesis of benzoic acid from toluene using $KMnO_4$
b. Reduction- i. Hydrogenation of alkene to alkane using Raney Ni catalyst.
   ii. Synthesis of p-aminophenol from nitrobenzene using Pd/C catalyst.
c. Cyclization- Benzimidazole synthesis using o-phenenediamine and benzaldehyde by acidic support or clay-solid support, amberlist or NH_4Cl.
d. Biodiesel Synthesis- using heteropolyacid catalyst- Transesterification using phosphomolybdic or phosphotungstic acid.

Ref. 5 Related Pages
Ref. 11 Related Pages
Ref. 13 Related Pages

Aims and objectives

A student should:

i. Define the heterogeneous catalyst and heterogeneous catalysis.
ii. Give examples of heterogeneous catalysts.
iii. Understand the essential properties of heterogeneous catalysts.
iv. Give the catalytic reactions for oxidation, reduction and cyclization processes.
v. Give the brief account of biodiesel synthesis using heterogeneous catalysis.
vi. Enlist the catalysts used for benzimidazole synthesis.

vii. Understand the catalytic reactions used in industries around.

6. Bioinorganic Chemistry (06 L)

I. Introduction, Role of metals in bioinorganic chemistry-

a. Classification as enzymatic and non-enzymatic metals,
Enzymatic redox metals such as Cu (SOD) and enzymatic non redox metals such as Zn (Hydrolase).
b. Role of metal ions in non-enzymatic process- Na, K, Ca, Mg (one example of each and brief discussion).
c. Role of metals in enzymatic processes-Transition metals- Catalase, peroxidase and nitrogenase (Redox active).

II. Metalloproteins-Iron proteins-Introduction of Fe-S proteins, Electron transfer proteins (Fe-S, Fe_2S_2, Fe_3S_4, Fe_4S_4). Transport protein (transferrin) and Storage protein (ferritin)

III. Bioinorganic Chemistry of Fe: Hemoglobin and myoglobin, its structure and functions.

IV. Bioinorganic Chemistry of Co: Vitamin-B_{12}, its structure and function.

Ref. 3 Pages 782-806
Ref. 2 Pages 353, 775, 779, 796-797
Ref. 12 Pages 1-13, 24, 285-290

Aims and objective

A student should:

i. Identify the biological role of inorganic ions & compounds.
ii. Know the abundance of elements in living system and earth crust.
iii. Give the classification of metals as enzymatic and non-enzymatic.
iv. Understand the role of metals in non-enzymatic processes.
v. Know the metalloproteins of iron.
vi. Explain the functions of hemoglobin and myoglobin in O_2 transport and storage.
vii. Understand the toxicity of CN^- and CO binding to Hb.
viii. Draw the structure of Vit.B_{12} and give its metabolism.

Reference Books:

Ref. 1 Introduction to Electrochemistry by Glasstone - 2nd edition.
Ref. 2 Concise Inorganic Chemistry by J.D. Lee - 5th edition.
Ref. 3 Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H.Longford ELBS - 2nd edition.
Ref. 4 Basic Inorganic Chemistry, - F.A. Cotton and G. Wilkinson, Wiely Eastern Ltd 1992.
Ref .5 Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels - 3rd edition.
Ref. 6 Chemistry by Raymond Chang - 5th edition
Ref. 7 New Guide to Modern Valence Theory by G.I. Brown - 3rd edition
Ref. 8 Co-ordination Compounds by Baselo and Pearson
Ref. 9 Theoretical Inorganic Chemistry by Day and Selbin
Ref.10 Inorganic Chemistry by A. G. Sharpe - 3rd Edition
Ref.11 Heterogenous Catalysis by D.K Chakrabarty and B. Vishwanathan, New Age Intl. Publishers, 1st Edn.
Ref. 12 Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1st Edn.
Ref. 13 Inorganic Chemistry by J.E. Huheey, 4th Edn, Pearson Education.

CH-348 - INORGANIC CHEMISTRY PRACTICALS

A) Gravimetric estimations (Any 3)

1. Fe as Fe_2O_3
2. Nickel as Ni – DMG
3. Al as Aluminum oxide
4. Gravimetric estimation of Ba as $BaSO_4$ using homogeneous precipitation method.

B) Volumetric Estimations (Any 4)

1. Mn by Volhard's method
2. Estimation of NO_2^- by using $KMnO_4$.
3. Estimation of % purity of given sample of Sodium Chloride
4. Analysis of Brass-Estimation of copper by Iodometry
5. Fertilizer analysis (PO_4^{3-})

C) Inorganic preparations (Any 4)

1. Preparation of Hexamminenickel(II), $[Ni(NH_3)_6]^{2+}$.
2. Preparation of Potassium Trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$.
3. Preparation of Tetraamminecopper (II) suplhate, $[Cu(NH_3)_4]SO_4$.
4. Preparation of Manganese (III) acetylacetonate $[Mn(acac)_3]$.
5. Preparation of Tris(Thiourea)Copper (I) Chloride $[Cu(Thiourea)_3]Cl$.

D) Colorimetric Estimations (Any 2)

1. Iron by thiocyanate method.
2. Cobalt by using R-nitroso salt method.
3. Titanium by H_2O_2.

E) Separation of binary mixture of cations by Column Chromatography (3 mixtures)

(One mixture should be colorless, Zn + Al, Zn + Mg)

OR

E) Flame Photometry (Any 3)

1. Estimation of Na by flame photometry by calibration curve method.
2. Estimation of Na by flame photometry by regression method.
3. Estimation of K by flame photometry by calibration curve method.
4. Estimation of K by flame photometry by regression method.

F) Qualitative Analysis (4 mixtures including Borates and Phosphates)

G) Visit to a chemical industry and report writing is compulsory.

Reference Books: Ref. 1 General Chemistry Experiment – Anil J Elias (University press).
Ref. 2 Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
Ref. 3 Quantitative Chemical Analysis S. Sahay (S. Chand & Co.).
Ref. 4 Quantitative Analysis R.A. Day, Underwood (Prentice Hall).
Ref. 5 Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
Ref. 6 Vogel's Textbook of Quantitative Chemical Analysis.
Ref. 7 Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST.
Ref. 8"Experimental Methods in Inorganic Chemistry." Tanaka, J. and Suib, S.L., Prentice Hall, New Jersey, 1999.

STRUCTURE OF PRACTICAL EXAMINATION

Experiment		**Marks**
Q.1.	Qualitative analysis OR Gravimetric Experiment*	**35**
Q.2.	Volumetric Experiment (25 Marks) Preparation (10 marks) OR Flame Photometry (20 marks) Preparation (10 marks) OR Column Chromatography (20 marks) Preparation (10 marks) OR Colorimetric Estimation (25 Marks) Preparation (10 marks)	**35**
Q.3.	Oral	**10**

*Minimum 50 % students of each batch should be allotted Gravimetric Estimation.

Semester III
Course: Organic Chemistry (CH-333)

Topic	No. of Lectures
1. Strength of organic acids and bases	03
2. Stereochemistry of disubstituted cyclohexane	06
3. Nucleophilic substitution at aliphatic Carbon	08
4. Reactions of unsaturated hydrocarbons and carbon oxygen double bond	15
5. Elimination Reactions	06
6. Aromatic Electrophilic and Nucleophilic Substitution Reactions	10
Total Lectures	**48**

1. Strength of organic acids and bases **(03)** Introduction, pk_a, origin of acidity, influence of solvent, simple aliphatic saturated and unsaturated acids, substituted aliphatic acid, phenols, aromatic carboxylic acids, pk_a and temperature, pk_b, aliphatic and aromatic bases, heterocyclic bases, acid base catalysis.

Aimsand objectives: Students should know –

1. Definition and types of organic acid and base
2. The pka and pkb concepts
3. Effect of temperature on pk_a/pk_b
4. Comparison between strengths of acids/bases
5. What is acid-base catalysis

Ref.8 (53-75), Ref. 7 Relevant pages.

2. Stereochemistry of disubstituted cyclohexane **(06)**

Introduction, 1,1-alkyl disubstituted cyclohexane; Dimethyl cyclohexane 1,2; 1,3 and 1,4. Geometrical isomerism, Optical isomerism, stability of conformation, energy calculations.

Aimsand objectives: Students should learn –

1. To draw different types of disubstituted cyclohexane in Chair form
2. To distinguish between geometrical and optical isomerism
3. Stability, energy calculations with potential energy diagram and optical activity of these conformers.

Ref. 1 Relevant pages, Ref. 3 (204-214),

3. Nucleophilic substitution at aliphatic Carbon **(08)**

Introduction, Nucleophile and leaving groups, Mechanism of nucleophilic substitution. The S_N1 reaction: Kinetics, mechanism and stereochemistry (Racemization), stability of carbocation. The S_N2 reaction: Kinetics, mechanism & stereochemistry (inversion). How to know whether a given reaction will follow S_N1 or S_N2 mechanism.Comparison of S_N1 & S_N2 reactions.S_Ni reaction and mechanism.

Aimsand objectives: Students should understood –

1. Definition and type of nucleophiles and leaving groups
2. Different types of nucleophilic substitution reactions
3. Definition of inversion and racemization
4. The kinetics, mechanism & stereochemistry of these reactions
5. Whether a given reaction follows $_{SN}1$ or $_{SN}2$ mechanism?
6. The comparison between S_N1 & S_N2 reactions
7. An S_Ni mechanism in presence and absence of pyridine
8. To predict product/s or supply the reagent/s for these reactions

Ref.1. Pages 172-203 and 208 to 210 Ref.8.Relevant pages

4. Reactions of unsaturated hydrocarbons and carbon oxygen double bond (15)

a) Reaction of Carbon-Carbon double bond: Introduction, Mechanism of electrophilic addition to C=C bond. Orientation & reactivity, Rearrangements, (Support for formation of carbocation). Addition of hydrohalogen, Anti Markownikoff's addition (peroxide effect) with mechanism, Addition of halogens (dl pairs and meso isomers), hypohalous acids (HOX), Hydroxylation (Mechanism of cis and trans 1,2-diols). Hydroboration- Oxidation (Formation of alcohol), Hydrogenation (Formation of alkane), Ozonolysis (formation of aldehydes & ketones)

Ref.1. (Pages 317-323,327-343,346-355,357,360)

b) Reactions of Carbon –Carbon triple bond: Addition of hydrogen, halogens, halogen acids, water and formation of metal acetylides and its application.

Ref.1 (Pages 431-433)

c) Reactions of Carbon –Oxygen double bond:

Introduction, Structure of carbonyl group, reactivity of carbonyl group, addition of Hydrogen cyanide, alcohols, thiols, water, ammonia derivatives, Cannizzaro and Reformaski reactions with mechanism.

Aimsand objectives: Students should know –

1. Different types of carbon-carbon unsaturated compounds
2. Orientation / rules in addition reactions
3. The structure of carbonyl group
4. Reactivity concept
5. Correct mechanism of addition reactions using different reagents
6. Types of some known addition reactions
7. To predict product/s or supply the reagent/s for such reactions.

Ref.1.Relevant pages

5. Elimination Reactions (06)

Introduction; 1,1; 1,2 elimination,E1, E2 and E1cB mechanism with evidences, Hoffmann and Saytzeff's elimination, reactivity effect of structure, attacking and leaving groups.

Aimsand objectives: Students should learn –

1. Definition and types of elimination reactions
2. Different types of bases and leaving groups

3. Statement of Hoffmann and Saytzeff rule
4. The evidences, mechanism & stereochemical aspects of these reactions
5. Whether a given reaction follows E1, E2 or E1cB mechanism?
6. Comparison between E1 & E2 reactions
7. The effect of structure, attacking and leaving group on reactivity of such reactions
8. To predict product/s or supply the reagent/s for these reactions

Ref. 1. (Pages 290-310)

Ref. 2.Relevant Pages.

6. Aromatic Electrophilic and Nucleophilic substitution reactions (10)

Introduction, arenium ion mechanism, Effect of substituent group (Orientation, o/p directing and meta directing groups). Classification of substituent groups (activating and deactivating groups) Mechanism of – Nitration, Sulfonation, Haloganation, Fridel-Crafts reactions, Diazo Coupling reactions, Ipso-substitution.Addition-elimination (S_NAr), S_N1, Elimination-addition (Benzyne) S_NR1 reactions, reactivity.

Aimsand objectives: Students should understood –

1. Definition and types of aromatic substitution reactions
2. Classification of directing groups
3. What is an arenium ion and Ipso substitution?
4. The evidences, reactivity and mechanism of these reactions
5. Whether a given reaction follows addition-Elimination or Elimination-addition mechanism?
6. To predict product/s or supply the reagent/s for these reactions

Ref 1-(Pages 517-544, 666-67), Ref 7 and 8- Relevant Pages.

Reference Books:

1) Organic Chemistry by Morrison and Boyd 6thEdn
2) Organic Chemistry by Cram and Hammond.
3) Stereochemistry of Organic compounds by Eliel Tata McGraw Hill 1989.
4) Organic Chemistry by John McMurryVthEdn. 1999
5) Organic Chemistry by Graham Solomans
6) Organic Chemistry by I.L.FinarVol.IIVthEdn.
7) Organic Chemistry by Clayden, Greeves, Warren and Wothers (Oxferd Press)
8) A guide book to reaction Mechanism by Peter Sykes VI thEdn.

Semester IV
Course: Organic Chemistry (CH-343)

Topic	No. of Lectures
1. Carbanions and their reactions	06
2. Retrosynthetic analysis and applications	05
3. Rearrangement reactions	06
4. Spectroscopic methods in structure determination of Organic compounds	24
5. Natural Products	07
Total Lectures	**48**

1. Carbanions and their reactions (06)

Introduction, Formation and stability of Carbanion. Reactions involving carbanions and their mechanisms: Aldol, Claisen, Dieckmann and Perkin condensations. Synthesis and Synthetic applications of Malonic ester, Acetoacetic ester and Wittig reagent.

Aimsand objectives: Students should know –

1. Definition and formation of carbanions
2. Possible mechanism of some known name reactions involving carbanions
3. Synthetic applications some reagents
4. To predict product/s or supply the reagent/s for these reactions

Ref. 2 (270-299).

2. Retrosynthetic analysis and applications (05)

Introduction, Different terms used – Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules: Acetophenone, Crotonaldehyde, Cyclohexene, Benzylbenzoate, and Benzyl diethyl malonate.

Aimsand objectives: Students should learn –

1. Meaning of terms Disconnection, Synthons, Synthetic equivalence, Functional Group Interconversion, Target Molecule
2. What is retrosynthesis?
3. Various steps involved in the synthesis of some molecules (detailed mechanism is not expected)

Ref.3 Relevant pages

Ref.4. Relevant pages

3. Rearrangement reactions (06)

Introduction, Mechanism of rearrangement reaction involving carbocation, nitriene and oxonium ion intermediate.Beckmann, Bayer-Villiger, Pinacol-pincolone, Curtis, Favorski, Claisen rearrangement.

Aimsand objectives: Students should understood –

1. What is rearrangement reaction?
2. Different types of intermediate in rearrangement reactions?
3. To write mechanism of some named rearrangement reactions

Ref. 8. (Pages 86-90,105,112,122,158)
Ref. 6.Relevant Pages.

4. Spectroscopic methods in structure determination of Organic compounds (24)

Introduction, meaning of spectroscopy, nature of electromagnetic radiation, wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength frequency, different regions of electromagnetic radiations. Interaction of radiation with matter.Excitation of molecules with different energy levels, such as rotational, vibrational and electronic level. Types of spectroscopy and advantages of spectroscopic methods.

Aimsand objectives: Students should know –

1. What is Spectroscopy?
2. Different regions of electromagnetic radiations
3. Various terms used in spectroscopy
4. What is the interaction of radiation with matter
5. Types of energy levels with diagram
6. Brief idea about the advantages of spectroscopic methods

Ref-5.(Pages 1-3, 7-11), Ref. 9 and 10 Relevant pages.

A) Ultra Violet Spectroscopy

Introduction, nature of UV, Beer's law, absorption of UV radiation by organic molecule leading to different excitation. Terms used in UV Spectroscopy- Chromophore, Auxochrome, Bathochromic shift(Red shift), hypsochromic shift(Blue shift), hyperchromic and hypochromic effect. Effect of conjugation on position of UV band. Calculation of λmax by Woodward and Fisher rules for dienes and enone systems, Colour and visible spectrum, Applications of UV Spectroscopy- Determination of structure, Determination of stereo chemistry (Cis and trans)

Aimsand objectives: Students should learn –

1. What is UV Spectroscopy and Beer's law?
2. Different types of electronic excitations
3. Various terms used in UV spectroscopy
4. What is the effect of conjugation on UV band
5. To calculation of λmax for dienes and enone systems
6. Define colour?
7. What is the range of vision region ?
8. Applications of UV Spectroscopy

Ref-5. (Pages 13-15, 18-38)

B) Infra red Spectroscopy

Introduction, Principle of IR Spectroscopy, Fundamental modes of vibrations (3N-6, 3N-5) Types of vibrations (Stretching and bending), Hooks law, Condition for absorption of IR radiations, vibration of diatomic molecules. Regions of IR Spectrum: fundamental group region, finger print region aromatic

region, Characteristic of IR absorption of functional groups: Alkanes, alkenes, alkynes, alcohol, ethers, alkyl-halides, carbonyl compounds (-CHO, C=O,-COOR-COOH), amines, amides and Aromatic Compounds and their substitution Patterns. Factors affecting on IR absorption: Inductive effect, resonance effect, hydrogen bonding. Application of IR Spectroscopy in determination of structure, chemical reaction and hydrogen bonding.

Aimsand objectives: Students should understood–

1. What is IR Spectroscopy?
2. To calculate fundamental modes of vibrations for a given molecule
3. Which factors affect IR band position?
4. To distinguish compounds by this spectroscopic method
5. To determine structure and follow the course of reaction by IR spectrum

Ref-5.(Pages 46-51, 53, 54,72-81, 86)

C) PMR Spectroscopy

Introduction, Principles of PMR Spectroscopy, Magnetic and nonmagnetic nuclei, Precessional motion of nuclei without mathematical details, Nuclear resonance, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, delta and Tau-scales. TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, *J*-value (Only first order coupling be discussed)

Aimsand objectives: Students should know–

1. What is the principle of PMR?
2. Various terms used in PMR spectroscopy.
3. Why TMS is used as a reference compound?
4. To distinguish compounds by PMR

Ref-5. (Pages 95-98, 106-108)

D) Problems based on U.V., I.R. and PMR.

Ref-1, 9 and 10.

5) Natural Products (07)

Terpenoids: Introduction, Isolation, Classification. Citral- structure determination using chemical and spectral methods, Synthesis of Citral by Barbier and Bouveault Synthesis.

Alkaloids: Introduction, extraction, Purification, Some examples of alkaloids and their natural resources. Ephedrine- structure determination using chemical methods.Synthesis of Ephedrin by Nagi.

Aimsand objectives: Students should learn–

1. What are terpenoids and alkaloids?
2. Various methods of isolation/extraction of these natural products.
3. Synthesis of Citral and Ephedrin by Barbier- Bouveault and Nagi methods, respectively.
4. To determine the structure of above compounds by chemical methods.

Ref-6 (1437-1440) Ref.7.Relevant Pages.

Reference Books :

1. Organic Chemistry by Morrison and Boyd. VIthEdn.
2. A guide book to reaction mechanism by Peter Sykes VIthEdn.
3. Designing organic Synthesis by Stuart Warren 1983
4. Organic Chemistry by Cram and Hammond
5. Absorption Spectroscopy of Organic Molecules by V. M. Parikh 1974
6. Organic Chemistry by Clayden, Greeves, Warren and Wothers
7. Organic Chemistry by I. L. Finar Vol. II VthEdn.
8. Reactions, Rearrangements and reagents by S. N. Sanyal
9. Introduction Spectroscopy by Pavia
10. Spectroscopic identification of organic molecules by Silverstein

Organic Chemistry Practical (CH-349)

A) Separation of Binary Mixtures and Qualitative Analysis (8 Mixtures)

Solid-Solid (4 Mixtures), Solid-Liquid (2 Mixtures), Liquid-Liquid (2 Mixtures).

At least one mixture from each of the following should be given-Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral- Neutral.

Name and structure of the separated components of the binary mixture is not necessary. Students are expected to record the- Type, Separation of mixture, Preliminary tests, Physical constants, Elements and Functional groups only. The purified samples of the separated components should be submitted. Separation and qualitative analysis of the binary Mixtures should be carried out on micro scale using micro scale kits.

B) Organic Estimations (Four)

i. Estimation of acetamide.

ii. Estimation of Glucose.

iii. Estimation of Ethyl benzoate.

iv. Determination of Molecular weight of Monobasic acids by Volumetric Methods.

v. Determination of Molecular weight of Dibasic acids by Volumetric Methods.

C) Organic Preparations (Eight)

Preparation of: Adipic acid from cyclohexanone (Oxidation by Con. HNO_3)

Benzoquinone from Hydroquinone (Oxidation by $KBrO_3/K_2CrO_3$)

P-nitroacetanilide from Acetanilide (Nitration)

B-Napthyl ether from B-napthol (Methylation by DMS, NaOH)

Hippuric acid from Glycine (Benzoylation)

P-Iodonitrobenzene from P-Nitroaniline (Sandmeyer Reaction)

Benzoic acid from Ethyl benzoate (Ester hydrolysis)

P-Bromacetanilide from Acetanilide (Bromination)

Paraacetomol from P-Hydroxyaniline (Acetylation)

Ethylbenzene from Acetophenone (Wolff Kishner reduction)

The preparation should be carried out on small scale. The starting compound should not be given more than one gm. Double burette method should be used for titration. Monitoring of the reaction and purification should be carried out by recrystallization and purity of the product in preparation should be checked by physical constant(M.P/B.P.) determination and thin layer Chromatography (TLC) with proper selection of the solvent system.

Reference Books

1) Practical Organic Chemistry by – A.I. Vogal.
2) Practical Organic Chemistry by – O.P. Agarwal.

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STRUCTURE OF ANNUAL PRACTICAL EXAMINATION

1. Binary Mixture separation and qualitative Analysis 40 Marks
2. Organic Estimation/ Preparation 30 Marks
3. Oral 10 Marks

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Semester-III

Course: Analytical Chemistry (CH-334)

Sr. No.	Topic	No. of Lectures
1	Gravimetric Analysis	12
2	Thermal methods of analysis	06
3	Spectrophotometry	10
4	Polarography	08
5	Atomic Absorption Spectroscopy	06
6	Flame Emission Spectroscopy	06
Total Lectures		**48**

1. Gravimetric Analysis (12 L)

Common ion effect and solubility product principles, Conditions for good precipitation,Factors affecting precipitation like acid, temperature, nature of solvent,Super saturation and precipitation formation,Precipitation from homogeneous solution and examples, Co-precipitation, post-precipitation and remedies for their minimization, Washing of precipitate and ignition of precipitate,Brief idea about method of filtration and drying of precipitate, Introduction to electrogravimetry: principle, applications, electrolytic separations of Cu and Ni, Numerical problems only on gravimetric analysis.

Ref. 1. Pg. 22-28, 30-33, 95, 107-114, 169-171, 403-404, 407-415
Ref. 3. Pg. 527-532

Aims and Objectives

Student should know,

1. Principles of common ion effect and solubility product
2. Formation of complex ion
3. Factors affecting on solubility of precipitation
4. Phenomenon of super saturation and precipitation formation
5. Meaning of co-precipitation and post precipitation
6. Choice of liquid for washing the precipitate
7. Precautions during filtration, drying and ignition of precipitate
8. Conceptual understanding of electrogravimetric principle
9. Numerical Problems

2. Thermal methods of analysis (06L)

Principle of thermal analysis, classification of thermal techniques, Principle, instrumentation and applications of TGA and DTA, factors affecting the thermal analysis, numerical problem.

Aims and Objectives

Student should know,

1. Methods of thermo gravimetric analysis

2. Principles of TGA and DTA
3. Types of TGA
4. Relation between TGA and DTA
5. Thermal equation of TGA
6. Different factors affecting TGA curve
7. Determination of calcium oxalate precursor
8. Applications of TGA, DTA and DSC

Ref. 1. Pg. 515-527,531-537

Ref. 6 Pg. 732-737

3. Spectrophotometry (10 L)

Introduction, Electromagnetic spectrum, Interaction of electromagnetic radiations with the matter, Mathematical Statement and derivation of Lambert's Law and Beer's Law, Terminology involved in spectrophotometric analysis, Instrumentation of single beamcolorimeter, Instrumentation of single and double beam spectrophotometer, Principle of additivity of absorbance and simultaneous determination, Spectrophotometric Titrations, Experimental Applications-Structure of organic compounds, Structure of complexes, Numerical Problems

Ref. 1 Pg. 693-705

Ref. 3 Pg. 144-153, 157-160, 170-174

Aims and Objectives

Student should know,
1. Principles of Spectrophotometric analysis and properties of electromagnetic radiations
2. Different Terms like absorbance, transmittance, and molar absorptivity
3. Mathematical Statement and derivation of Lambert's Law and Beer's Law
4. Different wavelength selectors and their importance
5. Instrumentation and working of single and double beam spectrophotometer
6. Additivity Principle
7. Different methods of color comparators
8. Applications
9. Numerical Problems

4. Polarography (08 L)

Introduction to voltammetric methods of analysis, Principles of polarographic analysis, Dropping Mercury Electrode, Instrument and working of polarographic apparatus, Ilkovic equation and quantitative analysis, Polarogram and chemical analysis, Analysis of mixture of cations, Factors affecting polarographic wave, Quantitative Applications, Numerical Problems

Ref.6. 691-734

Aims and Objectives

Student should know,
1. Voltammetry and polarography as an analytical tool
2. Construction, working, advantages and disadvantages of DME

3. Different terms involved in Ilkovic equation
4. Determination of Zn and Cd from the mixture
5. Significance of the different terms involved.
6. Need of removal of dissolved oxygen from analyte solution
4. Applications and numerical problems

5. Atomic Absorption Spectroscopy (06 L)

Introduction and theory of atomic absorption spectroscopy, Instrumentation of single beam atomic absorption Spectrophotometer, Measurement of absorbance of atomic species by AAS, Spectral and Chemical Interferences, Qualitative and Quantitative Applications of AAS. Numerical Problems.

Ref. 3. Pg. 321-342

Aims and Objectives
Student should know,
1. Atomic absorption spectroscopy as an analytical tool
2. Measurement of absorbance of atoms by AAS.
3. Interferences in atomic absorption spectroscopy
4. Applications and numerical problems

6. Flame Emission Spectroscopy (06 L)

Introduction and theory of atomic emission spectroscopy, Instrumentation of single beam flame emission spectrophotometer, Measurement of emission of atomic species, Interferences in emission spectroscopy, Methods of analysis- calibration curve method, Standard addition method, and internal, standard method, Qualitative and Quantitative Applications of FES, Numerical Problems.

Ref. 3. Pg. 321-322, 336-341, 364-370, 372-376

Aims and Objectives
Student should know,
1. Emission spectroscopy as an analytical tool
2. Measurement of emission of atomic species
3. Different methods of analysis
4. Application and numerical problems.

References
Ref.1 Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I. Vogel
Ref.2 Principles of Physical Chemistry 4th edition – Prutton and Marron
Ref.3 Instrumental Methods of Chemical Analysis- Chatwal and Anand
Ref.4 Basic Concept of Analytical Chemistry-2nd edition S.M. Khopkar
Ref.5 Vogel's textbook of Quantitative Inorganic Analysis-4th edition
Besset Denney, Jaffrey, Mendham
Ref.6 Instrumental Methods of Chemical Analysis- 6th edition
Willard, Merritt, Dean and Settle
Ref.7 Analytical Chemistry by Skoog
Ref.8 Introduction to Instrumental Analysis- R.D. Braun
Ref.9 Instrumental methods of Chemical Analysis-Willard, Dean & Merrit-6th Edition

Semester-IV

Course: Analytical Chemistry (CH-344)

Sr. No.	Topic	No. of Lectures
1	Solvent Extraction	08
2	Chromatography	10
3	Gas Chromatography	09
4	High Performance Liquid Chromatography	09
5	Electrophoresis	06
6	Nephelometry and Turbidimetry	06
Total Lectures		**48**

1. Solvent Extraction (08L)

Introduction, Principle of solvent extraction, Distribution coefficient, distribution ratio, relationbetween Distribution coefficient and distribution ratio, factors affecting solvent extraction,percentage extracted, solvent extraction method, separation factor, batch extraction, counter currentextraction, application of solvent extraction, numerical problems.

References: 3,4,7,9 relevant pages**.**

Aims and Objectives

A student should know,

i) Principles of solvent extraction.

ii) Difference between KD and D

iii) Various types of techniques of solvent extraction such as-

(a) extraction (b) continuous extraction (c) counter current extraction.

iv) Difference between batch and multiple extraction.

v) Advantages and applications of solvent extraction.

vi) To solve the numerical problems.

2. Chromatography (10L)

Introduction and classification of chromatographic methods, Principle of chromatographic analysis with match box model, Theoretical plates and column efficiency, Theory, Principle, technique and applications of-Column Chromatography, Ion exchange Chromatography, Thin layer Chromatography, Paper Chromatography, Numerical Problems

Ref. 1-8 Relevant pages

Aims and Objectives

Student should know:

1. Principle of chromatographic methods
2. Relation between theoretical plates and column efficiency
3. Technique and applications of- Column Chromatography,
4. Technique and applications of- Thin layer Chromatography
5. Technique and applications of- Paper Chromatography

6. Technique and applications of- Ion exchange Chromatography
7. Numerical Problem

3. Gas Chromatography (09 L)

Introduction, Theory, Principle, GSC and GLC, Separation mechanism involved in GSC and GLC, Instrumentation of Gas chromatography, Working of gas chromatography,Gas chromatogram and qualitative-quantitative analysis, Applications of gas chromatography

Ref. 1. Pg. 167-174

Ref. 4. Pg. 454-464

Ref. 5 Pg. 624-640

Aims and Objectives
Student should know,
1 Principle of GSC and GLC analysis
2. Separation mechanism involved in GSC and GLC
3. Instrumentation- stationary phases, column types, detectors
4. Working of gas chromatographic apparatus.
4. Chromatogram and use in qualitative-quantitative analysis
5. Applications of gas chromatography

4. High Performance Liquid Chromatography (09 L)

Introduction, Need of liquid chromatography, Separation mechanism involved in adsorption and partition HPLC, Instrumentation and working of HPLC, Applications of HPLC, Introduction to supercritical fluid chromatography

Ref. 6. Pg. 529-545

Ref. 4. Pg. 178-183

Aims and Objectives
Student should know,
1 Need of liquid chromatography
2. Separation mechanism involved in adsorption and partition HPLC
3. Instrumentation and working of HPLC
4. Applications of HPLC
5. Advantages of supercritical fluid chromatography

5. Electrophoresis (06L)

Introduction, Principle and theory of electrophoresis, Different types of electrophoresis techniques, Moving Boundary Electrophoresis, Zone electrophoresis- Paper, Cellulose acetate and Gel electrophoresis, Applications of electrophoresis

Ref. 3 and Ref. 4 relevant pages

Aims and Objectives
Student should know,
1 Comparison between electrophoresis and chromatography

2. Principle and theory of electrophoresis
3. Different types of electrophoresis techniques
Applications of electrophoresis

6. Nephelometry and Turbidimetry (06L)

Introduction, Principles and instrumentation of Nephelometric and Turbidimetric analysis, Difference between Nephelometric and Turbidimetric measurements, Choice between Nephelometry and Turbidimetry, Factors affecting Nephelometric and Turbidimetric measurements, Quantitative Applications, Numerical Problems

Ref.1. Pg.781-785

Ref.3. Pg.380-390

Aims and Objectives
Student should know,
1. Nephelometry and Turbidimetry as an analytical tool
2. Measurement of turbidance
3. Difference between Nephelometry and Turbidimetry
4. Application and numerical problems

List of References

Ref.1 Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I. Vogel

Ref.2 Principles of Physical Chemistry 4th edition – Prutton and Marron

Ref.3 Instrumental Methods of Chemical Analysis- Chatwal and Anand

Ref.4 Basic Concept of Analytical Chemistry-2nd edition S.M. Khopkar

Ref.5 Vogel's textbook of Quantitative Inorganic Analysis-4th edition
Besset Denney, Jaffrey, Mendham

Ref.6 Instrumental Methods of Chemical Analysis- 6th edition
Willard, Merritt, Dean and Settle

Ref.7 Analytical Chemistry by Skoog

Ref.8 Introduction to Instrumental Analysis- R.D. Braun

Ref.9 Instrumental methods of Chemical Analysis-Willard, Dean & Merrit-6th Edition

Semester- III

Course: Industrial Chemistry (CH-335)

Topics	No. of lectures
1. Modern Approach to Chemical Industry	08
2. Agrochemicals	08
3. Manufacture of Basic Chemicals	08
4. Petrochemicals and eco-friendly fuels	08
5. Food and Starch Industry	08
6. Cement and Glass industry	08
Total Lectures	**48**

1. Modern Approach to Chemical Industry (08)

Introduction, basic requirements of chemical industries, chemical production, raw materials, unit process and unit operations, Quality control, quality assurance, process control, research and development, pollution control, human resource, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity and yield, copy right act, patent act, trade marks

Ref. 1: Chapter 2 (relevant pages)

2. www.wikipedia.org/wiki/copyright_act_of1976

3. www.wikipedia.org/wiki/patentact

4. www.wikipedia.org/wiki/trademark

2. Agrochemicals (08)

General introduction and scope of agrochemicals, meaning and examples of: Insecticides, Herbicides, Fungicides, Rodenticides, Pesticides, Plant growth regulators. Pesticide formulation, slow release pesticide formulations, storage stability test, and Industrial entomology. Advantages and disadvantages of agrochemicals. Structure,: DDT, BHC, Warfarin, Aldrin, Endosulphan,synthesis and application:DDT, BHC andEndosulphan. Biopesticides like Neem oil and Karanj oil.

Ref. No. 5-7

3. Manufacture of Basic Chemicals (08)

a) Ammonia: Physicochemical principles involved, Manufacture of ammonia by modified Haber-Bosch process, its uses.

b) Sulphuric acid: Physicochemical principles involved, Manufacture of sulphuricacid by contact process, its uses.

c) Nitric acid: Physicochemical principles involved, Manufacture of nitric acid by Ostwald's process, its uses.

Ref.No.1: P.No. 571 to 588, 618 to 664

4. Petrochemicals and eco-friendly fuels (08)

a) Introduction, occurrence, composition of petroleum, resources, processing of petroleum, calorific value of fuel, cracking, octane rating (octane number), cetane number, flash

point, and petroleum refineries, applications of petrochemicals, synthetic petroleum, lubricating oils & additives

b) *Fuels and eco-friendly fuels:* liquid, gaseous fuel (LPG, CNG), fossil fuels, diesel, bio diesel, gasoline, aviation fuels. Use of solar energy for power generation.

Ref. 15, 16, 17

5. Food and Starch Industry (08)

Food Industry:

(a) Definition and scope, nutritive aspects of food constituents, , food deterioration factors and their control; (b) Preservation and processing: Heat and cold preservation and processing, cold storage, food dehydration and concentration, various foods, their processing and preservation methods, fruits, beverages, cereals, grains, legumes and oil seeds; (c) Food additives: Enhancers, sugar substitutes, sweeteners, food colors,

Ref.12

Starch industries:

Chemistry of starch, manufacturing of industrial starch and its applications, characteristics of some food starches, non-starch polysaccharides-cellulose-occurrence.

Ref. 11

6. Cement and Glass industry (08)

Cement industry:

Introduction, Importance, composition of portland cement, raw materials, proportioning of raw materials, setting and Hardening of cement, reinforced concrete.

Ref.1: P.No. 313-333 Ref. 8: P.No173-176, Ref. 10: P.No.188-192

Glass industry

Introduction, importance, physical and chemical properties of glass, chemical reaction, annealing of glass Special glasses: colored, safety, hard, borosilicate, optical, photosensitive, conducting, glass laminates.

Ref.1: *P. No*.160-171;Ref. 8: *P. No*. 247-265; Ref.9: *P. No*. 197-212

Aims and objectives

1. Modern Approach to Chemical Industry

The students are expected to learn;

i. Importance of chemical industry,

ii. Meaning of the terms involved,

iii. Comparison between batch and continuous process,

iv. Knowledge of various industrial aspects

2. Agrochemicals

Students should know the

i. Various insecticides,

ii. Pesticides,
iii. Fungicides,
iv. Rodenticides &biopesticides used in agriculture field with their synthesis and applications.

3. Manufacture of Basic Chemicals

Students should know the
i. Concept of basic chemicals,
ii. their uses and manufacturing process.
iii. They should also know the physic chemicals principals involved in manufacturing process

4. Petrochemicals and eco-friendly fuels

Introduction, occurrence, composition of petroleum, resources, processing of petroleum, other properties
Fuels and eco-friendly fuels, use of solar energy etc.

5. Food and Starch Industry

Food Industry:

Students should know
i. Scope,
ii. Nutritive aspects of food constituents,
iii. Quality factors and their measurements,
iv. Food deterioration factors and their control;
v. Food preservation and Food additives

Starch Industry:

Students should know about the
i. Chemistry of starch,
ii. Manufacturing of industrial starch and its applications,
iii. Characteristics of some food starches,
iv. Non-starch polysaccharides-cellulose-occurrence

6. Cement and Glass industry

Cement industry

The students are expected to
i. Learn importance of these industries,
ii. Manufacture of cement by modern methods
iii. Definition of setting and hardening
iv. Reinforced concrete

Glass industry

The students are expected
i. To learn about making of glass by different methods,
ii. Various operations involved in the manufacture and compositions,
iii. Properties and uses of special glasses.

References

1. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Mirut, Chapter 2 (relevant pages)
2. www.wikipedia.org/wiki/copyright_act_of1976
3. www.wikipedia.org/wiki/patentact
4. www.wikipedia.org/wiki/trademark
5. Insects and Pesticides, Saxena A B, Anmol Publications
6. Emergency Medicine: Chapter 146 Insecticides, Herbicides & Rodenticides, by James Adams
7. Growth Regulators in Agriculture and Horticulture, by Amarjit Basra, CRC Press, 2000
8. Shreeve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
9. Riegel`s hand book of Industrial chemistry, 9th Edition, Jems A. Kent
10. Industrial chemistry –R.K. Das, 2nd Edition, 1976.
11. Chemistry and industry of starch, New York, N.Y., Academic Press, incby Kerr, Ralph Waldo Emerson
12. The Complete Manual Of Small-Scale Food Processing, by Peter Fellows, Practical Action Pub
13. Polymeric Materials, C. C. Winding and G. D. Hiatt McGraw Hill Book Co. Polymer Science by Gowarikar
14. Polymer science, Bill Meyer, F. W. Jr. John Wiley& sons
15. The Petroleum chemicals industry by R. F. Goldstine, e &Fn London
16. Fundamentals of petroleum chemical technology by P Below.
17. Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company
18. Perfumes Soaps Detergents & Cosmetics (Soaps & Detergents) (Volume 1) 1st Edition, CBS Publisher
19. Dyes & Paints: A Hands-On Guide to Coloring Fabric, by Elin Noble

Semester- IV
Course: Industrial Chemistry (CH-345)

Topics	No. of lectures
1. Polymer chemistry	10
2. Sugar and Fermentation Industry	08
3. Soap, detergents and Cosmetics	08
4. Dyes and paints	08
5. Chemistry of pharmaceutical industries	08
6. Pollution prevention and waste management	06
Total Lectures	**48**

1. Polymer chemistry (10)

Classification of Polymers: Organic and Inorganic polymers

(a) Basic concepts, nomenclature, degree of polymerization, classification of polymerization reactions, thermodynamic and transport properties of polymer

b)*Commercial polymers and their importance:* (a) Nylon, polyesters (terylene and dacron), rubber, vulcanization of rubber, synthetic rubber, Bun 2-N rubber, copolymers of butadiene, PVC, acrylic, teflon, polyethylene and acrylonitrile; (b) Silicone polymers: silicone oils, rubber, grease and resin; (c) Resins: Phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins, melamine-formaldehyde resins;

Ref. 13, 14

2. Sugar and Fermentation Industry (08)

Sugar: Occurrence, Manufacturing of refine cane sugar from sugar cane, general idea of carbonation and sulphitation processes and their comparison, by-product and their use.

Ref.8-10

Fermentation Industry:

Introduction, importance, Basic requirement of fermentation process, Manufacture of industrial alcohol from molasses, fruits, food grains, & ethylene, Manufacturing of wine, beer, whisky, rum ; importance Power alcohol

Ref. 1, 8-10

3. Soap, detergents and Cosmetics (08)

A. Chemistry of soap, row material, chemical reaction, types of soap.
B. Meaning of the terms detergent and surfactants, emulsion and emulsifying agents, wetting and non-wetting, hydrophobic and hydrophilic nature, amphipathic structures, types of surfactants, raw materials for detergents, washing action of soaps and detergents, detergent builders, additives.

C. Raw materials: emulsifiers (natural, synthetic and finely dispersed solids), lipid components (oils, waxes, fats), humectants, colours (dyes and pigments), preservatives and antioxidants. (b) Cosmetics for skin: Types and problems of skin, key ingredients of skin cleansing, toners, moisturizers, nourishing, protective sunscreen, talcum powder and bleaching products. (c) Hair care: classification, ingredients, special additives for conditioning and scalp health, hair colourants (temporary, semi-permanent and gradual colourants), the plant materials (herbs) used in hair cosmetics.

Ref. 18.

4. Dyes and paints

(a)*Dyes:* Introduction, classification of dyes: Structures and applications, nitro, nitroso, azo, heterocyclic, phthalenes, xanthenes, rhodamines, thiazine, cyanine, anthraquinone, indigoids, thioindigoids, phthalocyanines, wet dyes.

(b) *Paints:* Introduction of paints, ingredients and classification, new technologies; properties of coatings; solvents, plasticizers, dyes and bioactive additives;

(c) *Pigments:* Introduction, classification and general physical properties.

Ref.1: P. No.777-814; Ref.9: P. No.863-915 ;Ref.10 Relevant page
Ref. 19.

5. Chemistry of pharmaceutical industries (08)

a. *General aspects of drug action:* Introduction, classification, nomenclature, structure-activity relationship, action of drugs, factors affecting drug action, metabolism of drugs, chemical structures, methods of production and pharmacological activity.

b. Meaning of the terms: Prescriptions, doses, analgesic, antipyretic, diuretic, anesthetics, antibiotics, anti-inflammatory, anti-viral, tranquilizer, antiulcer, antialargic and bronchodilators, cardiovascular, cold preparations, anti-hypertensive, cough preparation, anti-neoplastic, sedative and hypnotics, steroidal, contraceptive, histamine and antihistamine.

c. Synthesis and uses: Paracetamol, Aspirin, Sulphanilamide.

Ref.1: P. No.762-775; Ref.8: P. No.803-804, 818-822 ; Ref.9: P. No.987-1011

6. Pollution prevention and waste management (06)

Introduction, importance of waste management, concept of atom economy, Terms involved in waste minimization: source reduction, recycling, product changes, source control, use and reuse, reclamation, assessment procedures, types of wastes, treatment and disposal of industrial waste. Treatment of wastes or effluents with organic impurities.Treatment of wastes or effluents with inorganic impurities. The nature, effect and treatment of some important chemical wastes-(Pulp and paper industries, soap and detergent industries and food processing
industries).

Ref. 1: P.No. 8-92; Ref.6: P.No. 15-30;
Ref. www.wikipedia.org/atom economy

Aims and Objectives:

1. Polymer chemistry

Students should know

i. Basics of polymer,
ii. ii. Nomenclature,
iii. Degree of polymerization,
iv. Classification of polymerization reactions,
v. Thermodynamic and transport properties of polymer,
vi. Commercial polymers and their importance,
vii. Biomedical polymers: implants,
viii. Contact lens and dental polymers.

2. Sugar and Fermentation Industry

The students are expected to learn

i. Importance of sugar industry,
ii. Manufacture of direct
iii. Consumption (plantation white) sugar with flow diagram.
iv. Cane juice extraction by various methods,
v. Clarification by processes like carbonation,
vi. Sulphitation,
vii. Phosphatation, etc.
viii. Concentration of juice by using multiple effect evaporator system,
ix. Crystallization of sucrose by using vacuum pan.

Fermentation Industry

i. Importance,
ii. Basic requirement of fermentation process,
iii. Manufacturing of ethyl alcohol by using molasses,
iv. Food grains, fruits & ethylene.
v. Manufacturing of wine, beer, whisky, rum etc.

3. Soap, detergents and Cosmetics

Students should know about

i. Different types of soap products,
ii. Chemistry of soap.
iii. Students should know about various cosmetics,
iv. Raw materials,
v. Properties and various types of cosmetics used.
i. Meaning of the terms detergent,
ii. Surfactants, emulsion and emulsifying agents,
iii. Wetting and non-wetting,
iv. Hydrophobic and hydrophilic nature,
v. Amphipathic structures,
vi. Types of surfactants,
vii. Raw materials for detergents,

viii. Washing action and detergents,
ix. Detergent builders, additives.

4. Dyes and paints

Students should know about

i. *Dyes:* introduction,
ii. Dye intermediates,
iii. Preparation of dye intermediates,
iv. Structural features of a dye;
v. Classification of dyes,
vi. Structures and applications,
vii. Nitro, nitroso,
viii. Azo, heterocyclic,
ix. Phthalenes,
x. Xanthenes,
xi. Rhodamines,
xii. Thiazine,
xiii. Cyanine,
xiv. Anthraquinone,
xv. Indigoids,
xvi. Thioindigoids,
xvii. Phthalocyanines, wet dyes.

(b) *Paints:*

i. Introduction of paints,
ii. Ingredients and classification,
iii. New technologies;
iv. Properties of coatings;
v. Solvents, plasticizers, dyes and bioactive additives.

(b) *Pigments:*

i. Introduction,
ii. Classification and general physical properties.

5. Chemistry of pharmaceutical industries

Students should know about

i. *General aspects of drug action:*
ii. Introduction, classification,
iii. Nomenclature,
iv. Structure-activity relationship,
v. Action of drugs,
vi. Assay of drugs and factors affecting drug action,
vii. Metabolism of drugs,
viii. Chemical structures,
ix. Methods of production and pharmacological activity.
x. Meaning of the terms of the various drugs.
xi. Synthesis and uses of few drug molecules.

6. Pollution prevention and waste management

The students are expected to learn all the problems of pollution and deposal of waste of various industries.

References

1. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Mirut, Chapter 2 (relevant pages)
2. www.wikipedia.org/wiki/copyright_act_of1976
3. www.wikipedia.org/wiki/patentact
4. www.wikipedia.org/wiki/trademark
5. Insects and Pesticides, Saxena A B, Anmol Publications
6. Emergency Medicine: Chapter 146 Insecticides, Herbicides & Rodenticides, by James Adams
7. Growth Regulators in Agriculture and Horticulture, by Amarjit Basra, CRC Press, 2000
8. Shreeve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
9. Riegel`s hand book of Industrial chemistry, 9th Edition, James A. Kent
10. Industrial chemistry –R.K. Das, 2nd Edition, 1976.
11. Chemistry and industry of starch, New York, N.Y., Academic Press, incby Kerr, Ralph Waldo Emerson
12. The Complete Manual Of Small-Scale Food Processing, by Peter Fellows, Practical Action Pub
13. Polymeric Materials, C. C. Winding and G. D. Hiatt McGraw Hill Book Co. Polymer Science by Gowarikar
14. Polymer science, Bill Meyer, F. W. Jr. John Wiley& sons
15. The Petroleum chemicals industry by R. F. Goldstine, e &fn London
16. Fundamentals of petroleum chemical technology by P Below.
17. Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company
18. Perfumes Soaps Detergents & Cosmetics (Soaps & Detergents) (Volume 1) 1st Edition, CBS Publisher
19. Dyes & Paints: A Hands-On Guide to Coloring Fabric, by Elin Noble

Optional Course

Semester-III

Course: Nuclear Chemistry (CH-336A)

Topic	No. of Lectures
1. The Atomic Nucleus, Properties of Nucleons and Nuclei	08
2. Nuclear Models	12
3. Radioactivity	16
4. Nuclear Reactions	12
Total Lectures	**48**

1. The Atomic Nucleus, Properties of Nucleons and Nuclei (08 L)

The atom, Elementary particles, Sub-nucleons, quarks, The nucleus and outer sphere, Classification of nuclides, Nuclear stability, Even-odd nature, N/Z ratio, The Nuclear potential, Binding energy, Binding energy calculations.
The nucleus, its size, shape and radius, Mechanical effects due to orbiting and spinning of nucleons, Magnetic quantum numbers, principal and radial quantum number.

Ref.1: pages 1 to 13 and19 to 25.

2. Nuclear Models (12 L)

Historical, The shell model, Periodicity in nuclear properties: the magic numbers, The salient features of shell model, The sequence of filling the orbit, Rectangular well potential model, Harmonic oscillator potential model, Spin-orbit coupling model, Nuclear configuration of lighter nuclides ($Z < 20$), Merits of the shell model, The liquid drop model, The semi-empirical mass equation, Merits of the liquid drop model, Limitations of liquid drop model.

Ref.1 pages 64 to 69, 72 to 84 and 91 to 92.

Ref.2 pages 464 to 469

3. Radioactivity (16 L)

Discovery, Types of radioactive decay, Decay schemes,General characteristics of radioactive decays, decay kinetics, units of radioactivity, problem solving on decay kinetics.

Alpha decay: Alpha active nuclides, The alpha energy spectrum,Geiger-Nuttals law, The theory of alpha decay. **Beta decay:** Types of beta decay, absorption and range through matter, Fermi theory of beta decay. (Mathematical details are not expected) **Gamma decay:** Nuclear isomerism and isomeric transitions, internal conversion, Auger effect.

Ref.1 pages 100 to 106,120 to 135, 138 to 142, and 150 to 154.

4. Nuclear Reactions (12 L)

Bethe's notation, Types of nuclear reactions, Conservation of nuclear reactions (Conservation of protons and neutrons, Conservation of momentum and energy), Reaction cross-section, The compound nucleus theory, Calculations of excitation energy of compound nucleus, Photonuclear reactions, Thermonuclear reactions.

Ref.1 pages 160 to 174 and 192 to 196.

Aims and objectives:

1. The Atomic Nucleus, Properties of Nucleons and Nuclei:

The students are expected to know the following from this topic.

a) The atom, elementary particles,sub-nucleons and the quarks.

b) Classification of nuclides, isotopes, isobars, isotones and isomers.

c) Nuclear stability on the basis of even-odd nature of Z and N, N/Z ratio. d) The binding energy

e) The nucleus, its size and shape, mechanical effects due to orbiting and spinning ofnucleons, Magnetic quantum numbers, principal and radial quantum number.

2. Nuclear Models:

By studying this topic students are expected to understand

a) The Shell model
b) Magic number
c) Salient features of shell model
d) Nuclear configuration
e) The liquid drop model
f) Semi-empirical mass equation

3. Radioactivity:

By studying this topic students are expected to understand

a) Types of radioactive decay, decay kinetics and their general characteristics.

b) Alpha decay, Beta decay and gamma decay

c) Nuclear isomerism, isomeric transitions, internal conversion, Auger effect.

4. Nuclear Reactions:

The students are expected to understand,

a) Bethe's notation

b) Different types of Nuclear reactions.

c) Conservation in nuclear reaction

d) Excitation energy of compound nucleus

References:

1. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th Revised Edition, New Age International Publishers.

2. Source book of Atomic energy by Samuel Glasstone, 3rd edition, East -West press.

Semester-IV

Course: Nuclear Chemistry (CH-346A)

Topic	No. of Lectures
1. Nuclear Fission	10
2. Nuclear Reactors	08
3. Nuclear Accelerators	08
4. Detection and measurement of nuclear radiations	08
5. Applications of Radioactivity	10
6. Radiation Safety precautions	04
Total Lectures	**48**

1. Nuclear Fission (10 L)

Introduction, Discovery of nuclear fission, The process of nuclear fission, Fission fragments and their mass distribution, Fission energy, Fission cross-section and thresholds, Fission neutrons, Theory of nuclear fission**.**

Ref.1: pages 209 to 225

2. Nuclear Reactors (08 L)

The fission energy, The natural uranium reactor, The four factor formula, The classification of reactors. Reactor power, Critical size of a thermal reactor, Breeder reactor, The fast breeder test reactor at Kalpakkam, India's nuclear energy programme.

Ref.1: pages 232 to 249

3. Nuclear Accelerators (08 L)

Electrostatic Accelerators, The cockcroft-walton Accelerator,The Vande-Graft Accelerator, Cyclic Accelerator, Linear Accelerator**.**

Ref: 2 Pages 290 to 305,325 to 330

4. Detection and measurement of nuclear radiations (08 L)

Scintillation Counters, Semiconductor detectors, Neutron detectors.

Ref.2 Pages 211 to 222.

5. Applications of Radioactivity (10 L)

Probing by isotopes, Typical reactions involved in the preparation of radioisotopes, Szilard-Chalmer reaction, Cow and milk system, Use of charged plates in the collection of radioisotopes, Radiochemical principles in the use of tracers, Analytical applications: Isotope dilution analysis, Neutron activation analysis, Radiometric titrations, Numericals, medical applications a) thyroidisis (goitre), b) radioimmunoassay.

Ref.1 Pages 309 to 328, 338 to 345

6. Radiation Safety precautions (04 L)

Safety standards, safe working methods, biological effects of radiations, nuclear waste and its management.

Ref.3 Pages 322 to 328

Aims and objectives:

1. Nuclear Fission:

By studying this topic students are expected to understand

a) Discovery of nuclear fission

b) The process of nuclear fission

c) The charge distribution

d) Fission energy

e) Theory of nuclear fission

2. Nuclear Reactors

The students are expected to know the following from this topic

a) the natural Uranium reactor, The breeder reactor

b) the four factor formula

c) Classification of reactors. d) India's Nuclear Energy programme

3. Nuclear Accelerators:

The student should understand

a) Principle and working of various accelerators

b) What are the electrostatic accelerators?

4. Detection and measurement of nuclear radiations

The aims and objectives are as follows

a) Gaseous ionization and its applications

b) Principle and working of Scintillation Counters , Semiconductor detectors, Neutrondetectors

5. Applications of Radioactivity

The students are expected to know the following from this topic

a) The Probing by isotopes.

b) Typical reactions involved in the preparation of radioisotopes

c) Szilard-Chalmer reaction

d) Analytical applications – Isotope Dilution Analysis, Neutron Activation Analysis, Radiometric Titrations

e) Medical applications such as thyrodisis and radioimmunoassay.

6. Radiation Safety precautions

By studying this topic students are expected to understand

a) Biological effects of radiations, safety standards, safe working methods
b) Reprocessing of the nuclear waste and its management.

References :

1. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th Revised Edition, New Age International Publishers

2. Source book of Atomic energy by Samuel Glasstone, 3rd edition, East -West press.

3. Nuclear Physics by Irving Kaplan, 2nd edition.

4. Introduction to Nuclear physics and chemistry by B.G. Harvey.

5. Fundamentals of Radiochemistry by D. D. Sud, A.V. R. Reddy and N. Ramamoorthy.

Semester- III

Course: Polymer Chemistry (CH-336B)

Topic	No. of lectures
1. Introduction to Polymer Chemistry	04
2. Mechanism and Nomenclature of Polymers	04
3. Chemistry of Polymerization	10
4. Polymerization Techniques	08
5. Polymer Additives	06
6. Molecular Weights of Polymers	05
7.Silicone and Cellulose Polymers	04
8. Polymer Reactions	07
Total Lectures	**48**

1. Introduction to Polymer Chemistry (04 L)

Brief History, Polymer definition, Preparation, Classification, Structures, Chemical bonding & Molecular forces in Polymers.

Ref. 1: Pages 1-14

Ref. 2: Pages 1-16

Ref. 3: Pages 1-12

Ref. 4: Pages 1-17

Ref. 7: Relevant Pages

Ref. 9: Pages 1-8

2. Mechanism and Nomenclature of Polymers (04 L)

a) Polymerization Mechanism, b) Nomenclature of Polymers-i) Common/Trivial names ii) Source-Based names, iii) Structure-Based names (Non IUPAC), iv) IUPAC Structure-based and Linkage-based nomenclature system and v) Trade names / Brand names & Abbreviations

Ref. 4: Pages 11-25 **Ref. 12: Pages 6-17**

3. Chemistry of Polymerization (10 L)

a) Introduction, b) Chain Polymerization: Free radical Polymerization, Ionic polymerization, Co-ordination polymerization- Ziegler-Natta catalyst c) Step Polymerization: Polycondensation, Polyaddition polymerization, and Ring Opening polymerization.

Ref. 1: Pages 15-64

Ref. 2: Pages 25-32, 49-56, 82-86, 88-89, 91-94

Ref. 3: Relevant Pages

Ref. 4: Relevant Pages

Ref. 6: Relevant Pages

Ref. 9: Pages 22-63

4. Polymerisation Techniques (08 L)

Bulk polymerisation, Solution polymerization, Suspension polymerization, Emulsion polymerization, Melt polycondensation, Solution Polycondensation, Interfacial condensation, electrochemical polymerisation, Salient features of different polymerization techniques

Ref. 1: Pages 71-79, 82-84

Ref. 2: Pages 126-132

Ref. 4: Pages 309-324

Ref. 12: Pages 335-341, 173-175

5. Polymer Additives (06 L)

Fillers & Reinforcement, Plasticizers, Antioxidants & Thermal Stabilizers (Heat Stabilizers), Ultraviolet stabilizers, Fire retardants, Colourants, Antistatic agents & Curing agents.

Ref. 3: Pages 170-176

Ref. 4: Pages 502-512, 528-538

Ref. 10: Relevant Pages

6. Molecular Weights of Polymers (05 L)

a) Average Molecular weight, Number Average & Weight Average Molecular weight, Molecular weight & degree of polymerisation, Practical significance of polymer molecular weights, b) Molecular weight determination by End Group Analysis & Viscosity method and c) Problems based on Number Average & Weight Average Molecular weight

Ref. 1: Pages 86-89, 92, 96-98, 402-409

Ref. 2&4: Relevant Pages

7. Silicone and Cellulose Polymers (04 L)

a) Introduction, Synthesis, Reactions, Uses of Silicone polymers, b) Cellulose & Derivatives of cellulose: Rayon, Cellophane, Cellulose nitrate, Cellulose acetate and their uses.

Ref. 1: Pages 255-261

Ref. 5: Pages 143-155

8. Polymer Reactions (07 L)

Introduction, Hydrolysis, Hydrogenation, Addition and Substitution reactions, Cross-linking reactions, Cure reactions, Reactions of various aliphatic and aromatic pendent groups in polymers.

Ref. 1: Pages 291-297, 306-308, 311-321, Ref. 3: Relevant Pages, Ref. 4: 545-555

Aims and Objectives:

The students are expected to learn the following aspects of Polymer Chemistry

1) History of polymers.
2) Difference between simple compounds and polymer.
3) Names of polymers.
4) Various methods of nomenclature.
5) Difference between natural synthetic, organic and inorganic polymers.
6) Terms-Monomer, Polymer, Polymerization, Degree of polymerization, Functionality, Number average, Weight average molecular weight.
7) Mechanisms of polymerization.
8) Polymerization techniques.
9) Importance of silicone polymers.
10) Derivatives of cellulose polymers & their applications.
11) Ingredients added to polymers.
12) What are fillers.
13) Polymer reactions and applications.
14) Polymer reactions and their effect on physical and chemical properties.
15) Advantages of polymer reactions to change their properties.

Reference Books:

1. Polymer Science by V.R. Gowarikar, N.V.Vishvanathan, JaydevShreedhar New Age International Ltd. Publisher 1996.(Reprint 2012)

2. Textbook of Polymer Science by Fred Billmeyer, 3rdEdn. A Wiely-Interscience Publication John Wiely& Sons New York 1984. (Reprint 2008)

3. Introductory Polymer Chemistry by G.S.Misra New Age International (P) Ltd. Publisher 1996.

4. Polymer Chemistry by Charles E. Carraher (Jr.), 6thEdn, (First Indian Print 2005), New York-Basel.

5. Inorganic Polymers by G.R.Chatwal Himalaya Publishing House 1st Edn.1996

6. Polymer Science – A Text Book by V.K. Ahluwalia, Anuradha Mishra.

7. Principle of Polymer Science by P. Bahadur, N.V. Sastry, 2ndEdn, Narosa Publishing House.

8. Polymer Chemistry by Ayodhya Singh, 2008, Published by Campus Book International, New Delhi.

9. Organic Polymer Chemistry by Jagdamba Singh, R.C. Dubey, 4thEdn, 2012.

10. Advanced Polymer Chemistry by V.K. Selvaraj, 1stEdn, 2008, Published by Campus International, New Delhi.

11. Organic Polymer Chemistry by V. Jain, IVY Publishing House, New Delhi.

12. Principles of Polymerisation by George Odian3rdEdn. John Wiely& Sons New York.

Semester- IV

Course: Polymer Chemistry (CH-346B)

Topic	No. of lectures
1. Polymer Degradation	03
2. Chemical and Geometrical structures of Polymer Molecules	04
3. Glass Transition Temperature and Heat Distortion Temperature (Softening Point)	05
4. Crystallinity in polymers	04
5. Some Important Polymers	08
6. Analysis and testing of polymers	06
7. Some Special Polymers	06
8. Polymer Processing	12
Total Lectures	**48**

1. Polymer Degradation (03 L)

Introduction, Types of Degradation, Thermal degradation, Mechanical degradation, Photo degradation.

Ref. 1: Pages 262 – 277 Ref. 3: Pages 151-160

Ref. 4: Relevant Pages Ref. 11: Pages 60-65

2. Chemical and Geometrical structures of Polymer Molecules (04 L)

a) Microstructures based on chemical structures-Organic & Inorganic polymers, Homochain&Heterochain polymers, Homopolymers& Copolymers, b) Microstructures based on geometrical structures-Interpenetrating coils, Folded chain, Helical chain, Linear, Branched, Random, Alternating, Graft and Block polymers and c) Stereo-regular polymers-Optical and Geometric Isomerism.

Ref 1: Pages 136-149 Ref 4: Relevant Pages

3. Glass Transition Temperature (GTT) and Heat Distortion Temperature(Softening Point)**(05 L)**

Definition, Factors influencing the Glass transition temperature, Glass transition temperature and molecular weight, Glass transition temperature and plasticizers, Glass Transition Temperature and Crystalline melting point (Tm), Importance of Glass transition temperature.

Ref 1: Pages 150, 163-169, 171-172, 219 Ref 4: Relevant pages

Ref 9: Page 113-116 Ref 10: Pages 47-58

4. Crystallinity in polymers (04 L)

Introduction, Degree of Crystallinity, Crystallisability, crystallites, Factors affecting crystallisability, Effect of crystallinity on the properties of polymers.

Ref. 1: Pages 173-177, 180-183, 189-191, Ref. 5: Pages 69-74, Ref. 9: Pages 103-112

5. Some Important Polymers (08 L)

Polystyrene, Polymethylmethacrylate, Polyester, Polycarbonates, Polyamides, Polyvinyl alcohol (PVA), Polyvinyl chloride (PVC), Polytetrafluoroethylene (Teflon) &polyvinyl fluoride, lyisoprene, Polyimide, Phenol formaldehyde resin (Novolac), Urea formaldehyde resin, Epoxy polymers.

Ref. 1: Pages 213-254, **Ref. 3: Relevant Pages**

Ref. 4: Relevant Pages, **Ref. 8: Relevant Pages**

6. Analysis and testing of polymers **(06 L)**

a) Spectroscopic Methods: IR, NMR, b) Thermal analysis: Differential Scanning Calorimeter (DSC), &Thermo Gravimetric Analysis (TGA), c) Physical testing: Mechanical properties, Thermal properties, Optical properties, Electrical properties, Chemical properties.

Ref 2: Pages 229-237, 242-252, **Ref 4: Pages 121-139**

7. Some Special Polymers **(06 L)**

Polymer blends, Bio-medical polymers, Biodegradable polymers, Liquid Crystalline polymers (LC's), Conducting polymers, thermally stable polymers, Optical fibers,

Ref. 4: Relevant Pages, **Ref. 6: Pages 179,185,197**

Ref.7: Pages 262-299, **Ref. 9: Pages 130-162**

8. Polymer Processing **(12 L)**

a) Plastic Technology **(04)**

1) Molding 2) Extrusion 3) Other processing methods: Calendaring, Film Casting, Coating, Foaming, Forming, Laminating & Low pressure molding, Compounding.

Ref. 2: Pages 457-469, 474-475., **Ref. 1, 4, 6, 7, 9: Relevant pages**

b) Fiber Technology **(04)**

1) Introduction, Textile & Fabric properties, 2) Fiber Spinning: i) Melt spinning ii) Dry spinning iii) Wet spinning and 3) Fiber after treatments: Scouring, Lubrications, Sizing, Dyeing, Finishing, Texture yarns, Nonwoven fabrics.

Ref 2: Pages 486-501, **Ref. 1, 4, 6, 7, 9: Relevant pages**

c) Elastomer Technology **(04)**

1) Introduction, Vulcanization (Sulphur& non sulphur vulcanization), 2) Reinforcement, Elastomer Compounding.

Ref. 2: Pages 506-518 , **Ref. 1, 4, 6, 7, 9: Relevant pages**

Aims and Objectives

The students are expected to learn the following aspects of Polymer Chemistry

1) What is polymer degradation?
2) Chemical and geometric structures of polymers.
3) Important polymers like PVC, polystyrene, polyvinyl alcohol, Teflon, Resins, nylon, epoxy polymers, etc.

4) Uses & properties of polymers.
5) Role of polymer industry in the economy.
6) Advantages of polymers.
7) Some industrially important polymers
8) What is polymer processing?
9) Different polymer processing techniques.
10) Polymer testing and analysis.
11) Properties of polymers & testing.
12) Various fiber spinning techniques.
13) Reinforcement & compounding of polymers.

Reference Books:

1. Polymer Science by V.R. Gowarikar, N.V.Vishvanathan, JaydevShreedhar New Age International Ltd. Publisher 1996.(Reprint 2012)
2. Textbook of Polymer Science by Fred Billmeyer, 3rd Edn. A Wiely-Interscience Publication John Wiely& Sons New York 1984. (Reprint 2008)
3. Introductory Polymer Chemistry by G.S.Misra New Age International (P) Ltd. Publisher 1996.
4. Polymer Chemistry by Charles E. Carraher (Jr.), 6th Edn, (First Indian Print 2005), New York-Basel.
5. Inorganic Polymers by G.R.Chatwal Himalaya Publishing House 1st Edn.1996
6. Polymer Science – A Text Book by V.K. Ahluwalia, Anuradha Mishra.
7. Principle of Polymer Science by P. Bahadur, N.V. Sastry, 2nd Edn, Narosa Publishing House.
8. Polymer Chemistry by Ayodhya Singh, 2008, Published by Campus Book International, New Delhi.
9. Organic Polymer Chemistry by Jagdamba Singh, R.C. Dubey, 4th Edn, 2012.
10. Advanced Polymer Chemistry by V.K. Selvaraj, 1st Edn, 2008, Published by Campus International, New Delhi.
11. Organic Polymer Chemistry by V. Jain, IVY Publishing House, New Delhi.
12. Principles of Polymerisation by George Odian3rd Edn. John Wiely& Sons New YorkYork.

Semester- III

Course: Introduction To Biochemistry And Molecular Biology (CH-336C)

Name of the Topic	Number of lectures
1. Amino acids and Proteins	11
2. Carbohydrates	06
3. Lipids	06
4. Hormones	03
5. Enzymes	07
6. Vitamins and Coenzymes	04
7. Cell Biochemistry	05
8. Biochemical techniques	06
Total lectures	**48**

1. Amino acids and proteins: (11 L)

Introduction, biological functions, classification-based on structure, function and composition. Structural organization of proteins- primary, secondary, tertiary and quarternary structures (general overview). Factors that stabilize protein structure.Denaturation of Proteins.

Reference: 3, Chapter 4, Amino acids and Proteins, pg 45-71.

1)Foldings and misfoldings of protiens by stepwise process
2) Diseases caused by misfoldings of protiens for ex..Alzhimer,Prions
Reference: 1, Page no 116 to 153

2. Carbohydrates: (06 L)

Introduction of carbohydrates, Introduction and biological significance of proteoglycans, Glycoproteins, Glycolipids, Lectin Carbohydrates- Interaction(Sugar code). Analysis of carbohydrates.

Reference.1: page no. 255 to 268
Reference.2: Page no : 648 to 653 .

3. Lipids: (06 L)

Introduction, Biological significance, Classification-Simple ,compound, steroids and derived lipids. Structure of saturated and unsaturated fatty acids, structure of phospholipids (Phosphatidic acid, Lecithin, Cephalin, Lipositol), structure of Sphingomyelin and Cholesterol.Amphipathic lipids and their behavior in water.Saponification number, Acid number, Iodine number and their significance.Rancidity of lipids. Types of Lipoproteins and their significance, Structural Lipids in membrane glycerophopholipids, Sulphalipids, Galactolipids, glycosphingolipids

Reference.1: page no. 343 to 360
Reference: 3, Chapter 3, Lipids, pg 29-42.

4. Hormones: (03 L)

Definition, classification based on biochemical nature, location and mechanism of action. Concept of second messengers-c.AMP and Calcium inositide system.

Reference: 2, Chapter 42 and 43, pg 434, 462 and 464.

5. Enzymes: (07 L)

Classification- Six major classes of enzymes, Conjugated enzymes- Apoenzyme, Holo enzyme, prosthetic group (coenzymes and cofactors). Features of active site.enzyme specificity, Factors affecting enzyme activity- substrate concentration, pH, temperature, and enzyme concentration, product concentration. MM equation, LB equation (derivation not required) and significance of Km. Enzyme inhibition-competitive, non competitive and uncompetitive with suitable examples.Allosteric enzymes and clinical significance of Isoenzymes.

Reference: 3, Chapter 6, Enzymes, pg 85 – 112.

6. Vitamins and Coenzymes: (04 L)

Classification- Fat soluble and water soluble vitamins (source, biological functions and deficiency disorders), coenzyme forms of vitamin B complex.(Structure not required).

Reference: 2, Chapter 45: pg 481-496

7. Cell Biochemistry: (05 L)

Introduction to Cell, Unicellular and Multicellular organisms, Distinguishing features of Prokaryotic and Eukaryotic cell. Structure and function of Cell membrane, Mitochondria, Endoplasmic reticulum, Golgi complex, Lysosomes, Peroxisomes, Plant cell wall and Chloroplast. Concepts of Biomolecules and types of bonds in biomolecules.

Reference: 5, Chapter 3, Unicellular and multicellular cell, cell membrane, pg 32- 68, Chapter 10, Mitochondria, pg 191- 219, Chapter 6, Endoplasmic Reticulum, pg 154- 165, Chapter 7, Golgi Complex, pg 166- 174, Chapter 8, Lysosomes, pg 175- 183, Chapter 9, Peroxisomes, pg 184-189, Chapter 1, Chloroplast, pg 220- 240.

8. Biochemical techniques. (06 L)

Principle, working and applications of dialysis, Paper chromatography, Thin layer chromatography, Column chromatography- Gel filtration, Ion exchange, Affinity Chromatography. Electrophoresis- Paper and Gel (Agarose, Native and SDS- PAGE).

Reference: 6, Chapter 11, pg 524- 546. Chapter 10, pg 449- 473.**2**, Chapter 3, pg 89. 7, pg 344-421,

Aim and Objectives :

I **Cell Biochemistry**: The student needs to understand of Cell types, Difference between a bacterial cell., Plant cell and animal cell. Biological composition and organisation of cell membrane as per Singer and Nicholson model, structure and function of various cell organelles of plant and animal cell. Concepts of biomolecules,Bonds that link monomeric units to form macromolecules.

II.**Carbohydrates,:** The student needs to know the types of carbohydrates and their biochemical significance in living organisms, structure of carbohydrates and reactions of carbohydrates with Glucose as example. Properties of carbohydrates.

III**. Lipids:** The student needs to know the types of lipids with examples, structure of lipids, properties of lipids.

IV. **Aminoacids and proteins:** The student needs to know the structure and types of amino acids. Reactions of amino acids.Properties of aminoacids.Peptide bond formation.Types of proteins.Structural hierarchy in proteins. Features of denaturation of proteins.

V. **Enzymes:** The student needs to know the classes of enzymes with subclasses and examples. Enzyme specificity, Equations of enzyme kinetics Km and its significance, features of various types of enzyme inhibitions.

VI. **Biochemical techniques:** The student needs to know the principle, working procedure and applications of various techniques used in biochemical studies.

VII.**Vitamins and Coenzymes:** The student needs to know the types of vitamins ,their source, biochemical significance and deficiency disorders. Coenzyme forms of Vitamin B complex and their metabolic significance.

VIII. **Hormones**: Basic concepts of Endocrinology.Types of Endocrine glands and their hormones.Biochemical nature of hormones.Role of Second messengers in hormone action.

Reference Books

1. Lehninger's, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4thEdn..
2. Harper's Illustrated Biochemistry, 26th Edition.
3. Biochemistry by U. Satyanarayana
4. Biotechnology, B.D.Singh, 3rd edition.
5. Cell biology, Genetics, Molecular Biology, Evolution and Ecology, by Verma and Agarwal, 14th edition.
6. Principle techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 6th edition.
7. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.

Semester- III

Course: Introduction To Biochemistry And Molecular Biology (CH-346C)

Name of the Topic	Number of lectures
1. Introduction to Metabolism	02
2. Carbohydrate metabolism	06
3. Lipid metabolism	04
4. Amino acid metabolism	04
5. Electron Transport Chain and Oxidative Phosphorylation	06
6. Nucleic acids	07
7. DNA replication	06
8. Transcription	05
9. Translation	04
10. Introduction to Genetic engineering	04
Total lectures	**48**

1. Introduction to Metabolism: (02 L)

Definition of catabolism and anabolism, Types of metabolic reactions, High energy compounds, Significance of ATP.

Reference: 3, Chapter 12,Introduction to metabolism , pg 247- 249 and Chapter 11 Biological oxidation pg. 227-230.

2. Carbohydrate metabolism and TCA cycle (06 L)

Aerobic and anaerobic glycolysis- structures of intermediates, various enzymes involved and energetics. Fate of Pyruvate, Pyruvate dehydrogenase complex.TCA cycle- enzymatic reactions and energetics.

Reference: 2, Chapter 17: Glycolysis pp 136-144 and Chapter 16: The Citric Acid Cycle pp. 130-135

3. Lipid metabolism (04 L)

Transportation of fatty acids with the help of carnitine, β-oxidation of palmitic acid in mitochondria and its energetics.Triacylglycerol synthesis, ketogenesis.

Reference:2, Chapter 22, Oxidation of fatty acids: Ketogenesis, pp 180-189.

4. Amino acid metabolism: (04 L)

Significance of transamination, deamination, decarboxylation reactions of amino acids.Urea cycle.

Reference: 2, Chapter 29: Catabolism of Proteins and of amino acid nitrogen. pp 242 - 248

5. Electron Transport Chain and Oxidative Phosphorylation: (06 L)

Location of Electron carriers, Electron transport chain, Proton gradient, Oxidative phosphorylation-Chemiosmotic hypothesis, Inhibitors and Uncouplers of Electron transport chain and Oxidative phosphorylation .

Reference: 3, Chapter 11 Biological oxidation, pg 230-239.

6. Nucleic acids: (07 L)

Structures of Purines and Pyrinmidines, Nucleosides, Nucleotides, Polynucleotides.Difference between DNA and RNA. Watson and Crick model of DNA. DNA as genetic material (Macleod and Mcarty, Hershey and Chase experiments).RNA and its types.Central dogma of molecular biology.

Reference: 3, Chapter 5, Nucleic acids, pg 73-83.

7. DNA replication: (06 L)

Semiconservative model of replication (Messelson and Stahl experiment). Brief account of initiation (features of OriC), elongation and termination of DNA replication in prokaryotes. Okazaki fragments, Leading and Lagging strands, Distinguishing features of DNA polymerase I, II and III. Klenow fragment of DNA polymerase I.

Reference: 1, Chapter 25, DNA metabolism, pg 950 - 984

8. Transcription: (04 L)

Brief account of initiation- Promoter sequences, elongation and termination of transcription in prokaryotes. RNA polymerase. Examples of inhibitors of transcription. Chapter 26: 996- 1027

Reference: 1, Chapter 26, RNA metabolism, pg 948 – 1033.

9. Translation: (05 L)

Genetic code and its features.Brief account of initiation, elongation and termination of translation in prokaryotes.Examples of inhibitors of translation.Regulation of gene expression- Lac operon.

Reference: 1, Chapter 27, Protein metabolism, pg 1034- 1075.

10. Introduction to genetic engineering: (04 L)

Basic concepts of genetic engineering - Restriction Enzymes- Types and features, Vectors (Plasmids,Phages and Cosmids) , Recombinant or Chimeric vector. Principle and Steps involved in gene cloning with insulin as example. Applications of genetic engineering in various fields.

Reference: 1, Chapter 9, pg 307- 310, pg 311-313(vectors), **4**, Chapter 2, pg 15.

Aim and Objectives

a. Metabolism, Carbohydrate, Lipid and Amino acid metabolism: The student needs to know the significance of metabolism and energetics. Role of ATP and types of other high energy compounds.Individual reactions of the metabolic pathways, various enzymes and coenzymes, energetic and features of the pathway.

b. **Electron Transport Chain and Oxidative Phosphorylation**: The student needs to know the concepts of biological oxidation. Types of electron carriers and their location in mitochondria.Formation of proton gradient, Proton motive force and Oxidative phosporylation, formation of ATP in the oxysomes. Inhibitors and Uncouplersof Mitochondrial ETC.

c. **Nucleic acids:** Understanding the structures of purines, pyrimidines, nucleosides and nucleotides , structural features of nucleic acid types and their role. Central dogma of molecular biology. Experimental procedures that prove DNA as genetic material and its interpretations.

d. **Replication:** The student needs to know the experiment that showed the salient features of semi conservative DNA replication, stepwise events involved in replication of DNA.

e. **Transcription:** The student needs to know stepwise events of transcription of RNA and list of inhibitors of transcription.

f. **Translation**: The student needs to know the stepwise events of translation of proteins and its significance. List of inhibitors of translation.Features of regulation of gene expression with lac operon studies.

e. **Introduction to genetic engineering:** The student needs to know the overview of the steps involved in insulin gene cloning, and applications of genetic engineering in various fields like agriculture, industries and medicine.

Reference Books

1. Lehninger's, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4thEdn..
2. Harper's Illustrated Biochemistry, 26th Edition.
3. Biochemistry by U. Satyanarayana
4. Biotechnology, B.D.Singh, 3rd edition.
5. Cell biology, Genetics, Molecular Biology, Evolution and Ecology, by Verma and Agarwal, 14th edition.
6. Principle techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 6th edition.
7. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.

Semester-III

Course: Environmental and Green Chemistry (CH-336D)

Name of the Topic	Number of lectures
1. Concepts and scope of Environmental Chemistry	02
2. Atmosphere and Air Pollution	14
3. Hydrosphere and water pollution	08
4. Introduction to Green Chemistry	10
5. Green Chemistry and Technology for sustainable development	10
6. Green Chemistry and Hazardous Organic Solvents	04
Total lectures	**48**

Chapter 1: Concepts and scope of Environmental Chemistry (02)

1.1 Introduction
1.2 Terminologies
1.3 Units of concentration
1.4 Segments of Environment
Ref. 1, Ref. 3

Aims and Objectives-
Students should know-
i. Importance and conservation of environment.

Chapter 2: Atmosphere and Air Pollution (14)

2.1 Composition and structure of atmosphere
2.2 Chemical and photochemical reactions in atmosphere
2.3 Chemistry of O_3, SOx, NOx and chlorides in atmosphere
2.4 Primary air pollutants
2.5 Sampling of air
2.6 Particulate matter: inorganic and organic
2.7 Smog: reducing and photochemical
2.8 Mechanism of ozone depletion
2.9 Stability and reactions of CFCs
2.10 Harmful effects of CFCs
2.11 CFCs substitutes
2.12 Bhopal gas tragedy
Ref. 1, Ref. 3, Ref. 5

Aims and Objectives-
Students should know-
i. Segments of atmosphere

ii. Hazards of flue gases
iii. Ozone depletion
iv. Ecological changes due to hazardous gases
v. Understand the social issues

Chapter 3: Hydrosphere and water pollution (08)

3.1 Water resources
3.2 Physical chemistry of sea water: composition, equilibria, pH, pE
3.3 Microbially mediated aquatic reactions, nitrogen cycle, iron and manganese bacteria
3.4 Classification of water pollutants
3.5 Organic and Inorganic pollutants: Pesticides, Detergents, Eutrophication, Marine, Oil, Acid mine drainage, remedial measures and sediments
3.6 Thermal pollution
3.7 Sampling and monitoring water quality parameters: pH, D.O. (Winkler Method), COD, TOC, Total hardness, free chlorine.
Ref. 1, 2, 3, and 5

Aims and Objectives-

Students should know-
i. Water resources
ii. Quality of potable water
iii. WHO limits for toxic materials in water stream
iv. Quality measures

Chapter4. Introduction to Green Chemistry [10]

4.1 Chemistry is good
4.2 The environment and the five environmental spheres
4.3 What is environmental Chemistry?
4.4 Environmental Pollution
4.5 What is green Chemistry?
4.6 Green Chemistry and synthetic chemistry
4.7 Reduction of risk: Hazard and exposure
4.8 The risk and no risks
4.9 Waste prevention
4.10 Basic principles of green chemistry
4.11 Examples based on green technology

[Ref: Green Chemistry By Stanley E Manahan, Chemchar Research Inc. (2006) -2nd Edn. chapter 1, P1-17 and Ref.6 Relevant pages.]

Chapter 5. Green Chemistry and Technology for sustainable development [10]

5.1 Green Chemistry from theory to practice
5.2 The twelve principles of green chemistry
5.3 Green Chemistry and sustainable Development
5.4 Designing Products under the holistic approach " Cardle-to Cardle"
5.5 Scientific areas for practical applications of green chemistry
5.6 Use of alternative basic chemicals as feedstocs in chemical industry and research

5.7 Green Chemistry and Reduction of solvent Toxicity (Alternative Solvents or replacement)
5.8 Applications of New Methodologies in the synthesis of chemical compounds- catalysis and green chemistry.

[Ref : Green Chemistry–Green engineering by AthanasiosValavanidis and ThomaisVlachogianni (March 2012) ; Chapter 2 p17-37 and Ref.6 Relevant pages]

Chapter 6. Green Chemistry and Hazardous Organic Solvents (Green solvents, replacement and Alternative techniques) [04]

6.1 Introduction to Green Chemistry and Toxic organic solvents
6.2 Green solvents and Alternative methods
6.3 Green Chemistry, Green solvents – Alternative techniques in organic synthesis
[Ref : Green Chemistry –Green engineering , Chapter 5, p81-91, Ref.6 Relevant pages]

Aims and Objectives-(for Chapters 4, 5 and 6)

Students should know-

i. Need of green chemistry technology
ii. Principles of green chemistry
iii. Advantages of green chemistry
iv. Simple examples to clarify the principles
v. Catalytic routes for sustainable developments

Reference Books:

1: Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
2: Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
3: Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
4: Analytical Chemistry – G. D. Christian 4th Edition (John Wiley and Sons)
5: Environmental Chemistry – H. Kaur 2nd Edition 2007, PragatiPrakashan, Meerut, India
6. Environmental Chemistry with Green Chemistry A. K Das , Books and Allied (P) Ltd, and

Semester-III
Course: Environmental and Green Chemistry (CH-346D)

Name of the Topic	Number of lectures
1.Water treatment and effluent management	08
2.Soil and solid waste management	04
3. Instrumental methods in environmental analysis	08
4. Green House Effect and Global Warming	04
5. Water the ultimate Green solvent	12
6. Energy Relations	12
Total lectures	**48**

Chapter 1: Water treatment and effluent management [08]

1.1 Domestic sewage, waste water treatment: primary, secondary and tertiary treatments, aerobic, anaerobic and upflow anaerobic sludge bed treatment processes

1.2 Industrial waste water treatment i) filtration method ii) ion-exchange method iii) membrane techniques: ultrafiltration, reverse osmosis and electrodialysis

1.3 Treatment of drinking water

Aims and Objectives-

Students should know-

i. Methods of water purification
ii. Waste water treatment process
iii. Waste water treatment plants

Chapter 2: Soil and solid waste management [04]

2.1 Composition of soil and types of soil.

2.2 Organic and inorganic components of soil

2.3 Acid base and ion exchange reactions in soil and pH of soil

2.4 Chemistry of disposal of solid waste i) sanitary landfills ii) incinerators iii) pyrolysis

Ref.1, Ref. 2, Ref. 3

Aims and Objectives-

Students should know-

i. Types of soil
ii. Components of soil
iii. Types of solid waste and their disposal

Chapter 3: Instrumental methods in environmental analysis [08]

3.1 Atomic absorption spectroscopy: determination of Hg, As, Zn, Ag, Pb, Mn, Fe, Cu, Cr, Cd

3.2 Gas chromatography: detection and determination of CO, HC and pesticides

3.3 HPLC: determination of pesticides, PAH as metabolites

3.4 Spectrophotometry: determination of NOx, SO_2, NH_3, CN, PO_4, Cd, Pb, Hg

3.5 Chemiluminescence: determination of NOx and O_3.

3.6 Non Dispersive IR spectrometry of determination of CO
3.7 Ion selective electrodes: determination of NO_3 and dissolved oxygen (D. O.)
[Ref. 1, Ref. 2]

Aims and Objectives-
Students should know-

i. Techniques used to monitor hazardous materials present in environment

Chapter 4: Green House Effect and Global Warming [04]
4.1 Introduction
4.2 Greenhouse gases
4.3 Radiative forcing
4.4 Sources and sinks of CO_2
4.5 Causes of fluctuations in global temperature
4.6 Global warming and climate changes
4.7 Implications of climate changes
[Ref. 5]

Aims and Objectives-
Students should know-

i. Green house gases and their effects
ii. Global warming
iii. Climate change

Chapter 5. Water the ultimate Green solvent [12]
5.1 H_2O : Simple formula and complex molecule
5.2 Important properties of water
5.3 The hydrologic cycle
5.4 Bodies of water and life in water
5.5 Chemical process in water
5.6 Fizzy water from underground
5.7 Oxygen in water
5.8 Weak acid from sky
5.9 Why natural water contains alkalinity and calcium
5.10 Metals in water
5.11 Water interactions with other phases
[Ref: Green Chemistry By Stanley E Manahan, Chemchar Research Inc. (2006)-2nd Edn Chapter 7 : P 161-173]

Aims and Objectives-
Students should know-

i. What do you mean by green solvent
ii. Resources of of green solvents like alcohol and water
iii. Importance of water as a green solvent

Chapter6 .Energy Relations : [12]
6.1 Energy

6.2 Radiant Energy from the sun
6.3 Storage and release of energy by chemicals
6.4 Energy sources
6.5 Conversions between forms of energy
6.6 Green engineering and energy conversion efficiency
6.7 Conversion of chemical energy
6.8 Renewable energy sources

[Ref: Green Chemistry By Stanley E Manahan, Chemchar Research Inc. (2006) -2nd Edn Chapter 6 : P 135-157]

Aims and Objectives-

Students should know-

i. Natural resources of energy
ii. Conventional and nonconventional energy resources
iii. Conservation of energy
iv. Utilization of solar and wind energies.

Reference Books:

1: Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
2: Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
3: Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
4: Analytical Chemisry – G. D. Christian 4th Edition (John Wiley and Sons)
5: Environmental Chemistry – H. Kaur 2nd Edition 2007, PragatiPrakashan, Meerut, India
6. Environmental Chemistry with Green Chemistry A. K Das , Books and Allied (P) Ltd.

Semester-III

Course: Agriculture Chemistry (CH-336E)

Name of the Topic	Number of lectures
1. Soil Chemistry	10
2. Problematic Soil and Soil testing	10
3. Quality of Irrigation Water	08
4. Plant Nutrients	08
5. Fertilizers and Manures	06
6. Protection of Plants	06
Total lectures	**48**

Chapter I –Soil Chemistry (10 L)

1.1 Role of agriculture chemistry
1.2 Scope and importance of agricultural chemistry
1.3 Agricultural chemistry and other science
1.4 Definition of soil, Soil components-mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism
1.5 Physical properties of soil- soil texture, soil structure, soil color, soil temp, soil density, porosity of soil.
1.6 Surface soil and sub-soil
1.7 Chemical properties of soil, soil reactions and solutions
1.8 Factor controlling soil reaction, buffering capacity, importance of buffer action in agriculture, ion exchange
Ref 1- Pagers 8-12, 92-94, 98-113, 116-146
Ref 3- Pages 28-50

Chapter II – Problematic Soil and Soil testing (10 L)

2.1 Acid soil- formation of acid soil, effect of soil acidity of soil, reclamation of acidic soil
2.2 Alkali Soil- formation of alkali soil, reclamation of alkali soil
2.3 Classification of alkali soil- saline soil, saline alkali soil, non-saline alkali soil
2.4 Calcareous soils
2.5 Introduction to soil testing
2.6 Objectives of soil testing
2.7 Phases of soil testing- collection of soil sample, analysis in the laboratory and fertilizer applications
Ref 1- 345-370, Ref 3- 301-312, Ref 4- 135-147 and 150-159

Chapter III- Quality of Irrigation Water (08 L)

3.1 Sources of Water- Atmospheric water, Surface Water, Stored Water, Ground Water
3.2 Impurities in Water, Water quality, related problems in public health, environment and agriculture

3.3 Analysis of irrigation Water (ppm, meq/lit.epm)
3.4 Dissolved constituents and their functions
Major constituents- Ca, Mg, Na, K, Carbonate, bicarbonate, sulfate, Chloride and nitrate
Minor constituents- B, Si, nitrite, Sulfide and fluoride
3.5 Water quality standard- total soluble salt (TSS), sodium adsorption ratio (SAR), Exchangeable sodium percentage (ESP), Residual sodium carbonate, salinity classes for irrigation water
Ref 8- Pages 293-309

Chapter IV- Plant Nutrients (08 L)
4.1 Need of plant nutrients, forms of nutrients updates, nutrient absorption by plants
4.2 Classification of essential nutrients
4.2.1 Primary nutrients (N, P, K), its role and deficiency symptoms in plants
4.2.2 Secondary nutrients, (Ca, Mg, S), its role and deficiency symptoms in plants
4.2.3 Micronutrients, General functions of micronutrients (Zn, Fe, Mn, Cu, B, Mo, Cl)
4.3 Effect of environmental condition, nutrient uptake
Ref 3- Pages 207-241, Ref 4- Pages 176-195, Ref 7- pages 287-300

Chapter V- Fertilizers and Manures (06 L)
Fertilizers
5.1 Introduction, Classification & application of fertilizers
5.2 Time and methods of fertilizers
5.3 Factors affecting efficiency of fertilizers
5.4 Vermicompost preparation, effect of vermicompost on soil fertility

5.5 Synthetic fertilizers definition, comparison of synthetic fertilizers with organic fertilizers , environmental effect of synthetic fertilizers
Manures
5.6 Introduction, Definition and classification of manures
5.7 Effect of bulky organic manures on soil, farm yard manures (FYM), Factors affecting on FYM, method of preparation, losses during handling and storage
5.8 Biogas plant. Human waste, sewage and sludge, types of sludge, carbon nitrogen ratio, sewage irrigation and uses
5.9 Green manuring, types of green manuring, characteristics, advantages and disadvantages of green manuring

6.0 Biofertlizers: definition, classification, role & advantages

Ref 2- Pages 205-213, Ref 3- 90-112, 137-149

Chapter VII- Protection of Plants (06 L)
Pesticide Classification and mode of action
7.1 Insecticide- Definition, Classification, chemical properties, elemental composition, mode of action of synthetic and plant originated compounds organophosphates, malathion, parathion, carbamates
7.2 Fungicides- Definition, Classification, Chemical properties, mode of action of S

& Cu fungicides
7.3 Herbicides- Definition,, Classification, composition, mode of action of Selective and non-selective herbicides.

Ref 6- Relevant Pages

Learning Objectives of Agriculture Chemistry

After studying this course, student is expected to
1. Know the role of agriculture chemistry and its potential
2. Understand basic concept of soil, properties of soil & its classification on the basis of pH
3. Know the different plant nutrients, Their functions and deficiency symptoms
4. Understand importance of manures as compared to chemical fertilizers'
5. Understand the importance of green manuring
6. Have the knowledge of the use of proper the plants
7. Know various techniques to protect the plants
8. Have the knowledge of various pesticides, insecticides, fungicides and herbicides
9. Identify the problematic soil and recommend method for their reclamation
10. Have the knowledge of quality irrigation water, water quality standard and analysis of irrigation water

Reference Books

1. A text book of soil science (Recise Ed) J.A. Daji, Revised by J.R. Adam, N.D. Patil, Media promoters and publishers, Mumabi, 1996
2. Text book of soil science, T.D. Biswas, S.K. Mukharjee, Tata McGraw Hill Publishing company, New Delhi
3. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan)
4. Principals of soil science, M.M. Rai, Millian complex of India, Bombay, 1977
5. Manures and fertilizers (sixth ed), K.S. Yawalkar, J.P. Agarwal and Bokde, Agrihorticulture publishing house, Nagpur, India
6. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd Ed), oxford and IBH Publishing company, New Delhi
7.Fundamentals of soil sciences, C.E. Millar and L.M. Turk, Bio-Tech- New Delhi (1st Ed 2001)
8. Soil, Plant, Water and fertilizer analysis, P.K. Gupta, Published by Agro Botanica
9. **Biofertilizers** and biopesticides , Author: Deshmukh, A. M. (ArvindMadhavrao),

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Semester-IV

Course: Dairy Chemistry (CH-336E)

Name of the Topic	Number of lectures
1. Market Milk	08
2. Common Dairy Processes	06
3. Special Milks	08
4. Milk proteins, Carbohydrates and Vitamins	08
5. Preservatives & Adulterants in Milk	06
6. Milk Products	08
7. Dried Milk Products	04
Total lectures	**48**

Chapter I – Market Milk (08 L)

Introduction, Definition, constituents of milk of different species such as cow, buffalo, goat, etc., Chemical composition of milk of Indian breed and foreign breeds of cow, factor affecting composition of milk, characteristics of milk of different mammals, physicochemical properties of milk, acidity, pH, density, specific gravity, color and flavor of milk, food and nutritive value of milk. Microbiology of milk, growth of microorganism, stages of growth, product of microbial growth, destruction of microorganisms growth.

Ref 1 chap I relevant pages, Ref 2 pages 9-26, Ref 6 – relevant pages.

Chapter II – Common Dairy Processes (06 L)
(Manufacture, storage and packaging)

Cream separation- Basic principles, gravity creaming water dilution and centrifugal creaming method, construction of centrifugal separator, factors affecting percentage of fat, speed of machine, temp. of milk, rate of inflow amount of flushing water formation of separator slime Pasteurization of milk, flow sheet diagram, process receiving milk, preheating filtration, clarification, cooling and storage raw milk, standardization, pasteurization, homogenization, packing and storage, uses of milk.

Ref 1.- Relevant pages.

Chapter- III Special Milks (08 L)

1. Sterilized milk- Definition, method of manufacture in detail, Advantages and disadvantages. 2. Homogenized milk,- Definition, merits and demerits factor influencing homogenization, Process of manufacture. 3. Soft curd milk- Definition, characteristics, method of preparation of soft curd milk. 4. Flavored milk- Definition, types, method of manufacture flow sheet diagram. 5. Vitaminised / irradiated milk- - Definition, method of manufacture. 6. Fermented milk-Definition, method of manufacture. 7. Standardized milk- Definition, method of manufacture.

Ref 1 Chap II relevant pages.

Chapter IV- Milk proteins, Carbohydrates and Vitamins (08 L)

1. Milk proteins- importance of proteins found in the milk-casein, albumin and globulin, composition, nomenclature, properties and uses. 2. Carbohydrates- importance of lactose, classification, properties, nutritive value of lactose use of lactose. 3. Vitamins- importance, definition,

properties nutritive value of vitamins, Vit-A, Vit-B, B2, B6, B12, Vit-C (Ascorbic acid) & Vitamin-D. 4. Food and nutritive value of milk, milk & public health.

Ref-2 Pages 11,12,33 to 38, 42 to 49, 51 to 53

Chapter V- Preservatives & Adulterants in Milk (06 L)

1. Preservation of milk- Introduction, Common preservatives are used. 2. Adulterants- Introduction, Modes of Adulteration and their detection such as skimming, addition of separated milk, skim milk, Water, Starch and cane sugar.

Ref -2 Pages 78-81

Chapter VI- Milk Products (08 L)

Cream, Butter, Cheese and Ice-Cream.

1. Cream- Definition, Classification, Composition, Food & Nutritive value, Physicochemical properties, Manufacture and uses of cream. Ref-1 117, 118, 121 & 142

2. Butter- Definition, Classification, Composition, Food & nutritive value, Physicochemical properties, Manufacture and uses of Butter selection of milk/cream. Preheating of milk, Separating of milk, neutralization of cream, Pasteurization of cream, Cooking & ageing, repending of cream, salting of butter, washing of butter, packaging & Storage, use of butter.

Ref -1 Pages 143, 144, 145 to 158 & 173

3. Cheese- Definition, Classification, Food & nutritive value, properties, Manufacture and uses of cheese.

Ref -1 Pages 224, 227, 229 to 242 & 267

4. Ice-cream- Definition, Classification, Composition, Food & Nutritive value, Manufacture, packing, hardening & Storage, uses of Ice-cream.

Ref -1 Pages 182, 183, 184, 193,223

Chapter VII- Dried Milk Products (04 L)

Introduction, butter milk powder, whey powder, cream powder, infact milk powder, Shrikand powder, Ice-cream mix powder, cheese powder.

Ref-1 Pages 357 to377

Learning Objectives-

The students are expected to study “Dairy Chemistry” in view of-

1. Knowing importance of the subject from the point of rural economy.
2. Knowing the composition of milk, its food & nutritive value
3. Understanding the Microbiology of the milk
4. Understanding various preservation and adulterants, various milk proteins and their role for the human body.
5. Knowing various milk products, their composition, manufacture and uses.

References-

Ref- 1: Qutline of Dairy Technology- Oxfored University press By- Sukumar De. (Edition-1983)

Ref- 2: Dairy Chemistry and Animal Nutrition- M.M. Rai, Kalyani, Publishers, New Delhi 3rd Edition, 1980
Ref- 3: Fundamentals of Dairy Chemistry- B.H. Webb, A.H. Hohsson, J.A. Alford, CBB Publishers and Distributors.
Ref- 4: Milk and Milk Products- C.H. Eckles, H. Macy, Tata McGraw Hikk Publishing Company Ltd.
Ref- 5: Chemistry and Testing of Dairy Products- H.V. Athertion, J.A. New Lander, CBS, Publishers and Distributors.
Ref-6: Dairy Microbiology, Dr. K.C. MahantaOmsons Publication New Delhi.
