SPPU S. Y. B. Sc. Microbiology Sem I and Sem II Syllabus 2020-21

Titles of the Papers

Semester	Paper Code	Paper	Paper title
III	MB 211	I	Medical Microbiology and Immunology
	MB212	II	Bacterial Physiology and Fermentation Technology
	MB 213	III	Practical based on MB211 & MB 212
IV	MB 221	I	Bacterial Genetics
	MB 222	II	Air, Water and Soil Microbiology
	MB 223	III	Practical based on MB221 & MB 222

S. Y. B. SC. MICROBIOLOGY SYLLABUS (SEM I)

MB – 211: MEDICAL MICROBIOLOGY AND IMMUNOLOGY		**[30]**
Credit I	**MEDICAL MICROBIOLOGY**	**(15)**
1	**Definitions:** Incubation period, Viability, Susceptibility, Pathogenicity, Virulence, Pathogenesis, Lab diagnosis, Epidemic, Sporadic, Endemic, Pandemic	**2**
2	**Study of following pathogens with respect to –**Classification, Morphological, Cultural and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy: **Bacteria:** a) *Escherichia coli* b) *Staphylococcus aureus* **Fungi:** a) *Candida* b) *Dermatophytes*	**8**

3	**Introduction to Chemotherapy** i. Selective toxicity, Bioavailability MIC, MBC, LD_{50} ii. Antagonism and synergism in drug administration iii. Antibiotic sensitivity, iv. Antibiotic misuse/antibiotic overuse v. Concept of drug resistance (e.g. MRSA, ESBL)	**5**
Credit II	**IMMUNOLOGY**	**(15)**
1	**Immunity:** Definition, types (Innate and acquired, active and passive, humoral and cell mediated)	**2**
2	**Formation of blood cells** (hematopoiesis) Myeloid and lymphoid lineages and differentiation process Lymphocytes types	4
3	**Antigens and antibodies: definition and concept**	1
4	**Immunohematology** a. ABO and Rh blood group systems b. Bombay blood group c. Biochemistry of blood group substances d. Inheritance of ABH antigens e. Medico legal applications of blood groups	6
5	**Active and Passive Immunization** a. Active Immunization Whole organism vaccines i. Attenuated vaccines ii. Inactivated Vaccines b. Passive Immunization Transfer of preformed antibodies c. Latest Immunization schedule in India	2

REFERENCES:

1. Davis B.D., Delbacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY
2. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20th Edition, McGraw-Hill Professional Publishing.
3. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17th Edition
4. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Textbook of microbiology, 5th edition, Orient Longman.
5. David Greenwood, 1995, Antimicrobial Chemotherapy, 3rd Edition, Oxford University Press.
6. Mukherjee, K.L 1988 Medical Laboratory Technology, Vol III, 10th Edition, Tata Mc.
7. Medical Microbiology edited by Samuel Baron. Fourth edition. (University of Texas Medical Branch of Galvesion)
8. Sherris, John C, Ed, Medical Microbiology: an Introduction to infectious diseases. Elsevier Publication IInd edition.
9. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael.
10. Kuby J. Graw-Hill Pub Co(1996) Immunology 3rd Ed. W. H. Freeman & Co.
11. Sudha Gangal, Shubhangi Sontakke. (2012) Textbook of Basic and Clinical Immunology. Universities Press Private limited.
12. Pathak S. S. and Palan V. (1997) Immunology - Essential and Fundamental, Pareen Publications Bombay.
13. Roitt Evan, Brostoff J. Male D. (1993) Immunology 6th Ed., Mosby & Co. London.
14. Roitt I. M. (1988) Essentials of Immunology, ELBS, London.
15. Roitt M. (1984) Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.
16. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. New Delhi.
17. Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V., (1982), Basic and Clinical Immunology, 4th Ed., Lange Medical Publications, Maruzen Asia Pvt. Ltd., Singapore.
18. William E., Md. Paul. Fundamental Immunology 5th edition (August 2003): By Lippincott Williams & Wilkins Publishers

MB – 212: BACTERIAL PHYSIOLOGY AND FERMENTATION TECHNOLOGY [30]		
Credit I	**BACTERIAL PHYSIOLOGY**	[15]
1.	**Enzymes**	**(7)**
	a. Introduction to Enzymes: Properties of enzymes, Nature of active site, Structure of active site, commonly occurring amino acids at active site. Ribozymes, coenzymes, apoenzymes, prosthetic group and cofactors.	2
	b. Nomenclature & classification as per IUB (up to class level).	2
	c. Models for catalysis – i. Lock and key ii. Induced fit iii Transition state.	1
	d. Effect of pH & temperature, substrate concentration & enzyme concentration, activators, and inhibitors of enzyme	2
2	**Bacterial Physiology**	**(8)**
	a. Definitions of Metabolism, catabolism, anabolism, respiration, and fermentation	**1**
	b. Metabolic pathways (with structures) 1. Embden Meyerhof Parnas pathway (Glycolysis) 2. Hexose monophosphate pathway 3. Entner Doudoroff pathway 4. Phosphoketolase pathway (Pentose and hexose) 5. TCA cycle (with emphasis on amphibolism) and Glyoxylate bypass 6. Gluconeogenesis and its significance	 1 1 1 1 2 1

Credit II	**FERMENTATION TECHNOLOGY**	**15**
1.	**Concept of fermentation technology** a. Microbial biomass- based fermentation (Biofertilizer, biopesticide, Probiotics) b. Production of Primary metabolites (Organic acids, amino acids, vitamins, enzymes) c. Production of Secondary metabolites (Antibiotics) d. Production of recombinant products (insulin and growth hormones) e. Production of Fermented food products (Cheese, yoghurt) f. Microbial bio transformation (Steroid transformation)	3
2	**Strains of industrially important microorganisms:** i. Desirable characteristics of industrial strain ii. Principles and methods of primary and secondary screening iii. Master, working and seed culture; development of inoculum iv. Preservation and maintenance of industrial strains.	**4**
3	**Design of a Fermenter (typical CSTR Continuous stirred Tank Reactor):** Different parts and their working	1
4	**Monitoring of different fermentation parameters** (Temperature, pH, aeration, agitation, foam)	2
5	**Types of fermentations: Batch, continuous, dual**	**2**
6	**Media for industrial fermentations:** Constituents of media (Carbon source, nitrogen source, amino acids vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors, and inducers)	**2**
7	**Contamination: Sources, precautions, and consequences**	**1**

REFERENCES

1. Conn E., Stumpf P.K., Bruuening G., Doi RH. (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi. (Unit I & II)
2. Moat A.G. & Foster J.W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York. (Unit II & III)
3. Nelson D. L. & Cox M. M. (2005) Lehninger's Principles of Biochemistry, 4th edition, W. H. Freeman & Co. NY (Unit II & III)
4. Voet D. & Voet J. G. (1995) Biochemistry, 2nd Ed.. John Wiley & sons New York. (Unit II & III)
5. Madigan M. T., Martinko J. M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc. (Unit I, II& III)
6. Prescott L. M., Harley J. P. and Klein D. A. (2005) Microbiology, 6th Edition. MacGraw Hill Companies Inc.(Unit II)
7. A. H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd.
8. Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths Heinemann.
9. Casida, L. E., (1984), Industrial Microbiology, Wiley Easterbs, New Delhi
10. Peppler, H. L (1979), Microbial Technology, Vol I and II, Academic Press, New York.
11. Peter F. Stanbury. Principles of Fermentation Technology, 2E, Elsevier (A Division of Reed Elsevier India Pvt. Limited), 2009
12. Prescott, S.C. and Dunn, C. G., (1983) Industrial Microbiology, Reed G. AVI tech books.
13. Reed G. Ed. Prescott and Dunn's Industrial Microbiology. 4th Ed., CBS Pub. New Delhi.
14. Stanbury, P. F. and Whittaker, A. (1984) Principles of Fermentation technology, Pergamon press.

S. Y. B. SC. MICROBIOLOGY SYLLABUS (SEM II)

MB 221- BACTERIAL GENETICS [30]		
Credit I		**(15)**
1	**Understanding DNA**	**9**
	i. Experimental evidences for nucleic acid as genetic material. a. Discovery of transforming material (hereditary material): Griffith's experiment b. Avery and MacLeod experiment c. Gierer and Schramm d. Fraenkel-Conrat & Singer experiment (TMV virus) e. Hershay & Chase experiment	6
	ii. Types of nucleic acids (DNA and RNAs)	1
	iii. Structure of DNA a. Structure of Nitrogen bases, Nucleoside, Nucleotide and polynucleotide chain b. Bonds involved in DNA structure c. Different forms of DNA	2
2	**Prokaryotic DNA replication**	7
	i. Models of DNA replication. (Conservative, semiconservative, and Dispersive) ii. Meselson and Stahl's experiment (semiconservative)	2
	iii. Six basic rules of DNA replication iv. Enzymes, proteins and other factors involved in DNA replication. v. Modes of DNA replication Rolling circle mechanism, theta and linear DNA replication	5

	Credit II	**(15)**
1	**Gene expression** i. Concept of Genetic code and its properties **ii.** Concept of transcription and translation	2
2	**Mutations and reversions** Concept of Mutation and Types of mutations: Nonsense, Missense, Silent, Conditional lethal- temperature sensitive, Amber, Reverse, suppressor i. Spontaneous Mutation a. Discovery of spontaneous mutation (Fluctuation test) b. Mechanism of spontaneous mutation c. Isolation of Mutants: Replica plate technique ii. Concept of Induced Mutations a. Base pair substitution (Transitions, Transversions), Insertions and deletions- Frame /Phase shift mutations b. Physical Mutagenic agent: UV and Xray c. Chemical mutagenic agents ➢ Base analogues (2amino purine, 5bromo uracil), ➢ HNO2, Alkylating agents ➢ Intercalating agents (EtBr, acridine orange)	8
3	**Plasmid genetics** i. Types of plasmids ii. Properties of Plasmid iii. Plasmid replication iv. Plasmid incompatibility v. Plasmid curing vi. Plasmid amplification Concept	5

References:

1. Bruce A. (2008), Molecular Biology of the Cell, 5th Edn. Publisher: Garland Science, New York.
2. David Freidfelder, (1987). Molecular Biology, 2nd Edn. Jones & Bartlett Pub.
3. Gardner, Simmons, Snustad. (2006), Principles of Genetics, 8th Edn.John Wiley & Sons. Inc. New York.
4. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2nd Edn. W.H. Freeman & Co.
5. Hayes, W. (1964), The Genetics of Bacteria and their Viruses, CBS Pub. New Delhi.
6. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, (2013), Molecular Biology of the Gene, 7th Edn. Pearson Publishers.
7. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, (2012) Lewin's GENES XI , 11th Edn. Jones &Bartlett Learning
8. Lodish H. et al. (2012), Molecular Cell Biology, 7th Edn. W. H. Freeman & Company. New York.
9. Primrose, S. B. (2002). Principles of Gene Manipulation6th Edn. Oxford: Blackwell Scientific Publications
10. Russel Peter. (2009), iGenetics: A Molecular Approach, 3rd Edn. Publisher Benjamin Cummings
11. Russel, Peter, (1990), Essential Genetics, 7thEdn. Blackwell Science Pub.
12. Stanier, R. Y. (1987), General Microbiology, 5th Edition, Macmillan Pub. Co. NY
13. Strickberger, M.W. (1985), Genetics, 3rd Edition Macmillan Pub. Co. NY.
14. R. J. Brooker, Genetics: analysis and principles, 6th edition, ISBN10: 1259616029 ISBN13: 9781259616020
15 Pawar and Daginawala, General Microbiology Vol.I and II, 1st Edition, Himalaya Publishing House, Mumbai
16. Genetics - Analysis and Principles, Robert J Brooker, Benjamin-Cummings Pub Co; Edition:1st (September 1, 1998) ISBN-10: 0805391754, ISBN-13: 978-0805391756.

MB – 222: Air, Water and Soil Microbiology		[30]
Credit I	**AIR MICROBIOLOGY and WATER MICROBIOLOGY**	**15**
1	**AIR MICROBIOLOGY**	**05**
	a. Air flora i. Transient nature of air flora ii. Droplet, droplet nuclei, and aerosols	1
	b. Methods of Air sampling and types of air samplers i. Impaction on solids ii. Impingement in liquid iii. Sedimentation iv. Centrifugation	2
	c. Air sanitation: Physical and chemical methods	1
	d. Air borne infections	1
2	**WATER MICROBIOLOGY**	**10**
	a. Types of water: surface, ground, stored, distilled, mineral and de-mineralized water	1
	b Recommended Bacteriological standards of Water Quality i. Maharashtra pollution control board (MPCB) Main Functions of MPCB Water quality standards for best designated usages ii. Central pollution control board, (CPCB)	1

	Main Functions of CPCB Designated Best Use Water Quality Criteria	
	c. Water purification methods	1
	d. Water borne Infections	1
	e. Indicators of faecal pollution i. *Escherichia coli* ii. *Bifidobacterium* iii. *Streptococcus faecalis* iv. *Clostridium perfringens* v. New indicators: *Campylobacter* and *Pseudomonas*	2
	f. **Bacteriological analysis of water for potability** i. Bacteriological standards of potable water: Bureau of Indian standards (BIS) World health Organization (WHO) ii. Presumptive coliform count iii. Confirmed test iv. Completed test v. Eijkman test vi. Membrane filter technique	4
Credit II	**SOIL MICROBIOLOGY**	**15**
	a. Rhizosphere microflora and its role in the rhizosphere	1
	b. Role of microorganisms in composting and humus formation	2
	c. Biofertilizers: Bacterial, Cyanobacterial, fungal and their large-scale production	

		3
	d. Biocontrol agents: Bacterial, Viral, Fungal and their large-scale production	3
	e. Brief account of microbial interactions: Symbiosis, Neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism, and Predation	3
	f. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen	3

References:

1. Martin A. Introduction to Soil Microbiology (1961) John Wiley& Sons, New York and London publication

2. Subba Rao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.

3. Dubey R.C., and Maheswari, D. K. Textbook of Microbiology, S. Chand & Co.

4. Martin A. (1977) An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

5. Dube H.C. and Bilgrami. K.S. (1976) Text book of modern pathology. Vikas publishing house. New Delhi.

6. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi.

7. Daniel Lim., Microbiology, 2nd Edition; McGraw-Hill Publication

8. Ingraham J.L. and Ingraham C.A. (2004) Introduction to Microbiology. 3nd Edition. Thomson Brooks / Cole.

9. Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.

10. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.

11. Tortora G.J., Funke B.R., Case C.L. (2006) Microbiology: An Introduction. 8th Edition.

12. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY

13. Pelzar M. J., Chan E. C. S., Krieg N. R.(1986) Microbiology. 5th Edition, McGraw-Hill Publication

14. Prescott, Lancing M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education

15. Hans G. Schlegel (1993) General Microbiology, 8th Edition, Cambridge University Press

16. Martin Frobisher (1937) Fundamentals of Microbiology, 8th Edition, Saunders, Michigan University press

17. Pawar and Daginawala, General Microbiology Vol.I and II, 1st Edition, Himalaya Publishing House, Mumbai

18. Nilesh S. Kulkarni and Shiva C. Aithal, Water Microbiology, 2016,

19. WHO guidelines for drinking water quality Volume I

20. MPCB, CPCB, BIS and WHO websites.

S. Y. B. Sc. Microbiology Practical Course MB 213

Semester I: Practical course based on MB211 & MB 212		
Expt. No.	**Topics**	**No. of Practicals**
1	**Measurements of cell dimension by micrometry using 10x,45x,100x objectives**	**1**
2	**Blood grouping**	**1**
3	**I. Biochemical characterization of bacteria:** a. Sugar utilization test (minimal medium + sugar) b. Sugar fermentation test c. IMViC d. Enzyme detection – Gelatinase, Catalase, Oxidase e. Oxidative-fermentative test **II. Isolation and identification of *E. coli, Staphylococcus aureus* and *Candida* from clinical samples using** a. Gram staining, motility/ slide culture b. Cultural and biochemical characterization	**6**
4	**Primary screening of industrially important organisms:** a. Organic acid / Antibiotic producing microorganisms by crowded plate technique b. Microorganisms producing industrially important enzyme- amylase	**2**
5	**Industrial visit**	**1**
	Total	**11**

S. Y. B. Sc. Microbiology Practical Course MB 223

Semester II: Practical course based on MB221 & MB 222		
Expt. No.	**Topics**	**No. of Practicals**
1	Air sampling using an air sampler calculation of air flora from different locations with the knowledge of respective standards of bacterial and fungal counts.	**1**
2	**Air Flora:** a. Diversity determination. b. Simpson index and settling velocity determination	**1**
3	**I. Bacteriological tests for potability of water** a. MPN, Confirmed and Completed test. b. Membrane filter technique (Demonstration)	**4**
4	**Enrichment, Isolation, Preparation and Application of Bioinoculant (Azo-Rhizo / Blue Green Algae (cyanobacteria)**	**2**
5	a. Induction of mutations by using physical mutagen (e.g. UV rays) and chemical mutagen (e.g. HNO2) b. Isolation of mutants by any suitable method c. Demonstration of UV survival curve	**3**
	Total	**11**

Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Botany

(Faculty of Science & Technology)

S.Y.B.Sc Botany

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020- 2021

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	Botany Theory Paper 1	2
			BO 352	Botany Theory Paper 2	2
			BO 353	Botany Theory Paper 3	2
			BO 354	Botany Theory Paper 4	2
			BO 355	Botany Theory Paper 5	2
			BO 356	Botany Theory Paper 6	2
			BO 357	Botany Practical Paper 1	2
			BO 358	Botany Practical Paper 2	2
			BO 359	Botany Practical Paper 3	2
		Skill Enhancement course	BO 3510	Botany Theory Paper 7	2
			BO 3511	Botany Theory Paper 8	2
3	6	Discipline Specific Elective Course	BO 361	Botany Theory Paper 1	2
			BO 361	Botany Theory Paper 2	2
			BO 362	Botany Theory Paper 3	2
			BO 363	Botany Theory Paper 4	2
			BO 364	Botany Theory Paper 5	2
			BO 365	Botany Theory Paper 6	2
			BO 366	Botany Practical Paper 1	2
			BO 367	Botany Practical Paper 2	2
			BO 368	Botany Practical Paper 3	2
		Skill Enhancement course	BO 3610	Botany Theory Paper 7	2
			BO 3611	Botany Theory Paper 8	2

2. Equivalence of Previous Syllabus:

Old Course (2014 Pattern)	New Course (2020 CBCS Pattern)
BO-211: Taxonomy of Angiosperms and Plant community	BO 231: Taxonomy of Angiosperms and Plant Ecology
BO-212:Plant Physiology	BO 232: Plant Physiology
BO-221: Plant Anatomy and Embryology	BO 241: Plant Anatomy and Embryology
BO-222: Plant Biotechnology	BO 242: Plant Biotechnology
Practical based on theory courses (Paper I and Paper II)	Semester III: Practical based on BO 231 & BO 232 Semester IV: Practical based on BO 241 & BO 242

S.Y.B.Sc. Botany CBCS Pattern
(Semester III, Paper I) 2020-2021
BO 231: Taxonomy of Angiosperms and Plant Ecology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Introduction to Angiosperms Taxonomy** Definition, scope, objectives and importance of taxonomy Exploration, Description, Identification, Nomenclature and classification Concept of Systematics with brief historical background	**02**
2.	**Systems of classification** Comparative account of various systems of classification Artificial system- Carl Linnaeus Natural system- Bentham and Hooker Phylogenetic system- Engler and Prantl APG systems- A brief review	**05**
3.	**Study of Plant Families** Study of following families with reference to systematic position (As per Bentham and Hooker's system of classification), salient features, floral formula, floral diagram and any five examples with their economic importance – Annonaceae, Brassicaceae, Myrtaceaee, Rubiaceae, Solanaceae, Apocynaceae, Nyctaginaceae and Amaryllidaceae	**08**
	Credit-II	**15**
4.	**Botanical Nomenclature** Concept of nomenclature, brief history, Binomial nomenclature ICBN- Principles, Rules and Recommendations of nomenclature 'Type' specimen and its types (Holotype, Paratype, Isotype, Lectotype, Neotype). Concept of Typification. Ranks and endings of taxa names, Coining of Genus and Species names Single and double authority citation,	**05**
5.	**Introduction to ecology** Definition, concept, scope, and interdisciplinary approach, autecology and synecology. Species diversity: definition, concept, scope, and types: Alpha, Beta and Gamma diversity. Methods of vegetation sampling: quadrat method, transect method, plot less method Genetic Diversity: definition, nature and origin of genetic variations Species Diversity: definition, origin of species diversity, diversity indices, species abundance Ecosystem Diversity: definition, major ecosystem types of the world, Hotspots in India – concept and basis of 'hotspot' identification.	**06**
6.	**Ecological grouping of the plants** Ecological grouping of the plants with reference to their significance of adaptive external and internal features: a) Hydrophytes, b) Mesophytes c) Xerophytes d) Halophytes with examples.	**04**

References-

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge, University Press.
3. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
4. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
5. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
6. Datta S.C. (1988). Systematic Botany. New Age Publ.
7. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
8. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
9. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
10. Kormondy Edward (1995). Concepts of Ecology, Pearson Publ.
11. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.
12. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
13. Michael P. (1984). Ecological Methods for field and Laboratory investigations TMH Co. ltd. Bombay.
14. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
15. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
16. Odum E.P., (2004). Fundamentals of Ecology, Publ. Cengage Learning, Australia
17. Pande B.P. (1997). Taxonomy of Angiosperms. S. Chand.
18. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
19. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
20. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
21. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
22. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
23. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms. Vikas Publ.
24. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
25. Singh Gurucharan (2005). Systematics: Theory and Practice. Oxford IBH.
26. Singh J.S., S.P. Singh, and S.R. Gupta (2006). Ecology, Environment and Resource Conservation. Anamaya Publ. New Delhi.
27. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
28. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
29. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
30. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
31. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
32. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, second edition. Columbia University Press.

33. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
34. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

IMPORTANT WEBSITES

THE FAMILIES OF FLOWERING PLANTS- L. Watson and M.J. Dallwitz
https://www.delta-intkey.com/angio/index.htm
ANGIOSPERM PHYLOGENY WEBSITE, version 14.
http://www.mobot.org/MOBOT/research/APweb/
THE PLANTS OF THE WORLD ONLINE PORTAL
http://www.plantsoftheworldonline.org/
INTERNATIONAL PLANT NAME INDEX (IPNI)
https://www.ipni.org/
TROPICOS
https://www.tropicos.org/home
BIODIVERSITY HERITAGE LIBRARY
https://www.biodiversitylibrary.org/
BOTANICUS DIGITAL LIBRARY
https://www.botanicus.org/
INTERNET ARCHIVE- DIGITAL LIBRARY
https://archive.org/
DATABASE OF PLANTS OF INDIAN SUBCONTINENT
https://sites.google.com/site/efloraofindia/
BOTANICAL SURVEY OF INDIA
https://bsi.gov.in/content/1416_1_FloraofIndia.aspx
FLOWERS OF INDIA
http://www.flowersofindia.net/
eFLORAS OF WORLD
http://www.efloras.org/

S.Y.B.Sc. Botany CBCS Pattern
(Semester III, Paper II) 2020-2021
BO 232: Plant Physiology - 2 Credits (30 Lectures)

Credit I:

1. Introduction to Plant Physiology **2L**

Scope and applications of plant physiology

2. Absorption of water **3L**

2.1 Role of water in plants
2.2 Mechanisms of water absorption with respect to crop plants
2.3 Factors affecting rate of water absorption

3. Ascent of sap **3L**

3.1 Introduction and definition.
3.2 Transpiration pull or cohesion-tension theory, evidences and objections
3.3 Factors affecting ascent of sap

4. Transpiration **7L**

4.1 Definition
4.2 Types of transpiration – cuticular, lenticular and stomatal
4.3 Structure of stomata
4.4 Mechanism of opening and closing of stomata –Steward's hypothesis, active K+ transport mechanism
4.5 Factors affecting the rate of transpiration
4.6 Significance of transpiration
4.7 Antitranspirants
4.8 Guttation
4.9 Exudation

Credit II:

5. Nitrogen metabolism **7L**

5.1 Introduction and role of nitrogen in plants
5.2 Nitrogen fixation by *Rhizobium* and BGA
5.2.1 Symbiotic nitrogen fixation, nitrogenase enzyme- structure and function
5.2.2 Non-symbiotic nitrogen fixation
5.3 Importance and production technique of BGA
5.4 Denitrification, ammonification and nitrification
5.5 Reductive amination and transamination

6. Seed dormancy and germination **4L**

6.1 Definition, types of seed dormancy and germination
6.2 Methods to break seed dormancy
6.3 Metabolic changes during seed germination
6.4 Role of phytohormones to improve seed germination
6.5 Vigor Index

7. Physiology of flowering **4L**

7.1 Photoperiodism – Concept, definition, short day plants, long day plants and day neutral plants.

7.2 Phytochrome theory, role of phytohormones in induction and inhibition of flowering
7.3 Applications of photoperiodism
7.4 Vernalization–concept and definition, mechanism of vernalisation, applications of vernalisation and devernalization

References:

1. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan Pub. Co., N.Y.
2 Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinnauers Associates, Saunders land, Massachusetts, USA
3. Salisbury F.B. and Ross C.B. 2005. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
4. Helgi OPik, Stephen A. Rolfe, Arthur J. Willis. 2005. The Physiology of Flowering Plants, Cambridge University Press, UK
5. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
6. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
7. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
8. Press, M.C., Barker, M.G., and Scholes, J.D. 2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.
9. Sayyed Iliyas, 2020. Steps in Plant Physiology, Lambert Academic Publishing, Mauritius.
10. Devlin, R.M. and F.H. Witham. 1983. Plant Physiology. Willard Grant Press. U.S.A.
11. Hans-Walter Heldt. 1997. Plant Biochemistry and Molecular Biology. Oxford University Press, New York.
12. Moore, T.C. 1979. Biochemistry and Physiology of Plant Hormones. SpringerVerlag. Berlin.
13. Raman, K. 1997. Transport Phenomena in Plants. Narosa Publishing House. New Delhi.
14. Jain, V.K. 2000: Fundamentals of Plant Physiology. S. Chand & Co, New Delhi.
15. Pandey, S.N. 1991: Plant Physiology, Vikas Publishing House (P) Ltd., New Delhi, India.
16. Verma, V. 200): Text Book of Plant Physiology, Ane Books India, New Delhi.
17. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology.4th edition Academic Press, UK.

S.Y.B.Sc. Botany CBCS Pattern
Practical (Semester III Paper III) 2020-2021
BO 233: Practical based on BO 231 & BO 232

Practical based on Taxonomy of Angiosperms and Plant Ecology, and Plant Physiology

Sr. No.	Title	No. of Practical
	Taxonomy of Angiosperms and Plant Ecology	
1	Study of tools of taxonomy and ecological instruments (any four each)	1
2	Description of flowering plant in botanical terms	1
3	Study of plant families (any four)	3
4	Study of ecological adaptations in Hydrophytes with any two examples	1
5	Study of ecological adaptations in Xerophytes with any two examples	1
6	Study of vegetation by list count quadrat method.	1
	Plant Physiology	
7	Perform phytochemical test for starch and protein in germinating and non germinating seeds	1
8	Isolation of Leaf Protein Concentration (LPC) from suitable plant material.	1
9	Determination of Diffusion Pressure Deficit (DPD)	1
10	Determine rate of transpiration under different conditions of Sunlight, Shade and Wind	1
11	Demonstration of the following **a.** Commercial biofertilizers **b.** Imbibition in seeds **c.** Ringing experiment **d.** Arc Auxanometer **e.** Spectrophotometer **f.** Nitrogen fixing bacteria / BGA (specimen/ slide)	1
12	Calculate seed germination percentage and vigor index	1
13	Botanical excursion tour and visit to Floriculture industry / Soil testing center / Seed testing center	1

N.B. Botanical excursion tour and submission of report along with herbarium of any five weeds of the following (List of Weeds attached).

List of weeds

Acanthospermun hispidum DC. Asteraceae

Aerva javanica (Burm.f.) Juss. ex Schult. Amaranthaceae

Aeschynomene americana L. Fabaceae Tropical America

Ageratum conyzoides L. Asteraceae America

Alternanthera paronychioides St. Hill. Amaranthaceae Tropical America

Alternanthera philoxeroides (Mast.) Griseb. Amaranthaceae America

Alternanthera pungens Kunth Amaranthaceae Tropical America

Alternanthera sessilis (L.) R.Br. ex DC. Amaranthaceae Tropical America

Amaranthus spinosus L. Amaranthaceae Tropical America

Antigonon leptopus Hk. & Arn. Polygonaceae America

Argemone mexicana L. Papaveracae West Indies

Asclepias curassavica L. Apocynaceae Tropical America
Bidens pilosa L. Asteraceae Tropical America
Blainvillea acmella (L.) Philipson Asteraceae Tropical America
Blumea eriantha DC. Asteraceae Tropical America
Blumea lacera (Burm.f.) DC. Asteraceae Tropical America
Boerhavia erecta L. Nyctaginaceae Tropical America
Cardamine hirsuta L. Brassicaceae Tropical America
Cassia absus L. Caesalpiniaceae Tropical America
Cassia occidentalis L. Caesalpiniaceae South America
Cassia pumila Lam. Caesalpiniaceae Tropical America
Cassia tora L. Caesalpiniaceae South America
Celosia argentea L. Amaranthaceae Tropical America
Chrozophora rottleri (Geis.) Spreng. Euphorbiaceae Tropical Africa
Cleome viscosa L. Capparaceae Tropical America
Conyza canadensis (L.) Cronquist Asteraceae South America
Coronopus didymus (L.) Smith Brassicaceae South America
Cronton bonplandianum Baillon Euphorpiaceae South America
Crotalaria pallida Dryand Fabaceae Tropical America
Crotalaria retusa L. Fabaceae Tropical America
Cryptostegia grandiflora R.Br. Apocynaceae Madagascar
Cuscuta chinensis Lam. Cuscutaceae Mediterranean
Cuscuta reflexa Roxb. Cuscutaceae Mediterranean
Cyperus difformis L. Cyperaceae Tropical America
Cyperus iria L. Cyperaceae Tropical America
Datura innoxia Mill. Solanaceae Tropical America
Dicoma tomentosa Cass. Asteraceae Tropical America
Digera muricata (L.) Mart. Amaranthaceae North America
Eclipta prostrata (L.) L. Asteraceae Tropical America
Eichhornia crassipes (Mart.) Solms Pontederiaceae Tropical America
Emilia sonchifolia (L.) DC. Asteraceae Tropical America
Eupatorium adenophorum Spreng. Asteraceae Central America
Eupatorium odoratum L. Asteraceae South America
Euphorbia heterophylla L. Euphorbiaceae Tropical America
Euphorbia hirta L. Euphorbiaceae Tropical America
Galinsoga parviflora Cav. Asteraceae Tropical America
Hyptis suaveolens (L.) Poit. Lamiaceae South America
Ipomoea carnea Jacq. Convolvulaceae Tropical America
Ipomoea hederifolia L. Convolvulaceae Tropical America
Ipomoea obscura (L.) Ker Gawl. Convolvulaceae Tropical Africa
Ipomoea pes-tigridis L. Convolvulaceae Tropical Africa
Lagascea mollis Cav. Asteraceae Tropical America
Lantana camara L. Verbenaceae Tropical America
Malachra capitata (L.) L. Malvaceae Tropical America

Malvastrum coromandelianum (L.) Garcke Malvaceae Tropical America
Martynia annua L. Pedaliaceae Tropical America
Mecardonia procumbens (Mill.) Small Scrophulariaceae Tropical America
Mikania micrantha Kunth Asteraceae Tropical America
Oxalis corniculata L. Oxalidaceae Europe
Parthenium hysterophorus L. Asteraceae Tropical America
Physalis minima L. Solanaceae Tropical America
Pistia stratiotes L. Araceae Tropical America
Portulaca oleracea L. Portulacaceae South America
Prosopis juliflora (Sw.) DC. Mimosaceae Mexico
Ruellia tuberosa L. Acanthaceae Tropical America
Scoparia dulcis L. Scrophulariaceae Tropical America
Solanum nigrum L. Solanaceae Tropical America
Solanum torvum Sw. Solanaceae West Indies
Sonchus oleraceus L. Asteraceae Mediterranean
Spilanthes radicans Jacq. Asteraceae South America
Synedrella nodiflora (L.) Gaertn. Asteraceae West Indies
Tridax procumbens L. Asteraceae Tropical America
Waltheria indica L. Sterculiaceae Tropical America
Xanthium indicum Koenig Asteraceae Tropical America
Youngia japonica (L.) DC. Asteraceae South America

SEMESTER IV

S.Y.B.Sc. Botany CBCS Pattern
(Semester IV, Paper I) 2020-2021
BO 241: Plant Anatomy and Embryology- 2 Credits (30 Lectures)

Credit-I Plant anatomy: (15 Lectures)

1. Introduction 2L

1.1 Definition

1.2 Scope of plant anatomy

2. Epidermal tissue system 3L

2.1 Structure, types and functions of epidermis

2.2 Structure, types and functions of Stomata

2.3 Epidermal outgrowths- non-glandular and glandular

2.4 Motor cells

3. Mechanical tissue system 3L

3.1 Principles involved in distribution of mechanical tissues with one example each

a) Inflexibility,

b) Incompressibility,

c) Inextensibility and

d) Shearing stress

3.2 Vascular tissue system: Structure and function of xylem, phloem and cambium

4. Normal secondary growth 3L

4.1 Introduction

4.2 Normal secondary growth in dicotyledonous stem

4.3 Development of annual rings, periderm, bark, tyloses and lenticel

5. Anomalous secondary growth 4L

5.1 Introduction

5.2 Causes of anomalous secondary growth

5.3 Anomalous secondary growth in:

a) Dicotyledonous stem (*Bignonia*),

b) Dicotyledonous root (*Raphanus*),

c) Monocotyledonous stem (*Dracaena*)

Credit-II Plant Embryology (15 Lectures)

7. Introduction 1L

7.1 Definition and scope of plant embryology

8. Microsporangium and male gametophyte 4L

8.1 Structure of tetrasporangiate anther

8.2 Types of tapetum

8.3 Sporogenous tissue

8.4 Microsporogenesis: process and its types

8.5 Types of microspore tetrad

8.6 Male gametophyte: structure and development of male gametophyte

9 Megasporangium and female gametophyte **4L**

9.1 Structure
9.2 Types of ovules
9.3 Types of megaspore tetrads
9.4 Female gametophyte: structure of typical embryo sac
9.5 Types of embryo sacs – monosporic, bisporic and tetrasporic

10. Pollination and Fertilization: **3L**

10.1 Introduction and definition
10.2 Types of pollination
10.3 Germination of pollen grain
10.4 Entry of pollen tube- porogamy, mesogamy and chalazogamy
10.5 Double fertilization and its significance.

11. Endosperm and embryo **3L**

11.1 Endosperm: Types – nuclear, helobial and cellular.
11.2 Structure of Dicotyledonous and Monocotyledonous embryo.

References:

1. Plant Anatomy, Chandurkar P J, Plant Anatomy Oxford and IBH publication Co. New Delhi 1971
2. B P Pandey, Plant Anatomy. S Chand and Co. Ltd, New Delhi 1978
3. Greulach V A and Adams J E Plant- An introduction to Modern Biology, Toppen Co. Ltd, Tokyo,
4. Eams and Mc Daniel,An Introduction to Plant Anatomy, McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan
5. Adriance S Foster Practical Plant Anatomy, D Van Nostrand Co. INC, New York
6. Esau, Plant Anatomy, Wiley Toppan Co. California, USA
7. Pijush Roy, Plant Anatomy. New Central Book Agency Ltd, Kolkata
8. Pandey S N and Ajanta Chadha, Plant Anatomy and Embryology, Vikas Publishing House, Pvt, Ltd, New Delhi
9. Bhojwani S S and Bhatnagar S P, An Embryology of Angiosperms
10. Maheshwari P, An introduction to Embryology of Angiosperm
11. Nair P K K Essentials of Palynology.

S.Y.B.Sc. Botany CBCS Pattern
(Semester IV, Paper II) 2020-2021
BO 242: Plant Biotechnology (2 Cr- 30 Lectures)

Credit I:

Chapter 1 Introduction to Plant Biotechnology 3L

1.1 History and definition
1.2 Scope and importance of plant biotechnology
1.3 Current status of biotechnology in India.

Chapter 2 Plant Tissue Culture 8L

2.1 Concept of plant tissue culture and cellular totipotency
2.2 Basic techniques: Types of culture, Media preparation, sterilization, inoculation, incubation, hardening
2.3Applications with reference to: Micropropagation, Somaclonal variation, Haploid production, Protoplast fusion & Somatic hybrids, Embryo rescue, Production of secondary metabolites.
2.4 Commercial Plant Tissue culture laboratories in Maharashtra and India.

Chapter 3 Single Cell Protein (SCP) 4L

3.1 Concept and definition
3.2 Importance of proteins in diet
3.3 Production of SCP from *Spirulina* and Yeast
3.4 Importance & acceptability of SCP

Credit II:

Chapter 4 Plant Genetic Engineering 5L

4.1 Introduction, concept
4.2 Tools of genetic engineering (restriction enzymes, ligases, plasmid vectors)
4.3 Gene cloning Technique
4.4 Applications of plant genetic engineering: insect pest resistance, abiotic stress tolerance, herbicide resistance

Chapter 5 Genomics, Proteomics and Bioinformatics 5L

5.1 Genomics- concept, types, methods used for whole genome sequencing
5.2 Proteomics-concept, types, methods used in proteome analysis
5.3 Bioinformatics-concept, database and its classification, data retrieval tools.

Chapter 6 Bioremediation 2L

6.1 Introduction and concept
6.2 Microbial remediation
6.3 Phytoremediation

Chapter 7 Biofuel technology 3L

7.1 Definition, Concept and types of Renewable and nonrenewable energy sources
7.2 Definition and concept of Biogas, Bioethanol, Biobutanol, Biodiesel & Biohydrogen

References

1. B.D. Singh (4th Edn 2012) Biotechnology-expanding horizons, Kalyani Publishers.
2. K.S. Bilgrami & A.K. Pandey (2007) Introduction to Biotechnology CBS Publishers and Distributors PVT LTD
3. M.K. Razdan (2002) Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co., New Delhi.
4. H.S. Chawla (2005) Introduction to Plant Biotechnology. Oxford and IBH Publishing Co. New Delhi.

S.Y.B.Sc. Botany CBCS Pattern
Practical (Semester IV Paper III) 2020-2021
BO 243: Practical based on BO 241 & BO 242

Sr. No.	Title	No. of Practical
	Plant Anatomy and Embryology	
1	Study of epidermal tissue system – non-glandular and glandular trichomes, multilayered epidermis, typical stomata (Dicotyledonous and Monocotyledonous).	2
2	Study of mechanical tissues and their distribution in root, stem and leaves.	1
3	Study of normal secondary growth in dicot stem – *Annona* /*Moringa* (Double stained temporary preparation).	1
4	Study of anomalous secondary growth in *Bignonia* and *Dracaena* stem (Double stained temporary preparation).	1
5	Study of tetrasporangiate anther and types of ovules with the help of permanent slides	1
6	Study of dicot and monocot embryo.	1
	Plant Biotechnology	
7	Instruments/equipments used in plant tissue culture laboratory: Principle and working of Autoclave, oven, laminar air flow cabinet, micropipette, culture bottles/tubes with cotton plug	1
8	Preparation & sterilization of MS medium	1
9	Surface sterilization and Inoculation of nodal sector, leaf, anther and maize embryo	2
10	Laboratory cultivation of *Spirulina*	1
11	Demonstration practical on transgenic crops viz; Bt-Cotton, Golden rice	1
12	Demonstration of principle and working of agarose gel electrophoresis, centrifuge, spectrophotometer	1
13	Visit to plant tissue culture laboratory	1

Savitribai Phule Pune University, Pune

(Formerly University of Pune)

Second Year B.Sc in Mathematics

(Faculty of Science & Technology)

Revised Syllabi for

S.Y.B.Sc. - Mathematics

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System Syllabus

To be implemented from the Academic Year 2020-2021

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
Board of Studies in Mathematics Syllabus for S. Y. B. Sc
Subject: MATHEMATICS
(With effect from June 2020)

Introduction:

Savitribai Phule Pune University, Pune has decided to change the syllabi of various faculties from June 2020. 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 teachers of Mathematics from different colleges affiliated to Savitribai Phule Pune University, Pune has prepared the syllabus of S.Y.B.Sc. Mathematics. To develop the syllabus the U.G.C. Model curriculum is followed.

Aims:

- 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.
- Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.
- 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 .
- Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

Objectives:

- A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such as notations, terminology and recognize basic geometrical figures and graphical displays ,state important facts resulting from their studies.
- A student should get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning.
- A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.
- A student be able to 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.
- A student should be made aware of history of mathematics and hence of its past, present and future role as part of our culture.

Eligibility: F. Y. B. Sc., as per University rules.

Structure of the course:

Semester - III			Semester -IV	
Paper I	**MT-231**	**Calculus of Several Variables**	**MT-241**	**Linear Algebra**
Paper II	**MT-232(A)** **MT-232(B)**	**Numerical Methods and Its Applications** **Graph Theory**	**MT-242(A)** **MT-242(B)**	**Vector Calculus** **Dynamical Systems**
Paper III	**MT-233**	**Mathematics Practical based on MT - 231 and MT - 232**	**MT-243**	**Mathematics Practical based on MT - 241 and MT-242**

- All three above courses are compulsory.
- In Semester-III, select any one from **MT-232(A) and MT-232(B).**
- In Semester-IV, select any one from **MT-242(A) and MT-242(B).**

Medium of Instruction: English.

Examination:

A) Pattern of examination: Semester.
B) Standard of passing: 20 marks out of 50 marks for each papers.
But for MT- 231, MT -232(A), MT -232(B), MT -241, MT -242(A), MT -242(B), MT -233 and MT-243 for passing a student should obtain minimum 14 marks out of 35 in the theory examination and overall total marks for theory and internal should be minimum 20.
C) Pattern of question papers: For MT- 231, MT -232(A), MT -232(B), MT -241, MT -242(A), MT -242(B).

Q1. Attempt any 05 out of 07 questions each of 01 marks. [05 Marks]

Q2. 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].

Q4. Attempt any 02 out of 04 questions each of 10 marks. [10 Marks].

D) External Students: Not allowed.

E) Verification /Revaluation: Allowed for MT- 231, MT -232(A), MT -232(B), MT - 241, MT -242(A), MT -242(B).

The pattern of question paper for MT -233, MT-243 is given in the detailed syllabus.

Equivalence of Previous syllabus along with new syllabus:

	Semester-III		**Semester-IV**	
	New Course	**Old Course**	**New Course**	**Old Course**
Paper I	**MT-231: Calculus of Several Variables**	**MT-211 : Multivariable Calculus-I**	**MT-241:Linear Algebra**	**MT-221: Linear Algebra**
Paper II	**MT-232(A): Numerical Methods and Its Applications** **MT-232(B): Graph Theory**	**MT-212(A): Discrete Mathematics** **MT- 212(B): Laplace Transform and Fourier Series**	**MT-242(A): Vector Calculus** **MT-242(B): Dynamical Systems**	**MT-222(A): Multivariable Calculus - II** **MT-212(B): Numerical Analysis**
Paper III	**MT-233: Mathematics Practical based on MT-231 and MT-232**	**MT-213 : Mathematics Practical based on MT-211 and MT-212**	**MT-243: Mathematics Practical based on MT-241 and MT-242**	**MT–223: Mathematics Practical based on MT-221 and MT-222**

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

Semester – III

MT-231: Calculus of Several Variables

Unit-1 Limits and Continuity **[06 lectures]**

1.1 Functions of Several Variables :- Functions of two variables, Domain and Range, Graphs, Level Curves, Functions of Three or More Variables

1.2 Limits and Continuity.

Unit-2 Partial Derivatives and Differentiability **[10 lectures]**

2.1 Definition and examples.

2.2 Higher Derivatives, Clairaut's Theorem (Statement Only) , Partial Differential Equations, Wave equation.

2.3 Differentiable function, Differentials

2.4 Chain Rule, Homogeneous Functions, Euler's theorem

Unit-3 Extreme Values [**08 lectures**]

3.1 Extreme values of functions of two variables.

3.2 Necessary conditions for extreme values.

3.3 Second Derivative Test (without proof).

3.4 Lagrange Multipliers (with one constraints)

Unit-4 Multiple Integrals **[12 lectures]**

4.1 Iterated Integrals, Fubini's Theorem (Statement only)

4.2 Double integral over general regions, Change of order of integration for two variables.

4.3 Double integral in Polar coordinates.

4.4 Triple integrals , Evaluation of triple integrals. Triple integrals in spherical coordinates

4.5 Jacobians , Change of variables in multiple integrals .(Results without proofs)

Text book: Multivariable Calculus 7th Edition By James Stewart, Brooks/Cole, Cengage Learning, 2012, 2008.

Unit 1:- Chapter 14: Sec- 14.1, 14.2
Unit 2:- Chapter 14: Sec- 14.3(except the Cobb-Douglas production function), 4.4 (except Tangent Planes and Linear Approximations), Sec-14.5
Unit 3:- Chapter 14: Sec 14.7, 14.8 (except two constraints)
Unit 4:- Chapter 15: Sec 15.2, 15.3, 15.4, 15.7 (without Riemann sum and Application), 15.9, 15.10

Reference Books:

1. Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba , A. Weinstein, Springer Verlag (Indian Edition).

2. Shanti Narayan, R.K. Mittal, A Text-book of Vector Calculus, S.Chand and Company.

3. D.V. Widder, Advanced Calculus (2nd Edition), Prentice Hall of India ,NewDelhi,(1944).

4. T.M. Apostol , Calculus Vol. II (2nd Edition), John Wiley, New York, (1967).

MT-232(A): Numerical Methods and It's Applications

Unit1: Solution of Algebraic and Transcendental Equations **[10 Lectures]**

1.1 Errors and their computations
1.2 Bisection method.
1.3 The method of False position
1.4 Newton- Raphson method

Unit 2: Interpolation **[12 Lectures]**

2.1 Finite Difference Operators and their relations (Forward, Backward difference and Shift operator).
2.2 Differences of a polynomial
2.3 Newton's Interpolation Formulae (Forward and Backward)
2.4 Lagrange's Interpolation Formula

Unit 3: Numerical Differentiation and Integration [06 Lectures]

3.1 Numerical Differentiation (Derivatives using Newton's forward difference formula)
3.2 Numerical Integration, General quadrature formula.
3.3 Trapezoidal rule.
3.4 Simpsons's 1/3rd rule.
3.5 Simpsons's 3/8th rule.

Unit 4: Numerical solution of first order ordinary differential equations [08 Lectures]

4.1 Taylor's Series method
4.2 Picard's method of successive approximations
4.3 Euler's method.
4.4 Modified Euler's methods.
4.5 Runge - Kutta Methods.

Text book:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th edition, Prentice Hall of ndia.

Unit 1: Chapter 1: section 1.3, Chapter 2: section 2.2, 2.3, 2.5
Unit 2: Chapter 3: section 3.3, 3.5, 3.6, 3.9(3.9.1 only)
Unit 3: Chapter 4: section 6.2 (excluding 6.2.1 to 6.2.3), 6.4
Unit 4: Chapter 5: section 8.2, 8.3, 8.4 (excluding 8.4.1).

Reference Books:

1. C.F. Gerald and O.P. Wheatley, Applied Numerical Analysis, Addison Wesley; 7thedition (2003).

2. K.E. Atkinson; An Introduction to Numerical Analysis, Wiley Publications.

3. T. Sauer, Numerical analysis, 3rd edition, Pearson.

4. M. K. Jain, SRK Iyengar and R.K. Jain, Numerical Methods For Scientific & Engg 5e, New Age International (P) Ltd (2008).

MT-232(B) : Graph Theory

Unit 1. Introduction [04 Lectures]

1.1 What is a Graph?
1.2 Application of Graphs
1.3 Finite and Infinite Graphs
1.4 Incidence and Degree
1.5 Isolated Vertex, Pendant Vertex and Null Graph

Unit 2. Paths and Circuits [12 Lectures]

2.1 Isomorphism
2.2 Subgraphs
2.4 Walks, Paths, and Circuits
2.5 Connected Graphs, Disconnected Graphs, and Components
2.6 Euler Graphs
2.7 Operations on Graphs
2.8 More on Euler Graphs
2.9 Hamiltonian Paths and Circuits
2.10 The Traveling Salesman Problem

Unit 3. Trees and Fundamental Circuits [14 Lectures]

3.1 Trees
3.2 Some Properties of Trees
3.3 Pendant Vertices in a Tree
3.4 Distance and Centers in a Tree
3.5 Rooted and Binary Trees
3.6 On Counting Trees
3.7 Spanning Trees
3.8 Fundamental Circuits
3.10 Spanning Trees in a Weighted Graph

Unit 4. Cut-Sets and Cut-Vertices [06 Lectures]

4.1 Cut-Sets
4.2 Some Properties of a Cut-Set
4.3 All Cut-Sets in a Graph
4.4 Fundamental Circuits and Cut-Sets
4.5 Connectivity and Separability

Recommended Book :

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science" Printice-Hall, of India Pvt. Lt. New Delhi.

Unit 1 : Chapter 1: Sec.1.1 to 1.5
Unit 2: Chapter 2: Sec. 2.1 to 2.10 (Excluding 2.3)
Unit 3: Chapter 3: Sec. 3.1 to 3.10 (Excluding 3.9)
Unit 4: Chapter 4 : Sec. 4.1 to 4.5

Reference books:

1. John Clark and Derek Holton, A First Look at Graph Theory (Allied Publishers)
2. Robin J. Wilson, Introduction to Graph Theory, Fourth Edition (low price edition)
3. Introduction to Graph Theory, Douglas West 2nd edition.
4. A Textbook of Graph Theory, Balakrishnan, R., Ranganathan, K.

Outcomes of Course:

Upon completion of the course, the students will achieve the following.

(i) The mathematical maturity of students in their current and future courses shall develop.

(ii) The student develops theoretical, applied and computational skills.

(iii) The student gains confidence in proving theorems and solving problems.

MT 233: Mathematics Practical

(Practicals based on the applications of articles in MT - 231 and MT - 232)

In Semester-III, we should conduct 4 written practical and 2 practical on maxima software for each paper MT-231 and MT-232.

List of Practical

Practical 1 : Problems on Unit 1(Written) from MT-231.

Practical 2 : Problems on Unit 2 (Written) from MT-231.

Practical 3 : Problems on Unit 3 (Written) from MT-231.

Practical 4 : IProblems on Unit 4 (Written) from MT-231.

Practical 5 : Problems on unit 1 and unit 2 from MT-231using maxima software.

Practical 6 : Problems on Unit 3 and Unit 4 from MT-231using maxima software.

Practical 7 : Problems on Unit 1 (Written) from MT-232.

Practical 8 :Problems on Unit 2 (Written) from MT-232.

Practical 9 : Problems on Unit 3 (Written) from MT-232.

Practical 10 : IProblems on Unit 4 (Written) from MT-232.

Practical 11 : Problems on unit 1 and unit 2 from MT-232 using maxima software.

Practical 12 : Problems on Unit 3 and Unit 4 from MT-2322 using maxima software.

Note:

1. The soft copy of practicals on maxima software will be prepared and provided by the Board of Studies in mathematics.

2. Practicals on maxima software can be performed on computer only.

3. Practical examination of 25 marks on written problems, 10 marks for problems on maxima software (5 marks for writing syntax and 5 marks to perform the same on computer).

Semester - IV

MT-241: Linear Algebra

Unit-1: Matrices and System of Linear Equations [06 lectures]

1.1 Row echelon form of a matrix, reduced row echelon form of a matrix.
1.2 Definition of rank of a matrix using row echelon or row reduced echelon form.
1.3 System of linear equations- Introduction, matrix form of linear system, definition of row equivalent matrices.
1.4 Consistency of homogeneous and non-homogeneous system of linear equations using rank, condition for consistency.
1.5 Solution of System of Equations: Gauss elimination and Gauss-Jordan elimination method, examples.

Unit-2: Vector Spaces-I [10 lectures]

2.1 Definition and Examples.

2.2 Subspaces.

2.3 Linear Dependence and Independence.
2.4 Basis of Vector Space

Unit-3: Vector Spaces-II [08 lectures]

3.1 Dimension of a Vector Space.
3.2 Row, Column and Null Space of a matrix.
3.3 Rank and nullity.

Unit-4: Linear Transformations [12 lectures]

4.1 Definition and Examples, Properties, Equality.
4.2 Kernel and range of a linear Transformation
4.3 Rank-Nullity theorem.
4.4 Composite and Inverse Transformation.
4.5 Matrices and Linear Transformation.
4.6 Basic Matrix Transformations in R^2 and R^3
4.7 Linear Isomorphism.

Text Book::

Howard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, Ninth Edition, Wiley, 11th edition.

Unit-1: Chapter-1: Sec. 1.1, 1.2.

Unit-2: Chapter- Sec. 4: 4.1 to 4.4.

Unit-3: Chapter- Sec. 4: 4.5, 4.7, 4.8

Unit- 4: Chapter- Sec.8: 8.1 to 8.4, 1.8, 4.9.

Reference Books:

(1) K. Hoffman and R. Kunze, Linear Algebra, 2nd edition(2014), Prentice Hall of India, New Delhi

(2) Steven J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall of India. New Delhi

(3) Vivek Sahai, Vikas Bist, Linear Algebra, 4th Reprint 2017, Narosa Publishing House, New Delhi

(4) Promode Kumar Saikia, Linear Algebra, 2009, Pearson, Delhi

(5) S. Lang, Introduction to Linear Algebra, 2nd edition,1986, Springer-Verlag, New York, Inc.

MT 242(A): Vector Calculus

Unit 1: **Vector-Valued Functions** **[08 lectures]**

1.1 Curves in Space, Limits and Continuity, Derivatives and Motion, Differentiation Rules for Vector Function, Vector Functions of Constant Length.

1.2 Integrals of Vector Functions.

1.3 Arc Length along a Space Curve, Speed on a Smooth Curve, Unit Tangent Vector.

1.4 Curvature of a Plane Curve, Circle of Curvature for Plane Curves, Curvature and Normal Vectors for a Space Curve.

Unit 2: **Integrals** **[12 Lectures]**

2.1 Line Integral of Scalar Functions, Additivity, Line integral in the Plane.

2.2 Vector Fields, Gradient Fields, Line Integral of Vector Fields, Line Integrals with respect to dx, dy, dz .

2.3 Work done by a Force over a Curve in Space, Flow Integrals and Circulation for Velocity Fields, Flow across the Simple Closed Plane Curve.

2.4 Path Independence, Conservative and Potential Functions.

2.5 Divergence, Two forms for Green's Theorem, Green's Theorem in the Plane (Proof for special regions),

Unit 3: **Surface Integrals** **[08 Lectures]**

3.1 Parameterizations of Surfaces, Implicit surfaces.

3.2 Surface integrals, Orientation of Surfaces.

3.3 Surface Integrals of Vector Fields.

Unit 4: Applications of Integrals **[08 Lectures]**

4.1 The Curl Vector Field, Stokes' Theorem(without proof), Conservative Fields and Stokes' Theorem.

4.2 Divergence in three Dimensions, Divergence Theorem (without proof).

4.3 Unifying the Integral Theorems.

Text Book:

- Thomas' Calculus (14th Edition) by Hass, Heil, Weir, Pearson Indian Education Services Pvt. Ltd.
  Unit 1: Chapter 13: Sec- 13.1, 13.2, 13.3, 13.4
  Unit 2: Chapter 16: Sec-16.1, 16.2, 16.3, 16.4
  Unit 3: Chapter 16: Sec- 16.5, 16.6
  Unit 4: Chapter 16: Sec- 16.7, 16.8

Reference books:

(1) Basic Multivariable Calculus byJ.E.Mardson, A.J.Tromba, A. Weinstein, Sppriger Verlag (Indian Edition)

(2) Advanced Calculus by M.R. Spiegel, Schaum Series.

(3) Advanced Calculus (IInd Edition) byD.V. Widder, Prentice Hall of India, New Delhi(1944).

(4) Advanced Calculus by John M. H. Olmsted, Eurasia Publishing House, New Delhi(1970)

(5) Calculus Vol. II (IInd Edition) by T.M. Apostol, John Wiley, New York (1967).

MT-242(B): Dynamical Systems

Unit 1: Eigenvalues and Eigenvectors [08 Lectures]

1.1 Eigenvalues and Eigenvectors

1.2 Diagonalisation(matrices with real and distinct eigenvalues)

Unit 2: First-Order Equations and Planar Linear Systems [12 Lectures]

2.1 The Simplest Example

2.2 The Logistic Population Model

2.3 Second-Order Differential Equations

2.4 Planar Systems

2.5 Preliminaries from Algebra

2.6 Planar Linear Systems

2.7 Eigenvalues and Eigenvectors

2.8 Solving Linear Systems

2.9 The Linearity Principle.

Unit 3: Phase Portraits for Planar Systems [08 Lectures]

3.1 Real Distinct Eigenvalues

3.2 Complex Eigenvalues

3.3 Repeated Eigenvalues

3.4 Changing Coordinates

Unit 4: Classification of Planar Systems and Exponential of a matrix [08 Lectures]

4.1 The Trace-Determinant Plane
4.2 Exponential of a matrix.

Textbooks :

1) Elementary Linear Algebra by Howard Anton and Chris Rorres (9thedition), Applications Version.

Unit 1: Chapter 7 : Section 7.1 (Examples, Theorems with Statements only) , Section 7.2 (2 x 2 and 3 x 3 matrices with real and distinct eigenvalues, Theorems with Statements only)

2) Differential Equations, Dynamical Systems and An Introduction to Chaos (2nd edition) by Morris Hirsch, Stephen Smale and Robert Devaney, Academic Press.

Unit 2: Chapter 1 : Section - 1.1 to 1.2, Chapter 2 : Section - 2.1 to 2.7.
Unit 3: Chapter 3 : Section, 3.1 to 3.4,
Unit 4: Chapter 4 :Section 4.1, Chapter 6 : Section 6.4 (2 x 2 matrices with distinct real, repeated real and complex eigenvalues, 3 x 3 matrices with distinct real eigenvalues).

Reference Books :

1. K.B.Datta, Matrix and Linear Algebra, Prentice hall of India Pvt.Ltd, New Delhi 2000.

2. Differential Equations and Dynamical Systems (Third Edition) by Lawrence Perko, Texts in Applied Mathematics 7, Springer.

Outcomes of Course:

Upon completion of the course, the students will achive the following.

(i) The mathematical maturity of students in their current and future courses shall develop.
(ii) The student develops theoretical, applied and computational skills.
(iii) The student gains confidence in proving theorems and solving problems.

MT 243: Mathematics Practical

(Practical based on the applications of articles in MT- 241 and MT -242)

In Semester-IV, we should conduct 4 written practical and 2 practical on maxima software for each paper MT-241 and MT-242.

List of Practical

Practical 1 : Problems on Unit 1 (Written) from MT-241.

Practical 2 : Problems on Unit 2 (Written) from MT-241.

Practical 3 : Problems on Unit 3(Written) from MT-241

Practical 4 : Problems on Unit 4(Written) from MT-241.

Practical 5 : Problems on unit 1 and unit 2 from MT-241using maxima software.

Practical 6 : Problems on Unit 3 and Unit 4 from MT-241 using maxima software.

Practical 7 : Problems on Unit 1 (Written) from MT-242.

Practical 8 : Problems on Unit 2 (Written) from MT-242.

Practical 9 : Problems on Unit 3(Written) from MT-242.

Practical 10 : Problems on Unit 4(Written) from MT-242.

Practical 11 : Problems on unit 1 and Unit 2 from MT-242 using maxima software.

Practical 12 : Problems on Unit 3 and Unit 4 from MT-242 using maxima software.

Note:

1 The soft copy of practical on maxima software will be prepared and provided by the Board of Studies in mathematics.

2. Practicals on maxima software shall be performed on computer only..

3.Practical examination 25 marks on written problems, 10 marks for problems on maxima software (5 marks for writing syntax and 5 marks to perform the same on computer only).

Modalities For Conducting The Practical and The Practical Examination:

1) There will be one 4 hour 10 minutes (250 minutes) practical session for each batch of 15 students per week.
2) The College will conduct the Practical Examination at least 15 days before the commencement of the Main Theory Examination. The practical examination will consist of written examination of 20 marks, 10 marks on maxima software and oral examination of 05 marks.
3) There will be external examiner; the practical exam will be of the duration of 3hours.
4) The teacher will set a question paper at the time of paper setting meeting conducted by Savitribai Phule Pune University, Pune based on pattern as follows

Q1. Any 2 out of 4 each question of 5 marks on paper - I.
Q2. Any 2 out of 4 each question of 5 marks on paper - II.
Q3. (a) Any 1 out of 2 each question of 5 marks on maxima software from paper – I.
(b) Any 1 out of 2 each question of 5 marks on maxima software from paper – II.

5) Each student will maintain a journal to be provided by the college.

7) The internal 15 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.

8) It is recommended that concept may be illustrated using computer software maxima and graphing calculators wherever possible.

9) Study tours may be arranged at places having important mathematical institutes or historical places.

10) **Special Instruction:**

a) There should be well equipped mathematics practical laboratory of size 20x20 sq. fts containing at least 20 computers.

b) Examiners should set separate question papers, solutions and scheme of marking for each batch and claim the remuneration as per rule.

c) Before starting each practical necessary introduction, basic definitions, intuitive inspiring ideas and prerequisites must be discussed**.**

Savitribai Phule Pune University

(Formerly University of Pune)

Second Year B.Sc. Degree Program in Physics

(Faculty of Science & Technology)

S.Y.B.Sc. (Physics)

Choice Based Credit System

To be implemented from Academic Year 2021-2022

Savitribai Phule Pune University, Pune

Revised syllabus for S.Y.B.Sc. (Physics) (CBCS Pattern-2019-20)

To be implemented from Academic Year 2021-22

Structure of the Course:

Semester	Course Type	Course Code	Course Name	Credit
III	Compulsory Course	PHY-231	Mathematical Methods in Physics I	2
		PHY-232	(A) Electronics-I **OR** (B) Instrumentation	2
		PHY-233	Physics Laboratory-2A	2
	Ability Enhancement Compulsory Course	PHY-2310	Environment -I	2
		PHY-2311	Language-I	2
IV	Compulsory Course	PHY-241	Oscillations, Waves and Sound	2
		PHY-242	Optics	2
		PHY-243	Physics Laboratory-2B	2
	Ability Enhancement Compulsory Course	PHY-2410	Environment -II	2
		PHY-2411	Language-II	2

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)
PHY-231: Mathematical Methods in Physics-I

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

Learning Outcomes: After the completion of this course students will be able to

1. Understand the complex algebra useful in physics courses.
2. Understand the concept of partial differentiation.
3. Understand the role of partial differential equations in physics.
4. Understand vector algebra useful in mathematics and physics.
5. Understand the concept of singular points of differential equations.

1. Complex Numbers: **(9L)**

1.1 Introduction to complex numbers
1.2 Rectangular, polar and exponential forms of complex numbers
1.3 Argand diagram
1.4 Algebra of complex numbers using Argand diagram
1.5 De-Moivre's Theorem (Statement only)
1.6 Power, root and log of complex numbers
1.7 Trigonometric, hyperbolic and exponential functions
1.8 Applications of complex numbers to determine velocity and acceleration in curved motion.
1.9 Problems.

2. Partial Differentiation: **(9L)**

2.1 Definition of partial differentiation
2.2 Successive differentiation
2.3 Total differentiation
2.4 Exact differential
2.5 Chain rule
2.6 Theorems of differentiation
2.7 Change of variables from Cartesian to polar co-ordinates
2.8 Conditions for maxima and minima (without proof)
2.9 Problems.

3. Vector Algebra and Analysis: **(12L)**

3.1 Introduction to scalars and vectors, dot product and cross product of two vectors and their physical significance. (Revision)
3.2 Scalar triple product and its geometrical interpretation
3.3 Vector triple product and its proof
3.4 Scalar and vector fields
3.5 Differentiation of vectors with respect to scalar
3.6 Vector differential operator and Laplacian operator
3.7 Gradient of scalar field and its physical significance
3.8 Divergence of scalar field and its physical significance
3.9 Curl of vector field and its physical significance.

3.10 Vector Identities.

a. $\nabla \times (\nabla\Phi) = 0$

b. $\nabla.(\nabla \times V) = 0$

c. $\nabla.(\nabla\Phi) = \nabla^2\Phi$

d. $\nabla.(\Phi A) = \nabla\Phi.A + \Phi(\nabla.A)$

e. $\nabla \times (\Phi A) = \Phi (\nabla \times A) + (\nabla\Phi) \times A$

f. $\nabla.(A \times B) = B.(\nabla \times A) - A(\nabla \times B)$

3.11 Problems.

4. Differential Equation: **(6L)**

4.1 Degree, order, linearity and homogeneity of differential equation.

4.2 Concept of Singular points. Example of singular points ($x = 0$, $x = x_0$ and $x = \infty$) of differential equation.

4.3 Problems.

Reference Books:

1. Methods of Mathematical Physics - Laud, Takwale and Gambhir.
2. Mathematical Physics - B.D.Gupta.
3. Mathematical Physics - Rajput and Gupta.
4. Mathematical Methods in Physical Science - Mary and Boas.
5. Vector analysis - Spiegel and Murrey.
6. Mathematical Methods for Physicists - Arfkenand Weber (5^{th} Edition)
7. Fundamentals of Mathematical Physics - A.B.Gupta.
8. Vector Analysis - Seymour Lipschutz and Dennis Spellman.

S.Y.B.Sc. (Physics) (Sem-III)
PHY-232(A): Electronics-I

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

N.B: This course is for students **who have not taken Electronic Science as one of the subjects at F.Y.B. Sc.**

Learning outcomes: On successful completion of this course the students will be able to

- Apply different theorems and laws to electrical circuits.
- Understand the relations in electricity.
- Understand the parameters, characteristics and working of transistors.
- Understand the functions of operational amplifiers.
- Design circuits using transistors and applications of operational amplifiers.
- Understand the Boolean algebra and logic circuits.

1. Network Theorem: **(6L)**

1.1 Krichhoff's Law
1.2 Voltage and current Divider Circuit
1.3 Thevenin's Theorem
1.4 Norton's Theorem
1.5 Superposition Theorem
1.6 Maximum Power transfer theorem (With proof)
1.7 Problems

2. Study of Transistor: **(12L)**

2.1 Bi-junction Transistor:

1. Revision of bipolar Junction Transistor, Types, Symbol and basic action.
2. Configuration (Common Base, Common Emitter and Common Collector)
3. Current Gain Factors (α and β) and their relations
4. Input, Output and transfer Characteristic of CE Configuration
5. Biasing method and Voltage Divider
6. DC Load line (CE), Operating Point (Q- point)
7. Transistor as a switch
8. Problems

2.2 Unijunction Transistor:

1. Symbol, Types, Construction, Working Principle, I-V characteristics, Specifications and Parameters of Unijunction Transistor (UJT)
2. UJT as a relaxation Oscillator.

3. Operational Amplifiers and Application **(12 L)**

3.1 Operational Amplifiers:

1. Introduction
2. Ideal and practical Characteristics
3. Operational Amplifier: IC741- Block Diagram and Pin diagram
4. Concept of Virtual Ground
5. Inverting and Non-inverting operational amplifiers with concept of gain

6. Operational amplifier as an adder and subtractor
7. Problems

3.2 Oscillators:

1. Concept of Positive and negative feed back
2. Barkhausein Criteria for an oscillator
3. Construction, working and application of phase shift oscillator using IC741
4. Problems

4. Number System and Logic Gates (6 L)

1. Number System: Binary, Binary coded Decimal (BCD), Octal, Hexadecimal
2. Addition and Subtraction of binary numbers and binary fractions using one's and two's complement
3. Basic Logic gates (OR, AND, NOT)
4. Derived gates: NOR, NAND, EXOR, EXNOR, with symbols and truth table
5. Boolean Algebra
6. De Morgan's theorem and its verification
7. Problems

Reference Books:

1. Electronic Principles-Malvino, 7th Edition, Tata Mc-Graw Hills publication.
2. Principles of Electronics-V.K. Mehta, S. Chand publication.
3. Op-amp and Linear Integrated Circuit-Ramakant Gaikwad, Prentice Hall of India publication.
4. Integrated Circuit-Botkar, Khanna Publication, New Delhi.
5. Digital Principles and Application-Malvino and Leech, Tata Mc-Graw Hills publication.

S.Y.B.Sc. (Physics) (Sem-III)
PHY-232(B): Instrumentation

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

N.B: This course is for students **who have taken Electronic Science as one of the subjects at F. Y. B. Sc.**

Learning outcomes: After successful completion of this course, the student will be able to

- Understand the concept of measurement.
- Understand the performance of measuring instruments.
- Design experiments using sensors.

1. Fundamental of measurement: **(8L)**

1.1 Aims of measurement

1.2 Functional elements of typical measurement system (Block diagram and its explanation).

1.3 Standards of measurement and its classification. (International, primary or national, secondary and working standards).

1.4 Static characteristics: Accuracy, Precision, Sensitivity, Linearity, Resolution, Drift and Hysteresis.

1.5 Dynamic characteristics concepts: First and Second order instruments, Examples of first order: Resistance thermometer and thermal element, Example of 2nd order: U–tube Manometer.

1.6 Errors in measurement and its classifications.

1.7 Problems

2. Transducers: **(12L)**

2.1 Classification of Transducers and its characteristics

2.2 Displacement Transducer

a) Resistive Type: Linear and Angular (Rotary) Potentiometer, Strain Gauge: Bonded and Unbonded

b) Inductive Type: Self inductive: Variable number of turns, Variable Reluctance Mutual Inductive: LVDT

c) Piezoelectric Type: Quartz Crystal

2.3 Force Transducer: Cantilever beam, Column type devices

2.4 Temperature Measurement

Scales for temperature: Celsius, Kelvin and Fahrenheit

Temperature Measurement Techniques

a. Non-electrical: Liquid filled thermometer and bimetallic thermometer

b. Electrical Methods:

i. Platinum Resistance Thermometer

ii. Thermistor: PTC and NTC with characteristics

iii. Thermocouple: Seebeck effect and Peltier effect,

iv. Types of Thermocouple

3. Measurement of Pressure: **(8L)**

3.1 Unit of pressure, Concept of vacuum, Absolute gauge and differential pressure,

3.2 Elastic Transducer- Diaphragm, Corrugated Diaphragm, Bellows, Bourdon Tube

3.3 Electric Type- LVDT, Strain gauge

3.4 Pressure Transducer- Calibration by dead weight tester Method

3.5 Problems

4. Signal Conditioning and Processing: (8L)

4.1 Current to voltage, Voltage to current convertors, buffer amplifier, S/H Amplifier and Characteristics, Acquisition time, Aperture time, Drop rate

4.2 Filters: First order LPF and HPF with design,

4.3 Instrumentation Amplifier (Using 3 op-amp)

Reference Books:

1. Instrumentation Device and System - Rangan,Mani and Sarma, Tata Mc Graw Hill
2. Instrumentation Measurement and Analysis - Nakra, Choudhari, Tata Mc Graw Hill India publication.
3. Sensors and Transducers - D. Patranabis, PHI publications.
4. Op-Amps and Linear Integrated Circuits - Ramakant A. Gayakwad, Pearson India publications.
5. Process control Instrumentation Technology - C.D. Johnson, PHI publications.

S.Y.B.Sc. (Physics) (Sem-III)
PHY-233: Physics Laboratory-2A

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

Learning Outcome: After completing this practical course students will be able to

- Use various instruments and equipment.
- Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
- Investigate the theoretical background of an experiment.
- Setup experimental equipment to implement an experimental approach.
- Analyze the data, plot appropriate graphs and reach conclusions from data analysis.
- Work in a group to plan, implement and report on a project/experiment.
- Keep a well-maintained and instructive laboratory logbook.

Section-I: Electronics-I/Instrumentation

1. Circuit Theorems (Thevenin's, Norton's and Maximum Power Transfer Theorems)
2. Transistor Characteristics(Input and Output characteristics of CE Configuration)
3. Single Stage Transistor Amplifier
4. Study f Rectifiers (Half, Full Wave and Bridge) with different filters
5. I-V Characteristics of UJT/ UJT as Relaxation Oscillator
6. Zener as a Regulator (Line and Load Regulation)
7. Op-amp as inverting and non-inverting amplifier
8. Study of Wein Bridge / Phase Shift Oscillator using 741
9. Op-amp as an adder and subtractor
10. Study of logic gates and verification of de Morgan's theorems
11. To measure displacement using potentiometer/variable inductor/ variable capacitor
12. Use of CRO(AC/DC Voltage measurement, Frequency measurement)
13. To measure force using load cell
14. To measure pressure using elastic diaphragm(In Variable Capacitor / Bourdon Tube)
15. To measure magnetic field using Hall Probe for a system of ring magnets

Section-II: Use of Computer

1. Plotting of various trigonometric functions using spread sheet/any graphic software viz. Microsoft Excel, Origin: sinx, cosx, tanx,ex, e-x, logx, lnx, xn
2. Plotting of conic sections using spreadsheet /any graphic software viz. Microsoft Excel, Origin: circle, ellipse, parabola, hyperbola
3. Inverse, determinant of matrix, solution of linear equations using Microsoft Excel or Origin software

Additional Activities (Any two)

1. Plotting of any **two** graphs using spreadsheets (of data obtained from various experiments performed by the student)

2. Any **two** computer aided demonstrations (Using computer simulations or animations)

3. Demonstrations-Any **two** demonstrations
4. Study tour with report
5. Mini project

Total Experiments to be performed by a student: (A) **10** OR (B) **8 + Two Activities**

(A): At least **6** experiments from **Section-I** and **2** experiments from **Section-II**
(B): At least **4** experiments from **Section-I** and **2** experiments from **Section-II + Any Two Activities**

Semester-IV

S.Y.B.Sc. (Physics) (Sem-IV)
PHY-241: Oscillations, Waves and Sound

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

Learning Outcomes: On completion of this course, the learner will be able:

- To study underlying principles of oscillations and its scope in development.
- To understand and solve the equations / graphical representations of motion for simple harmonic, damped, forced oscillators and waves.
- To explain oscillations in terms of energy exchange with various practical applications.
- To solve numerical problems related to undamped, damped, forced oscillations and superposition of oscillations.
- To study characteristics of sound, decibel scales and applications.

1. Undamped Free Oscillations: **(7L)**

1.1 Different types of equilibria (static, dynamic, stable, unstable, and metastable equilibrium) – definitions only with examples.

1.2 Definitions of linear Simple Harmonic Motion (S.H.M) and angular S.H.M.

1.3 Differential equation for linear S.H.M. and its solution.

1.4 Composition of two perpendicular linear S.H.Ms. for frequency ratio 1:1 and 2:1 (analytical method).

1.5 Lissajous figures, their demonstration (optical and electrical method) and applications.

1.6 Problems.

2. Damped Oscillations: **(7L)**

2.1 Introduction

2.2 Differential equation for damped harmonic oscillator and its solution, discussion of different cases.

2.3 Logarithmic decrement.

2.4 Average energy of damped harmonic oscillator.

2.5 Quality factor.

2.6 Application: LCR series circuit.

2.7 Problems.

3. Forced Oscillations: **(8L)**

3.1 Introduction.

3.2 Differential equation for forced oscillations and its solution.

3.3 Resonance: mechanical, acoustic and electrical.

3.4 Velocity and Amplitude resonance.

3.5 Sharpness of resonance and half width.

3.6 Average energy of forced oscillator.

3.7 Quality factor of forced oscillator.

3.8 Relation between quality factor and bandwidth.

3.9 Application of forced oscillations- LCR series circuit.

3.10 Problems.

4. Wave Motion: **(6L)**

4.1 Introduction.
4.2 Equation for longitudinal waves and its solution (one dimension only).
4.3 Equation for transverse waves and its solution (one dimension only).
4.4 Energy density and intensity of a wave.
4.5 Qualitative discussion of seismic waves and gravitational waves.
4.6 Problems.

5. Sound and Doppler Effect: **(8L)**

5.1 Definition of sound Intensity, Loudness, Pitch, Quality and timbre.
5.2 Reverberation time and reverberation of hall.
5.3 Sabine's formula (without derivation).
5.4 Doppler Effect in sound, Expression for apparent frequency in different cases.
5.5 Asymmetric nature of Doppler Effect in sound.
5.6 Doppler Effect in light, Symmetric nature of Doppler Effect in light.
5.7 Applications: Radar, Speed of distant star, Rotational speed of binary star, Red Shift and Width of spectral line.
5.8 Problems.

Reference Books:

1. Waves and Oscillations - Stephenson.
2. The Physics of Waves and Oscillations - N. K. Bajaj, Tata McGraw- Hill, publication.
3. Fundamentals of Vibrations and Waves - S. P. Puri, Tata McGraw-Hill publication.
4. A Text Book of Sound - Subramanyam and Brijlal, Vikas Prakashan.
5. Sound - Mee, Heinmann Edition, London.
6. Waves and Oscillations - R.N. Chaudhari, New Age International (p) ltd.
7. A Textbook on Oscillations, Waves and Acoustics - M. Ghosh, and D. Bhattacharya, S. Chand and Company Ltd.

S.Y.B.Sc. (Physics) (Sem-IV)
PHY-242: Optics

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

Learning Outcomes: On successful completion of this course the students will be able to

- Acquire the basic concept of wave optics.
- Describe how light can constructively and destructively interfere.
- Explain why a light beam spread out after passing through an aperture
- Summarize the polarization characteristics of electromagnetic wave
- Understand the operation of many modern optical devices that utilize wave optics
- Understand optical phenomenon such polarization, diffraction and interference in terms of the wave model
- Analyze simple example of interference and diffraction.

1. Geometrical optics and Lens aberrations: (12L)

(a) Geometrical optics:

1.1 Introduction to lenses and sign conventions.
1.2 Thin lenses: Lens equation for single convex lens
1.3 Lens maker equation
1.4 Concept of magnification, deviation and power of a thin lens
1.5 Equivalent focal length of two thin lens system
1.6 Concept of cardinal points
1.7 Problems

(b) Lens Aberrations:

1.8 Introduction to Aberration
1.9 Types of aberration: Monochromatic and Chromatic Aberration (Only discussion)

2. Optical Instruments: (6L)

2.1 Introduction to optical instruments
2.2 Types of optical instruments: Simple Microscope, Compound Microscope and Astronomical telescope (only construction and working)
2.3 Eyepiece: Ramsden's eye piece (Expression), Huygens eye piece and Gauss's eyepiece (only qualitative discussion)
2.4 Problems.

3. Interference and Diffraction: (12L)

(a) Interference:

3.1 Introduction to interference
3.2 Types of Interference (only discussion)
3.3 Phase change on reflection (Stokes treatment).
3.4 Interference due to reflected light
3.5 Interference due to transmitted light.
3.6 Newton's ring (to calculate wavelength)

3.7 Problems

(b) Diffraction:

3.8 Introduction to diffraction

3.9 Types of diffraction (only discussion)

3.10 Fraunhoffer's diffraction due to single slit and double slit (only qualitative discussion)

3.11 Plane transmission grating and grating equation (only principal maxima)

3.12 Rayleigh criterion for resolution (only qualitative discussion)

3.13 Problems

4. Polarization: **(6L)**

4.1 Introduction to polarization

4.2 Brewster's law

4.3 Malus's Law

4.4 Polarization by double refraction

4.5 Nicol Prism

4.6 Application of polarization

4.7 Problems

Reference Books:

1. Optics - A.R. Ganesan, 4th edition, Pearson Education.
2. A Textbook of Optics - N. Subhramanyam, Brijlal, M.N. Avadhanulu, S. Chand Publication.
3. Physical Optics - A.K. Ghatak, McMillan, New Delhi
4. Fundamental of Optics - F.A. Jenkins, H.E.White, Mc Graw-Hilll International edition
5. Principles of Optics - D.S. Mathur, Gopal Press, Kanpur.

S.Y.B.Sc. (Physics) (Sem-IV)
PHY-243: Physics Laboratory-2B

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

Learning Outcome: After completing this practical course students will be able to

- Use various instruments and equipment.
- Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
- Investigate the theoretical background of an experiment.
- Setup experimental equipment to implement an experimental approach.
- Analyze the data, plot appropriate graphs and reach conclusions from data analysis.
- Work in a group to plan, implement and report on a project/experiment.
- Keep a well-maintained and instructive laboratory logbook.

Section I: Oscillations, Waves and Sound

1. Logarithmic decrement (in air and water).
2. Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination of coupling coefficient.
3. 'g' by bar pendulum.
4. Study of musical scales using a signal generator and musical instruments.
5. Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, paper etc.).
6. Study of Lissajous's figures and determination of unknown frequency.
7. Determination of speed of sound by Quincke's method interferometer.
8. Directional characteristics of Microphone.
9. Velocity of sound by Phase shift method.
10. To determine the frequency of an electrically maintained tuning fork by stroboscopic method.
11. To determine the velocity of sound in air at room temperature with Kundt's Tube.

Section II: Optics

1. Newton's Ring: Determination of wavelength of monochromatic light source (λ).
2. Dispersive power of glass prism.
3. Total internal reflection using LASER beam and glass prism.
4. Diffraction at the edge of a razor blade.
5. Optical activity of sugar solution using Polarimeter.
6. Goniometer to determine cardinal points and focal length.
7. To determine temperature of sodium flame.
8. Double refracting prism.
9. Determination of Cauchy's constant.

Additional Activities (Any two)

1. Plotting of any **two** graphs using spreadsheets (of data obtained from various experiments performed by the student).

2. Any **two** computer aided demonstrations (Using computer simulations or animations).

3. Demonstrations –Any **two** demonstrations.

4. Study tour with report.

5. Mini project.

Total Experiments: (A) **10** OR (B) **8 + Two Activities**

(A): **5** experiments from **Section-I** and **5** experiments from **Section-II**

(B): **4** experiments from **Section-I** and **4** experiments from **Section-II + Any Two Activities**

Savitribai Phule Pune University [SPPU]

B.Sc. (Chemistry)

(Three Years Integrated Degree Program)

Choice Based Credit System [CBCS]

2019 Pattern

Second Year Bachelors of Science

(S. Y. B. Sc.)

From Academic Year

2020-21

Board of Studies in Chemistry

Savitribai Phule Pune University [SPPU]

Pune-411007

Structure of S. Y. B. Sc. Chemistry

(According to CBCS – 2019 Pattern of SPPU)

Semester	Course	Discipline Specific Core (DSCC)*
III	Theory	**CH-301** : Physical and Analytical Chemistry (2 credit, 36 L)
	Theory	**CH-302** : Inorganic and Organic Chemistry (2 credit, 36 L)
	Practical	**CH-303** : Chemistry Practical - III (2 credit, 72 L)
IV	Theory	**CH-401** : Physical and Analytical Chemistry (2 credit, 36 L)
	Theory	**CH-402** : Inorganic and Organic Chemistry (2 credit, 36 L)
	Practical	**CH-403** : Chemistry Practical - IV (2 credit, 72 L)

***Important Notice:**

i. Each lecture (L) will be of 50 minutes.

ii. Each practical of 4 hours and 12 practical sessions per semester

iii. 12 weeks for teaching 03 weeks for evaluation of students (theory as well as practical).

iv. For details refer UG rules and regulations (CBCS for Science program under Science & Technology) published on SPPU website.

Evaluation Pattern (As per CBCS rules, SPPU 2019 Pattern)

1. Each theory and practical course carry 50 marks equivalent to 2 credits.
2. Each course will be evaluated with Continuous Assessment (CA) and University Assessment (UA) mechanism.
3. Continuous assessment shall be of 15 marks (30%) while university Evaluation shall be of 35 marks (70%).
4. To pass each course, a student has to secure 40% mark in continuous assessment as well as university assessment i.e. 6 marks in continuous assessment and 14 marks in university assessment for the respective course.
5. For Continuous Assessment (internal assessment) minimum two tests per paper must be organized, of which one must be written test of 10 marks.
6. Method of assessment for internal exams: Viva-Voce, Project, survey, field visits, tutorials, assignments, group discussion, etc. (on approval of the head of centre).

Theory - University Assessment Question Paper Pattern

(According to CBCS - 2019 Pattern of SPPU)

Note that in theory question paper weightage will be given to each topics equivalent to number of lectures assigned in the syllabus.

<table>
<tr><td colspan="3">Total Marks: 35</td><td colspan="2">Duration: 2 Hours</td></tr>
<tr><td colspan="5">Note: i) Question -1 will be compulsory (5 marks).
ii) Solve any three questions from question 2- 5.
iii) Questions 2 to 5 carry equal marks (10 each).</td></tr>
<tr><td>Q-1</td><td></td><td>Solve any five of the following
(a)
(b)
(c)
(d)
(e)
(f)</td><td>a) four tricky questions and b)two question on problem type (if applicable).</td><td>5 marks</td></tr>
<tr><td>Q-2</td><td>(A)

(B)</td><td colspan="2">Describe type of question(s)
i)
ii)
Short question, but tricky</td><td>6 mark

4 mark</td></tr>
<tr><td>Q-3</td><td>(A)

(B)</td><td colspan="2">Explain type of question(s)
i)
ii)
Problem based question if applicable. Justification type of question</td><td>6 mark

4 mark</td></tr>
<tr><td>Q-4</td><td>(A)

(B)</td><td colspan="2">Discuss type of question(s)
i)
ii)
Problem based question if applicable. Justification type of question</td><td>6 mark

4 mark</td></tr>
<tr><td>Q-5</td><td>
(A)
(B)
(C)</td><td colspan="2">Attempt any two of the following
Questions A, B, C, - will be Explain, Derivation, Discuss, Notes, etc. type of long questions</td><td>10 mark</td></tr>
</table>

S. Y. B. Sc. Chemistry Syllabus

(CBCS - 2019 Semester Pattern)

From Academic Year 2020-21

Equivalence with Previous Syllabus (2013 Pattern)

New Course (2019 Pattern)	Old Course (2013 Pattern)
CH-301 : Physical and Analytical Chemistry	**CH-211** : Physical and Analytical Chemistry
CH-302 : Inorganic and Organic Chemistry	**CH-212** : Organic and Inorganic Chemistry
CH-303 : Chemistry Practical - III	**CH-223** : Chemistry Practical
CH-401 : Physical and Analytical Chemistry	**CH-221** : Physical and Analytical Chemistry
CH-402 : Inorganic and Organic Chemistry	**CH-222** : Organic and Inorganic Chemistry
CH-403 : Chemistry Practical - IV	**CH-223** : Chemistry Practical

Preamble:

The syllabus of Chemistry for second year has been redesigned for Choice based Credit System (CBCS: 2019 pattern) to be implemented form 2020-21.

In CBCS pattern semester system has been adopted for FY, SY and TY which includes Discipline Specific Core Course (DSCC) at F Y level, Ability Enhancement Compulsory Course (AECC), Discipline Specific Elective Course (DSEC) and Skill Enhancement Course (SEC). A DSCC course has been introduced at FY level and AECC courses at SY level along with DSEC. At TY level DSEC and SEC courses has been introduced.

Syllabus for Specific Core Courses of Chemistry (2 Theory and 1 Practical) subject for F. Y. B. Sc. is to be implemented from the year 2019-20. Syllabus for S. Y. and T. Y. B. Sc. will be implemented from the year 2020-21 and 2021-22 respectively as per structure approved.

Learning Outcome:

1. To understand basic concept/principles of Physical, Analytical, Organic and Inorganic chemistry.
2. To impart practical skills and learn basics behind experiments.
3. To prepare background for advanced and applied studies in chemistry.

Overall Syllabus

SEMESTER-III			
Sr. No.	**Course Code**	**Course Name**	**Credits and No of Lect.**
1	CH-301	Physical and Analytical Chemistry	Credit -2, 36 L
2	CH-302	Inorganic and organic Chemistry	Credit -2, 36 L
3	CH-303	Practical Chemistry-III	Credit -2, 72 L
SEMESTER-IV			
4	CH-401	Physical and Analytical Chemistry	Credit -2, 36 L
5	CH-402	Inorganic and organic Chemistry	Credit -2, 36 L
6	CH-403	Practical Chemistry-IV	Credit -2, 72 L

The detailed Semester and Course wise of Syllabus is as follows:

SEMESTER-III

CH-301: Physical and Analytical Chemistry [Credit -2, 36 L]

Chapter No.	Chapter	No of Lectures
1	Chemical Kinetics	12
2	Surface Chemistry	06
3	Errors in Quantitative Analysis	05
4	Volumetric analysis	13

1. Chemical Kinetics: [12 L]

Introduction to kinetics, the rates of chemical reactions – definition of rates, rate laws and rate constants, reaction order and molecularity, determination of rate law, factors affecting reaction rates, integrated rate laws – zeroth-order reactions, first-order reactions, second-order reactions (with equal and unequal initial concentration of reactants), half-life period, methods for determination order of a reactions, Arrhenius equation- temperature dependence of reaction rates, interpretation of Arrhenius parameters, reaction dynamics - collision theory and transition-state theory of bimolecular reactions, comparison of the two theories, Problems.

*(**Ref. No: 1**- 725-728, 731-733, 741-742, 780-784, 792-794, **Ref. No: 2**- 1033- 1067)*

Learning Outcome:

After studying the Chemical Kinetics student will able to-

1. Define / Explain concept of kinetics, terms used, rate laws, molecularity, order.
2. Explain factors affecting rate of reaction.
3. Explain / discuss / derive integrated rate laws, characteristics, expression for half-life and examples of zero order, first order, and second order reactions.
4. Determination of order of reaction by integrated rate equation method, graphical method, half-life method and differential method.
5. Explain / discuss the term energy of activation with the help of energy diagram.
6. Explanation for temperature coefficient and effect of temperature on rate constant k.
7. Derivation of Arrhenius equation and evaluation of energy of activation graphically.
8. Derivations of collision theory and transition state theory of bimolecular reaction and comparison.
9. Solve / discuss the problem based applying theory and equations.

2. Surface Chemistry [6L]

Introduction to surface chemistry - some basic terms related to surface chemistry adsorption, adsorption materials, factors affecting adsorption, characteristics of adsorption, types of adsorption, classification of adsorption isotherms, Langmuir adsorption isotherm, Freundlich's adsorption isotherm, BET theory (only introduction), application of adsorption, problems. *(**Ref. No:1**- 824-826, 832-837, **Ref. No: 2**- 1251-1264; **Ref. No: 3**- 932-938)*

Learning Outcomes

- Define / explain adsorption, classification of given processes into physical and chemical adsorption.
- Discuss factors influencing adsorption, its characteristics, differentiates types as physisorption and Chemisorption
- Classification of Adsorption Isotherms, to derive isotherms.
- Explanation of adsorption results in the light of Langmuir adsorption isotherm, Freundlich's adsorption Isotherm and BET theory.
- Apply adsorption process to real life problem.
- Solve / discuss problems using theory.

Reference Books (Physical Chemistry)

1. Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -11th edition
2. Principles of physical chemistry by B.R. Puri, L.R. Sharma**,** M.S. Pathania
3. Essentials of Physical chemistry by BahlTuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
4. Physical-Chemistry-4th Edition - Gilbert W. CastellanNarosa (2004).
5. Principles of ChemicalKinetics-2rdEdition- James E. House
6. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
7. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton
8. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
9. Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
10. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co. New York, 1985).
11. Physical Chemistry by Thomas Engel, Philip Reid, Warren Hehre.

3. Errors in Quantitative Analysis [5 L]

Introduction to errors, limitations of analytical methods, classifications of errors, accuracy, precision, minimization of errors, significant figures and computation, methods of

expressing accuracy and precision: mean and standard deviations, reliability of results and numerical. ***(Ref-1:** 127-138, supplementary references- **Ref-2:** 62-75, **Ref-3:** 82-121)*

Learning Outcomes

- Define, explain and compare meaning of accuracy and precision.
- Apply the methods of expressing the errors in analysis from results.
- Explain / discuss different terms related to errors in quantitative analysis.
- Apply statistical methods to express his / her analytical results in laboratory.
- Solve problems applying equations.

4. Volumetric Analysis [13 L]

Introduction to volumetric analysis, classification of reactions in volumetric analysis, standard solutions, equivalents, normalities, and oxidation numbers, preparation of standard solutions, primary and secondary standards. **Types of Volumetric Analysis methods: 1. Neutralization titrations**: Theory of indicators, neutralization curves for strong acid strong base, weak acid strong base, weak base strong acid. Preparation of approximate 0.1 M HCl and standardization against anhydrous sodium carbonate, determination of Na_2CO_3 content in washing soda. **2. Complexometric Titrations:** Definition of complexing agent and complexometric titration, EDTA-as complexing agent (structure of EDTA and metal ion-EDTA complex), Types of EDTA titration (direct and back titration), pH adjustment and amount of indicator in EDTA titration, metal ion indicators (general properties, solochrome black – T, Patton and Reeder's indicator only), standard EDTA solution, determination of Ca(II) and Mg(II), total hardness of water. **3. Redox Titrations:** Definition of oxidizing agent, reducing agent, redox titration, $K_2Cr_2O_7$ and $KMnO_4$ as oxidizing agents, 1,10-phenanthroline as indicator in reduction titration, diphenyl amine as oxidation indicator, $KMnO_4$ as self-indicator, Standard $KMnO_4$ solution and standardization with sodium oxalate, Determination of H_2O_2. **4. Precipitation titrations:** precipitation reactions, determination of end point (formation of coloured ppt, formation of soluble coloured compound, adsorption indicator), standard $AgNO_3$ soln., standardization of $AgNO_3$ soln. – potassium chromate indicator- Mohr's titration, determination of chloride and bromide, determination of iodide. Problems based on analysis.

***(Ref-1:** Pages-257-275, 286, 295, 309 -322, 328-332, 340-351, 364-372.; supplementary reference **Ref-2:** 382-302, 322-334, 366-374, 437-452)*

Learning Outcome:

After studying the Volumetric Analysis student will able to-

1. Explain / define different terms in volumetric analysis such as units of concentration, indicator, equivalence point, end point, standard solutions, primary and secondary standards, complexing agent, precipitating agent, oxidizing agent, reducing agent, redox indicators, acid base indicators, metallochome indicators, etc.
2. Perform calculations involved in volumetric analysis.
3. Explain why indicator show colour change and pH range of colour change.
4. To prepare standard solution and **b.** perform standardization of solutions.
5. To construct acid – base titration curves and performs choice of indicator for particular titration.
6. Explain / discuss acid-base titrations, complexometric titration / precipitation titration / redox titration.
7. Apply volumetric methods of analysis to real problem in analytical chemistry / industry.

Reference Books: (Analytical Chemistry)

1. Vogel's Textbook of quantitative Chemical Analysis, 5th Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical, 1989.
2. Analytical Chemistry, G. D. Christian, P. K. Dasgupta, K. A. Schug, 7th Ed, Wily, 2004.
3. Fundamentals of Analytical Chemistry- Skoog, west, Holler, Crouch, 9th Ed. Brooks / Cole, 2014/2004.
4. Basic Concept of Analytical Chemistry- S. M. Khopkar
5. Instrumental methods of chemical analysis- Chatwal Anand
6. Analytical Chemistry, G.R. Chatwal, Sham Anand.

CH-302: Inorganic and Organic Chemistry [2Credit, 36 L]

Chapter No.	Chapter	No of Lectures
1	Molecular Orbital Theory of Covalent Bonding	13
2	Introduction to Coordination chemistry	05
3	Aromatic hydrocarbons	05
4	Alkyl and Aryl Halides	07
5	Alcohols, Phenols and Ethers	06

1. Molecular Orbital Theory of Covalent Bonding [13 L]

Introduction to Molecular Orbital Method (MOT) and postulates of MO theory, LCAO approximation, s-s combination of orbitals, s-p combination of orbitals, p-p combination of orbitals, p-d combination of orbitals, d-d combination of orbitals, non-bonding combination of orbitals, Rules for linear combination of atomic orbitals, example of molecular orbital treatment for homonuclear diatomic molecules: Explain following molecules with respect to MO energy level diagram, bond order and magnetism: *H_2^+ molecule ion, H_2 molecule, He_2^+ molecule ion, He_2 molecule, Li_2 molecule, Be_2 molecule, B_2 molecule, C_2 molecule, N_2 molecule, O_2 molecule, O_2^- and O_2^{2-} ion, F_2 molecule,* Heteronuclear diatomic molecules: *NO, CO, HF.*

(***Ref.-1:****89-112,* ***Ref-4:*** *278-292,* ***Ref-5:*** *33-38)*

Learning Outcome:

After studying the Molecular Orbital Theory student will able to-

1. Define terms related to molecular orbital theory (AO, MO, sigma bond, pi bond, bond order, magnetic property of molecules, etc).
2. Explain and apply LCAO principle for the formation of MO's from AO's.
3. Explain formation of different types of MO's from AO's.
4. Distinguish between atomic and molecular orbitals, bonding, anti-bonding and non-bonding molecular orbitals.
5. Draw and explain MO energy level diagrams for homo and hetero diatomic molecules. Explain bond order and magnetic property of molecule.
6. Explain formation and stability of molecule on the basis of bond order.
7. Apply MOT to explain bonding in diatomic molecules other than explained in syllabus.

2. Introduction to Coordination Compounds [5 L]

Double salt and coordination compound, basic definitions: *coordinate bond, ligand, types of ligands, chelate, central metal ion, charge on complex ion, calculation of oxidation state of central metal ion, metal ligand ratio*; Werner's work and theory, Effective atomic number, equilibrium constant ***(Ref-6: 138-140)***, *chelate effect, IUPAC nomenclature.*

*(**Ref.-1:** 194-200, 222-224; **Ref-4:** 483-492)*

Learning Outcome:

After studying the Introduction to Coordination Compounds student will able to-

1. Define different terms related to the coordination chemistry (double salt, coordination compounds, coordinate bond, ligand, central metal ion, complex ion, coordination number, magnetic moment, crystal field stabilization energy, types of ligand, chelate effect, etc.)
2. Explain Werner's theory of coordination compounds. Differentiate between primary and secondary valency. Correlate coordination number and structure of complex ion.
3. Apply IUPAC nomenclature to coordination compound.

Reference Books: (Inorganic Chemistry)

1. Concise Inorganic Chemistry, J. D. Lee, 5th Ed (1996) Blackwell Science
2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008
3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.
4. Principles of Inorganic Chemistry, Brian W. Pfennig, Wiley (2015)
5. Inorganic Chemistry, Catherine Housecroft, Alan G. Sharpe, Pearson Prentis Hall, 2008.
6. Basics Inorganic Chemistry, Cotton and Wilkinson

3. Aromatic Hydrocarbons: [5 L]

Introduction and IUPAC nomenclature, preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. *Reactions* (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

*(**Ref-1:** 493-513)*

Learning Outcome:

After studying the aromatic hydrocarbons student will able to-

1. Identify and draw the structures aromatic hydrocarbons from their names or from structure name can be assigned.

2. Explain / discuss synthesis of aromatic hydrocarbons.
3. Give the mechanism of reactions involved.
4. Explain /Discuss important reactions of aromatic hydrocarbon.
5. To correlate reagent and reactions.

4. Alkyl and Aryl Halides: [7 L]

Alkyl Halides (up to 5 Carbons): Introduction and IUPAC nomenclature, Types of Nucleophilic Substitution (SN^1, SN^2 and SNi) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs. substitution.

Aryl Halides: Introduction and IUPAC nomenclature, *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer and Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides**.**

***(Ref.-1:** 165-211 and 943-967)*

Learning Outcome:

After studying the Alkyl and Aryl Halides student will able to-

1. Identify and draw the structures alkyl / aryl halides from their names or from structure name can be assigned.
2. Explain / discuss synthesis of alkyl / aryl halides.
3. Write / discuss the mechanism of Nucleophilic Substitution (SN^1, SN^2 and SNi) reactions.
4. Explain /Discuss important reactions of alkyl / aryl halides.
5. To correlate reagent and reactions.
6. Give synthesis of expected alkyl / aryl halides.

5. Alcohols, Phenols and Ethers (Up to 5 Carbons): [6 L]

Alcohols: Introduction and IUPAC nomenclature, *Preparation:* Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* with sodium, HX (Lucas test), esterification, oxidation (with PCC, alc. KMnO4, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols (Phenol case): Introduction and IUPAC nomenclature, *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann Reaction, Houben–Hoesch Condensation, Schotten–Baumann Reaction. **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.

(***Ref-1:*** *213-244 and 889-912)*

Learning Outcome:

After studying the Alcohols and Phenols student will able to-

1. Identify and draw the structures alcohols / phenols from their names or from structure name can be assigned.
2. Able to differentiate between alcohols and phenols
3. Explain / discuss synthesis of alcohols / phenols.
4. Write / discuss the mechanism of various reactions involved.
5. Explain /Discuss important reactions of alcohols / phenols.
6. To correlate reagent and reactions of alcohols / phenols
7. Give synthesis of expected alcohols / phenols.

References: (Organic Chemistry)

1. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Prentice Hall of India, Sixth Edition, **2002**, 283-308.

Other Reference Books for All Chapters:

2. Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers *Organic Chemistry* - Oxford University Press, USA, 2nd Ed.

3. Bahl, A. and Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, **2010**.

4. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley and Sons (2014).

5. Mc Murry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

6. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).

7. Finar, I. L. *Organic Chemistry* (Vol. I and II), E.L.B.S.

CH-303: Practical Chemistry-III [2 credit, 72* L]

* 72 L distributed as 58 L for performing practicals and 14 L for internal evaluation.

For practicals, see the manual prepared by BOS of Chemistry. The examination will be held according to this manual.

Instructions

1. **Use molar concentrations for volumetric /estimations/synthesis experiments.**
2. **Use optimum concentrations and volumes**
3. **Two burette method should be used for volumetric analysis (Homogeneous mixtures)**
4. **Use of Microscale technique is recommended wherever possible**

A. Chemical Kinetics: (Any Three)

1. To Study the Acid catalysed hydrolysis of an ester (methyl Acetate) and determine the rate constant (k). (first order reaction)
2. To study the kinetics of saponification reaction between sodium hydroxide and ethyl acetate.
3. To compare the relative strength of HCl and H_2SO_4 or HNO_3 by studying the kinetics of hydrolysis of methyl acetate.
4. Energy of activation of the reaction between $K_2S_2O_8$ and KI with unequal initial concentration.

   OR

4. To determine the order of the reaction with respect to $K_2S_2O_8$ by fractional life method following the kinetics of per sulphate-iodide reaction.

References:

i) Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.

ii) Practical Physical Chemistry, Vishwanathan and Raghwan , Viva book.

iii) Practical Chemistry, O. P. Pandey, D. N. Bajpai Dr. S. Giri, S Chand Publication

iv) Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publication.

B. Inorganic quantitative / qualitative analysis (Any two)

1. Estimation of Fe(III) from given solution by converting it to Fe(II) using Zn metal and then by titrating with standard solution of $K_2Cr_2O_7$-A Green Approach (Ref.-1,3).

2. Determination of $BaCO_3$ content in a given sample by precise determination of volume of CO_2 (Ref-2).
3. Separation and Identification of metal ions by Paper Chromatography (Ref.,4,5)

References:

1. Iron Analysis by Redox Titration A General Chemistry Experiment, ***Journal of Chemical Education***, Volume 65, Number 2, February 1988.183.
2. A Precise Method for Determining the CO_2 Content of Carbonate Materials, ***Journal of Chemical Education***, Vol. 75, No. 12, December 1998.
3. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 6th Ed.
4. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut.
5. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co.

C. Organic Qualitative Analysis (Two mixtures: solid-solid type)

1. **Separation of Two Components** from given binary mixture of organic compounds containing mono-functional group (Ex. - carboxylic acid, phenols, amines, amide, nitro, etc.) and systematic identification of each component qualitatively.

D. Organic Preparations (Any two)

1. Preparation of benzoic acid from ethyl benzoate (Identification and confirmatory Test of –COOH group, M.P and purity by TLC)
2. Acetylation of primary amine (Green approach)
3. Base catalyzed Aldol condensation (Green approach)
4. Preparation of Quinone from hydroquinone (Confirm the conversion by absence of phenolic –OH group in product, M.P and purity by TLC)

E. pH Metry (Compulsory)

4. To determine equivalence point of neutralisation of acetic acid by pH-metric titration with NaOH and to find best indicator for the titration.

F. Volumetric Analysis (Any two)

1. Estimation of Aspirin from a given tablet and find errors in quantitative analysis. (***Standardization of acid must be performed with standard Na2CO3 solution, prepared from dried anhydrous AR grade Na_2CO_3***)

2. Determination of acetic acid in commercial vinegar by titrating with standard NaOH. Express your results as average ± standard deviation. (***Standardization of base must be performed with standard KHP***)

3. Determination of Hardness of water from given sample by complexometric titration (Using E.D.T.A.) method and total dissolve solids by conductometry. Express your results as average ± standard deviation. (***Standardization of Na_2EDTA must be performed with standard Zn(II) solution***)

Reference:

1. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 5th Ed.

2. Experiments in chemistry, D. V. Jahagirdar, Himalaya Publication.

Examination Pattern: At the time of examination student will have to perform one experiment. In case of organic qualitative analysis, after separation of binary mixture any one component has to be analysed according to OQA scheme. Distribution of 35 marks: 30 marks for experimental performance and 5 mark for oral.

To cope up with NACC criterion and to motivate and inculcate research culture among the students, interested students can be assigned mini-scale project. Project should be based either on applications of chemistry in day to day life or application or novel / applied synthesis / demonstrating principles of chemistry. The project work is equivalent to three experiments. ***Student performing project can be exempted from 3 experiments from two semester. (*from three different sections of two semester) and project will be evaluated by external examiner. Project being choice based activity; student will not get any exemption in external examination***. Systematic project report (Name page, certificate, introduction/theory, importance of project, learning outcome, requirements, safety precautions, procedure, observations, calculations, results and conclusions) be submitted separately in binding form duly certified by mentor teacher and HOD.

Illustrative list of some projects is given below for your perusal.

1. Synthesis of soap from different types of oils with respect to i) percent yield ii cost of obtaining 50 g soap (students will learn saponification or alkaline hydrolysis of oils – a chemical reaction for the synthesis of day to day life product, which oil is better for soap making).
2. Synthesis of biodegradable plastic (Principles demonstrated: Chemical reactions for mores safe products and to mitigate environmental pollution).
3. Synthesis of azo dyes and effect substituents of benzene ring on colour of azo dye (Principle demonstrated -Inductive effect a visible demonstration, strategy to charge the colour of dye, chemical reactions for industries).

4. Quality of Consumer products: identification reactions and Purity of $NaHCO_3$ (eating soda) of different brands by thermal decomposition. (Application of analytical chemistry and simple decomposition reaction for the determination of purity of consumer product)
5. Determination pH, surface tension, CMC and washing action of detergent of different brands for comparing their quality. (Application of chemistry principles in determination of quality of consumer product)
6. Removal of dyes / nitrophenols / by Fenton's process or by adsorption on activated charcoal. (Applications of principles of chemistry in mitigation of environmental pollution, an industrial application of chemistry).
7. Study of deionization water using cation and anion exchange resins / zeolites. Amount of zeolites / resin required for the softening of water. (Day to day life application of chemistry, student can apply their knowledge and can construct their own deionizer).
8. Preparation shampoo. Ingredients required, their proportion, mixing and testing.
9. Eudiometer: Determination of oxidation state, equivalent wt. and determine stoichiometry of the reaction between i) iron metal and HCl. Fe can have oxidation state +2 or +3. ii) Zn and HCl iii) Al and HCl. What happens with HNO_3? Why similar method cannot used to investigate reaction between HNO_3 and these metals?
10. Study stoichiometry of simple chemical reactions thereby determination of equivalent wt. of one of the reactant: i) $FeSO_4 7H_2O$ and $KMnO_4$ (determine equivalent wt. of $KMnO_4$) ii) Mn(II) and $KMnO_4$ (determine equivalent wt. of $KMnO_4$).Explain the concept of variable oxidation state and variable equivalent wt. for same substance i.e. mol. wt. is constant. (Known Fe^{2+} oxidizes to Fe^{3+} only).
11. Synthesis /isolation of essences, purity by TLC/ B.P. (at least two).
12. Synthesis and estimation of purity of aspirin (medicinal compound) by green chemistry route.
13. Compare the paracetamol content in tablet of different brands (at least three different brands).
14. Compare the vitamin-c content in tablet of different brands. (at least three different brands).
15. Determination of Avagdro Number (N) by various technics such as Brownian Moment, Electrodeposition, number of molecules in monolayer etc.
16. Hess Law verification
17 Determination of Farday constant and Avagadro number
18 To determine thermodynamic values of various compounds

19 To determine density of various substances

20 Preparation of Nylon and study its properties

21 Microscale techniques in Chemistry

References:

1. A laboratory manual for general, organic and biological chemistry, 3rd Ed. Pearson.
2. Safety-Scale Laboratory Experiments for Chemistry for Today: General, Organic and Biochemistry Seventh Edition, Spencer L. Seager, Michael R. Slabaugh, Cengage Learning, 2010
3. Laboratory Manual for Principles of General Chemistry, Bearen, 8th Ed. Wiley.
4. Green Chemistry Laboratory Manual for General Chemistry, Sally A. Henrie, CRC Press Taylor & Francis Group, and Informa Business. 2015
5. Experiments in General Chemistry, G. S. Weiss T. G. Greco L. H. Rickard, Ninth Edition, Pearson Education Limited, 2014.
6. Mini-scale and micro-scale organic chemistry laboratory experiments 7th Ed. Schoffstall, Gaddis, Mc-Graw-Hill Higher Education, 2004.
7. Journal of Chemical Education, ACS, (search relevant topics).

II. Students short activity (for both semesters)

These are the extra-time activities for the students which can be performed with the permission of mentor. Mentor can arrange a demonstration on these activities to explain basic principles of chemistry. **Teacher can design many such activities to explain theory that you taught in the class.** Systematic report of activity performed be written in journal. Sample list of small activities is given below. These short activities can be considered for internal evaluation. Some activities are given below.

1. Amphoteric nature of $Al(OH)_3$ (Principle demonstrated-demonstration of amphoteric nature substance and why $Al(OH)_3$ is used in antacid preparations)
2. Enzyme deactivation by Hg^{2+} (Principle demonstrated–catalyst deactivation and toxicity effect of Hg^{2+})
3. Adsorption of dyes on activated charcoal (Principle demonstrated and application- surface adsorption for removal of dyes from effluents)
4. Detection of adulteration in milk / chilli powder / turmeric power / food colours
5. Use of EXCEL in drawing of graphs and calculations.
6. Catalysis by Mn(II) in $KMnO_4$–Oxalic acid titration. (Principle, demonstrated - Homogeneous catalysis)

7. Identification of type of salt (strong acid – strong base, strong acid – weak base, weak acid – strong base) by hydrolysis reactions and indicators. (Principle demonstrated – hydrolysis reaction of salts, it really takes place)
8. Identification of inorganic ions in soft drinks / tooth paste, form of iodide in table salt / waste water / bore well water.
9. Spectrochemical series using $CuSO_4$ solution and i) NaCl, ii) KBr, iii) Ammonia, iv) ethylene diamine, v) salicylic acid [correlate colour with wavelength and predict ligand strength]
10. Green Chemistry principles in Organic Chemistry.

References: Journal of Chemical Education, ACS, (search relevant topics).

Learning Outcome- Practical Chemistry-III

1. Verify theoretical principles experimentally.
2. Interpret the experimental data on the basis of theoretical principles.
3. Correlate theory to experiments. Understand/verify theoretical principles by experiment observations; explain practical output / data with the help of theory.
4. Understand systematic methods of identification of substance by chemical methods.
5. Write balanced equation for the chemical reactions performed in the laboratory.
6. Perform organic and inorganic synthesis and is able to follow the progress of the chemical reaction by suitable method (colour change, ppt. formation, TLC).
7. Set up the apparatus / prepare the solutions - properly for the designed experiments.
8. Perform the quantitative chemical analysis of substances explain principles behind it.
9. Systematic working skill in laboratory will be imparted in student.

Important Notes:

i) Wherever feasible develop and practice micro or semi-micro methods from known / recommended procedures and the reference books. This is to i) minimize the cost of experiment, ii) reduce wastage of chemicals iii) reduce environmental pollution.

ii) Mentor should promote students to ***complete the Journal on the same day before leaving of the lab***. Ensure that the original data is retained and used by the candidate. Students may adjust the data from their lab work to reach close to theoretical values. If journal is completed before leaving the lab it will not encourage students to "adjust" the facts from their lab work. (**Ref-Journal of Chemical Education, Min J. Yang and George F. Atkinson, Designing New Undergraduate Experiments, Vol. 75, No. 7, July 1998**).

Internal Evaluation Strategy for practical (Both semester):

During start of the practical course methodology of internal evaluation should be discussed with students. Internal evaluation is a continuous assessment (CA). Hence during each practical, internal evaluation must be done with different tools. **Guidelines for internal evaluation:** To each practical 15 marks can be assigned which can be distributed as follows:

Overall performance and timely arrival	**Interaction**	**Accuracy of results**	**Journal /Lab report**	**Post laboratory quiz / assignment / oral**
4	2	2	5	2

At the end of semester, average of 12 experiments can be assigned as internal marks out of 15. Systematic record of internal evaluation must be maintained which is duly sign by mentor and student. If student is absent with prior-intimation her/his absentee will be considered but student will have to complete the experiment in the same week or in with the permission of mentor. Mentor or practical in-charge should arrange the practical for such students. Students performing projects (one mini project equivalent to three practical session) / student activities (4 to 6 activities equivalent to three practical session) can be assigned up to 3 marks out of 15.

SEMSER-IV

CH-401: Physical and Analytical Chemistry [Credit: 2, 36 L]

Chapter No	Chapter	No of Lectures
1	Phase Equilibrium	09
2	Ideal and Real Solutions	09
3	Conductometry	06
4	Colorimetry	06
5	Column Chromatography	06

1. Phase equilibrium [9L]

Introduction; definitions of phase, components and degrees of freedom of a system; stability of phases, criteria of phase equilibrium. Gibbs phase rule and its thermodynamic derivation, phase diagrams of one- component systems- water, carbon dioxide and sulphur systems, problems. *(**Ref. No: 1**, Page No- 119 - 126, **Ref. No: 2**, Page No – 661-675,**Ref. No:4,** Page No 344- 354).*

Learning Outcomes

- Define the terms in phase equilibria such as- system, phase in system, components in system, degree of freedom, one / two component system, phase rule, etc.
- Explain meaning and Types of equilibrium such as true or static, metastable and unstable equilibrium.
- Discuss meaning of phase, component and degree of freedom.
- Derive of phase rule.
- Explain of one component system with respect to: Description of the curve, Phase rule relationship and typical features for i) Water system ii) Carbon dioxide system iii) Sulphur system
- **Reference Books (Physical Chemistry)**

1. Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -11th edition
2. Principles of Physical chemistry by B.R. **Puri**, L.R. **Sharma**, M.S. Pathania
3. Essentials of Physical chemistry by Bahl Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
4. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton
5. Physical-Chemistry-4th Edition - Gilbert W. Castellan Narosa (2004).
6. Principles of Chemical Kinetics- 2rdEdition- James E. House.

7. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
8. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
9. Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
10. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
11. Physical Chemistry by Thomas Engel**,** Philip Reid, Warren Hehre.

2. Ideal and real solutions [9L]

Introduction, chemical potential of liquids - ideal solutions, ideal dilute solutions - Raoult's and Henry's Law, liquid mixtures, phase diagram of binary systems : liquids - vapour pressure diagrams, temperature composition diagrams, liquid-liquid phase diagrams, solubility of partially miscible liquids-critical solution temperature, effect of impurity on partially miscible liquids, Problems. (***Ref. No:*** *1, Page Nos- 150-153, 155-157, 166 – 175,* ***Ref. No: 2****, Page No. - 750-775, 696-705****Ref. No:4****, Page No. 261-292, 298- 302).*

Learning Outcomes

- Define various terms, laws, differentiate ideal and no-ideal solutions.
- Discuss / explain thermodynamic aspects of Ideal solutions-Gibbs free energy change, Volume change, Enthalpy change and entropy change of mixing of Ideal solution.
- Differentiate between ideal and non-ideal solutions and can apply Raoult's law.
- Interpretation of i) vapour pressure–composition diagram ii) temperature- composition diagram.
- Explain distillation of liquid solutions from temperature – composition diagram.
- Explain / discuss azeotropes, Lever rule, Henrys law and its application.
- Discuss / explain solubility of partially miscible liquids- systems with upper **c**ritical. Solution temperature, lower critical solution temperature and having both UCST and LCST.
- Explain / discuss concept of distribution of solute amongst pair of immiscible solvents.
- Derive distribution law and its thermodynamic proof.
- Apply solvent extraction to separate the components of from mixture interest.
- Solve problem by applying theory.

3. Conductometry [6 L]

Introduction, Electrolytic Conductance, Resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, variation of equivalent and specific conductance with concentrations, Kohlrausch's law and its applications, conductivity cell, conductivity meter, Whetstone Bridge, determination of cell constant,

conductometric titrations (strong acid-strong base, strong acid-weak base, weak acid strong base) and Numericals. ***Ref-1:*** *398-402, 414-423, 433-434,* ***Ref-2:*** *519-527,* ***SupplementaryRef-3:*** *746-756,* ***Ref-4:*** *528-532.*

Learning Outcomes

- Explain / define different terms in conductometry such as electrolytic conductance, resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, Kohlrausch's law, etc.
- Discuss / explain Kohlrausch's law and its Applications, Conductivity Cell, Conductivity Meter, Whetstone Bridge.
- Explain / discuss conductometric titrations.
- Apply conductometric methods of analysis to real problem in analytical laboratory.
- Solve problems based on theory / equations.
- Correlate different terms with each other and derive equations for their correlations.

4. Colorimetry: [6 L]

Introduction, interaction of electromagnetic radiation with matter, essential terms: radiant power, transmittance, absorbance, molar, Lamberts Law, Beer's Law, Lambert-Beer's Law, molar absorptivity, deviations from Beer's Law, Colorimeter**:** *Principle, Construction and components, Working*. Applications–unknown conc. By calibration curve method, Determination of unknown concentration of Fe(III) by thiocynate method, Numericals. (***Ref-2:*** *645-651, 658-661, 690,* ***Ref-3:*** *97, 100, 159-172,* ***Ref-4:*** *144-153, 157-160,* ***Ref-6****-Relevent pages).*

Learning Outcomes

- Explain / define different terms in Colorimetry such as radiant power, transmittance, absorbance, molar, Lamberts Law, Beer's Law, molar absorptivity
- Discuss / explain / derive Beer's law of absorptivity.
- Explain construction and working of colorimeter.
- Apply colorimetric methods of analysis to real problem in analytical laboratory.
- Solve problems based on theory / equations.
- Correlate different terms with each other and derive equations for their correlations.

5. Column Chromatography [6 L]

Introduction, Principle of Column Chromatography, **Ion Exchange Chromatography:** Ion exchange resins, action of ion exchange resin (Ion exchange equilibria, Ion exchange capacity), Experimental technique, Application: i) Separation of

Metal ions / non-metal ions on Ion Exchange Chromatography (*Zn(II) and Mg(II), Cl^- and Br^-),* ii) Purification of water, (***Ref-2:*** *186-192, 205-209*) **Adsorption Chromatography – Liquid solid chromatography**: Introduction, the technique of conventional chromatography, column packing materials, Selection of solvent for adsorption chromatography, Adsorption column preparation and loading, Application – Purification of anthracene (***Ref-5:*** *209-215, 221*), Size Exclusion Chromatography*(Supplementary -* ***Ref-4:*** *pages 111-153, 212-215,* ***Ref-6****-Relevent pages)*

Learning Outcomes

- Explain / define different terms in column chromatography such as stationary phase, mobile phase, elution, adsorption, ion exchange resin, adsorbate, etc.
- Explain properties of adsorbents, ion exchange resins, etc.
- Discuss / explain separation of ionic substances using resins.
- Discuss / explain separation of substances using silica gel / alumina.
- Apply column chromatographic process for real analysis in analytical laboratory.

References (Analytical Chemistry)

1. Principles of Physical Chemistry, S.H. Marron and C. F. Pruton4th ed., Oxford and IBH publishing company / CBS, new Delhi.
2. Vogel's Textbook of quantitative Chemical Analysis, 5th Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical, 1989.
4. Basic Concept of Analytical Chemistry- S. M. Khopkar
5. Vogel's Text Book of Practical Organic Chemistry, Furniss, Hannaford, Smith, Tatchel, 5th Ed., Longman Scientific and Technical, 2004.
6. Analytical Chemistry, G.R. Chatwal, Sham Anand.

CH-402: Inorganic and Organic Chemistry [2 credit, 36L]

Chapter No.	Chapter	No of Lectures
1	Isomerism in coordination complexes	02
2	Valance Bond Theory of Coordination Compounds	04
3	Crystal field Theory	12
4	Aldehydes and ketones	05
5	Carboxylic acids and their derivatives	05
6	Amines and Diazonium Salts	04
7	Stereochemistry of Cyclohexane	04

1. Isomerism in coordination complexes [2 L]

Introduction, polymerization isomerism, ionization isomerism, hydrates isomerism, linkage isomerism, coordination isomerism, coordination position isomerism, geometric isomerism, optical isomerism.

***(Ref-1:** 232-236)*

Learning Outcome:

After studying the aromatic hydrocarbons student will able to-

1. Isomerism in coordination complexes
2. Explain different types of isomerism in coordination complexes.

2. Valance Bond Theory of Coordination Compounds [4 L]

Aspects and assumptions of VBT, applications of VBT on the basis of hybridization to explain the structure and bonding in $[Ag(NH_3)_2]^+$, $[Ni(Cl_4)]^{2-}$, $[Ni(CN)_4]^{2-}$, $[Cr(H_2O_6)]^{3+}$, $[Fe(CN)_6]^{3-}$ (Inner orbital complex) and $[FeF_6]^{3-}$(outer orbital complex). Use of observed magnetic moment in deciding the geometry in complexes with C.N.4, limitations of VBT.

(**Ref-2:** 592-597, **Ref-3:**350-351).

Learning Outcome:

After studying the aromatic hydrocarbons student will able to-

1. Apply principles of VBT to explain bonding in coordination compound of different geometries.
2. Correlate no of unpaired electrons and orbitals used for bonding.
2. Identify / explain / discuss inner and outer orbital complexes.
4. Explain / discuss limitation of VBT.

3. Crystal Field Theory [12 L]

Shapes of d-orbitals, Crystal field Theory (CFT): Assumptions, Application of CFT to i) Octahedral complexes (*splitting of 'd' orbitals in Oh ligand field, effect of weak and strong ligand fields, colour absorbed and spectrochemical series, crystal splitting energy, Crystal field stabilization energy and factors affecting it, tetragonal distortion in Cu(II) complexes*) ii) Square planar complexes and iii) Tetrahedral complexes; spin only magnetic moment of Oh and Td complexes.

(Ref-1:*194-225).*

Learning Outcome:

After studying the aromatic hydrocarbons student will able to-

1. Explain principle of CFT.
2. Apply crystal field theory to different type of complexes (Td, Oh, Sq. Pl complexes)
3. Explain: i) strong field and weak field ligand approach in Oh complexes ii) Magnetic properties of coordination compounds on the basis of weak and strong ligand field ligand concept. iii) Origin of colour of coordination complex.
4. Calculate field stabilization energy and magnetic moment for various complexes.
5. To identify Td and Sq. Pl complexes on the basis of magnetic properties / unpaired electrons.
6. Explain spectrochemical series, tetragonal distortion / Jahn-Teller effect in Cu(II) Oh complexes only.

Reference Books: (Inorganic Chemistry)

1. Concise inorganic chemistry, J. D. Lee, 5th Ed (1996), Blackwell Science
2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008
3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.

4. Aldehydes and Ketones (aliphatic and aromatic) [5 L]

(Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Introduction and IUPAC nomenclature, *Preparation:* from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Clemenson reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction. (***Ref-1:*** *657-700 and 797-816*)

Learning Outcome:

After studying the aldehydes and ketones student will able to-

1. Identify and draw the structures aldehydes and ketones from their names or from structure name can be assigned.
2. Explain / discuss synthesis of aldehydes and ketones.
3. Write / discuss the mechanism reactions aldehydes and ketones.
4. Explain /Discuss important reactions of aldehydes and ketones.
5. To correlate reagent and reactions of aldehydes and ketones
6. Give synthesis of expected aldehydes and ketones.
7. Perform inter conversion of functional groups.

5. Carboxylic acids and their derivatives [5 L]

Carboxylic acids (aliphatic and aromatic): Introduction and IUPAC nomenclature, *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell–Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (up to 5 carbons) *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. Reaction: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation. *(**Ref-1:** 713-745 and 753-785).*

Learning Outcome:

After studying the carboxylic acids and their derivatives student will able to-

1. Identify and draw the structures carboxylic acids and their derivatives from their names or from structure name can be assigned.
2. Explain / discuss synthesis of carboxylic acids and their derivatives.
3. Write / discuss the mechanism reactions carboxylic acids and their derivatives.
4. Explain /Discuss important reactions of carboxylic acids and their derivatives.
5. Correlate reagent and reactions of carboxylic acids and their derivatives
6. Give synthesis of expected carboxylic acids and their derivatives.
7. Perform inter conversion of functional groups.

6. Amines and Diazonium Salts: [4 L]

Amines (Aliphatic and Aromatic): Introduction and IUPAC nomenclature, *Preparation* from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. *Reactions:* Hofmann vs. Saytzeff elimination, Electrophilic substitution (Case Aniline): nitration, bromination, sulphonation.

Diazonium salts: Preparation from aromatic amines. (***Ref-1:** 821-877)*

Learning Outcome:

After studying the amines and diazonium Salts student will able to-

1. Identify and draw the structures amines from their names or from structure name can be assigned.
2. Explain / discuss synthesis of carboxylic amines.
3. Write / discuss the mechanism reactions carboxylic amines.
4. Explain /Discuss important reactions of carboxylic amines.
5. To correlate reagent and reactions of carboxylic amines.
6. Give synthesis diazonium salt from amines and reactions of diazonium salt.
7. Perform inter conversion of functional groups.

7. Stereochemistry of Cyclohexane: [4 L]

Bayer's strain theory, heat of combustion of cycloalkanes, structure of cyclohexane, axial and equatorial H atoms, conformations of cycloalkane, stability of conformations of cyclohexane, methyl and t-butyl monosubstituted cyclohexane, 1,1 and 1,2 dimethyl cyclohexane and their stability.

***(Ref-1:** 283-308*).

Learning Outcome:

After studying the aromatic hydrocarbons student will able to-

1. Draw the structures of different conformations of cyclohexane.
2. Define terms such as axial hydrogen, equatorial hydrogen, confirmation, substituted cyclohexane, etc.
3. Convert one conformation of cyclohexane to another conformation and should able to identify governing structural changes.
4. Explain / discuss stability with respect to potential energy of different conformations of cyclohexane.
5. Draw structures of different conformations of methyl / t-butyl monosubstituted cyclohexane (axial, equatorial) and 1, 2 dimethyl cyclohexane.
6. Identify cis- and trans-isomers of 1, 2 dimethyl substituted cyclohexane and able to compare their stability.

Reference Books: (Organic Chemistry)

1. Morrison, R.T. and Boyd, R.N. *Organic Chemistry*, Prentice Hall of India, Sixth Edition, 2002, 283-308.

Other Reference Books for all chapters:

2. Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, ***Organic Chemistry***- Oxford University Press, USA, 2nd Ed.

3. Bahl, A. and Bahl, B.S. *Advanced Organic Chemistry,* S. Chand**,** 2010**.**

4. Graham Solomon, T. W., Fryhle, C. B. and Dnyder, S. A. ***Organic Chemistry***, John Wiley and Sons (2014).

5. Mc Murry, J.E. ***Fundamentals of Organic Chemistry***, 7th Ed. Cengage Learning India Edition, 2013.

6. Sykes, P. ***A Guidebook to Mechanism in Organic Chemistry***, Orient Longman, New Delhi (1988).

7. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.

CH-403: Practical Chemistry-IV [2 credit, 72* L]

* 72 L will be distributed as 58 L performing practical and 14 L for internal evaluation.

Instructions:

1. **Use molar concentrations for volumetric /estimations/synthesis experiments.**
2. **Use optimum concentrations and volumes**
3. **Two burette method should be used for volumetric analysis (Homogeneous Mixtures)**
4. **Use of Microscale technique is recommended wherever possible.**

A. Conductometry (Compulsory)

a) To determine the cell constant of the given cell using 0.01 M KCl solution and determine dissociation constant of a given monobasic weak acid.

b) To investigate the conductometric titration of any one of the following a) Strong acid against strong base b) Strong base against weak acid. (***standardization of base must be performed with KHP***)

B. Chromatography (compulsory)

1. Separation of binary mixture of cations by Column Chromatography by ion exchange resins / cellulose (any one mixture) (Co + Al, Cu + Mg, Zn+Mg). Separation of cations must be confirmed by qualitative test

References:

i. Vogel's Textbook Quantitative Chemical Analysis, 3rd, 6th Ed.

ii) Experiments in chemistry, D. V. Jahagirdar, Himalaya publication.

C. Ideal and Real solutions (Any two)

1. To study the variation of mutual solubility temperature with % concentration for the phenol - water system
2. To study the effect of added electrolyte on the critical solution temperature of phenol-water system and to determine the concentration of the given solution of electrolyte.
3. To obtain the temperature-composition phase diagram for a two component liquid system with maximum (or minimum) boiling point and to determine the maximum (or minimum) boiling point and composition.

D. Adsorption (Compulsory)

1. To verify the Freundlich and Langmuir adsorption isotherm for adsorption of acetic acid on activated charcoal.

References:

i) Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.

ii) Practical Physical Chemistry, Vishwanathan and Raghwan , Viva book.

iii) Practical Chemistry, O. P. Pandey, D. N. Bajpai Dr. S. Giri, S Chand Publication

E. Synthesis of Coordination compounds (any two)

1. Synthesis of sodium cobaltinitrite (a laboratory chemical) from Co(II) salt and $NaNO_2$ salts. Comment on colour and magnetic properties of the complex. (Ref.-1, 2)
2. Synthesis of potassium Tris(oxalate)aluminium(III) using Al metal powder(Scrap aluminium). Comment on colour and magnetic properties of the complex. (Ref-2, 3, 4)
3. Synthesis of Tris(acetylacetone)iron(III) by green chemistry method by reaction between $Fe(OH)_3$ and acac. Comment on colour and magnetic properties of the complex. (Ref.- 5,6).
4. Synthesis of Tris(ethylenediamine)nickel(II) from Ni(II) salt, ethylediamine and sodium thiosulfate. Comment on colour and magnetic properties of the complex. (Ref.-7)

F. Inorganic colorimetric investigations (Any two)

1. Prepare standard solutions of $KMnO_4$ / $CuSO_4$, record their absorbance and Verify Beer's Law and determine unknown concentration. **(Compulsory)**
2. Prepare solution of Fe(III) and $SCN^-$of in different molar proportion, record their absorbance and calculate equilibrium constant of $[Fe(SCN)]^{2+}$ complex (Ref.-9,10)
3. Prepare solution of Fe(III)/Cu(II) and salicylic acid in different molar proportion and determine metal ligand ratio in Fe(III) or Cu(II)–Salicylic acid complex. (Ref.-11, 12, 13)

References

1. Handbook of Preparative Inorganic Chemistry, Volume 2, Second Edition, Edited By Georg Braue R, Academic Press, New York, London, 1965. (Page-1541)

2. Practical Chemistry, Panday, Bjpai, Giri, S.Chand and Co.

3. McNeese, T.J.; Wierda, D.A. Synthesis of Potassium Tris(oxalato)aluminate(III) Trihydrate. ***Journal of Chemical Education***,1983, 60(11), 1001.

4. Inorganic Syntheses Vol -1 by H S Booth. First Ed, 1939. (page-36).

5. Novel Synthesis of Tris(acetylacetonato)-iron(III), ***Journal of Chem. Soc. Dalton Trans.*** 1983

6. Metal Acetylacetonate Synthesis Experiments: Which Is Greener?, ***Journal of Chemical Education,*** 2011, 88, 947–953, dx.doi.org/10.1021/ed100174f

7. Experimental Inorganic/Physical Chemistry: An Investigative, Integrated Approach to Practical Project Work, Mounir A . Malati, Woodhead Publishing Limited, 1999.
8. Vogel's Textbook Quantitative Chemical Analysis, 6th Ed.
9. Colorimetric Determination of the Iron(III)-Thiocyanate Reaction Equilibrium Constant with Calibration and Equilibrium Solutions Prepared in a Cuvette by Sequential Additions of One Reagent to the Other, ***Journal of Chemical Education***, Vol.88 No.3 March 2011.
10. Experiments in chemistry, D. V. Jahagirdar, Himalaya publication.
11. A spectrophotometric study of complex formation between Fe(III) and salicylic acid, Kinya Ogawa, Nobuko Tobe, Bulletin of chemical society of Japan, 39, 227-232, 1966.
12. Salicylate determination by complexation with Fe(III) and optical absorbance spectroscopy
13. Determination of Equilibrium Constants of Metal Complexes from Spectrophotometric Measurements: An Undergraduate Laboratory Experiment, ***Journal of Chemical Education***, Vol. 76, No. 9, September 1999.

G. Organic Estimations (any two)

1. **Determination of molecular weight:** Determination of molecular weight of organic acid by titration against standardized NaOH - a) monobasic acid or b) dibasic acid
2. **Estimation of amides:** Determine the amount of acetamide in given solution by volumetric method. (Standardization of acid must be performed)
3. **Estimation of Ethyl benzoate:** To determine the amount of ethyl benzoate in given solution volumetrically. (Standardization of acid must be performed).

References:

i) Vogel's textbook of practical organic chemistry
ii) Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal

Examination Pattern: At the time of examination student has to perform one experiment either from inorganic sections or organic section. 50% students must be assigned inorganic chemistry and 50% organic chemistry experiment. In case of organic qualitative analysis, after separation of binary mixture any one compound has to be analysed. Distribution of or 35 marks: 30 marks for experimental performance and 5 mark for oral.

Section - C: Industrial Visit

Visit any Chemical / Pharmaceutical / Polymer / Research Institutes / Sugar Factories / waste water treatment plant, etc. and submit report.

Learning Outcomes

1. Verify theoretical principles experimentally

2. Interpret the experimental data on the basis of theoretical principles.
3. Correlate the theory to the experiments. Understand / verify theoretical principles by experiment or explain practical output with the help of theory.
4. Understand systematic methods of identification of substance by chemical methods.
5. Write balanced equation for all the chemical reactions performed in the laboratory.
6. Perform organic and inorganic synthesis and able to follow the progress of the chemical reaction.
7. Set up the apparatus properly for the designed experiments.
8. Perform the quantitative chemical analysis of substances and able to explain principles behind it.
