UNIVERSITY OF KOTA

SEMESTER SCHEME

(w.e.f. 2022-23)

M.Sc. (Botany)

MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005

3. Morris, I.1986. An Introduction to the Algae. Cambridge University Press, U.K.
4. Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
5. Puri, P. 1980, Bryophytes. Atma Ram & Sons, Delhi.
6. Round, F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.

1.5 I:

Suggested Laboratory Exercises

Morphological study of representative members of algae, fungi and bryophytes:- *Microcystis, Aulosira, Oocysits, Pediastrum, Hydrodictyon, Ulva, Pithophora, Stigeoclonium, Draparnaldiopsis. Closterium, Cosmarium Batrachospermum Chara, Stemonitis, Peronospora, Albugo, Mucor, Pilobolus, Yeast, Emericella, Chaetomium, Pleospora, Morchella, Melampsora, Phallus, Polyporus, Drechsiera, Phoma, Penicillium, Aspergillus, Colletotrichum, Plagiochasma, Asterella, Notothylus, Polytrichum, Shaerocarpos, Porella, Calobryum, Sphagnum, Pogonatum.*

Symptomology of some diseased specimens: White rust, downy mildew, powdery mildew, rusts, smuts, ergot, groundnut leaf spot, red rot of sugarcane, wilts, paddy blast, citrus canker, bacterial blight of paddy, angular leaf spot of cotton, tobacco mosaic, little leaf brinjal, sesame phyllody, mango malformation.

Study of morphology, anatomy and reproductive structures of bryophytes.

Identification of fungal cultures : *Rhizopus, Mucor, Aspergillus, Penicillium, Emericella, Chaetomium, Drechslera, Curvularia, Fusarium, Phoma, Colletotrichum, Graphiu*

Unit-IV

General Characters and life history of fossil gymnosperm *Lyginopteris, Medullosa, Caytonia, Glossopteris, Cycadeoidea, Pentoxylon,* and *Cordaites.*

Unit-V

General introduction of Paleobotany, fossilization, types of fossils, Techniques of fossil study, Geological time scale, General characters of fossil members of pteridophyta with special reference to *Horneophyton, Asteroxylon* and *Cladoxylon.* Paleobotany and evolution of vascular plants.

Suggested Reading;

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperm New Age International pvt. Ltd., NewDelhi.

2. Parihar, N.S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.

3. Singh, M. 1978, Embryology of Gymnosperms, Encyclopaedia of Plant Anatomy. X. Gebruder Bortraeger, Berlin.
4. Sporne, K.K. 1991. The morphology of pteridophytes. B.I. publishing Pvt. Ltd. Mumbai.
5. Stewart, W.N and Rathwell, G.W.1993. Paleobotany and the evolution of plants, Cambridge University press.
6. Sunderrajan, S.2007. Introduction to pteridophyta, New Age International Publishers, New Delhi.

1.5 I:

Suggested Laboratory Exercises

Morphology and anatomy of vegetative and reproductive part of *Psilotum, Lycopodium, Selaginella, Equisetum, Gleichenia, Isoetes, Ophioglossum, Botrychium, Pteris, Cycas, Ginkgo, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Pedocarpus, Agathis, Taxus, Ephedra and Gnetum* and the members in their natural habitat found in your locality.

Study of important fossil of Pteridophytes and Gymnosperms from specimens.

Paper 1.3-Plant Physiology

	Maximum Marks : 100 Marks
Duration of Examination: 3 Hours	Semester Assessment : 70 Marks
	Continuous (Internal) Assessment : 30 Marks

Note: The syllabus is divided into five independent units and question paper will be divided into three sections.

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Unit-I

Water relation of plants:- Unique physicochemical properties of water, chemical potential, water potential, apparent free space, bulk movement of water. Soil plant atmosphere continuum (SPAC), stomatal regulation of transpiration, signal transduction in guard cell.

Membrane Transport:- Passive-non-mediated transport and Ernst equation, passive-mediated transport, ATP driven active transport, Uniport, Symport, Antiport, Ion channels.

3. Galston, A.W. 1989. Life Processes in Plants. Scientific American, Springer-Verlag. New York, USA.
4. Hooykaas, P.J.J., Hall M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elservier, Amsterdam, The Netherlands.
5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
6. Lodish, II., Berk, A., Zipursky, S.L., Matsudaira P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (fourth edition). W.M. Freeman and Company, New York USA.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. (second edition). Springer-Verlag, New York, USA
8. Nobel, P.S. 1999. Physiochemical and Environmental Plant Physiology (second edition), Academic Press, San Diego, USA.
9. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4^{th} edition). Wadsworth Publishing Co., California, USA.
10. Singhal, G.S. Renger, G., Sopory. S.K., Irrgang, K.D. and Govindjle 1999., Concepts in Photobiology : Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
11. Taiz. I., and Zeiger, E., 1998. Plant Physiology (2^{nd} edition) Sinaucr Associates, Inc., Publishers, Massachusetts, USA.
12. Thomas, B. and Vince-Preu, D. 1997 Photoperiodism in Plants (second edition). Academic Press, San Diego, USA.
13. Westhoff, P. 1998. Molecular Plant Development from Gent to Plant, Oxford University Press, Oxford, U.K.

1.5 II

Suggested Laboratory Exercises :

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase nitrate reductase).
2. Effect of substrate concentration on activity on any enzyme and determination of its Km value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
5. To determine the chlorophyll a. chlorophyll b. ratio in C_3 and C_4 Plants.

6. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
7. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS-PAGE and perform autoradiography.
8. Extraction of seed proteins depending upon the solubility.
9. Determination of succenate dehydrogenase activity, its kinetics and sensitivity to inmcitors.
10. Desalting of proteins by gel filtration chromatography employing Sepnadex.
11. Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry or Bradford's method.
12. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or Sephadex. G200.
13. SDS-PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Briliant Blue or silver nitrate.
14. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.
15. Radioisotope methodology, autoradiography, instrumentation (GM count and Scintillation counter) and principles involve.
16. Principles of colorimetry, spectrophotometry and fluorimetry.

7. Mehrotar R.S. Plant Pathology. Tata McGraw Hill.

8. Rangaswamy, G. & Mahadevan, A. 1999. Diseases of crop plants in India (4th edition) Prentice Hall of India, Pvt. New Delhi. Horsfall, J.G. & A.L. Dimond. Plant Pathology Vols. 1, 2 & 3. Academic Press, New York, USA.

9. Trivedi, P.C. 1998. Nematode Diseases in Plants, CBS Publisher & Distributor, New Dehli.

1.5 II:

Suggested Laboratory Exercises (Microbiology).

1. Calibration of microscope : determination of dimensions of micro-organisms (suggested model organisms : yeast, lactobacilli, cyanobacteria)

2. Cultivation media of autotrophic and heterotrophic micro-organisms (cleaning of glasswares, mineral media, complex media, solid media, sterilization).

3. Isolation of microorganisms, streaking on agar plates/pour plate method, isolation of clones, preservation.

4. Determination of growth of a microorganism (model organism : *Escherichia coli,* effects of nutrients, e.g. glucose, fructose, sucrose, principle of colorimerty/spectrocolorimeter).

5. Determination of microbial population size (suggested model organism yeast, use of haemocytometer, serial dilution techniques, relationship between dilution and cell count, determination of standard error, reliability in cell counts)

6. Preparation of Winogradsky column using pond bottom mud. Observations on temporal sequence of appearance of microbes (visual appearance, microscopic, observations)

7. Observation on virus infected plants (symptoms).

8. Fermentation by yeast (inverted tube method, use of different substrates, e.g. glucose, fructose, cane sugar, starch).

Suggested Readings:

1.Smith, R.L. 1996. Ecology and Field Biology, Harpr Collins, New York
2.Muller-Dombois, D. and Ellenberg, H., 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
3.Begon, M. Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
4.Ludwig. J. and Reynolds, J.F. 1988, Statistical Ecology. John Wiley & Sons.
5.Odum, E.P. 1971. Fundamentals of Ecology, Saunders, Philadelphia.
6.Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
7.Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology, Benjamin / Cummings Publication Company, California.
8.Kormondy, E.J. 1996 Concepts of ecology, Prentice- Hall of India Pvt. Ltd., New Delhi.
9.Chapman, E.J. and Reiss, M.J. 1988. Ecology, Principles and Applications, Cambridge University Press, Cambridge, U.K.
10.Molan, B. and Billharz, S. 1997. Sustainability Indicators, John Wily Sons, New York.
11.Treshow, M. 1985. Air Pollution and Plant Life, Wiley Interscience.
12.Heywood, V.H. and Watson, R.T. 1985. Global Biodiversity Assessment, Cambridge University Press.
13.Mason, C.F. 1991. Biology of Freshwater Pollution, Longman.
14.Hill, M.K. 1997. Understanding Environmental Pollution, Cambridge University Press.
15.Brady, N.C. 1990. The Nature and Properties of Soils, Macmillan

2.5-I

Suggested Laboratory Exercises :

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for comparing two means related to ecological data.
2. To prepare ombrothermic diagram for different sites on the basis of given data set and to comment on climate.
3. To find out the relationship between two ecological variables using correlation and regression analysis.
4. To determine minimum size and number of quadrats required for community study.
5. To find out association between important grassland species using chisquare test.

6. To compare protected and unprotected grassland stand using community coefficients (similarity indices).
7. To analyze plant communities using Bra-Curtis ordination method.
8. To determine diversity indices (Shannon – Wiener, concentration of dominance, species richness, equitability and biodiversity) for protected and unprotected grassland stands.
9. To estimate IVI of the species in a woodland using point centered quarter method.
10. To determine gross and net phytoplankton productivity by light and dark bottle method.
11. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
12. To determine the Water holding capacity of soils collected from different locations.
13. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
14. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Wrinkler's method.
15. To estimate chlorophyll content in SO_2 fumigated and unfumigated plants leaves.
16. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
17. To study environmental impact of a given developmental activity using checklist as a EIA method.

2.5-I

Suggested Laboratory Exercises The Practical course is divided into three units : (1) Laboratory work, (2) Field survey and (3) Scientific visits.

Laboratory Work

1. Forge/fodder crops : Study of any five important crops of the locality (for example fodder sorghum, bajra, berseem, clove, guar bean, gram, *Ficus* sp.)
2. Plant fibers :
   (a) Textile fibres : cotton, jute, linen, sunn hemp, *Cannabis.*
   (b) Cordage fibres : coir
   (c) Fibres for stuffing : silk cotton or kapok.

   Morphology, anatomy, (microscopic) study of whole fibres using- appropriate staining procedures.

3. Medicinal and aromatic plants : Depending on the geographical location college/university select five medicinal and aromatic plants each from a garden crop field (or from the wild only if they are abundantly available).

   Papaver somniferum, Atropa belladonna, Catharanthus roseus. Adhatoda zeylanica, (syn A. vasaca) Allium sativum, Rauwolfia serpentina, Withania somnifera, Phyllanthus amarus, (P. fraternus), Andrographis paniculata, Aloe barbadens, Mentha arvensis. Rosa sp., Pogostemon cablin, Origanum vulgare, Vetiveria zizanioides. Jasminum grandiflorum, Cymbopogon sp., Pandanus odoratissimus.

   Study of live or herbarium specimens or other visual materials, to become familiar with these resources.
4. Vegetaible oils : Mustard, groundnut, soyabean, coconut, sunflower, castor, Morphology, microscopic structure of the oil-yielding tissues, tests for oil and iodine number.

5. Gums, resins, tannins, dyes : Perform simple tests for gums and resins. Prepare a water extract of vegetable tannins *(Acacia, Terminalia, mangroves, tea, Cassia spp., Myrobalans)* and *dyes (Curcuma longa, Bixa orellana, Indigofera sps., Butea monosperma, Lawsonia inermis)* and perform tests to understand their chemical nature.

Field Survey

6. **Firewood and timber yielding plants and NWF's :**
   a. Prepare a short of 10 most important sources of firewood and timber in your locality. Give their local names, scientific names, and families to which they belong. Mention, their properties.
   b. Prepare an inventory of the bamboos and rattans of your area giving their scientific and local names and their various uses with appropriate illustrations.
   c. A survey of a part of the town or city should be carried out by the entire class, In batches, Individual students will select one avenue/road and locate the trees planted on a graph paper. They will identify the trees, mention their size, canopy shape, blossoming and fruiting period and their status (healthy, diseased, infested, mutilated, misused or dying) and report whether or not the conditions in which they are surviving are satisfactory. The individual reports will be combined to prepare a larger map of the area, which can be used for subsequent monitoring either by the next batch of students/teachers/local communities/NGOs/or civic authorities. The purpose of exercise in item C above is to make the students aware of the kinds of trees and value in urban ecosystems and ecological services.

Scientific Visits*

The students should be taken to one of the following :

3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing USA.

4. Rost, T, etal. 1998. Plant Biology. Wadsworth Publishing Co., California USA.

5. Krishnamurthy, K.V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.

6. Buchanan, B.B., Gruissem, W., and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists. Maryland, USA.

7. De, D.N. : 2000. Plant Cell Vacuoles : An Introduction. CSIRO Publication Collingwood, Australia.

8. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York USA.

9. Lodish, H., Berk, A. Zipursky, S.L. Matsudaira, P., Baltimore D. and Darnell, J. 2000. Molecular Cell Biology (4th Edition) W.H. Freeman and Co., New York, USA.

See the following Review Journals

Annual Review of Plant Physiology and Molecular Biology.

Current Advances in Plant Sciences.

Trends in Plant Sciences.

Nature Reviews : Molecular and Cell Biology.

2.5-II

Suggested laboratory Exercises

1. Isolation of mitochondria and the activity of its marker enzyme succinate dehydrogenase (SDH).
2. Isolation of chloroplasts and SDS-PAGE profile, of proteins demarcate the two subunits of Rubisco.
3. Isolation of nuclei and identification of histones by SDS-PAGE.

4. Isolation of plant DNA and its quantitation by spectrophotometric method.
5. Isolation of DNA. And preparation of ‘cot’ curve.
6. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
7. Isolation of RNA and quantitation by a spectrophotometric method.
8. Separation of plant RNA by agarose gel electrophoresis and visualization by EtBr staining.
9. Southern blot analysis using a gene specific probe.
10. Northern bolt analysis using a gene specific probe.
11. Immunological techniques : Ouchterlony method, ELISA and western blotting.
12. Fluorescence staining with FDA for cell viability and cell well staining with calcolflour.
13. Demonstration of SEM and TEM.

Note : Chemicals and kits for conducting some of the above molecular biology experiments are available in India, for example from M/s Bangalore Genei and Centre for Biotechnology (CSTR) Mall ‘Road, Delhi.’

Suggested Reading (For laboratory exercises)

1. Glick, B.R. and Thompson, J.E. 1993, Methods in Plant Molecular, Biology and Biotechnology, CRC Press, Boca Raton, Florida.
2. Glover, D.M. and Hames, B.D. (Eds.), 1995. DNA Cloning 1: A Practical Approach, Core techniques. 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
3. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology : Structure and Function Jones and Bartlett Publishers, Boston, Massachusetts.

5 Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology. Asia Ltd. Singapore.
6 Devlin, R.M. and Witham, F.H. 1986. Plant Physiology, 4th Ed. CBS Pub. Delhi.
7 Voet, D and Voet J.G. 1995. Plant Biochemistry, John wiley, New York.
8 Lehnenger, A.L. 1982. Principles of biochemistry, CBS Publication.

2.5-II

Suggested Laboratory Exercises :

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase nitrate reductase)
2. Determination of succenate dehydrogenase activity, its kinetics and sensitivity to inmcitors.
3. Principles of colorimetry, spectrophotometry and fluorimetry.
4. Estimation of Lipids
5. Separation of chlorophyll by paper chromatography.
6. Separation of amino acids by paper chromatography.
7. Separation of chlorophyll by liquid chromatography.
8. Test of phenols, alkaloids and terpenoids.
9. Isolation of VAM fungi.
10. Determination of amylase activity
11. Separation of aliphatic wax components by thin layer chromatography (TLC)
12. Isolation of root nodule bacteria from roots of legume plant.
13. Quantification of protein in given plant sample.
14. Quantification of carbohydrates in given sample.
15. The effect of temperature on enzyme activity.
16. The effect of pH on enzyme action.
17. To determine total soluble carbohydrates in given plant material.
18. To determine proline in given plant material.

10. Murphy, T.M. and Thompson, W.E., 1988. Molecular Plant Development. Prenitice Hall, New Jersey.
11. Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins, London.
12. Raghavan, V. 1997. Molccular Embryology of Flowering Plant. Cambridge University Press, Cambridge.
13. Raghavan, V. 1999. Development Biology of Flowering Plants. Springer-Verlag, New York.
14. Raven, P.H., Evrt, R.F. and Eichhorn, S. 19992. Biology of Plant (5^{th} edition). Worth, New York.
15. Steeves, T.A. and Sussex, I.M., 1989. Patterns in Plant Development (2^{nd} edition). Cambridge University Press, Cambridge.
16. Sdgely, M. and Griffin, A.R. 1989. Sexual Reproduction to Tree Crops. Academic Press, London.
17. Waisel, Y., Eshel, A. and Kafkaki, U. (eds.) 1996. Plant Roots: The Hidden Hall (2^{nd} edition), Marcel Dekker, New York.
18. Shivanna, K.R. and Sawhney, VK. (eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
19. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag. Berlin.
20. Shivanna, K.R. and Johri, B.M. 1995. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd. New York.

Suggested Laboratory/Field Exercises:

1. Effect of gravity, unilateral light and growth regulators on the growth of young seedlings.
2. Study of tracheary elements by elements by maceration technique.
3. L.S. of shoot tip to study the organization of meristem and origin of leaf primordial.
4. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum*and *Hydrilla.*
5. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe, Tobacco.* Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordial.
6. Study of alternate and distichous, alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement, Examination of rosette plants *(Launaea, Mollugo, Raphanus, Hyoscyamus*etc.) and induction of bolting under natural conditions as well as by GA treatment.
7. Microscopic examination of vertical sections of leaves such as *Cannabis, Tobacco, Nerium,* maize and wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the C_3 and C_4 leaf anatomy of plants.
8. Study of epidermal peels of leaves such as *Coccinia, Gaillardia, Tradescantia, Notonea*etc. Study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.

9. Study of whole roots in monocots and dicots. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives (use maize, aerial roots of banyan, *Pistia, Jussiaea* etc.). Origin of lateral roots. Study of leguminous roots with different types of nodules.
10. Study of microsporogenesis in sections of anthers.
11. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Crotolaria, Tradescantia, Brassica, Petunia,Solanummelongena* etc.)
12. Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
13. Estimating percentage and average pollen tube length *in vitro*.
14. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
15. Pollen storage, pollen-pistil interaction, self-incompatibility, *in vitro* pollination.
16. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrasporic types of embryo sac development thorough examination of permanent, stained serial sections.
17. Field study of several types of flower with different pollination, mechanisms (Wind pollination, bee/butterfly pollination, bird pollination).
18. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate outcrossing systems. Study ofcleistogamous flowers and their adaptations.

5. Khush, G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
6. Karp, G. 1999. Cell and Molecular Biology : Concepts and Experiments. John Wiley & Sons, Inc., USA.
7. Lewin. B. 2000. Gene VII. Oxford University Press, New York, USA.
8. Lewis, R. 1997. Human Genetics : Concepts and Applications (2nd edition). WCB McGraw Hill, USA.
9. Malacinski, G.M. and Freifeldo, D. 1998 : Essentials of Molecular Biology (3rd edition). Jones and B Artlet Publishers Inc. London.
10. Russel, P.J. 1998. Genetics (5th edition). The Benjamin Cummings Publishing Company Ind., USA.
11. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetic (2ndedtition). John Wiley & Sons Inc., USA.

Suggested Laboratory Exercises:

1. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding.
2. Silver banding for staining nucleolus-organizing region, where 18S and 28srDNA are transcribed.
3. Orecein and Feulgen. Staining of the salivary gland chromosomes of Chironomas and Drosophila.
4. Characteristics and behaviour of B chromosomes using maize any other appropriate material.
5. Working out the effect of mono-and tri-somy on plant type, fertility and meiotic behaviour.
6. Induction of polyploidy using colchicines, different methods of the application of Colchicines.
7. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
8. Effect of translocation heterozygosity on plant phenotype. Chromosome pairing and chromosome disjunction and pollen and seed fertility.
9. Meiosis of complex translocation heterozygotes.
10. Isolation of chlorophyll mutants, following irradiation and treatment with chemical mutagens.
11. Estimation of nuclear DNA content through microdensitomerty and flow cytometry.
12. Fractionation and estimation of repetitive and unique DNA sequences in nuclear DNA.

Suggested Laboratory Exercises:

Description of a specimen from representative, locally available families.

1. List of Locally Available Families:

   (1) Ranunculaceae, (2) Capparidaceae, (3) Portulacaceae, (4) Caryophyllaceae, (5) Malvaceae, (6) Tiliaceae, (7) Streculiaceae, (8) Zygophyllaceae, (9) Rhamnaceae, (10) Sapindaceae, (11) Leguminosae, (12) Combretaceae, (13) Myrtaceae, (14) Cucurbitaceae, (15) Apiaceae, (16) Rubiaceae, (17) Asteraceae, (18) Primulaceae, (19) Plumbaginaceae, (20) Asclepiadaceae, (21) Convolvulaceae, (22) Solanaceae, (23) Boraginaceae, (24) Polemoniaceae, (25) Acanthaceae, (26) Pedaliaceae, (27) Martyniaceae, (28) Bignoniaceae, (29) Lamiaceae, (30) Nyctaginaceae, (31) Polygonaceae, (32) Chenopodiaceae, (33) Amaranthaceae, (34) Aizoaceae, (35) Molluginaceae, (36) Euphorbiaceae, (37) Commelinaceae, and (38) Cyperaceae.
2. Description of species based on various specimens to study intraspecific vartation: a collective exercise.
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Location of key characters and use of key at family level.
5. Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants, natural or cultivated as are abundant.
6. Training in using floras and herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

UNIT-III

Fungal diseases: Symptomatology and disease identification,Some important diseases of cereals: Smuts, rusts, leaf blights, spots, mildews, karnal bunt and flag smut of wheat; covered smut and stripe disease of barley. Brown spot and blast of paddy, downy mildews and Drechlera (Helminthosporium) blights of Maize; ergot and smut of Bajra, leafspots and smuts of jowar, green ear disease of Bajra.

UNIT-IV

Other Diseases: Red rot and smut of sugarcane; Wilt of cotton, flax and pigeon pea; Flax rust; Blight of gram; Early blight of tomato and potato; Late blight of potato; Tikka disease of groundnut, and downy and powdery mildews of grapes.

UNIT-V

Molecular base of host-parasitic interactions,signal transductionand plant disease development,acquired immunity, SAR, role of salicylic acid in plant disease development,culture of obligate parasites.

Suggested Readings:

1. Agrios, G.N. 2005 Plant Pathology. 5th edition Academic Press. New York, USA
2. Alexopoulus, C.J, C.W. Mims and M. Blackwel, 1996. IntroductoryMycology, 4th edition, John Wiley and Sons, inc., New York, USA
3. Khan, J.A. and J. Dijkstra. 2002 Plant Virus as Molecular Pathogens. The Haworth Press Inc. USA
4. Mehrotra R.S. and A. Agarwal. 2003 Plant Pathology. 2nd Edition TATA McGraw Hill. Pub.Company Ltd. New Delhi.
5. Singh, R.S. 1982. Plant Pathogens. The Fungi. Oxford and IBH Publishing Company, New Delhi, India.
6. Singh, R.S. 1989.Plant Pathogens. The Prokaryotes.Oxford and IBH Publishing Company, New Delhi, India.
7. Trigiano, R.N., M.T. Windham and A.S. Windham. 2008. Plant Pathology: Concepts and Laboratory Exercises. 2nd edition. CRC Press.
8. Vidhyasekram, P. 2004. Concise Encyclopedia of Plant Pathology: Food product Press and Haworth Press Inc. Binghamton.
9. Kaushik, P 1996 Introductory Microbiology Emkay Pub. New Delhi.
10. Mehrotra R.S.1987 Plant Pathology.TATA MacgrawthllPub.Company Ltd., New Delhi.

11.Purohit S.S. 2002 Microbiology-Fundamentals& applications Agrobios (India) Pub. Jodhpur.

Suggested Laboratory Exercises:

1. Culture transfer techniques
2. Techniques for isolation of pure culture
3. Isolation of discrete colonies from a mixed culture

4. Isolation of pure culture from spread plate streak plate preparation.
5. Culture characteristics of microorganisms
6. Grams staining.
7. To draw camera lucida drawings of fungal spores.
8. Calibration of Microscopes
9. Study of fungal and other disease

Paper XIV (b): Advanced Plant Ecology-I(Environmental Biology)

Scheme of Examination **Duration : 3 hours** **Max. Marks : 100**

Maximum Marks : 100 Marks
Duration of Examination: 3 Hours
Semester Assessment : 70 Marks
Continuous (Internal) Assessment : 30 Marks

Note: The syllabus is divided into five independent units and question paper will be divided into three sections.

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc. Contact Hours will be 4 Hours per week for the faculty.

UNIT-I

Ecosystem: Concept, structure and function of grassland, forest, fresh water and marine ecosystems, biogeochemical cycles, evolution of ecosystem, ecological energetic and flow of energy.

Suggested Laboratory Exercises:

18. To determine minimum size and number of quadrat required for reliable estimate of biomass in grassland.
19. To compare protected and unprotected grassland stand using community coefficients (similarity indices).
20. To estimate IVI of the species in a grassland/woodland using quadrat method.
21. To determine gross and net phytoplankton productivity by light and dark bottle method.
22. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
23. To determine the Water holding capacity of soils collected from different locations.
24. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
25. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Wrinkler's method.
26. To estimate chlorophyll content in SO_2 fumigated and unfumigated plants leaves.
27. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
28. To study environmental impact of a given developmental activity using checklist as a EIA method.
29. To analyze plant community characters.
30. Soil/water test (different parameters).
31. Compare polluted and non-polluted plants (different parameters).
32. Study of morphological and anatomical adaptations of plants.

Paper XV: Practical
M.Sc. Botany Semester-III

Skeleton Paper

Duration: 6 hrs **Max. Marks: 100**

1. (a) Study the tracheary elements by maceration techniques. 10

or

Determine/study the phyllotaxy of selected plants (A).

or

L.S. of shoot tip to study the organization or meristem.

5. Chrispeels, M.J. and Sadava, D. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers, Biston, USA.
6. Collins, H.A. and Edwards, S. (1998) Plant Cell Culture. Bios. Scientific Publishers, Oxford, UK.
7. Glazer, A.N. and Nikaido, H. (1995) Microbial Biotechnology. W.H. Freeman & Company, New York, USA.
8. Gustafson, J.P. (2000) Genomes. Kluwer Academic Plenum Publishers, New York, USA.
9. Henry, R.J. (1997) Practical Applications of Plant Molecular Biology. Chapman Hall, London, UK.
10. Jain, S.M., Sopory, S.K. and Veilleux, R.E. (1996) *In vitro* Haploid Production in Higher Plants,Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
11. Joles, O. and Jornvall, F. (Eds.) (2000) Proteomics Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
12. Kartha, K.K. (1985). Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.
13. Old, R.W. and Primrose, S.B. (1989) Principles of Gene Manipulation, Blackwell Scientific Publications, Oxford, UK.
14. Primrose, S.B. (1995) Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK.
15. Raghavan, V. (1986) Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York, USA.
16. Raghavan, V. (1997) Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.
17. Shantharam, S. and Montgomery, J.F. (1999) Biotechnology, Biosafety and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
18. Vasil, I.K. and Thorpe, T.A. (1994) Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.
19. Gupta, S.C. (2016) Fundamental of Statistics. Himalaya Publishing House, Mumbai.
20. Gupta, S.C. and Kapoor, V.K. (2000) Fundamentals of Mathematical Statistics (A Modern Approach).10th Edition, Sultan Chand & Sons,N. Delhi.
21. Rao, P.H. and Janardhan K. (2010) Fundamentals of Biostatistics. I.K.International Publishing House, New Delhi.

Suggested Laboratory Exercises:

1. Preparation of different explants and their surface sterilization.
2. Media preparation, sterilization and inoculation of explants.
3. Organogenesis and somatic embryogenesis and preparation of artificial seeds.

4. Demonstration of androgenesis in *Datura*.
5. Isolation of protoplasts from various plant tissues and testing their viability.
6. Effect of physical (e.g. temperature) and chemical (e.g.osmoticum) factors on protoplast yield.
7. Demonstration of protoplast fusion employing PEG.
8. Electroporation of protoplasts and checking of transient expression of the reporter gene.
9. Growth characteristics of *E. coli* using plating and turbidimetric methods.
10. Isolation of plasmids from *E. coli* by alkaline lysis method and its quantitation spectrophotometrically.
11. Restriction digestion of plasmid and estimation of the size of various DNA fragments.
12. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and selection of recombinants.
13. Demonstration of DNA sequencing by Sanger's di-deoxy method.
14. Co-cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.

Suggested Readings for Laboratory Exercises:

1. Butenko, R.G. (2000) Plant Cell Culture, University Press of Pacific.
2. Collin, H.A. and Edwards, S. (1998) Plant Cell Culture, Bios Scientific Publishers, Oxford, UK.
3. Dixon, R.A. (Ed.) (1987) Plant Cell Culture: Practical Approach. IRL Press, Oxford.
4. Gelvin, S.B. and Schilperoort, R.A. (Eds.) (1994) Plant Molecular Biology Manual. 2nd edition, Kluwer Academic Publishers, Dordrecht. The Netherlands.
5. George, E.F. (1993) Plant Propagation by Tissue Culture, Part I. The Technology, 2nd edition, Exegetics Ltd., Edington, UK.
6. George, E.F. (1993) Plant Propagation by Tissue Culture, Part 2, In Practice 2nd edition. Exegetics Ltd., Edington, UK.
7. Glick, B.R. and Thompson, J.E. (1993) Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
8. Glover, D.M. and Hames, B.D. (Eds.) (1995) DNA Cloning I: A Practical Approach, Core Techniques, 2nd edition. PAS. IRL Press at Oxford University Press, Oxford.

2. Esau, K. (2006) Anatomy of Seed Plants. John Wiley & Sons, New York, USA.
3. Pandey, B.P. (2001) Plant Anatomy. S. Chand Publishing, New Delhi
4. Bhojwani, S.S. and Bhatnagar, S.P. (2000) The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
5. Fahn, A. (1982) Plant Anatomy. Pergamon Press, Oxford.
6. Ganguly and Das. College Botany. Vol I and II, central Book Agency, Kolkata (India).
7. Leins, P., Tucker, S.C. and Endress, P.K. (1988) Aspects of Floral Development. J. Cramer, Germany.
8. Raghavan, V. (1999) Developmental Biology of Flowering Plants. Springer-Verlag, New York.
9. Raven, P.H., Evrt, R.F. and Eichhorn S. (1992) Biology of Plants. Worth, New York
10. Steeves, T.A. and Sussex, I.M. (1989). Patterns in Plant Develoments. Cambridge University Press, Cambridge.
11. Waisel, Y., Eshel, A. and Kafkaki, U. (Eds.) (1996) Plant Roots: The Hidden Hall. Marcel Dekker, New York.
12. Shivanna, K.R. and Rangaswamy, N.S. (1992). Pollen Biology: A Laboratory Mannual, Springer-Verlag, Berlin.
13. Koelling, C. (Ed.) (2016) Plant Anatomy, Morphology and Physiology. Syrawood Publishing House, New York, USA
14. Shibanna, K.R. and Johri B.M. (1995). The Angiosperm Pollen: Structure and Function. Wiley Eastern Limited, New York.
15. Eames, A.J. (1961) Morphology of the Angiosperms. McGraw-Hill Book Company, Inc., New York.
16. Eames, A.J. (1947) Introduction to Plant Anatomy, 2nd Edition. McGraw-Hill Book Company, Inc., New York.
17. Shivana, K.R. and Rangaswamy, N.S. (1992) Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.

Suggested Laboratory Exercises:

1. Anatomical study of dicot and monocot stems with special reference to anomalous secondary growth.
2. Microscopic examination of vertical sections of leaves such as *Cannabis*, Tobacco, *Nerium*, maize and wheat to understand the internal structure of leaf tissue and trichomes glands etc.

3. Study of epidermal peels of leaves such as *Coccinia*, *Gaillardia*, *Tradescantia*etc. to study the development and structure of stomata and prepare stomatal index.
4. Study of whole roots in monocots and dicots.
5. Anatomical study of monocot and dicot roots.
6. Study of leguminous roots with different types of nodules.
7. Microscopic examination of anthers of *Datura, Tradescantia, Brassica,* maize etc. to study the pollen grains.
8. Tests for pollen viability and pollen germination.
9. Monopodial and sympodial types of branching in monocots and Dicots.
10. Study the morphology of root/shoot/floral parts of commonly occurring plants.

Note: Field survey/visit to study thedifferent types of flowering plants.

Paper XVIII. Seed Biology and Plant Breeding

Duration of Examination: 3 Hours

Maximum Marks : 100 Marks
Semester Assessment : 70 Marks
Continuous (Internal) Assessment : 30 Marks

Note: The syllabus is divided into five independent units and question paper will be divided into three sections.

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt

1. Agarwal, RL (1980), Seed technology, oxford and IBH publishing co.pvt. Ltd. New Delhi.
2. Agrawal, G.K. and Rakwal, R. (Eds.) (2012)Seed Development: OMICS Technologies toward Improvement of Seed Quality and Crop Yield. Springer, Dordrecht.
3. Bewley, J D and Black, M (1994) Seeds: Psychology of Development and Germination. Plenum Press, New York.
4. Bewley J.D. and Black, M. (1982) Physiology and Biochemistry of Seeds in Relation to Germination. Springer-Verlag, Berlin.
5. Chopra, V.L. (2001) Plant Breeding: Theory and Practice. Oxford IBH Pvt. Ltd., New Delhi.
6. Khare, D and Bhale, MS (2014) seed technology scientific publishers, (India) Jodhpur, Revised 2nd Ed.
7. Kulkarni, G.N. (2002) Principles of seed teachnology, kalyani publishers, New Delhi.
8. Mohanan, K.V. (2010) Essentials of Plant Breeding. Prentice Hall of India Private Ltd.
9. Roberts, E.H. (2013) Seeds: Physiology of Development and Germination. Springer-Verlag New York.
10. Robert, R.W. (1999) Principles of Plant Breeding. John Wiley & Sons, New York, USA.
11. Singh Rajesh and Singh Rajeev (2018). Seed technology. Kalyani publishers, New Delhi.

Suggested Laboratory Exercises:

1. Seed structure of wheat, pearlmillet, mustard, gram, pea, etc.
2. Seed viability, Seed testing and Seed dormancy.
3. Seed storage content and seed germination.
4. Seed coat types of *Pisum*,*Cucurbita* and wheat.
5. Emasculation technique and Hybridization methods
6. Specimen study of modification of plants for vegetative propagation.
7. Specimen study of various seed dispersal mechanism (commonly occurring examples).

Note: Excursions to visit the CAZRI, NBPGR and other institutes in Rajasthan.

Paper XIX (a). Advanced Plant Pathology II

Suggested Readings:

1. Agrios, G.N. (1997) Plant Pathology. Academic Press, London.
2. Albajes, R., Cullino, M.L., Van Lenteren, J.C. and Elad, Y. (Eds.) (1999) Integrated Pest and Disease Management in Greenhouse Crops. Kiluwel Academic Publishers.
3. Clifton, A. (1958) Introduction to the Bacteria. McGraw Book Co., New York.
4. Khan, J.A. and Dijkstra, J.(2002) Plant Virus as Molecular Pathogens. The Haworth Press Inc., USA
5. Mandahar, C.I. (1978) Introduction to Plant Viruses. Chan Co. Ltd., Delhi.
6. Mehrotra, R.S. (1982) Plant Pathology. Tata McGraw Hill.
7. Mehrotra, R.S. and Agarwal, A.(2003) Plant Pathology. 2nd Edition TATA McGraw Hill. Pub.Company Ltd., New Delhi.
8. Singh, R.S. (1989) Plant Pathogens. The Prokaryotes.Oxford and IBH Publishing Company, New Delhi, India.
9. Purohit, S.S. (2002) Microbiology Fundamentals & Applications Agrobios (India) Pub., Jodhpur.
10. Rangaswamy, G. and Mahadevan, A. (1999) Diseases of Crop Plants in India (4th edition) Prentice Hall of India, Pvt. Ltd., New Delhi.
11. Horsfall, J.G. and Dimond, A.F. (1960) Plant Pathology vols. 1, 2 & 3. Academic Press, New York, USA.
12. Trivedi, P.C. (1998) Nematode Diseases in Plants, CBS Publisher and Distributor, New Dehli.
13. Trigiano, R.N., Windham, M.T. and Windham, A.S. (2008) Plant Pathology: Concepts and Laboratory Exercises. 2nd edition. CRC Press.

Suggested Laboratory Exercises:

1. Isolation of microorganisms, streaking on agar plates/pour plate method, isolation of clones and preservation.
2. Determination of growth of a microorganism (model organism: *Escherichiacoli*), effects of nutrients, e.g. glucose, fructose, sucrose.
3. Observations on bacterial and virus infected plants (symptoms).
4. Observations on important diseases caused by nematodes and mollicutes.
5. Observationsnon-parasitic diseases.

Note: Excursionsfor collection of diseased plant materialfrom different locations and to visit Agricultural Research Stations dealing pathological study in Rajasthan.

Scheme of Examinations
Rules & Regulations
and
Syllabus

(for Academic Session 2022-23)

M.Sc. Chemistry

First Semester Examination, December 2022
Second Semester Examination, June 2023

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

and biological functions of glucosaminoglycans or mucopolysaccharides, glycoproteins and glycolipids, role of sugars in biological recognition.

Unit-III: Lipids: **12-15 L**

Fatty acids, structure and function of triacylglycerols, cholesterol, bile acids; lipoproteins: composition and function, role in atherosclerosis; properties of lipid aggregates: micelles, bilayers, liposomes; biological membranes, fluid mosaic model of membrane structure, lipid metabolism: β-oxidation of fatty acids.

Unit-IV: Amino-acids and Proteins: **12-15 L**

Amino acid metabolism: degradation and biosynthesis of amino acids; sequence determination: chemical / enzymatic / mass spectral, racemization / detection.

Chemical and enzymatic hydrolysis of proteins, secondary structure of proteins, α-helix, β-sheets, tertiary structure of protein: folding and domain structure, quaternary structure.

Unit-V: Nucleic Acids: **12-15 L**

Purine and pyrimidine bases of nucleic acids, structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA, chemical and enzymatic hydrolysis of nucleic acids, chemical basis of heredity, an overview of replication, transcription, translation and genetic code.

Books:

- *Principles of Biochemistry, A.L. Leininger, Worth Publishers.*
- *Biochemistry, L. Stryer, W.H. Freeman.*
- *Biochemistry, J. David Rawn, Neil Patterson.*
- *Biochemistry, Voet and Voet, John Wiley.*
- *Outlines of Biochemistry E.E. Conn and P.K. Stumpf, John Wiley.*

Paper-1.5: CHEM-515: Chemistry Practical

Contact Hours / Week : 16 Hours
Duration of Examination: 12 Hours (6 Hrs. per Day) **Maximum Marks:** 200 Marks
Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: Major Experiment	30
2.	Exercise No. 2: Major Experiment	30
3.	Exercise No. 3: Major Experiment	30
4.	Exercise No. 4: Minor Experiment	15
5.	Exercise No. 5: Minor Experiment	15
6.	Exercise No. 6: Minor Experiment	15
7.	Practical Record	15
8.	Good Laboratory Skills and Regularity in Practicals	10
9.	Comprehensive Viva-voce	40
	Total Marks	**200**

Laboratory Safety, GLP, SOPs and Basic Concepts:

- General instructions for safe working in chemical laboratories.
- Planning of experiments and recording of results.
- Good laboratories practices.
- Sampling and sample preparation.
- Preparation of standard operating procedures (SOPs).
- Hazards in chemical laboratories.
- Apparatus and reaction procedures: Introduction of working with lab ware.
- Solvents and reagents.
- Concept of distillation, crystallization, drying, isolation and purification, determination of physical constants.

Solution Preparation and Standardization:

- Preparation of solutions in terms of molarity, molality, formality, normality, w/w, w/v, v/v, percent, mole ratio, partial pressure and presentation of concentration in g/L, percent, ppt, ppm, ppb.
- Standardization of solutions.

Inorganic Chemistry:

Qualitative Analysis:

Identification of inorganic mixture consisting of eight radicals (cations / anions / less common metal ions):

- Less common metal ions: Ti, Mo, W, Tl, Zr, Th, V, U (two metal ions in cationic / anionic forms)
- Insoluble: Oxides, sulphates and halides
- Interfering anionic radicals

Quantitative Analysis:

Separation and determination of two metal ions Cu-Ag, Cu-Ni, Zn-Cu, Ni-Zn, Cu-Fe, Ca-Fe, Ca-Mg, *etc.* involving volumetric and gravimetric methods

Inorganic Preparation:

Preparation and purification of selected inorganic compounds and their studies by magnetic susceptibility measurements, handling of air and moisture sensitive compounds

- Ferrous ammonium sulphate
- Ferric ammonium sulphate
- Nickel ammonium sulphate
- Bis(acetylacetonato) complexes of Cu, Co, Cr, Mn, and VO
- Prussian Blue, Turnbull's Blue
- $[Cr(NH_3)_6]Cl_3$
- $[Ni(NH_3)_6]Cl_2$
- $Ni(dmg)_2$
- $[Co(NO_2)\ (NH_3)_5]Cl_3$

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Organic Chemistry:

Qualitative Analysis:

Separation, purification and identification of compounds of binary mixture (two solids, one liquid & one solid, two liquids) using TLC, columns chromatography, and chemical tests

Organic Synthesis:

- Aromatic electrophilic substitutions:
  - Synthesis of m-dinitrobenzene from nitrobenzene
  - Synthesis of *p*-nitroacetanilide and *p*-bromoacetanilide.
- Sandmeyer reaction: p-Chlorotoluene, p-chloronitrobenzene and from *p*-iodonitrobenzene.
- Cannizzaro reaction: 4-Chlorobenzaldehyde as substrate.
- Aldol condensation: Dibenzalacetone from benzaldehyde.
- Friedel Crafts reaction: β-Benzoyl propionic acid from succinic anhydride and benzene.
- Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
- Oxidation: Benzoic acid from toluene.
- Grignard reaction: Synthesis of triphenylmethanol from benzoic acid**.**
- Grignard reaction: Synthesis of cyclohexyl methanol from cyclohexyl chloride.
- Acetoacetic ester Condensation: Synthesis of ethyl n-butyl acetoacetate by A.E.E. condensation.
- Oxime formation: Synthesis of benzophenone oxime from benzophenone.

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Physical Chemistry:

Distribution Law:

- Distribution coefficient of benzoic acid between toluene and water.
- Distribution coefficient of cinnamic acid between toluene and water Distribution coefficient of iodine between CCl_4 and water
- Distribution coefficient of ammonia between chloroform and water.

Chemical Kinetics:

- Determination of the effect of (a) change of temperature (b) change of concentration of reactant and catalyst and (c) ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction.

- Determination of the velocity constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as iodine clock reactions.

Conductometry:

- Determination of the amount of HCl conductometrically by using strong base.
- Determination of the amount of NaOH conductometrically by using weak acid.
- Determination of the amount of NH_4OH conductometrically by using strong acid.
- Determination of the amount of CH_3COOH conductometrically by using weak base.
- Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
- To determine equivalent conductance at several concentration and infinite dilution of strong electrolytes and weak acid by using Kohlrausch Law and dissociation constant for weak acid conductometrically.

Adsorption:

- To study surface tension-concentration relationship for solutions (Gibbs equation).
- Determine the CMC of surface-active material by surface tension method.
- Adsorption of acetic acid on charcoal.

Surface tension:

- Determination of surface tension of various liquids by stalagmometry method (drop number / drop weight)
- Determination of percent composition of mixture of liquids by surface tension method
- Determination of parachors of molecules and various groups.
- Determination of surface tension and parachor of liquids using double capillary method.

Viscosity:

- Determination of viscosity of various liquids using viscometer.
- Determination of unknown composition of given liquid mixture by viscosity method.
- Verification of Kendall's relation.
- Verification of Jon Dole's equation.

Polarimetry:

- Measurement specific rotation of sugar (*e.g.* glucose, fructose, sucrose, *etc.*)
- Determination of unknown concentration of sugar solution.
- Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
- Comparison of strengths of two acids by polarimetric study of kinetics of inversion of cane sugar.
- To determine the percentage of two optically active substances (d-sucrose and d-tartaric acid) in a given solution.
- To determine the electron polarization and electron polarizability of a liquid.

Note: *Any other relevant experiments may be added / performed.*

Books:

- *Vogel's Textbook of Quantitative Analysis, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham*
- *Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.*
- *Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health.*
- *Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.*
- *Handbook of Organic Analysis: Qualitative and Quantitative. H. Clark, Edward Arnold.*
- *Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.*
- *Experiments and Techniques in Organic Chemistry, D.P. Pasto, Johnson and Miller, Prentice Hall.*
- *Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.*
- *Findley's Practical Physical chemistry, B.P. Levitt, Longman.*
- *Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.*

……. x ……. x ……. x …….

Unit-I: General Introduction: **12-15 L**

Elements of a computer system, block diagram of computer system and function of its components, concept of hardware and software, memory, introduction to operating systems (DOS, Windows).

PC Software:

Word processing: Creating and saving documents, formatting, inserting tables and pictures, mail merge, spread sheets, charts, graphs and use of functions, introduction to presentation packages, graphics and animation.

Unit-II: Report Generation and Presentation: **12-15 L**

MS Office: Introduction to Word, Excel and Power Point; MS Word: Documentation and manipulation, saving and printing, incorporation of graphs, tables pictures and chemical structures into the documents; MS Excel: Spread sheets, report generation, cell manipulation, database management, graphical representation of tabulated data, Pi-chart, bar and line graphs, surface and 3D graphs; Power Point: Application of power point for the presentation of reports and slides.

Unit-III: Computing and Languages: **12-15 L**

Elements of programming languages, constants and variables, operations and symbol expressions, flow chart, functions and subroutines, graphics, statements, commands, commands for accessing hardware, elements of C language. Windows: Introduction and applications.

Unit-IV: Computer Applications in Chemistry: **12-15 L**

Introduction to CAD: A balance approach to computer aided process design, computer interface with instruments and laboratory information system: computers in fault & true analysis, computers in communication, internet: basic concepts, importance in chemical industries.

Unit-V: Computation in Chemistry: **12-15 L**

Computation in chemistry such as pressure from Van der Waals equation, pH of solution, kinetics, radioactive decay, lattice energy, determination of order of reaction, Pauling's relation, ionic radii, molecular weight of an organic compound, resonance energy, isoelectric point of amino acids, Lambert-Beer's law, bond lengths, bond angles, linear simultaneous equations to solve secular equations within the Hűckel theory.

Books:

- *The Big Basic Book of Window 98: Kraynak-PHI.*
- *Computational Chemistry: A.C. Norris.*
- *Programming in basic problems solving with the true and style: Stewant M. Venit Jaico.*
- *Mastering Windows Special edition: Robert Cowart - BPB Publications.*
- *Computer Fundamental Architecture Organisation: B. Ram - New Age international.*
- *Computers in Chemistry: K.V. Raman - TMH Pub.*
- *Fundamentals of Computer: V. Rajaraman (Prentice Hall)*
- *Computers in Chemistry: K.V. Raman (Tata Mc Graw Hill)*
- *Computer Programming in FORTRAN IV-V Rajaraman (Prentice Hall).*

Paper-2.5: CHEM-525: Chemistry Practical

Contact Hours / Week **:** 16 Hours
Duration of Examination: 12 Hours (6 Hrs. per Day) **Maximum Marks:** 200 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: Major Experiment	30
2.	Exercise No. 2: Major Experiment	30
3.	Exercise No. 3: Major Experiment	30
4.	Exercise No. 4: Minor Experiment	15
5.	Exercise No. 5: Minor Experiment	15
6.	Exercise No. 6: Minor Experiment	15
7.	Practical Record	15
8.	Good Laboratory Skills and Regularity in Practicals	10
9.	Comprehensive Viva-voce	40
	Total Marks	**200**

Inorganic Chemistry:

Quantitative Analysis:

- Determination of overall and stepwise stability constant of metal chelates by polarographic, pH-metric and conductometric techniques.

Inorganic Preparation:

Preparation and purification of selected inorganic compounds and their studies by magnetic susceptibility measurements, handling of air and moisture sensitive compounds

- $[Ti(urea)_6]I_3$
- $[Co(Py)_2Cl_2]$
- *trans*-$K[Cr(ox)_2(H_2O)_2]$
- *cis*-$K[Cr(ox)_2(H_2O)_2]$
- *Cis*-$[Co(en)_2Cl_2]$
- *Trans*-$[Co(en)_2Cl_2]$
- $[Co(H_2O)(NH_3)_5]Cl_3$
- $[Co(ONO)(NH_3)_5]Cl_2$
- $K_3[Fe(C_2O_4)_3]$

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Organic Chemistry:

Quantitative Analysis:

- Estimation of Nitrogen by Kjeldahl's Method.
- Estimation of Sulphur / Halogen by Messinger / Fusion Method.
- Estimation of glucose by titration using Fehling's solution/Benedict solution.
- Estimation of carbonyl group by using 2,4-dinitrophenylhydrazine
- Determination of the percentage or number of hydroxyl / amine groups in an organic compound by acetylation method.
- Estimation of amines / phenols using bromate-bromide solution or acetylation method.

Organic Synthesis:

- Nitrobenzene → *m*-Nitrobenzene → *m*-Nitroaniline
- Chlorobenzene → 2,4-Dintrochlorobenzene → 2,4-Dinitrophenol
- Aniline → 2,4,6-Tribromoaniline → 1,3,5-Tribromobenzene
- Aniline → Diazoaminobenzene → *p*-Aminoazobenzene
- Phthalic anhydride → Phthalimide → Anthranilic acid
- Phthalic anhydride→ Fluorescein → Eosin
- Phthalic anhydride→ *o*-Benzoyl benzoic acid → Anthraquinone
- Acetophenone → Oxime → Acetanilide
- Benzoic acid → *p*-Nitrobenzoic acid → p-Aminobenzoic acid

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Physical Chemistry:

Distribution Law:

- Determination of the equilibrium constant of the reaction $KI+I_2 \rightarrow [KI_3]$ and hence the concentration of given KI.
- Determination of equilibrium constant of copper-ammonia complex by partition method or coordination number of Cu^{2+} in copper-ammonia complex.

Transition Temperature:

- Determination of K_T of salt hydrate, molar mass of solute, mass of salt hydrate and composition of given sample

Thermochemistry:

- Determine the concentration of given strong acid / base solution by measuring heat change during dilution.
- Determine the lattice energy of $CaCl_2$ from its heat of solution using Born-Haber cycle.
- Thermometric titration of NaOH v/s standard HCl.
- Heat of displacement of copper by zinc.
- Determination of the heat of ionization of acetic acid.
- Determination of partial molar volume of solute (*e.g.* KCl) and solvent in a binary mixture.

- Determination of the temperature dependence of the solubility of a compound in two solvents having similar intra-molecular in interactions benzoic acid in water and in DMSO-water mixture and calculate the partial molar heat of solution.

Phase Equilibrium:

- To study the effect of impurities (KCl / NaCl / succinic acid) on the miscibility temperature of phenol-water system and hence the determine the concentration of given unknown solution
- Determination of congruent composition and temperature of a binary system (*e.g.* diphenylamine-benzophenone, naphthalene-biphenyl, naphthalene-benzophenone systems).
- To construct the phase diagram and determination of the composition of unknown mixture for two and three component system (*e.g.* diphenylamine-benzophenone, naphthalene-biphenyl, naphthalene-*m*-dinitrobenzene, chloroform-acetic acid-water, benzene-acetic acid-water systems).

Ionic Equilibrium:

- Determination of pKa of an indicator (*e.g.* methyl red) in (a) aqueous and (b) micellar media.
- Determination of stoichiometry and stability constant of Ferric isothiocyanation complex ion in solution.
- Determination of rate constant of alkaline bleaching of Malachite green and effect of ionic strength on the rate of reaction.
- Determine stability constant of Fe^{2+} complex ion keeping ionic strength constant

Conductometry:

- Study of relationship between ionic conductance and viscosity, measurement of conductivities of electrolytes in mixed solvents.
- Determination of concentration of sulphuric acid, acetic acid and copper sulphate from their mixture by conductometric titration with standard NaOH.
- Determination of hydrolysis constant and degree of hydrolysis of aniline hydrochloride conductometrically.
- Determination of transition temperature of given salt (*e.g.* $CaCl_2$) conductometrically.
- Determination of the critical micelle concentration of sodium lauryl sulphate from measurement of conductivities at different concentrations in aqueous solutions.

Potentiometry / *p*H metry:

- Determination of temperature dependence of EMF of a cell
- Determination of activity and activity constant of electrolytes.
- Determination of the valency of mercurous ions potentiometrically.
- Determination of the EMF of various $ZnSO_4$ solutions and hence the concentration of unknown $ZnSO_4$ solution.
- Determination of the pKa value of chloroacetic acid, trichloroacetic acid, orthophosphoric acid by potentiometry / pH metry using standard solution of NaOH.
- Determination of ferrous ammonium sulphate potentiometrically with standard ceric sulphate solution (Direct and back titration).
- Determine the solubility and solubility product of sparingly soluble salts potentiometrically
- Determination of standard electrode potential (Eo) value of Ag / AgI electrode and the solubility product of AgI and PbI2.
  Analysis of mixture of carbonate and bicarbonate (percent in ppm range) using a pH meter or suitable indicators.

Spectrophotometry & Colorimetry:

- To verify Lambert-Beer law for $KMnO_4$ solution & to determine the concentration of given $KMnO_4$ solution
- Determination of composition of complex by Job's method.
- Study of zirconium-alizarin Red-S complex: Mole-ratio method.
- Determine the pH of solution employing methyl red indicator spectrophotometrically.
- Determination of pKa of an indicator (e.g. methyl red) in (a) aqueous and (b) micellar media.

Polarography:

- To determine half wave potential of a given ion using half height method, differential method and wave equation method
- Identification and estimation of metal ions such as Cu^{2+}, Cd^{2+}, Pb^{2+}, Zn^{2+}, and Ni^{2+} *etc.* polarographically.
- To study the current-potential characteristics of Cd^{2+} ions using DC polarography, sampled DC, cyclic voltammetry and pulse polarographic techniques.

- Study of a metal ligand complex polarographically (using Lingane's Method).
- Determination of (a) Fe and Mo in steel (b) urea and glucose in biological fluids (c) heavy metals in wine samples and petroleum products polarographically.

Refractometry:

- Analysis of sugars by refractometer and polarimeter
- Determination of molar refraction of pure liquids
- Determination of concentration of KCl solution/glycerol solution
- Determination of concentration of KI solution
- Determination of molar refraction of solid KCl
- Determination of solubility of KCl in water
- Study the stoichiometry of potassium iodide-mercuric iodide complex.
- Determination of sugar and its concentration refractometrically.
- To study of quality of fruits, food and food products.
- To study of temperature effect on Brix measurement.
- To study of food and beverages:
  - Determination of soluble solids in fruit products
  - Determination of rancidity in edible oils
  - Determination of moisture in honey and strawberry jam
  - Determination of total solids, water and fat in milk
  - Determination of oil in avocado and olives
  - Determination of fat in chocolate
  - Determination of moisture in meat
- To study of petroleum:
  - Determination of petroleum content in oil sands
  - Determination of olefins, aromatics, paraffins
  - Determination of ethylene glycol in coolants
  - To study in agriculture field:
  - Determination of oil content of seeds
  - Determination of sweet corn maturity
  - Determination of salinity

Note: *Any other relevant experiments may be added / performed.*

Books:

- *Vogel's Textbook of Quantitative Analysis, Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.*
- *Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.*
- *Experiments and Techniques in Organic Chemistry, Pasto, C. Johnson and M. Miller, Prentice Hall.*
- *Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.*
- *Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.*
- *Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.*
- *Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.*

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Scheme of Examinations
Rules & Regulations
and
Syllabus

(for Academic Session 2023-2024)

M.Sc. Chemistry

Third Semester Examination, December 2023
Fourth Semester Examination, June 2024

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

SHWETA SAXENA

25.04.2024 11:14

Five-membered heterocycles with more than two heteroatoms: synthesis, reactions and some medicinal importance of triazoles and tetrazoles.
Benzo-fused five-membered heterocycles with one nitrogen heteroatoms: synthesis, reactions and some medicinal importance of indoles.
Benzo-fused five-membered heterocycles with two nitrogen heteroatoms: synthesis, reactions and some medicinal importance of benzimidazoles.

Unit-IV: Six-membered Heterocycles-I: **12-15 L**

Six-membered heterocycles with nitrogen heteroatoms: synthesis, reactions and some medicinal importance of azines (pyridines), diazines (pyradizine, pyrimidine and pyrazine) and triazines (s-triazines).
Benzo-fused six-membered heterocycles with one nitrogen heteroatoms: synthesis, reactions and some medicinal importance of quinoline and isoquinoline.
Benzo-fused six-membered heterocycles with one nitrogen heteroatoms: synthesis, reactions and some medicinal importance of acridine.
Benzo-fused six-membered heterocycles with two nitrogen heteroatoms: synthesis, reactions and some medicinal importance of quinazoline and quinoxaline.

Unit-V: Six-membered Heterocycles-II: **12-15 L**

Six-membered heterocycles with one oxygen heteroatom: synthesis and reactions of pyrylium salts and pyrones.
Benzo-fused six-membered heterocycles with one oxygen heteroatom: synthesis, reactions and some medicinal importance of coumarins and chromones.

Seven-membered Heterocycles:
Synthesis and some medicinal importance of azepines, oxepines, thiepines, benzodiazepines, benzoxazepines and benzothiazepines.

Books:

- *Heterocyclic Chemistry Vol. 1, II and III, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.*
- *The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.*
- *Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Blackhall.*
- *Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.*
- *Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.*
- *An Introduction to the Heterocyclic Compounds, R.M. Acheson, John Wiley.*
- *Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon Press.*

Paper-3.5: CHEM-635: Organic Chemistry Practical

(Only for Organic Chemistry Specialization)

Contact Hours / Week **:** 16 Hours
Duration of Examination: 12 Hours (6 Hrs. per Day) **Maximum Marks:** 200 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: Major Experiment	30
2.	Exercise No. 2: Major Experiment	30
3.	Exercise No. 3: Major Experiment	30
4.	Exercise No. 4: Minor Experiment	15
5.	Exercise No. 5: Minor Experiment	15
6.	Exercise No. 6: Minor Experiment	15
7.	Practical Record	15
8.	Good Laboratory Skills and Regularity in Practicals	10
9.	Comprehensive Viva-voce	40
	Total Marks	**200**

Qualitative Analysis:

Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid or two solids and one liquid), using TLC for checking the purity of the separated compounds, chemical analysis, IR, PMR and mass spectral data.

Chromatographic Analysis:

Separation and identification of compounds (*e.g.* amino acids, carbohydrates and other organic compounds) by following chromatographic techniques:

- Paper Chromatography
- Thin Layer Chromatography
- Column Chromatography
- Flash Chromatography
- Gas Chromatography
- Liquid Chromatography
- Electrophoresis

Three-steps / Multi-steps Organic Syntheses:

The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques:

- Aniline → Acetanilide → *p*-nitroacetanilide → *p*-nitroaniline
- Aniline → Acetanilide → *p*-bromoacetanilide → *p*-bromoaniline
- Benzene → Benzophenone → Benzpinacol → Benzpinacolone
- Benzene → Benzophenone → Benzophenoneoxime → Benzanilide
- Benzene → 3-benzoyl propanoic acid → 4-Phenyl butanoic acid → α-Tetralone
- Benzaldehyde → Benzoin → Benzil → Benzinilic acid

Note: *The products may be characterized by spectral techniques.* Other relevant preparations / syntheses may be performed.

Spectrophotometric (UV/VIS) Estimations:

- Amino acids
- Proteins
- Carbohydrates
- Cholesterol
- Ascorbic acid
- Caffeine
- Aspirin
- Paracetamol
- Ibuprofen
- Promethazine
- Methyldopa
- Penicillin
- Verapamil
- Propranolol
- Fluconazole
- Ciprofloxacin
- Griseofulvin
- Diazepam

Analysis of Fuel / Petroleum / Petroleum Products:

- Determination of calorific value of fuel and coal
- Estimation of moisture in given coal sample.
- Estimation of ash content in given coal sample.
- Estimation of proximate value of given coal sample.
- Determination of the strong acid number or inorganic acidity of oil
- Determination of viscosity and surface tension of oil / liquid.
- Determination of saponification value of oil
- Determination of bromine / hydroxyl / iodine value of oil.
- Determination of aniline point of oil.
- Determination of cloud point and pour point of oil.
- Determination of flash point & fire point of oil.
- Determination of aniline point of liquid fuel
- Determination of carbon residue of liquid fuel
- Determination of octane & cetane number
- Determination of sulphur / lead / other elements in petroleum products / coal
- Determination of alkalinity / salinity / rancidity / water content / diesel index of oil / petroleum sample.
- Determination of organic and inorganic chloride in oil / petroleum sample.
- The ultimate analysis of given sample of soft coke.
- Determine the viscosity of a given sample of oil in centistokes at room temperature and at 40°, 50°, 60° 65°, 70°C. Plot a graph between kinematic viscosity and temperature in degree centigrade

Analysis of Agrochemicals:

- Analysis of soil sample, soil micronutrients for Ca, Fe and P content
- Analysis of pigments with respect to Zn and Cr.
- Analysis of pesticide residue and toxicological effects.
- Analysis of malathion by colorimetry.

- Determination of organic carbon in soil by Walk Ley and Black method.
- Determination of available chlorine in bleaching powder by Bunsen method.
- Determination of total chlorine in pesticide formulation.
- Determination of copper in fungicide.
- Estimation of nitrogen from given fertilizer by Kjeldahl method.
- Estimation of phosphorus from given fertilizer by volumetry / colourimetry.
- Estimation of potassium from given fertilizer by gravimetry / Flame photometry.
- Determination of K_2O content in given sample of potash fertilizer.
- Determination of P_2O_5 content in give n sample of phosphatic fertilizers.
- Determination of moisture content in given sample of urea
- Analysis of insecticides: DDT, BHC, aldrin, endosulfon, malathion, parathion.
- Analysis of herbicides: 2,4-Dichlorophenoxyacetic acid, dalapon, paraquat, Banalin, Butacarb.
- Analysis of fungicides: Boardeaux mixture, copper oxychloride, zineb, benomyl.

Analysis of Polymers:

- Determination of acid, saponification, iodine, hydroxyl and carboxyl values of a plastic material.
- Determination of molecular weight of a polymer.

Ion Chromatography

(i) Chemical Applications

- Determination of anions in toothpaste by Ion Chromatography.
- Determination of anions and cations in high purity water by Ion Chromatography.
- Determination of metals and polyphosphates in given sample by Ion Chromatography.
- Determination of azide in aqueous samples by Ion Chromatography.
- Determination of dissolved hexavalent Cr in drinking water, groundwater & industrial waste.
- Determination of diethanolamine and triethanolamine in surface finishing, wastewater and scrubber solutions water effluents by Ion Chromatography
- Determination of fluoride in acidulated phosphate topical solution.
- Determination of oxalate and other anions in Bayer liquor using Ion Chromatography.
- Determination of amino acids, carbohydrates, alcohols, and glycols in fermentation Broths
- Determination of calcium, magnesium, manganese and iodine in Brine
- Determination of trace anions and cations in concentrated bases using auto-neutralization pre-treatment/Ion Chromatography.
- Determination of trace anions in organic solvents and concentrated hydrofluoric acid.
- Determination of trace transition metals in reagent grade acids, bases, salts, and organic solvents using chelation Ion Chromatography.
- Determination of polyphenols
- Determination of N,N-dimethyl-o-toluidine and N,N-diethyl-o-toluidine in ethylene gas samples.
- Determination of transition metals at ppt levels in High-Purity Water and SC2 (D-clean) Baths

(ii) Petroleum Refining

- Extraction of total petroleum hydrocarbon contaminants (diesel & waste oil) in soils
- Extraction of hydrocarbon contaminants (BTEX, Diesel, and TPH) in soils
- Extraction of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans
- Extraction of PAHs from environmental samples by accelerated solvent extraction (ASE)
- Determination of thiosulfate in refinery and other wastewaters
- Automated solid phase extraction (SPE) of total petroleum hydrocarbons using Dionex AutoTrace® Instrument.
- Determination of biofuel sugars by Ion Chromatography
- Determination of cations in biodiesel using a Reagent-Free Ion Chromatography.
- Determination of 32 low molecular mass organic acids in biomass by Ion Chromatography Mass Spectrometry

(iii) Safety and Security Applications

- Extraction of explosives from soils by accelerated solvent extraction (ASE)
- Determination of monovalent cations in explosives

(iv) Cosmetics

- Rapid Determination of benzalkonium chloride in cosmetics

(v) Polymers

- Polysialic acid analysis: Separating polymers with high degrees of polymerization

Note: *Any other relevant experiments may be added / performed.*

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Paper-4.5: CHEM-645: Organic Chemistry Practical

(Only for Organic Chemistry Specialization)

Contact Hours / Week : 16 Hours
Duration of Examination: 12 Hours (6 Hrs. per Day) **Maximum Marks:** 200 Marks
Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: Major Experiment	30
2.	Exercise No. 2: Major Experiment	30
3.	Exercise No. 3: Major Experiment	30
4.	Exercise No. 4: Minor Experiment	15
5.	Exercise No. 5: Minor Experiment	15
6.	Exercise No. 6: Minor Experiment	15
7.	Practical Record	15
8.	Good Laboratory Skills and Regularity in Practicals	10
9.	Comprehensive Viva-voce	40
	Total Marks	**200**

Extraction of Organic Compounds from Natural Sources:

- Isolation of nicotine from tobacco.
- Isolation of caffeine from tea leaves.
- Isolation of lycopene from tomatoes.
- Isolation of β-carotene from carrots.
- Isolation of limonene from citrus fruits
- Isolation of casein from milk.
- Isolation of lactose from milk.
- Isolation of oleic acid from olive oil.
- Isolation of eugenol from clove.
- Isolation of cinchonine from cinchona bark.
- Isolation of piperine from black pepper.

Note: Students are required to try some typical colour reactions and check purity of compounds by paper chromatography and TLC by reporting Rf values and determine the density and refractive index wherever it is possible.

Organic Synthesis:

The exercises should illustrate the use of organic reagents, eco-friendly synthetic techniques and may involve purification of the products by chromatographic techniques and characterization by UV, IR, NMR, MS, LC-MS, GC-MS, XRD, particle size analyzer, *etc.*:

- Fischer Indole synthesis: Preparation of 2-phenylindole from phenyl hydrazine
- Skraup synthesis: Preparation of quinoline from aniline.
- Bischler-Napieralski Synthesis: Preparation of isoquinoline from β-phenylethylamine.
- Fries rearrangement: Preparation of acetophenones.
- Vilsmeier-Haack reaction: Preparation of aromatic aldehydes.
- Wittig reaction: Preparation of alkenes.
- Microwave Assisted Organic Synthesis: any one reaction of acylation, alkylation, substitution, addition, condensation.
- Ultrasound Assisted Organic Synthesis: any one reaction of acylation, alkylation, substitution, addition, condensation.
- Synthesis using PTC: Alkylation, oxidation, Wittig reaction, synthesis of 3-alkyl coumarins.
- Electrochemical synthesis: Synthesis of sebacic acid and adiponitrile.
- Enzymatic synthesis: Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomaric excess of S(+)-ethyl-3-hydroxybutanoate and determine its optical activity.
- Vapour Phase Synthesis: Oxidation of toluene, esterification of acetic acid using isoamyl alcohol.
- Biosynthesis: Synthesis of ethanol from sucrose, synthesis of metronidazole from 2-aminoimidazole.

Drug Synthesis:

Synthesis, separation and characterization of some of the following drugs:

- Antipyretic Analgesic: Paracetamol, Phenacetin, Aspirin, Salol, Benorilate, Cinchophen, Mefenamic acid.

- Anti-inflammatory : Ibuprofen, Diclofenac
- Antibiotics : Penicillin V, Amoxicillin, Cefixime, Streptomycin, Chloramphenicol
- Sulphonamides : Sulphanilamide, Sulphapyridine, Sulphadiazine
- Anthelmintics : Albendazole, Thiabendazole
- Anti-bacterial : Fluconazole
- Local Anesthetics : Benzocaine, Procaine
- Anti-malarial : Chloroquine, Primaquine, Pyrimethamine.
- Sedative and Hypnotic: Barbital, allobarbital, phenobarbital, diazepam, alprazolam, zolpidem
- Anti-psychotic : Chlorpromazine, clozapine, olanzapine, quetiapine, citalopram
- Cardiovascular : Hydralazine, procainamide, propranolol, labetalol
- Anti-hypertensive : Chlorothiazide, Acetazolamide, captopril, losartan, verapamil, diltiazem, doxazosin.
- Anti-cancer : Mechlorethamine, methotrexate, imatinib, tamoxifen.
- Anti-viral : Idoxuridine, zanamivir, zidovudine, nevirapine, ritonavir

Note: *The products may be characterized by spectral techniques. Other relevant preparations / syntheses may be performed.*

Drug Analysis:

- Preparation and characterization of active pharmaceutical ingredients with purity assay.
- Complete assay of aspirin / ibuprofen / paracetamol / sulpha drugs
- Limit test for impurities like Pb, As, Fe, moisture, chloride, sulfate, boron, free halogen, selenium, *etc*.
- Determination of moisture in drug sample by Karl-Fischer titration.
- Estimation of mixture of benzoic acid / salicylic acid / iron in pharmaceutical preparation.
- Estimation of ascorbic acid
- Estimation of Benzoic acid in ointment by titrimetry
- Non-aqueous titration method for estimation of isoniazid and sodium benzoate.
- Estimation of sulphadiazine in sulpha tablets
- Determination of aspirin in drug tablet by pH metry titration with NaOH.
- Determination of viscosity of ointment / syrup / liquid, *etc*.
- Analysis of the aminoglycoside antibiotics kanamycin and amikacin matches USP requirements.
- Determination of viscosity of ointment/syrup/oils using Brookfield viscometer.

Clinical Analysis:

- Analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), vitamins (thiamine, ascorbic acid, Vit. A, etc.) and hormones (progesterone, oxytocin, insulin) chemical, instrumental and biological assay wherever applicable.
- Separation and identification of plasma proteins.
- Estimation of Cholesterol in egg yolk or blood serum.
- Estimation of amino acid in protein hydrolysate by Sorenson formal titration method.
- Estimation of blood glucose, protein, chloride, sodium, potassium, urea, uric acid
- Determination of cortisol from blood and urine samples; determination of estrogens from urine samples.

Analysis of Food & Food Products:

- Analysis of moisture content, ash, fiber, nutrients, anti-nutrients, toxicants, microorganism-spoilage, preservatives.
- Analysis of amino acids, proteins, carbohydrates, lipids and fat.
- Analysis of edible oils, dairy products, pickles etc., fruit and vegetable products
- Analysis of food additives and adulterations.
- Analysis of sugars in food and beverage by HPLC.
- Analysis of sugars and related hydroxyl acids by GC.
- Determination of sucrose in various food products.
- Determination of mono-and disaccharides in sweets and beverages by HPLC with refractometric detection
- Separation of Asparagine-Linked (N-Linked) oligosaccharides
- Estimation of vitamin A in food product by Carr-price method.
- Estimation of vitamin C in fruit juice by iodometry.
- Determination of Vitamin B_2 (Riboflavin) by fluorometry.
- Estimation of proteins, sugars, vitamins, amino acids, crude fiber, total minerals, metals, crude fat and water in foods.

- Estimation of ascorbic acid by ceric ammonium sulphate method.
- Estimation of Glucose and fructose in honey by Lane and Eynone method.
- Determination of Hydroxymethylfurfural in Honey and Biomass
- Estimation of lactose in milk by iodometry.
- Quantitative analysis of iron, calcium and phosphorus in milk powder. (Fe-Colorimetrically, Ca-Complexometrically, P-Colorimetrically)
- Casein isolation from milk by isoelectric precipitation (Yield expected).
- Analysis of lipids: saponification value, acid value and iodine value.
- Determination of tannins, chemical residues and aflatoxins,
- Estimation of preservative and antioxidants.
- Determination of strength of acetic acid from the commercial vinegar by potentiometric titration and its confirmation by conductometric/pH-metric titration using standard solution of NaOH.
- Determination of commercial washing soda by potentiometric titration method.
- Estimation of amino acid in protein hydrolysate by Sorenson formal titration method.
- Estimation of pectin as Ca-Pectate colorimetrically
- Determination of Ca in eggshell by flame photometry method.
- Determination of fluoride in tooth paste colorimetrically with alizarins.
- Estimation of sodium benzoate / sodium metabisulphite, boric acid and salicylic acid in food.
- Determination of carbohydrates in coffee.
- Determination of Na/K/Li/Ca in given sample by flame photometry method.
- Chemical analysis of chilli-powder

Forensic Chemistry:

- Determination of lethal dose, LD-50 and LC-50.
- Determination of cyanide, organophosphate and snake venom.
- Estimation of poisonous materials such as lead, mercury and arsenic in biological samples.

Environmental Chemistry:

- Determination of pH, DO, BOD, COD, free CO_2, hardness of water sample.
- Determination of pH, total nitrogen & nitrate, total phosphorous & phosphate, total organic carbon, silica & lime and slats in soil.
- Determination of sodium, potassium, sulphur, magnesium and manganese in soil.
- Monitoring and analysis of SO_2 concentration in ambient air samples using high volume sampler.
- Monitoring and analysis of CO concentration in ambient air samples.
- Monitoring and analysis of NOx concentration in ambient air samples using high volume sampler.
- Monitoring and analysis of ozone concentration in ambient air samples using ozone analyzer.
- A comparison of particulate composition of high polluted and low polluted sites with respect to carbon.

Ion Chromatography:

(i) Medical Science Applications

- Determination of sulfate counter ion and anionic impurities in aminoglycoside drug substances by IC with Suppressed Conductivity Detection
- Determination of tobramycin and impurities Using HPAE-PAD
- Determination of neomycin B and impurities Using HPAE-PAD
- Determination of streptomycin and impurities Using HPAE-PAD
- Determination of galactosamine containing organic impurities in heparin by HPAE-PAD Using the Dionex CarboPac PA20 Column
- Determination of hemoglobin variants by cation-exchange chromatography
- Determination of transition metals in serum and whole blood by Ion Chromatography
- Analysis of ions in physiological fluids
- Analysis of choline and acetylcholine
- Analysis of fatty acids.
- Determination of oxalate and carbohydrate in urine by Ion Chromatography
- Determination of protein concentrations using AAA-Direct.
- Monitoring protein deamidation by cation-exchange Chromatography
- Analysis of mannose-6-phosphate
- Determination of nucleotides by Ion Chromatography with UV absorbance detection
- Determination of residual trifluoroacetate in protein purification buffers and peptide preparations by Reagent-Free Ion Chromatography
- Determination of tryptophan using AAA-Direct.
- Identification of a hydroxylysine-containing peptide using AAA-Direct.

- High-resolution analysis and purification of oligonucleotides with the DNAPac PA100 Column
- High-resolution cation-exchange alternative to peptide mapping for protein ID and QA/QC

(ii) Food and Beverage Applications

- Determination of mercury contamination in herbal medicines
- Rapid separation of anthocyanins in Cranberry and Bilberry extracts using a Core-Shell Particle Column
- Determination of trace sodium in cranberry powder
- Determination of sudan dyes I–IV in curry paste.
- Determination of mono-, di-, and triphosphates and citrate in Shrimp by Ion Chromatography
- Determination of phytic acid in soybeans and black Sesame seeds
- Determination of nitrate and nitrite Ion Chromatography determination in milk samples
- Separation of organic acids and common inorganic anions in wine
- Determination of hydroxymethylfurfural in honey and biomass
- Fast determination of anthocyanins in pomegranate juice
- Determination of lactose in lactose-free milk products by high-performance anion-exchange Chromatography with Pulsed Amperometric Detection
- Fast HPLC Analysis of dyes in foods and beverages

(iii) Electronics Applications

- Determination of trace anion contamination in the extracts of electronic components
- Determination of sodium at the ppt level in the presence of high concentrations of ethanolamine in power plant waters
- Determination of inorganic anions and organic acids in fermentation broths
- Determination of phosphite in electroless nickel plating bath
- Determination of chloride, suppressors, additives and byproducts in acid copper plating baths
- Determination of saccharin in electrolytic nickel sulfate baths
- Determination of an anionic fluorochemical surfactant (FC-95) in a steel bath
- Determination of an anionic fluorochemical surfactant in a semiconductor Etch Bath.
- Monitor trace anion contamination in the extracts of electronic components.
- Determination of cations and amines in hydrogen peroxide by Ion Chromatography Using a RFIC™ (Reagent-Free) System
- Determination of dissolved silica and common Anions Using Dual Detection

(iv) Agrochemicals

- Determination of perchlorate in high ionic strength fertilizer extracts by Ion Chromatography

Interpretation of some following organic compounds using UV, IR, NMR and MS spectra:

- Acetone
- Phenylacetone
- Acetaldehyde
- Crotonaldehyde
- Cinnamaldehyde
- Furfuraldehyde
- Glycerol
- Ethyl alcohol
- Isopropyl alcohol
- t-Butyl alcohol
- *p*-aminophenol
- *p*-Bromophenol
- *p*-Methoxybenzyl alcohol
- Acetic acid
- Benzoic acid
- Cinnamic acid
- Phthalic acid
- Ethyl bromide
- Propyl chloride
- Benzyl bromide
- n-Propylamine
- Triethylamine
- Aniline
- Nitrobenzene
- Acetylene
- Styrene
- Cyclohexane
- Toluene
- Xylenes
- 1,3,5-Trimethylbenzene
- *p*-Dichlorobenzene
- Urea
- Acetamide
- Benzamide
- Acetonitrile
- Benzonitrile
- Anisole
- Cresols
- Toluidines
- Anisidines
- Pyridine
- 4-Picoline
- s-Triazine
- 2-Methoxyethyl acetate
- Vinyl acetate
- Diethyl phthalate
- Acetic anhydride
- Phthalic anhydride

Note: *Any other relevant experiments may be added / performed.*

…… x …… x …… x ……..

UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY

Department of Pure & Applied Physics
Faculty of Science

M.Sc. (Physics)

First Semester Examination, December 2022
Second Semester Examination, June 2023

UNIVERSITY OF KOTA
MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005
INDIA

Edition: 2022

Unit-III

Microwave Tube Devices: Conventional Vacuum tubes at microwave, O type device-Klystron (two cavity & reflex), M type device magnetron, Introduction to TWT (Travelling Wave Tubes), Microwave Semiconductor Devices IMPATT, TRAPATT & Gum Devices, Gyrotron, Free Electron Lasers.

Unit-IV

Opto-electronic devices: Basics of Optical Fiber, Optical Fibers- step index, single and multimode, graded index, Light propagation- total internal reflection, Acceptance angle and Numerical aperture, Fiber losses and dispersions, Optical Sources: Light Emitting diodes-spontaneous emission – surface emitting LED, edge emitters, semiconductor diode.

Unit-V

Optical Sources: LASER- stimulated emission, Double hetero structure LASER, drivers for LED and LASER, Optical Detectors: Photo detectors- characteristics of photo detectors-photoconductor, p-n photodiode, PIN photodiode Schottky barrier photodiode, Avalanche photodiode, Phototransistor.

Text/Reference Books:

1. Integrated Electronics by J. Millaman and C. Halkias, (McGraw Hill, New York), 1972
2. Electronic Devices and circuits by Malvino
3. Solid State Electronic Devices and Integrated Circuits by Ben. G. Sterectman, (Prentice Hall Inc.), 1995.
4. Physics of Semiconductors Devices by S.M. Sze (John Wiley & Sons), 1999.
5. Digital Principles and Applications by C. P. Malvino and D. P. Leach, Mc-Graw Hill, 1985.
6. Digital logic and computer design by M. M. Mano, Tata Mc-Graw Hill.
7. Digital Integrated Circuits by Taub and Shilling, Tata Mc-Graw Hill
8. Digital Fundamentals by Floyd, Mc-Graw Hill.

PHY105- Physics Laboratory-I

1. To study the potential energy curve for end on magnetic interaction.
2. To study the Fourier analysis of sinusoidal, square and triangular wave.
3. To study:
   (a) the excitations of normal modes and frequency splitting measurements using coupled oscillator.
   (b) the frequency of energy transfer as a function of coupling strength using coupled oscillator.
4. To study the dispersion curve for a beaded string to calculate the average mass per unit length of the beaded string and to find out cutoff frequency.
5. Study of Double stage R.C. Coupled amplifier for: (i). Frequency response (ii) the amplitude characteristics.
6. To study the waveform characteristics of multivibrators (Astable, Mono-stable and Bi-stable) and determine its frequency by varying R.
7. To study a various types of Oscillators (like Hartley etc.).
8. To study frequency response of Low pass filter, Band pass filter, High pass filter and Band elimination.
9. Study of clipping and clamping circuit.

10. Study of operational amplifier circuits.
11. Study of Lissajous figure using C. R. O.
12. Verify the various theorems of Boolean algebra.
13. Verify the D'morgans theorem.
14. Implement the Boolean expression and verify the truth table.
15. Study the various combinational circuits-Half Adder, Half subtractor, Full Adder, Full subtractor, Parity Generator, Parity Checker.
16. Study the advanced combination circuits-Multiplexer, Demultiplexer, Encoder, Decoder.
17. Study the various code converters & verify the truth table-Binary to BCD converter, Binary to Gray codes and Binary to EX-3.
18. Study the weighted code converter.
19. Study the flip flops and verify the truth table-R-S,D,J-K, T and Master slave.
20. Study the various registers using flip-flop-Serial in Serial out, Serial in Parallel out, Parallel in Parallel out, Parallel in Serial out
21. Study the various synchronous counters using flip-flop-Binary up, Binary down, Mod-10
22. Study the various asynchronous counters using flip flop- Binary up, Binary down.
23. Study the special counters-Ring counter and Twisted ring counter (Johnson counter).
24. To study the A/D & D/A converters also calculate resolution & error percentage in observation.
25. To study the behavior of V I characteristics of UJT.
26. To study the output and transfer characteristics of a FET.
27. To measure the input and output characteristics of BJT.
28. To draw the V-I characteristics of a DIAC / TRIAC / SCR / Optocoupler.
29. To study and plot the characteristics of Photo-Diode.
30. Any other experiments of the equivalent standard can be set.

PHY204- Atomic & Molecular Physics

Unit-I

Hydrogen Atom : Gross structure energy spectrum, probability distribution of radial and angular (l =1,2) wave functions (no derivation), Magnetic dipole in external magnetic field, Space quantization, effect of spin, relativistic and spin orbit corrections to energy levels of hydrogen, Hamiltonian including all corrections and term shifts, fine structure, the Lamb shift (only an qualitative description)

Unit-II

Systems with Identical Particles: Indistinguishability and exchange symmetry, many particle wave functions and Pauli's exclusion principle, spectroscopic terms for atoms, Heitler-London method for molecule, Vector representation and Coupling of angular momenta, interaction energies, LS- Russel Saunders coupling, jj coupling, their interaction energies, Term derivation of one and two electron system, singlet, doublet and triplet characters of emission spectra.

Unit-III

Interaction with External Fields: Atom in a weak uniform external electric field and first and second order Stark effect, calculation of the polarizability of the ground state of H-atom and of an isotropic harmonic oscillator, Linear Stark effect for H-atom levels, spin-orbit interaction, Normal and anomalous Zeeman Effect, Splitting of levels, Paschen Back effect, Difference between Zeeman and Paschen Back effect.

Unit-IV

Spectroscopy (qualitative) : General features of Alkali spectra, Born-Oppenheimer approximation, Rotational spectra of a molecule, The rigid rotator model, The non-rigid rotator, Isotope effect, Vibrational spectra of a molecule, The molecule as a simple harmonic oscillator, Anharmonic oscillator, Isotope effect, Molecule as vibrating Rotator, P, Q and R branches.

Unit-V

General features of electronic spectra, Fine structure of electronic bands, P, Q and R Branches, Franck-Condon's principle, Electronic, rotational and vibrational spectra of diatomic molecules, Classical and Quantum theory of Raman Effect, Raman spectra for rotational and vibrational transitions, Vibrational-Rotational Raman spectra, comparison with infra red spectra, Selection rules.

Text/Reference books:

1. Introduction to Atomic Spectra by H. E. White
2. Spectra of diatomic molecules by G. Herzberg
3. Spectroscopy Vol. I, II, & III by Walker & Straughan
4. Atomic Spectra by Kuhn.
5. Molecular Spectroscopy by C. N. Bennwell, Tata McGraw Hill Publication.
6. Elementary Atomic Structure: G.R.Woodgate
7. Quantum Physics (atoms, molecules…) R. Eisberg and R. Resnick (J. Wiley),2005

PHY205- Physics Laboratory-II

1. To study the hyperfine structure of spectral lines and Zeeman effect by C.D.S.
2. To study the absorption spectrum of Iodine vapour.
3. To determine the Rydberg's constant with the help of Spectrometer.
4. To study the variation of refractive index of the material of the prism with wavelength and to verify Cauchy's dispersion formula.

5. To determine the wavelength of Sodium light by Michleson Interferometer.
6. To determine the difference between two lines of Sodium light by Michleson Interferometer.
7. To determine the refractive index of glass by Michleson Interferometer.
8. To verify Hartmann's Formula using constat deviation spectrograph.
9. To determine wavelength of Monochromatic light using Fabry-Perot interferometer.
10 To determine g-factor by ESR setup.
11 To study Frank Hertz experiment i.e. variation of accelerating voltage with electron beam current.
12 To verify Fresnel's law of reflection and refraction from a plane refracting surface.
13 Determine the dielectric constant of turpentine oil with the help of Leacher wire system.
14 Determination of wavelength of He-Ne Laser light by diffraction grating.
15 Study of diffraction of laser beam by a slit.
16 To study the torque speed characteristics and determine the transfer function of a D.C. motor.
17 To study the V-I characteristic of solar cell and to calculate the fill factor of the solar cell.
18 Study of LC transmission line.
19 To determination the absorption coefficient of a liquid or solution (water, $KMnO_4$) with the help of a photo voltaic cell.
20 Any other experiments of the equivalent standard can be set.

UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY

Department of Pure & Applied Physics
Faculty of Science

M.Sc. (Physics)

Third Semester Examination, December 2022
Fourth Semester Examination, June 2023

UNIVERSITY OF KOTA
MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005
INDIA

Edition: 2022

moment, mirror confinement: loss cone angle, basic reactions, Lawson criterion, magnetic fusion, inertial confinement fusion, basics of toroidal confinements.

Unit V

Electromagnetic waves propagation in magnetised plasma: Anisotropic plasma behaviour, conductivity tensor, effective plasma permittivity tensor, wave propagation along the dc magnetic field, RCP mode, LCP mode, Faraday rotation, electron cyclotron heating, longitudinal propagation $\left(\vec{k} \parallel \vec{B}_s\right)$, RCP mode, LCP made, whistler, ion cyclotron and Alfven waves, Faraday rotation, cyclotron resonance heating.

Text/Reference Books:

1. An Introduction to Plasma Physics by F.F. Chen, (Plenum Press),1974.
2. Methods in Non-linear Plasma theory by R.C. Davidson, (Academic Press), 1972.
3. Plasma Physics in Theory and Application by W.B.Kunkel, (McGraw Hill), 1966,
4. Fundamentals of Plasma Physics by J.A. Bitten Court, Third Edition, Springer Publications.
5. Statistical Plasma Physics by S. Ichimaru, Addition Wesley Publishing Co.
6. STIX, T.H., Theory of Plasma Waves, McGraw-Hill, New York (1962).
7. Plasma Physics (Midway Reprint Series) by S K Trehan (Edited), S. Chandrasekhar, Chicago press.

PHY305- Physics Laboratory-III

1. To determine the ultrasonic velocity and obtain the compressibility of a given liquid.
2. To study dynamics of a lattice using electrical analogue.
3. To study variation of rigidity of a given specimen as a function of the temperature.
4. To determine the modulus of rigidity of matter by using torsional oscillator (simple brass and iron rod).
5. To determine half-life of a radio Isotope using G.M. Counter.
6. To study absorption of particles and determine range using at least two Sources.
7. To study characteristics of G.M. Counter and to study statistical nature of radio-active decay.
8. To study spectrum of β-particles Using Gamma ray spectrometer.
9. To calculate the solar azimuthal angle for solar radiation with solar time (8:00 a.m. to 4:00 p.m.) for 21 March, 21 June and 21 December.
10. To calculate the angle of incidence of solar radiation in degree at solar noon for different days (at an interval of 20 days) of a year at surface inclined at 0°, 45° and 90° facing towards south (surface azimuth angle = 0°) & to plot the results.
11. Determine the operating frequency of Reflex Klystron.
12. Draw the V-I characteristics of Reflex Klystron.
13. Draw the characteristics of Attenuator.
14. To verify the Waveguide Law.
15. To study the directivity and coupling coefficient of Directional Coupler.
16. To study the properties of Magic Tee and also determine isolation and coupling coefficient.
17. To measure the VSWR of (i) short circuit (ii) open circuit (iii) matched load (iv) unmatched load.
18. To study the properties and E-plane and H-plane Tees. Determine Isolation and coupling coefficient.

19. To determine the optical band gap of a given materials either in bulk or in film form by UV-VIS-NIR spectrometer.
20. Any other experiments of the equivalent standard can be set.

PHY404- [5] Plasma Physics II

Unit-I
Beam plasma system: Beam plasma system, physical mechanism of wave growth, equilibrium, response of beam and plasma electrons to a perturbation, dispersion relation, growth rate, saturation of instability, remarks on non-relativistic two stream instability.

Unit-II
Free electron laser: Response of relativistic electron beam to electrostatic wave, growth rate, practical applications, slow wave structure, relativistic election beam response to TM mode, growth rate, saturation, magnetic Wiggler, kinematics of radiation generation, operating frequency, relativistic electron beam response, mechanism of beam bunching, phase space behaviour.

Unit III
Compton free electron laser: Ponderomotive force, electron bunching in retarding phases of the ponderomotive wave, evolution of electron energy and phase of the ponderomotive wave, electron trapping, energy gain, energy gain in untapered FEL, tapered wiggler, potential energy buckets, Compton regime operation.

Unit-IV
Tokamak operation and laser interaction with plasma embedded with clusters: Schematic of tokomak, plasma equilibrium, Grad-Shafranov equation, Ohmic current, basic elements, tokamak parameters, inductive current drive, Ohmic heating, overview of tokamak operation, ion Coulomb explosion, neutron production, surface enhanced Raman scattering (SERS), Rayleigh scattering, laser interaction with nanotubes.

Unit-V
Instabilities in plasmas: Other schemes of self generated magnetic fields, plasma in a gravitational field $\vec{g} \times \vec{B}$ drift, physical mechanism of Rayleigh Taylor instability, instability analysis, dispersion relation, growth rate, applications, need for plasma confinement, wave-particle interaction, Landau damping, plasma diffusion,
ambipolar diffusion.

Text/Reference Books:

1. An Introduction to Plasma Physics by F.F. Chen, (Plenum Press),1974.
2. Methods in Non-linear Plasma theory by R.C. Davidson, (Academic Press), 1972.
3. Plasma Physics in Theory and Application by W.B.Kunkel, (McGraw Hill), 1966,
4. Fundamentals of Plasma Physics by J.A. Bitten Court, Third Edition, Springer Publications.
5. Statistical Plasma Physics by S. Ichimaru, Addition Wesley Publishing Co.
6. STIX, T.H., Theory of Plasma Waves, McGraw-Hill, New York (1962).
7. Plasma Physics (Midway Reprint Series) by S K Trehan (Edited), S. Chandrasekhar, Chicago press.

PHY405- Physics Laboratory-IV

1. To study the Electro-Optic effect and AC modulation.
2. To study of thermal expansion of quartz crystal using Newton's Ring method.

3. To study the Acoustic-Optic effect.
4. To study the Brewster angle and refractive index of a given materials.
5. To determine the attenuation and bending losses of an optical fiber.
6. Study the Gaussian distribution of intensity of a laser beam.
7. To study the spatial and temporal coherence of laser.
8. To determination particle size by diode laser.
9. To study the nature of polarization.
10. To determine the speed of light using laser.
11. To calibrate a scintillation spectrometer and determine energy of gamma-rays from an unknown Source.
12. To study Compton scattering of gamma-rays and verify the energy Shift formula.
13. To study the alpha particles using Spark chamber.
14. To study the Bremstralung effect Using Scintillation spectrometer.
15. To determine the end point energy of β-particles using β--ray Spectrometer.
16. To study the Hall effect in Semiconductor and determination of Allied parameters.
17. To find the Band gap of given Semiconductor Material with the help of Four Probe method.
18. Measurement of Magnetic susceptibility of paramagnetic Solution by Quinck Method.
19. To study numerical aperture of optical fiber and losses in Optical fiber.
20. Any other experiments of the equivalent standard can be set.

UNIVERSITY OF KOTA

FACULTY OF SCIENCE

M. SC. ZOOLOGY

SYLLABUS AND SCHEME OF SEMESTER EXAMINATION FOR THE ACADEMIC YEAR

2023-24

Semester-I: (July - December 2023)

Semester-II: (January - June 2024)

UNIVERSITY OF KOTA

MBS Marg, Near Kabir Circle, Kota (Rajasthan) 324 005

Syllabus Edition: 2023 (as per NEP 2020)

M.Sc. (Semester-I) ZOOLOGY

Syllabus of Practical-I/Lab. Course-I (based on Paper Z-1.1 & Z-1.2)

ZOO-12205: Paper-Z-1.5: Practical Lab Course I: Total No. of laboratory hrs. 240

1. **Invertebrates**: Identification, classification & study of distinguishing features of important representatives (Protozoa to Hemichordata).

II. **Study of permanent prepared slides** (Protozoa to Hemichordata).

III. **Anatomy/Dissections***:

1. Reproductive, excretory, nervous & heamocoelomic systems of leech.

2. Nervous system and general anatomy: Patella, lamellidens, Mytilus and Aplysia.

3. General Anatomy, reproductive and nervous system of Cockroach, Grasshopper.

IV. **Permanent preparations* and their study**:

1. Preparation of cultures of Amoeba, Paramaecium and Euglena. Study of these protozoans using vital dyes.

2. Permanent preparations of Amoeba. Paramaecium and Euglena from cultures, vorticella from the pond water; flagellates from the gut of white ant; Rectal ciliates, Trypansomes in the blood of house rat; lifecycle stages of Monocystis from the seminal vesicle of earthworm.

3. Permanent preparations through various parts of Animals mentioned in III (i-iv) anatomy section and study of the structure.

4. Permanent preparations of different materials provided for study using microtome.

V. **Biochemistry**:

1. Identification of protein, carbohydrates and Lipid in various tissues.

2. Identification of different kinds of mono, di and poly saccharides in biological and chemical materials.

3. Quantitative estimation of the following by spectrophotometric/semi-auto analyzer method in various tissues. (a) Carbohydrates: Glycogen and glucose. (b) Proteins: Total proteins. (c) Lipid: Phospholipids and cholesterol. (d) Nucleic acids: DNA and RNA. (e) Enzymes: Acid and alkaline phosphatase.

4. Paper chromatography and Thin Layer Chromatography: One-dimensional chromatography using amino acids from purified samples and biological materials.

5. Study of digestive enzymes in different parts of alimentary canal.

VI. Visit to National Park/Museum/Institute/Medical College.

Note: Use of animal for dissection and practical work is subject to the conditions that they are not banned under the wildlife protections act.

M.Sc. (Semester-I) ZOOLOGY

Syllabus of Practical-II/Lab. Course-II (based on Paper Z-1.3 & Z-1.4)

ZOO-12206: Paper Z-1.6: Practical Lab Course-II: Total No. of laboratory hrs. 240

I. Cell Biology:

1. Squash & smear preparations of testis of cockroach / grasshopper: Acetocarmine & Feulgen staining of these preparations.
2. Study of mitosis in onion root tip/ mammalian bone marrow cells.
3. Study of giant chromosomes in the salivary gland of Chironomus larva or Drosophila larva.
4. Vital and supra-vital staining (with neutral red and Janus Green B) of cells of the testis of an insect or mammal to study the mitochondria.
5. Chromosomal study of the testis of an insect or mammal or cells of the bone marrow of a mammal.
6. Study of permanent slides of various stages of Mitosis, Meiosis and Giant Chromosomes.
7. Preparation of Vital stains and Dye.

II. Biostatistics:

1. Preparation of frequency tables, histogram, bar diagram and line graphs (Computer based exercise).
2. Calculation of standard deviation, variance and standard error of the mean.
3. Correlation and rank of correlation.
4. Probability & Test of significance.
5. Calculation of significance using Chi-square test.
6. Plotting the slope of a line on a graph: calculations of the slope of a line, coefficient and regression.
7. Field Trip: Study of animals in their natural habitats.

Note: Use of animal for dissection and practical work is subject to the conditions that they are not banned under the wildlife protections act.

Suggested Readings:

1. Cell Biology : Practical Manual; Gupta, Makhija & Toteja; Prestige Publishers
2. Laboratory Manual of Cell Biology: Majumdar, Rina & Rama Sisodia.
3. Practical Use of Biostatistics: A. Bahera; Paras Medical Publisher
4. Biostatistics: S.K. Pundir; CBS Publication.

7. Textbook Of Physiology 10ed (Vol 1 & Vol 2): A.K. Jain; Arya Publishing House
8. BRS Physiology, 7/e: Constanzo; Wolters Kluwer India Pvt. Ltd.
9. Textbook of Physiology (Vol. I & II): APC Books Publisher
10. Manual of Practical Physiology: A.K. Jain; Arya Publishing House
11. Practical Physiology: A New Approach: Jaypee Brothers Medical Publishers
12. Practical Workbook of Human Physiology: Jaypee Brothers Medical Publishers

M.Sc. (Semester-II) ZOOLOGY

Syllabus of Practical-I/Lab. Course-I (based on Paper Z-2.1 & Z-2.2)

ZOO-12215: Z -2.5-: Practical/Lab Course-I: Total No. of laboratory hrs. 240

I. Biotechnology/Immunology

1. To determine the ABO blood groups by slide agglutination.
2. To conduct/demonstrate ELIZA Test
3. Demonstration of Immunological tests WIDAL, VDRL, Pregnancy.
4. To conduct Radio Immuno-diffusion.

II. Invertebrate Taxonomy

1. Identification of Invertebrates using taxonomic keys.
2. Field Trip: Study of animals in their natural habitats.

Note: Use of animal for dissection and practical work is subject to the conditions that they are not banned under the wildlife protections act.

Suggested Readings:

1. Immunology: Overview and Laboratory Manual: Sam-Yellowe; Springer Nature
2. A handbook of Practical and Clinical Immunology Vol 1 2ed: Talwar; CBS
3. Immunology Theory and Practical: A.K. Roy; Kalyani Publications
4. Practical Handbook on Medical Microbiology and Immunology: Banerjee et al; IJMS
5. Taxonomic Keys: Samuel Eddy; Burgess Publishing.
6. The Complete Zoo Adventure: A Field Trip in a Book: Gary Parker
7. Field Trips: Arnosky; HarperCollins Publisher

University of Kota

M.Sc. (Semester-II) ZOOLOGY

Practical-I/Day-I

Scheme of Practical Examination & Distribution of Mark

Duration: 6 hrs.		**Max. Marks: 100**
(1)	Exercise based on Biotechnology	10 Marks
(2)	Exercise based on Immunology	10 Marks
(3)	Exercise in Invertebrate Taxonomy (5x5) (Using Taxonomic Key)	25 Marks
(4)	Seminar based on any topic from Theory	10 Marks
(5)	Report on Field Visit	25 Marks
(6)	Vivo-Voce	10 Marks
(7)	Record	10 Marks
	Total	**100 Marks**

M.Sc. (Semester-II) ZOOLOGY

Syllabus of Practical-II/Lab. Course-II (based on Paper Z-2.3 & Z-2.4)

ZOO-12216: Z -2.6: Practical/Lab Course-II: Total No. of laboratory hrs. 240

I. Genetics:

1. Culture and identification of male and female *Drosophila* through prepared culture.
2. Identification of wild and mutant forms of *Drosophila.*
3. Problems based on Mendel's and gene interaction.
4. Identification of blood groups in man.
5. Demonstration of sex chromatin (Barr Bodies).

II. Animal physiology

1. Determination of osmotic potential by tissue weight method.
2. Study of ECG, Heart beat and Blood pressure.
3. Determination of hemoglobin in blood sample by haemoglobinometer/ Photometric (preferably).
4. Demonstration of the following in blood; Clotting time (CT), Bleeding time (BT), erythrocyte sedimentation rate (ESR), haemolysis and crenation, differential count of leucocytes.
5. Determination of blood urea and blood sugar value.
6. Determination of peroxide activity.
7. To carryout differential leukocyte count in human blood sample.
8. Blood film preparation and identification of cells.

9. To conduct serum preparation.
10. Separation of amino acids by Paper chromatography / Thin Layer Chromatography and calculating Rf value.
11. Visit to Pathology Lab/Medical Institute

Note: Use of animal for dissection and practical work is subject to the conditions that they are not banned under the wildlife protections act.

Suggested Readings:

1. A Laboratory Manual of Molecular Biology: Kumar, Gakhar & Miglani; Dreamtech Press
2. Techniques for Molecular Biology: D. Tagu; CRC Press
3. Williams Manual of Hematology: Lichtman et al; McGraw Hill
4. Manual of Hematology: Dr Neema Tiwari;
5. Hematology: Bernadette F. Rodak; Saunders Publication Inc.
6. Manual of Clinical Hematology: Bluerose Publishers Pvt. Ltd.

University of Kota

M.Sc. (Semester-II) ZOOLOGY

Practical-II/Day-II

Scheme of Practical Examination & Distribution of Marks

Duration: 6 hrs.		**Max. Marks: 100**
(1)	Exercise on Culture and identification of Drosophila variants	10 Marks
(2)	Exercise in Genetics	10 Marks
(3)	Exercise on Blood related	15 Marks
(4)	Exercise in Physiology	10 Marks
(5)	Seminar	10 Marks
(6)	Field work/Assessment	25 Marks
(7)	Viva-voce	10 Marks
(8)	Class record	10 Marks
	Total	**100 Marks**

Syllabus and Course Scheme
Academic year 2023-24

UNIVERSITY OF KOTA, KOTA

MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005

Master of Science

ZOOLOGY

Faculty of Science

SCHEME OF EXAMINATIONS AND SYLLABUS
M. Sc. Third and Fourth Semester Examinations

1. The M.Sc. Course in Zoology is a two-year full-time curriculum offered in the form of Choice-based Credit System organized in **Four Semesters**. The number of papers and maximum marks for each theory paper/practical has been shown in the syllabus. It will be necessary for a candidate to pass in the theory part as well as in the practical part (wherever prescribed) separately.
2. The course of study for M.Sc. (Zoology) examination shall be spread over a period of two years with examination at the end of each semester. There shall be F**our Semesters** in all.
3. Every semester will have four Theory papers and one practical. Syllabus of every theory paper of each semester will be divided into 5 units.
4. Scheme of examination:

Each Semester	Maximum Marks	Minimum Marks	Internal Assessment
Paper I	70	28	30
Paper II	70	28	30
Paper III	70	28	30
Paper IV	70	28	30
Practical	200	100	---

II Year: Semester III

Paper-Z-3.1 CHORDATA

Paper-Z-3.2 ANIMAL ECOLOGY

Paper-Z-3.3 SPECIAL PAPER

Paper-Z-3.4 SPECIAL PAPER

Paper-Z-3.5-I **(**Lab Course I)

succession; modifications in succession; concept of climax, monoclimax versus polyclimax theory; barriers and ecesis in succession; biome.

2. Fluctuations within community: Irruptive cycle, fluctuation, causes of fluctuation, cycles.
3. Environment and animals in ecosystem: (a) Nature and constituents of ecosystem. (b) Fundamental operation of ecosystem. (c) Flow of matter and energy in ecosystem. (d) Homeostasis in the ecosystem. (e) Cycling of chemical elements in ecosystem (biogeochemical cycles).

UNIT – V

1. Concept of productivity: Productivity of land and water, measurement of productivity.
2. Organization and dynamics of ecological communities: The habitat approach: A detailed knowledge of extent, zonation, environment, biota, adaptations and communities of fresh water, marine, terrestrial and estuarine ecosystems.
3. The ecological outlook: Space ecology, nuclear radiations, human population explosion, resources; applied human ecology.

Suggested Books for Reference:

1. Modern text book of Zoology- Vertebrate by R. L. Kotpal.
2. Vertebrate Zoology by Ezra Samberg.
3. Vertebrate Zoology by E. L. Jordan.
4. Ecology by P. D. Sharma.
5. Environment and Ecology by R. Rajagopalan.
6. Ecology and Environment by P. D. Sharma.
7. Fundamentals of Ecology and Environment by Pranav Kumar and Usha Mina.
8. Ecology by Odum.

M.Sc. ZOOLOGY PRACTICAL Semester III

Paper-Z-3.5-I (Lab Course I): Practical Work Based on Paper Z-3.1 & Z-3.2 (Total No. of laboratory hrs. 240)

1. **Chordates: (a). Taxonomy**: Study of museum specimens or representative animals from all chordate groups (Protochordata to Mammalia). (b) **Anatomy:** (i) General anatomy and neural gland of Herdmania using charts and computer software. (ii) Afferent and efferent

arteries, cranial nerves, membranous labyrinth, eye muscles and their innervation, brain of any fish. (iii) Study of fish anatomy through serial section of fry and fingerling stages. (iv) Limb musculature, cranial nerves and eye muscles and their innervation in frog dissection using computer software. (v) General anatomy, major blood vessels and cranial nerves of any nonpoisonous snake through charts / models / computer software. Study of differences between poisonous and non-poisonous snakes. (vi) Flight muscles, perching mechanism, air sacs and anatomy of the neck region in pigeon through charts / models / computer software. (vii) Reproductive system and anatomy of the neck region in rat. (c) **Osteology**: Comparative study of the axial and appendicular skeleton from fish to mammals, with particular reference to important skull types in amphibians, reptiles, birds and mammals. (d) **Permanent preparations**: Whole mounts of pelagic tunicates, cycloid scales, pecten and columella in pigeon, ear ossicles of rat or squirrel or any other mammal. (e) **Histology:** A detailed study of the histology of all mammalian tissues and organs through prepared slides.

2. **Ecology:** (a) Measurement of climatic factors (atmosphere, water, temperature and relative humidity). (b) Measurement of water and soil pH, edaphic factors of soil; preparation of soil extract, determination of humidity in microhabitat; pH, alkalinity of water, dissolved oxygen, free carbon-dioxide, chloride, salinity, temporary and permanent hardness of water, turbidity, velocity of current. (c) Measurement of population density. Numerical problems of population determination to be done. (d) A field study of any one of the following habitats to be assigned to an individual or to a group of students: (i) Pond habitat. (ii) Marine habitat. (iii) Terrestrial habitat.

M.Sc. ZOOLOGY PRACTICAL Semester III

Scheme of Practical Examination and Distribution of Mark

Max. Marks: 100 **Duration - 6 hrs.**

1.	Study of Chordates (Major)*	10 marks
2.	Study of Chordates (Minor)*	05 Marks
3.	Permanent preparation	05 Marks
4.	Exercise on Ecology	08 Marks
5.	Numerical problems	07 Marks
6.	Spotting (Museum specimens, slides and bones) 10 spots x 2 marks	20 Marks

3. Fish and Fisheries of India by V. G. Jhingran.
4. Day Volume I & II

Paper-Z-3.5-II (Lab Course II): Zoology (Fish Biology) Practical Work Based on Paper Z-3.3 (D) & Z-3.4 (D) (Total No. of laboratory hrs. 240)

1. Complete anatomy of a teleost, represented by Wallago attu or any other locally available teleost: External features, general viscera (including urino-genital organs), jaw and lateral musculature, brain and cranial nerves, eye muscles and their innervations, membranous labyrinth, Weberian ossicle swim bladder connection.
2. Anatomy through model/photograph/chart/CD. Of the head of any cat fish.
3. Breathing organs of Anabas. Clarias, Channa and Heteropneustis showing the blood supply wherever possible.
4. Preparation of Taxonomic key for the study of local fishes upto species level.
5. Permanent preparation and study of pharyngeal denticles, cycloid and other scales.
6. Micro-technical procedures: Preparation and study of serial sections of a larval fish and representative tissues and organs of fish.
7. Field trip to study local fish fauna/common fish diseases/visit to local fish market.

M.Sc. ZOOLOGY PRACTICAL (FISH BIOLOGY) Semester III

Scheme of Practical Examination and Distribution of Mark

Max. Marks: 100		**Duration - 6 hrs.**
1.	Learning of fish anatomy	10 Marks
2.	Permanent preparation	10 Marks
3.	Study of accessory respiratory organs	10 Marks
4.	Species identification using taxonomic key	10 Marks
5.	Microtomy	10 Marks
6.	Seminar	15 Marks
7.	Viva-voce	10 Marks
8.	Class Record	10 Marks
9.	Field/Project Report	15 Marks
	Total	**100 Marks**

(* Use of animal for dissection and practical work is subject to the condition that they are not banned under the Wildlife Protection Act)

3. Maternal contributions in early embryonic development.

UNIT – IV

1. Genetic regulations of early embryo development.
2. Embryonic adaptations: (a) Evolution of cleidoic egg and its structural and physiological adaptations. (b) Development and physiology of extra-embryonic membranes in amniotes. (c) Evolution of viviparity. (d) Development, types and physiology of mammalian placenta.
3. Metamorphosis in amphibia: (a) Structural and physiological changes during metamorphosis. (b) Endocrine control of metamorphosis.

UNIT – V

1. Types of regeneration, physiological, reparative and compensatory hypertrophy, regenerative ability in chordates. (b) Morphological and histological processes in amphibian limb regeneration. (c) Origin of cells of regeneration, de-differentiation, re-differentiation, (d) pattern formation during amphibian limb generation; Reasons for failure of limb generation ability in other chordates and mammals; methods for induction of regenerations.
2. Abnormalities of Embryonic development: teratogenesis.
3. Gerontology, Senescence and ageing.

Suggested books for reference:

1. Embryology by Bejamin
2. Developmental Biology by O. P. Jangir
3. Developmental Biology by M.A. SUBRAMANIAN.
4. Developmental Biology by Scott F. Gilbert.

M.Sc. ZOOLOGY PRACTICAL Semester IV

Paper-Z-4.5-I (Lab Course I): Practical Work Based on Paper Z-4.1 & Z-4.2 (Total No. of laboratory hrs. 240)

1. **Ethology:** (a) Study of the process of learning in rat with the help of animal maize; analysis of the results with simple experiments. (b) Study of the shock and avoidance behaviour in earthworm/rat. (c) Imprinting in precocial birds. (d) Chemical communication in the earthworms. (e) Study of the food preferences and feeding behaviour of an insect pest. (f) Study of the phototactic response in Tribolium/housefly. (g) Study of habituation in chicks.

2. **Developmental biology:** (a) Study of development of frog or toad (egg, spawn, embryo, larvae and metamorphic stages). (b) Study of development of chick through: (i) Permanent whole mount of successive embryonic stages. (c) Study of chick embryos of 18, 21, 24, 33, 48, 72 and 96 hours. Identification and mounting of Blastoderm. (d) Study of the mammalian foetus and placenta.
3. **Case Study/ Field observation:** Ant behaviour, Web construction and habituation in Spider. Geo-tactic response of Earthworm or any pest. Food preference and cleaning behaviour of house-fly. Listing of all animals in and around your surroundings. Visit to a Biological Park/Sanctuary/ National Park/Tiger Reserve.

M.Sc. ZOOLOGY PRACTICAL Semester IV

Scheme of Practical Examination and Distribution of Mark

Max. Marks: 100	**Duration - 6 hrs.**
1. Exercise on Ethology *	10 marks
2. Permanent preparation*	10 marks
3. Exercise on Development Biology	10 marks
4. Spotting (Permanent slides, Models, Photo etc.) 10 spots x 2 marks	20 marks
5. Seminar	15 marks
6. Viva-voce	10 marks
7. Class Record	10 marks
8. Case study/Field trip	15 marks
Total	**100 marks**

(* Use of animal for dissection and practical work is subject to the condition that they are not banned under the Wildlife Protection Act)

Paper-Z-4.3 (A) SPECIAL PAPER: CELL BIOLOGY-I

Unit I

Specialized function of cytoplasmic components in a cell with special references to the molecular mechanism (Contractibility, secretion, phagocytosis and pinocytosis) Vesicular Transport & membrane fusion.

Paper-Z-4.4 (D) SPECIAL PAPER: FISH BIOLOGY-II

UNIT-I

Estimation of population number and mortality rates in fresh waters. Age and growth studies: Factors influencing growth of fish, Regulation of Growth, Growth Periodicity, Methods for determining Age and Growth, Practical utility of determining Age and Growth. Length Weight relationship and indices of condition and growth.

UNIT-II

Limnology: Definition, types of lakes/ponds, their significance, Plankton: Definition, types, diurnal variations, planktons and their significance in fisheries. Fisheries management and threat: Conservation of genetic and ecological diversity. In-situ & Ex-situ conservation; cryopreservation, application of gametes. Threats and conservation of fishes.

UNIT-III

Water pollution and fisheries: causes of water pollution, Domestic sewage, Industrial wastes and effluents, Soil erosion and Sedimentation, Fertilizers, Pesticides and Insecticides, Radioactive Waste, Thermal Waste, Oil Pollution, Acidification, Mining Wastes, effect of Pollutants on fishes. Aquatic weeds: types, habitat and their control. Aquaria setting up and maintenance.

UNIT-IV

Diseases of fishes: Causes, etiology, Symptoms, treatment and their control. Specialized organs: Bioluminescent organs, electric organs, sound producing organs, poisonous and venomous organs.

UNIT-V

Adaptations to special conditions of life: Hill stream fishes, deep sea fishes, cave dwelling fishes. Application of genetics and biotechnology in fishes, transgenic fishes and fish genomics. Aspects of fish genetics: Gene and Chromosomes Mutation: Sex chromosomes, Sex determination, Polyploidy, hybridization and mutation.

Paper-Z-3.5-II (Lab Course II): Zoology (Fish Biology) Practical Work Based on Paper Z-4.3 (D) & Z-4.4 (D) (Total No. of laboratory hrs. 240)

1. Hydro-biological exercise: (a) Analysis of water Determination of pH, free Carbon-di-oxide, dissolved Oxygen, chlorides, Calcium, total alkalinity, total salinity, BOD, COD. (b) Collection: Qualitative and quantitative analysis of planktons.

2. Biochemical/Physiological/Embryological exercise: (a) Estimation of glycogen in liver. (b) Determination of free amino acids of muscles or blood plasma through chromatography. (c) Induced spawning. (d) Study of development of teleost fish through preserved material (whole embryo or sections) or models/charts: eggs, cleavage, blastula, gastrula, external gill, mature larva, fry and fingerlings.
3. (a) Periodical visit to a local fishing farm to gain a firsthand knowledge of its pisciculture practices and fisheries activities. (b) A week's tour of an inland fisheries research station. (c) One-week tour of an important marine biological or fishery center in the country. Lab based experiments.
4. Preparation and maintenance of fresh water aquarium housed with local and exotic fishes, in your department.
5. Study of available museum specimen in Lab.

Note: A dissertation under item 03 has to be submitted compulsorily by each candidate

M.Sc. ZOOLOGY PRACTICAL (FISH BIOLOGY) Semester IV

Scheme of Practical Examination and Distribution of Mark

Max. Marks: 100 **Duration - 6 hrs.**

1.	Hydrobiological exercise	05 Marks
2.	Study and identification of Zooplanktons	05 Marks
3.	Exercise on Biochemistry/Physiology/Embryology	05 Marks
4.	Identification and comments on spots 10x2	20 Marks
5.	Seminar	15 Marks
6.	Viva-voce	10 Marks
7.	Class Record	10 Marks
9.	Dissertation	30 Marks

(*Project report/dissertation will be based on field work on any topic related to the syllabus*)

Paper-Z-4.3 (E) SPECIAL PAPER: FORESTRY AND WILDLIFE MANAGEMENT-I

Unit I

Wildlife Conservation & Captive Breeding

Conservation Ethics and Values of Wildlife in India: Importance of Wildlife; Values of Wildlife- Positive and Negative Values. Captive breeding and Propagation: Founder population, rehabilitation, education, utilization, gene banks, Ex-situ and in-situ linkages. Conservation