

Department of Agricultural Chemistry
Curricula for M.S. in Agricultural Chemistry

October – March (Winter) Semester	
A. Compulsory Courses (9 credits)	Credits
ACHEM 501 Fertilizer Technology and Usage	2
ACHEM 502 Analyses of Fertilizer, Plant, Soil and Water	2
ACHEM 503 Formulation and Chemistry of Pesticides	3
ACHEM 505 Mineral Nutrition and Plant Growth	2
A. Elective Courses (4 credits)	
ACHEM 513 Waste Management and Green Chemistry	2
ACHEM 515 Water Science	2
ACHEM 517 Phyto-ecological Chemistry	2
ACHEM 519 Applied Bioorganic Chemistry	2
C. ACHEM 506 Research work	3 (S/U)
Total	16

April – September (Summer) Semester	
A. Compulsory Courses (9 credits)	Credits
ACHEM 504 Research Methodology and Data Processing	2
ACHEM 507 Instrumental Analysis and Nuclear Chemistry	3
ACHEM 509 Chemistry and Technology of Agroindustrial Crops	2
ACHEM 511 Environmental Chemistry	2
B. Elective Courses (4 credits)	
ACHEM 521 Chemistry of Manures and Fertilizers	2
ACHEM 523 Chemistry of Plant Products	2
ACHEM 525 Applied Plant Science and Rhizosphere Technology	2
ACHEM 527 Aquatic Geochemistry	2
C. ACHEM 506 Research work	3 (S/U)
Total	16

Thesis Semester	
	Credits
ACHEM 506 Research work	2 (S/U)
ACHEM 508 Thesis evaluation	5
ACHEM 510 Thesis defense	3
Total	10
GRAND TOTAL	42

Course No. ACHEM 501 (Fertilizer Technology and Usage)
2 Credit hours (Total marks 100)

Fertilizers: Concepts of fertilizer development; properties, raw materials and reserves.

N, P and K fertilizers: Chemistry, production technology, uses, comparative studies and factors influencing choice of nitrogenous and phosphatic fertilizers- urea, DAP, SSP and TSP; field study for manufacturing technology of commonly used nitrogenous and phosphatic fertilizers in Bangladesh; mineralogy of potash ores, mining and refining of muriate of potash (MOP).

Secondary and micronutrient fertilizers: Chemistry and production technology of gypsum, magnesium sulphate, zinc sulphate, borax and ammonium molybdate fertilizers.

Mixed, liquid and controlled released fertilizers: Preparation, properties, uses, advantages and disadvantages.

Pollution related to fertilizer production and use.

Economic feasibility of fertilizer manufacture and their use efficiency.

Compatibility among fertilizers and with other agrochemicals.

RECOMMENDED BOOKS AND PERIODICALS

Gustafson A. F. 2010. Handbook of Fertilizers. Agrobios, India.

Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers, 6th edn. Prentice-Hall, Inc., Upper Saddle River, New Jersey, USA.

Jain, B.K. and Sivashankaran, V.S. (eds.) 1980. Handbook on Fertilizer Technology. Fertilizer Association of India, New Delhi-110067, India.

Jones, U.S. 1979. Fertilizers and Soil Fertility. Reston Publishing Com., Reston, Virginia, USA.

Kannaiyan S. 2002. Azolla Biofertilizer for Sustainable Rice Production. Daya Pub. India.

Kannaiyan S. 2010. Biofertilizers Technology. Scientific Pub.

Millar, Charles E. 2012. Soil Fertility. Daya Pub. India.

UNIDO and IFDC (eds.) 1998. Fertilizer Manual. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Van Slyke. 2010. Fertilizers and Crop Production. Agrobios, India.

Van Vuren, J.P.J. 2002. Soil Fertility and Sewage. Agrobios, India.

Course No. ACHEM 502 (Analyses of Fertilizer, Plant, Soil and Water)

2 Credit hours (Total marks 100)

Sampling: Principles, time and frequency of sampling; procedures for obtaining soil, water, plant and fertilizer samples.

Analytical techniques: Titrimetry, colorimetry and spectrophotometry, flame emission and atomic absorption spectrophotometry; chromatography.

Soil analysis: Available, exchangeable and total nutrient contents and toxic elements; fractionation of soil macro and micronutrients.

Water analysis: Surface and ground water samples for ionic constituents including heavy metals like As, Cr, Cd, Pb, Co and Hg.

Plant analysis: Plant tissue for different nutrients, carbohydrates, proteins, fats, vitamins and pigments.

Fertilizer analysis: Moisture and nutrient contents in urea, SSP, TSP, DAP, MOP, gypsum, zinc sulphate, borax and mixed fertilizers samples.

Manure analysis: FYM, green manure, cow dung, poultry manure and biogas slurry samples.

Organic waste analysis: Municipal wastes, kitchen wastes, agroindustrial wastes and sewage-sludge samples.

Quality control (QC) and quality assurance (QA) of chemical analysis.

Pesticide residue analysis: Soil, water and plant samples.

RECOMMENDED BOOKS AND PERIODICALS

Allen, S.E.; Grimshaw, H.M.; Parkinson, J.A. and Quarmby, C. 1989. Chemical Analysis of Ecological materials. Blackwell Scientific Publication, Oxford, UK.

APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21st edn. AWWA and WEF, Washington, USA.

Bandyopadhyay, P.C. 2007. Soil Analysis. Daya Pub. India.

Joes Jr. J.B. 2001. Laboratory guide for conducting soil tests and plant analysis. CRC Press, USA.

Kaira Y. P. (ed.). 1998. Handbook of Methods for Plant Analysis. CRC Press, USA

PCARR (Philippine Council for Agriculture and Resources Research). 1980. Standard Methods of Analysis for Soil, Tissue, Water and Fertilizer. Farm Resources and System Research Division, Los Banos, Philippines.

Petersen, L. 2002. Analytical Methods: Soil, Water, Plant Material, Fertilizer, Soil Resources management and Analytical Services, SRDI, Dhaka.

Singh, D.; Chhonkar, P.K. and Pandey, R.N. 1999. Soil Plant Water Analysis: A method. Manual IARI, New Delhi, India.

Sparks, D.L. (ed.) 1996. Methods of Soil Analysis. Part 3 Chemical Methods-SSSA Book Series No. 5, Soil Science Society of America and American Society of Agronomy, Inc., Madison, USA.

Tandon, H.L.S. (ed.) 1995. Methods of Analysis of Soils, Plants, Waters and Fertilizers. Fertilizers Development and Consultation Organization, New Delhi, India.

Westerman, R.L. (ed.). 1990. Soil Testing and Plant Analysis, 3rd edn. Soil Science Society of America, Inc. Madison, Wisconsin, USA.

Course No. ACHEM 503 (Formulation and Chemistry of Pesticides)

3 Credit hours. (Total marks 100)

Introduction, classification and properties of carriers and their use in formulating dust, wettable powder, granular products and emulsifiers.

Formulation of pesticidal dust, wettable powder, granules, emulsifiable concentrates, fumigants, aerosol, capsules and microcapsules. Preparation methods, composition, advantages and disadvantages of new-generation formulations: Oil-in-water emulsions, Suspoemulsions, Microemulsions, Controlled-release Formulations, Water-dispersible granules, Formulations using a built-in wetter.

Surfactants for pesticides: General characteristics, Wetting Agents, Dispersion, Emulsification, Solubilization, Bioenhancement, Conventional Surfactants, Recent surfactant developments.

Concepts of pesticide metabolism: Defense system, nervous system; enzymes responsible for metabolism of pesticides and their role; acetylcholinesterase- its action and inhibition.

Classification, preparation, properties, field performance, storage, and uses of:

Organochlorinated insecticide: Aldrin, Dieldrin, Endosulfan and Heptachlor.

Organophosphorus insecticide: Chlorpyrifos, Diazinon, Dichlorvos, Dimethoate, Fenthion, Fenitrothion, Fenvalerate, Imidacloprid, Malathion, Phenthoate and Trichlorfon.

Organocarbamate insecticides: Carbaryl, Carbofuran and Carbosulfan. Synthetic pyrethroids insecticides: Cypermethrin, Deltramethrin, Permethrin.

Fungicides: Carbendazim, Copper oxychloride, Difenconazole, Edifenphos, Iprodione, Mancozeb, Propiconazole and Propineb. Herbicides: Anilofos, Butachlor, 2,4-D, Glyphosate, MCPA, Oxadiazon, Paraquate and Pretilachlor. Acaricide: Dicofol, Ethion, Tetradifon.

Mechanism of penetration and translocation of pesticides in insect and plants.

Mode of action of different pesticide groups.

Pesticide application methods: Chemical and integrated control.

Compatibility of pesticides with other agrochemicals.

Biochemical conjugation of pesticides in plants and microorganisms.

Environmental fate of pesticides in agroecosystem.

Risk Assessment of pesticides.

Disposal and degradation of pesticide wastes.

Quality control of pesticides. Pesticide ordinance and rule of Bangladesh.

Field survey and study of different types of pesticide formulation plants.

RECOMMENDED BOOKS AND PERIODICALS

Chattopadhyay, S.B. 1985. Principles and Procedures of Plant Protection, 2nd edn. Oxford & IBH Publishing Co., Pvt. Ltd. New Delhi, India.

Dubey, N.K. 2011. Natural Products in Plant Pest Management. CABI, UK

Green, M.B.; Hartley, G.S. and West, T.F. 1987. Chemicals for Crop Improvement and Pest Management. 3rd edn. Pergamon Press. New York.

Hall, J.C.; Hoagland, R.E. and Zablutowicz, R.M. (eds.) 2001. Pesticide Biotransformation in Plants and Microorganisms. American Chemical Society, Washington DC, USA

Handa, S.K. 2012. Principles of Pesticide Chemistry. Agrobios, India.

- Hassall, K.A. 1990. The Biochemistry and Uses of Pesticides. Structure, Metabolism, Mode of action and Uses in Crop production. 2nd edn., ELBS/Macmillan Press Ltd. Hampshire, UK
- Knowles D. A. 1998. Chemistry and Technology of Agrochemical Formulations. Kluwer Academic Publishers.
- Mathews, G. A. 1985. Pesticide Application Methods. Longman. England.
- Ministry of Law and Justice, Govt. of the Peoples Republic of Bangladesh. 1984. The Pesticide Ordinance, Govt. Press. Dhaka.
- Ramulu, U.S.S. 1985. Chemistry of Insecticides and Fungicides, 2nd edn. Oxford and IBH Pub. Co., New Delhi. India.
- Roberts, T. (ed.) 2000. Metabolism of agrochemicals in Plants. John Wiley and Sons. Ltd., Chichester, England.
- Srivastva, S.B. 1985. Agrobased Industries and Pesticides Formulations. S.I.R. Institute, New Delhi. India.
- Tarradellas, J.; Bitton, G and Rossel, D. (eds.) 1997. Soil Ecotoxicology. Lewis Publishers, Boca Raton, Florida, USA
- Tomlin, C.D.S. (ed.). 2003. The pesticide Manual 13th edn. British Crop Protection Council, Hampshire, UK.
- Tomlin, C.D.S. 2011. The Pesticide Manual: A World Compendium, 15th edn. CABI, UK.
- Valkenburg, W.V.(ed.) 1972. Pesticide Formulations. Marcel Dekker Inc. New York.
- Wheeler, W.B. (ed.). 2002. Pesticides in Agriculture and the Environment. Marcel Dekker Inc., New York, USA.
- Young, L.Y. and Cerniglia, C.E. (eds.) 1995. Microbial Transformation and Degradation of Toxic Organic Chemicals. Wiley-Liss, Inc., New York, USA.
- Yu, S. J. 2008. The toxicology and biochemistry of Insecticides. CRC Press.

Course No. ACHEM 504 (Research Methodology and Data Processing)

2 Credit hours (Total marks 100)

Research methodology:

Concept, characteristics of research, types of research, the purpose of research, criteria for good research, general research process, units of analysis in research.

Research Topics and Questions: Identification and prioritization of research problems. Steps in planning a research project, research topic, from topic area to research question, steps in formulation of a research problem, consideration in selecting a research problem, practical way of defining a research question, formulate objectives, steps in research project design, key decisions about your research.

Literature Review: Concept, importance, source and review process. Develop a theoretical framework, Writing-up the literature reviewed and references.

Methods of Data Collection: Qualitative research methods, quantitative research methods.

Research Proposal: Structure, Title, Research/problem statement, Aim/main research question, Objectives/subsidiary questions, Methodology, Anticipated findings, Working programme, Resources, Project management.

Data processing:

Experimental design and analysis of variance: Simple and factorial experiment- Field plot technique; basic principles of experimental designs; completely randomized design; randomized block design; latin square design and split-plot design; Mean separation test- Duncan's multiple range test; least significant difference.

Correlation and regression analysis: Exercise and implication.

Collection and analysis of data, transformation, presentation and interpretation of the experimental results using commonly used data processing softwares (R, SPSS, MiniTab, Statistica, Prism Graphpad, etc.).

Principles and procedures of scientific report writing.

Preparation and evaluation of a research proposal.

RECOMMENDED BOOKS AND PERIODICALS

Anonymous. 2004. A Handbook of Scientific Report Writing. Graduate Training Institute, BAU, Mymensingh.

Cargill, M. and O'Connor, P. 2009. Writing Scientific Research Articles: Strategy and Steps. Blackwell Publishing, West Sussex, UK.

Field, A. 2009. Discovering Statistics Using SPSS. 3rd edition. SAGE Publishing, London.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. 2nd edn. John Wiley & Sons, New York.

Kothari, C.R. 2004. Research Methodology: Methods and Techniques, 2nd edn. New Age International Publishers, New Delhi.

Little, T. M. and Hills, F. J. 1978. Agricultural Experimentation: Design and Analysis. John Wiley and Sons, New York.

Miller, J. N. and Miller, J. C. 2010. Statistics and Chemometrics for Analytical Chemistry. 6th edn. Pearson Education Ltd., United Kingdom.

Siddique, M. A. 1985. Practical Aspects of Thesis Writing. Mrs. Hena Siddique, BAU, Mymensingh.

Zaman, S. M. H.; Rahim, K. and Howlader, M. 1982. Simple Lesson from Biometry, Bangladesh Rice Research Institute, Joydebpur, Dhaka.

Course No. ACHEM 505 (Mineral Nutrition and Plant Growth)

2 Credit hours (Total marks 100)

Introduction, definition and classification of nutrients. Functions of Macronutrients, micronutrients and beneficial elements.

Ion uptake mechanisms of individual cells and roots (short-distance transport). Uptake and release of elements by leaves and other aerial plant parts; foliar application of nutrients.

Mineral nutrition, yield and source–sink relationships.

Nutrition and quality: properties determining plant quality; biofortification.

Relationship between nutrition, plant diseases and pests. Diagnosis of deficiency and toxicity of nutrients. Rhizosphere chemistry in relation to plant nutrition. Adaptation of plants to adverse chemical soil conditions. Nutrient and carbon fluxes in terrestrial agro-ecosystems.

Nutrient metabolism in plants: Activation, transport and reduction of nutrient ions-nitrogen, sulphur and zinc; biosynthesis of amino acids and their metabolism.

Relationships of nutrients: Antagonistic and synergistic interactions of nutrient ions in soil-plant system.

Nutrient-water interaction: Physiological effect of nutrients related to water requirement; fertilization and water extraction by plant roots.

Soil colloids: Nature and types of colloids; properties and mineralogical organization of silicate clay and humic colloids; development of charges of soil colloids. Ion exchange processes, Sorption phenomena.

RECOMMENDED BOOKS AND PERIODICALS

Bennett, W. F. (ed.) 1994. Nutrient Deficiencies & Toxicities in Crop Plants. APS Press, Minnesota, USA.

Brady, N. C. and Weil, R. R. 2007. The Nature and Properties of Soils. 14th edn. Pearson Publishing Ltd. USA.

Fageria, N. K.; Baligar, V. C. and Jones, C. A. 2012. Growth and Mineral Nutrition of Field Crops, 3rd edn., Marcel Dekker Inc., New York.

Havlin, Z. L.; Beaton, J. D.; Tisdale, S. L. and Nelson, W. L. 1999. Soil Fertility and Fertilizers. 6th edn. Prentice-Hall Inc., Upper Saddle River, New Jersey, USA.

Khan, M. S.; Zaidi, A. and Musarrat, J. (eds.) 2009. Microbial Strategies for Crop Improvement. Springer-Verlag, Berlin, Germany.

Marschner, H. 1996. Mineral Nutrition of Higher Plants. 2nd edn. Academic Press Ltd., London, UK.

Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. 3rd edn. Academic Press Ltd., London, UK.

Mengel, K. and Kirkby, E. A. 1987. Principles of Plant Nutrition. Inter. Potash Institute Pub., Switzerland.

Mortvedt, J. J.; Cox, F. R.; Shuman, L. M. and Welch, R. M. (eds.). 1991. Micronutrient in Agriculture. 2nd edn. Soil Science Society of America Inc., Madison, Wisconsin, USA.

Tabatabai, M. A. 1986. Sulphur in Agriculture. American Society of Agronomy, Inc. Crop Science Society of America Inc., Soil Science Society of America Inc., Madison, Wisconsin, USA.

Waisel, Y., Eshel, A. and Kafkafi, U. 2005. Plant Roots: The Hidden Half. 3rd edn. Marcel Dekker Inc., New York.

Course No. ACHEM 507 (Instrumental Analysis and Nuclear Chemistry)

3 Credit hours (Total marks 100)

Colorimetry and Spectrophotometry: Principle and theory of spectrophotometry; methods of colour measurement; instrumentation and application of colorimetry and of spectrophotometry.

Atomic spectrometry: Principle and theory of atomic emission and atomic absorption spectrophotometry; instrumentation and application of flame emission spectrophotometer (FES) and atomic absorption spectrophotometer (AAS); interferences in spectrophotometric analysis; principles, instrumentation application of atomic fluorescence spectrometry (AFS) and inductively coupled plasma spectrometry (ICP).

Mass spectrometry: Principles, instrumentation and application of mass spectrometry (MS); hyphenated systems. Nuclear magnetic resonance spectrometry: Theory, instrumentation and application of nuclear magnetic resonance spectrometry.

Chromatography: Column and planar chromatography; phases, basic technique and application of thin layer chromatography (TLC), ion chromatography (IC), gas liquid chromatography (GLC), high performance liquid chromatography (HPLC) and supercritical fluid chromatography (SFC).

pH and conductivity measurement: Principle, calibration and maintenance of pH and conductivity meters.

Laboratory instrumentation: Calibration, maintenance and trouble shooting of laboratory instruments.

Nuclear chemistry: Nuclear reactions and stability; properties and absorption of radionuclide radiations. Interaction of radiation with matter. Radioactive decay kinetics; average and half-life; specific activity and radiocarbon dating.

Radiation detection: Ionization based detectors; Geiger Muller counter and Scintillation counter; nuclear track detectors.

Radiation safety and biological effect of radiation.

Radiation techniques: Autoradiography - basic techniques and application; Radiotracer technique- basic principles, selection of radioisotopes for tracer studies, application; isotopic dilution analysis and plant injection techniques; difficulties in radiotracer methodology; application of radioisotopes in soil, crop, plant protection, food irradiation; induced mutation in plant breeding and irradiation studies.

Application of radiation in agriculture and life sciences.

RECOMMENDED BOOKS AND PERIODICALS

Adrovic, F. (ed). 2012. Gamma Radiation. InTech Publishing, Croatia.

Ahuja, S. 2003. Chromatography and Separation Science. Vol.4, Academic Press, California, USA.

Chopra, L.S. and Kanwar, J.S. 1980. Analytical Agricultural Chemistry. Kalyani Publishers, Ludhiana, New Delhi. India.

Comar, C.L. 1985. Radioisotopes in Biology and Agriculture-Principles and Practices. McGraw-Hill Book Company, Inc. New York.

Fritz, J.S. and Schenk, G.H. 1987. Quantitative Analytical Chemistry. 5th edn. Prentice Hall, Englewood Cliffs, New Jersey 07632, USA.

IAEA. 1976. Tracer Manual on Crops and Soils. International Atomic Energy Agency. Vienna, Austria.

Lieser, K.H. 2001. Nuclear and Radiochemistry: Fundamentals and Applications, 2nd edn. WILEY-VCH Verlag GmbH, Weinheim, Germany.

- Loveland, W.D.; Morrissey, D.J. and Seaborg, G.T. 2006. Modern Nuclear Chemistry. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
- Mendham, J.; Denney, R.C.; Barnes, J.D. and Thomas, M. 2000. Vogel's Textbook of Quantitative Chemical Analysis. 6th edn. Pearson Education Pte. Ltd. New Delhi, India.
- Mozumder, A. 1999. Fundamentals of Radiation Chemistry. Academic Press, United Kingdom.
- Patania, V.B. 2004. Spectroscopy. Campus Books International, New Delhi, India.
- Rai, M.M. 1981. Principles of Soil Science. 2nd edn. Macmillan India Ltd., New Delhi, India.
- Ramulu, U.S.S. 1982. Isotopes in Agriculture. Oxford & IBH Publishing Co. New Delhi.
- Robinson, J. W., Frame, W.M.K.S. and Frame II, G.M. 2005. Undergraduate Instrumental Analysis. 6th edn., Marcel Dekker, New York.
- Skoog, D.A.; West, D.M. and Holler, F.J. 2013. Fundamentals of Analytical Chemistry. 9th edn. Harcourt Asia Pvt. Ltd., Singapore.
- Vose, P.B. 1980. Introduction to Nuclear Techniques in Agronomy and Plant Biology. Pergamon Press. Ltd., Oxford, England.
- Willard, H.H.; Merritt, L. L. Jr, and Dean, J.A. 1988. Instrumental Methods of Analysis. 7th edn. Wadsworth Publishing Company, Belmont, California.

Course No. ACHEM 509 (Chemistry and Technology of Agroindustrial Crops)

2 Credit hours (Total marks 100)

Rubber: History, Soil and climatic requirements for rubber production. Exploitation of natural and synthetic rubbers: Evolution of tapping methods; stimulants, their methods and practices; microtapping method; natural and synthetic rubbers; production, properties and use of rubbers; rubber derivatives, processing and quality.

Sugarcane: History, Soil, climate and fertilizer requirements for sugarcane production. Manufacturing technology of raw sugar and plantation white sugar: Sucrose recovery and refining of sugar; physical and chemical characteristics of sugarcane and cane juice; chemistry and utilization of sugar mill by-products; fermentation of molasses products; molasses as a feed for livestock; colour of cane juice; deterioration of sugar during storage.

Tea: History, Soil, climate and fertilizer requirements for tea production. Chemistry and technology of black tea manufacturing processes: Withering, rolling, roll breaking and fermentation; biochemical changes; preparation of different forms of tea including green tea; composition of tea leaves and shoots; liquoring qualities, infusion, aroma, food value and polyphenols of tea.

Tobacco: History, Soil, climate and fertilizer requirements for tobacco production. Curing processes of tobacco leaves- their characteristic features and differences; chemical changes; chemical composition of leaf and its relation to type and quality, fermentation and aging processes.

Field studies of different agroindustries.

RECOMMENDED BOOKS AND PERIODICALS

- Barnes, A. C. 1974. The Sugarcane. Intersciences Publishers Inc., New York.
- Chaudhury, M. S. H. 1989. Tea Growing. Ananda Printers, Motijheel, Dhaka.
- Chen, J.C.P. and Chou, C.C. Cane Sugar Handbook: A Manual for Cane Sugar Manufacturers and Their Chemists, 12th edn. Wiley and Sons.
- Chi-Tang, H.; Jen-Kun, L. and Shahidi, F. (eds.) 2009. Tea and Tea Products- Chemistry and Health-Promoting Properties. CRC Press, Boca Raton.
- Chou, C.C. 2000. Handbook of Sugar Refining: A Manual for the Design and Operation of Sugar Refining Facilities. 2nd edn. Wiley and Sons.
- Crowther, B. 1998. Rubber Extrusion: Theory and Development. Rapra Technology Ltd.
- Das, R. K. 1987. Industrial Chemistry, Part-2, Kalayani Publishers, New Delhi, India.
- Dhingra, K. C. 1984. Hand Book on Rubber and Rubber Goods Industries. Small Industry Research Institute, New Delhi, India
- Garner, W. W. 1981. The Production of Tobacco. McGraw Hill Book, London.
- Harler, C. R. 1984. Tea Manufacture. Oxford University Press, UK.
- Jain, N. K. (ed.) 1999. Global Advances in Tea Science. Aravali Books International Pvt. Ltd., New Delhi, India.
- Kulkarni D.P. Cane sugar Manufacture in India. The Sugar Technologists' Association of India, New Delhi.
- Mathur, R. B. L. 1987. Hand Book of Cane Sugar Technology. Oxford and IBH Publishing Co. Calcutta. India.
- Sadhan, K. D. and White, J. R. (eds.) 2001. Rubber Technologist's Handbook. Rapra Technology Ltd., Shawbury, UK.
- White, J. L. 1995. Rubber Processing: Technology, Material, Principles. Hanser Verlag.

Course No. ACHEM 511 (Environmental Chemistry)

2 Credit hours (Total marks 100)

Concepts of environmental chemistry: Concept of environment compartments; chemical hazards and toxicants; factors affecting the environmental toxicants.

Environmental toxicology: Toxicological chemistry of chemical substances; biochemical effect of inorganic and organic compounds; food adulteration and its management.

Soil environmental chemistry: Sources and distribution of inorganic and organic contaminants in soil; environmental fate and adverse impact of contaminants in soil; remediation of the polluted soils.

Aquatic environmental chemistry: Aquatic toxicology and factors influencing toxicity; fate of toxicants in aquatic environments; bioaccumulation and biotransformation of contaminants in aquatic organisms.

Atmospheric chemistry: Chemical and photochemical reactions in the atmosphere; inorganic and organic pollutants with their effects on plants; acid rain and greenhouse gases; ozone layer destruction.

Environmental hazard monitoring and legislation: Environmental protection effects; toxic substances control act; risk and safety assessment programs for the environment; international regulations and efforts on environmental problem.

RECOMMENDED BOOKS AND PERIODICALS

Baird, C. and Cann, M. 2008. Environmental Chemistry. 4th edn. W. H. Freeman and Company, New York, USA.

Huang, P. M.; Bollag, J. M. and Senesi, N. (eds.). 2002. Interactions between soil Particles and Microorganisms: Impact on the Terrestrial Ecosystem, John Wiley & Sons Ltd., Chichester, England.

Kvesitadze, G.; Khatisashvili, G.; Sadunishvili, T. and Ramsden, J. J. 2006. Biochemical Mechanisms of Detoxification in Higher Plants: Basis of Phytoremediation. Springer-Verlag, Berlin, Germany.

Lecomte, P. 1999. Polluted Sites: Remediation of Soils and Groundwater. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Manahan, S. E. 2010. Environmental Chemistry. 9th edn., CRC Press LLC, Boca Raton, Florida, USA.

Mansour, M. (ed.) 1993. Fate and Predication of Environmental Chemistry in Soils, Plants and Aquatic Systems. Lewis publishers, Boca Raton, Florida, USA.

Rand, G. M. and Petrocelli, S. R. (eds.) 1985. Fundamentals of Aquatic Toxicology-Methods and Applications. Taylor & Francis Publishers, Frost Road, Suite 101, Bristol.

Sarkar, B. (ed.) 2002. Heavy Metals in the Environment. Marcel Dekker Inc., New York, USA.

Young, L. Y. and Cerniglia, C. E. (eds.) 1995. Microbial Transformation and Degradation of Toxic Organic Chemicals. Wiley-Liss, Inc., New York, USA.

Course No. ACHEM 513 (Waste Management and Green Chemistry)

2 Credit hours (Total marks 100)

Waste management: Past, present and future perspectives. Categories and generation of wastes. Cleaning agents and their industrial use.

Waste management technologies: Physical, chemical and thermal treatment methods; biodegradation of wastes. Sources and modes of release of pollutants.

Recycling of wastes for the generation of bioenergy and use of effluents; waste reduction; management and recycling of municipal and industrial wastes.

Chemistry and management of hazardous wastes.

Key issues related to waste management in Bangladesh. National 3R goal, objectives and priority sectors. Core principles of the National 3R strategy.

International regulations for waste management. Pollution prevention in industry and integrated pollution prevention and control.

Green chemistry: Green chemistry and sustainable development, solid acid catalysts, micelle-templated silicas as catalysts in green chemistry, biocatalysis, green catalysts for industry, green chemistry in practice.

Field study on utilization of industrial by-products from different mills and factories.

RECOMMENDED BOOKS AND PERIODICALS

Adriano, D. C. 2001. Trace Elements in Terrestrial Environments - Biogeochemistry, Bioavailability and Risk of Metals. 2nd edition. Springer-Verlag, New York.

Baird, C. and Cann, M. 2008. Environmental Chemistry. 4th edn., W. H. Freeman and Company, New York, USA.

Clark, J. and Macquarrie, D. (eds.) 2002. Handbook of Green Chemistry and Technology. Blackwell Publishing Ltd., London, UK.

Irwin, W. 1990. Pollution Prevention and Integrated Environmental Management. IPCT 119. UNIDO.

ISWA, 1989. Waste Minimization and Clean Technology. Proceedings, 1st Inter. Conf., Geneva.

Maltezou, S. P.; Metry, A. M. and Irwin, W. A. (eds.) 1990. Industrial Risk Management and Clean Technology. IACT. Vienna.

Manahan, S. E. 1990. Hazardous Waste Chemistry, Toxicology and Treatment. Lewis Publishers, Chelsea, Michigan, USA.

Manahan, S. E. 2005. Environmental Chemistry. 8th edn. CRC Press LLC, Boca Raton, Florida, USA.

Olguin, E. J.; Sanchez, G. and Hernandez, E. (eds.) 2000. Environmental Biotechnology and Cleaner Bioprocesses. Taylor & Francis Inc., London.

Pepper, I. L.; Gerba, C. P. and Brusseau, M. L. (eds.) 2006. Environmental and Pollution Science. 2nd edn., Academic Press, London, UK.

Course No. ACHEM 515 (Water Science)

2 Credit hours (Total marks 100)

Water quality: Physical, chemical, biological and radiological qualities; quality assessment and criteria for drinking, domestic, livestock, poultry, aquaculture, irrigation and agroindustrial usage; ionic toxicity and plant tolerance.

Irrigated soils: Chemistry, management and reclamation of irrigated soils; salt tolerance and plant growth. Precision and detection of water analytical result: Anion-cation balance; measured and calculated TDS to EC ratio.

Water pollution: Nature and types of water pollutants; sources and causes of water pollution; eutrophication; fate and transport of radionuclides, inorganic and organic pollutants in aquatic environment. Water treatment: Water disinfection; physical, chemical and biological processes of water and wastewater treatment.

Water harvesting: Development of water harvesting and perspectives, water harvesting systems for agriculture and other usage.

RECOMMENDED BOOKS AND PERIODICALS

APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21st edn., AWWA and WEF, Washington, USA.

Ayers, R. S. and Westcot, D. W. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 Rev. Rome, Italy.

FAO & IITA. 2000. Simple soil, water and plant testing techniques for soil resource management. Proceedings of a training course held in Ibadan, Nigeria, 16-27 September 1996. International Institute of Tropical Agriculture and Food and Agriculture Organization of the United Nations, Land and Water Development Division, Rome.

Freeze, R. A. and Cherry, J. A. 1979. Groundwater. Prentice-Hall Inc., Englewood Cliffs, New Jersey.

James, D. W.; Hanks, R. J. and Jurinak, J. J. 1982. Modern Irrigated Soils. John Wiley & Sons Inc., New York, USA.

Karant, K. R. 1987. Groundwater Assessment Development and Management. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.

Lal, R. and Stewart, B. A. (eds.) 1994. Soil processes and Water Quality (Advances in soil Science). CRC Press, Inc., Boca Raton, Florida, USA.

Manahan, S. E. 2005. Environmental Chemistry. 8th edn., CRC Press LLC, Boca Raton, Florida, USA.

Todd, D. K. 1980. Groundwater Hydrology. 2nd edn., John Wiley & Sons Inc., New York.

Course No. ACHEM 517 (Phyto-ecological Chemistry)

2 Credit hours (Total marks 100)

Scope of phytochemistry: Definition and role of phytochemistry in sustainable management of environment.

Higher plant-lower plant interactions: Phytoalexins and phytotoxins; biochemical basis of disease resistance; pre-infectious compounds; post-infectious compounds (post-inhibitors and phytoalexins) and phytotoxins in plant disease.

Biochemical interactions between higher plants: Allelopathy and its ecological importance; biochemistry of host parasite interactions.

Hormonal interactions between plants and animals: Plant oestrogens; insect moulting hormones in plants; insect juvenile hormones in plants and other hormonal interactions.

Plant toxins and their effects on animals: Different classes of plant toxins; cyanogenic glycosides, cardiac glycosides and pyrrolizidine alkaloids; utilization of plant toxins by animals.

Biochemical basis of plant adaptation to the environment: Biochemical basis of adaptation to climate; biochemical adaptation to the adverse soil and detoxification mechanism.

Molecular basis of plant-microbe interactions: Chemical communications between and amongst different rhizosphere microorganisms; biofilm formation, quorum sensing and other environmental sensing mechanism.

RECOMMENDED BOOKS AND PERIODICALS

Eisner, T. and Meinwald, J. (eds.) 1995. The chemistry of Biotic Interaction. National Academy Press, Washington D.C., USA.

Harborne, J. B. 1995. Introduction to Ecological Chemistry. 4th edn., Academic Press Inc., San Diego, CA, USA.

Khan, M. S.; Zaidi, A. and Musarrat, J. (eds.) 2009. Microbial Strategies for Crop Improvement. Springer-Verlag, Berlin, Germany.

Kumar, B. 2005. Biogenesis of Natural Products. Alpha Science Inter. Ltd., USA.

Kvesitadze, G.; Khatisashvili, G.; Sadunishvili, T. and Ramsden, J. J. 2006. Biochemical Mechanisms of Detoxification in Higher Plants: Basis of Phytoremediation. Springer-Verlag, Berlin, Germany.

Mann, J. 1987. Secondary Metabolism (Oxford Chemistry Series). 2nd edn., Oxford University Press, UK.

Reigosa, M. J.; Nuria, P and Luis, G. (eds.) 2005. Allelopathy: A Physiological Process with Ecological Implications. Springer Publishers, Germany.

Sadasivan, S. and Thayunanayan, B. (eds.) 2003. Molecular Host Plant Resistance to Pests. CRC Publishers, USA.

Seigher, D. S. 2001. Plant Secondary Metabolism. Springer Publishers, Germany.

Stanforth, S. 2006. Natural Product Chemistry at a Glance. Blackwell Publishers, USA.

Course No. ACHEM 519 (Applied Bioorganic Chemistry)
2 Credit hours (Total marks 100)

Chemistry and Application of Natural Product

General methods of extraction, isolation, purification, and determination of structure of natural products occurred in plants by chemical and spectroscopic methods with reference to alkaloids, terpenes, steroids and hormones.

Chemistry of Vegetable Oils: Occurrence, types, extraction, refining, and quality analysis of vegetable oils: cotton seeds, soybean, palm, sunflower, and linseeds; and their uses.

Natural Colouring Materials: Occurrence, types, and properties of natural dyes. A relationship between colour and constitution. Methods of extraction, isolation, and purification of natural colouring materials: bixin, lycopene, turmeric, betanin, saffron; and their uses.

Pheromones: Pheromones, their stereospecificity and action in biological systems.

RECOMMENDED BOOKS AND PERIODICALS

Agarwal, O.P. 2010. Organic Chemistry: Natural Products. Vol. I & II. 37th edition. Krishna Prakashan Media, U. P. India.

Austin, G. T. Shreve's Chemical Process Industries. Fifth edition. McGraw Hill, New York.

Bechtold, T. and Massak, R. (eds). 2009. John Wiley and Sons Ltd. United Kingdom.

Dean, J.R. 2009 Extraction Techniques in Analytical Sciences. John Wiley and Sons Ltd. United Kingdom.

Finar, I. L. 1985. Organic Chemistry Vol. II, ELBS. Fifth edition. John Wiley and Sons Ltd. USA.

Kent, J. A. Riegel's Handbook of Industrial Chemistry. 20th edn. Kluwer Academic, New York.

Mitra, S. (ed). 2001. Sample Preparation Techniques in Analytical Chemistry. John Wiley and Sons Ltd. United Kingdom.

Course No. ACHEM 521 (Chemistry of Manures and Fertilizers)
2 Credit hours (Total marks 100)

Aerobic and anaerobic decomposition of organic wastes and factors involved therein.

Biodynamics of nutrient elements during composting; losses of plant nutrients during preparation and conservation of composts. Field study on utilization of biogas effluent, sewage sludge, industrial and municipal wastes.

Vermicomposting of different agrowastes.

Fertilizer formulation with different types of ingredients.

Scope, importance and production technology of biofertilizer.

Integrated plant nutrition system (IPNS) and preparation of nutrient balance sheet.

Fertilizer management, balanced use of fertilizers. Time and methods of fertilizer application.

Use, overuse and misuse of fertilizers.

Fate of applied manures and fertilizers in soil.

RECOMMENDED BOOKS AND PERIODICALS

Elsas, J.D.V.; Trevors, J.T. and Wellington, E.M.H. (eds) 1997. Modern Soil Microbiology. Marcel Dekker Inc., New York, USA.

Hall, A. D. Fertilizers and Manures. Daya Pub.

Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers 6th edn. Prentice-Hall, Inc. Upper Saddle River, New Jersey, USA.

Ismail, S.A. 1997. Vermicology. The Biology of Earthworms Orient Longman Ltd. Chennai India.

Meelu, O.P; Singh, Y. and Singh, B. 2007. Green Manuring for Soil Productivity Improvement. Daya Pub. India.

Palaniappan, S.P. and Annadurai, K. 2003. Organic Farming: Theory & Practice, Scientific Publishers, Jodhpur, India.

Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press Inc., California, USA.

Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya Pub. India.

SubbaRao, N.S. 1982. Biofertilizers in Agriculture. Oxford & IBH Publishing Co., New Delhi, India.

UNIDO and IFDC (eds.) 1998. Fertilizer Manual Kluwer Academic Publishing. Dordrecht, The Netherlands.

Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1981. Manures and Fertilizers, 5th edn. Agricultural Publishing House, Nagpur-440010, India.

Course No. ACHEM 523 (Chemistry of Plant Products)

2 Credit hours (Total marks 100)

Biosynthesis, chemical nature and properties, formulations and mode of actions of nicotine and pyrethrin and azadirachtin.

Biosynthesis, functions, properties and regulations of chlorophylls, carotenoids, flavonoids, polyphenols and tannins.

Characteristics, chemical nature, biosynthesis, translocation, mode of action and role of auxins, gibberellins, cytokinins and abscissic acid. Hormone vs plant growth regulator.

The basic ethylene biosynthetic pathway in higher plants. Regulation of ethylene biosynthesis. Metabolism, translocation, role and mode of actions of ethylene.

Discovery, biosynthesis and role of phytochrome. Phytochrome action, Light and phytochrome, The phytochrome chromophore, Phytochrome destruction.

Definition and classification of vitamins. Biosynthesis, occurrence, chemical nature, precursors and physicochemical properties of vitamins.

RECOMMENDED BOOKS AND PERIODICALS

Ball, G. F. M. 2006. Vitamins in Foods: Analysis, Bioavailability and Stability. CRC Press.

Davies, P. J. 2004. Plant Hormones: Biosynthesis, Signal Transduction, Action. Springer.

Godfrey, C. R. A. (ed.) 1995. Agrochemicals from Natural Products. Marcel Dekker Inc., New York, USA.

Goodwin, T. W. 1980. The Biochemistry of the Carotenoids. 2nd edn., Chapman and Hall, New York.

Goodwin, T. W. and Mercer, E. I. 1985. Introduction to Plant Biochemistry. 2nd edn., Pergamon Press Ltd., New York.

Harborne, J. B. 1987. Comparative Biochemistry of the Flavonoids. Academic Press Inc., London.

James, B. and Varner, J. E. 1985. Plant Biochemistry. Academic Press Inc., New York.

Lehninger, A. L. 1987. Principles of Biochemistry. CBS Publishers & Distributors, New Delhi, India.

Pandey, S. N. and Sinha, B. K. 1993. Plant Physiology (Revised edn.). Vikas Publishing House Pvt. Ltd., New Delhi, India.

Richard E. Kendrick and Kronenberg, G. H. M. 1994. Photomorphogenesis in Plants. 2nd edn. Springer.

Srivastava, L. M. 2002. Plant Growth and Development: Hormones and Environment. Academic Press, New York.

Whittingham, C. P. 1984. The Chemistry of Plant Processes. Methuen & Co. Ltd., London.

Course No. ACHEM 525 (Applied Plant Science and Rhizosphere Technology)

2 Credit hours (Total marks 100)

Plant ionomics: Concept of ionome and ionomics; characterization of the plant ionome; environmental, temporal and spatial ionomics; linking the ionome and genome; analytical platforms for ionomics; bioinformatics platforms for ionomics; evolutionary context for ionomics.

Membrane transporters: Concept of ion homeostasis, channels, and transporters; plant vacuolar transporters and their functions; the role of membrane transporters in plant nutrition and stress.

Transporter transcriptomics: Introduction to microarray technology; importance of microarray studies; general aspects of microarray technology; transcriptomics data analysis and interpretation; exploring natural genetic variation to improve plant nutrient content.

Chemistry of root exudates and nutrient cycling: Root exudates and organic rhizodeposition, release mechanisms; chemical mobilization of nutrients, protective functions of root exudates against abiotic stress, knowledge gaps and perspectives.

Chemistry of microbial metabolites

Siderophores: introduction, sources, agricultural interests, utilization of siderophores by non-producers, methods to characterize siderophores, microbial siderophore and iron nutrition in plants, siderotyping and methods of studying siderophores.

Antibiotics: detection of antibiotics in rhizosphere, bacterial and fungal metabolites and their effect on phytopathogens, methods of studying bioactive metabolites.

RECOMMENDED BOOKS AND PERIODICALS

Blatt, M. R. 2004. Membrane Transport in Plants. Blackwell Publishing Ltd., United Kingdom.

Broadley, M. R. and White, P. J. (eds.) 2005. Plant Nutritional Genomics. Blackwell Publishing Ltd., United Kingdom.

Coruzzi, G. M. and Gutierrez, R. A. (eds.) 2009. Plant Systems Biology. Blackwell Publishing Ltd., United Kingdom.

Huang, Q.; Huang, P. M. and Violante, A. (eds.) 2008. Soil Mineral-Microbe-Organic Interactions: Theories and Applications. Springer-Verlag Publications, New York.

Jaiwal, P. K.; Singh, R. P. and Dhankher, O. P. (eds.) 2008. Plant Membrane and Vacuolar Transporters. CABI Publishing, United Kingdom.

Karlovsky, P. (Ed). 2008. Secondary Metabolites in Soil Ecology. Springer Verlag Publications, New York.

Khan, M. S.; Zaidi, A. and Musarrat, J. (eds.) 2009. Microbial Strategies for Crop Improvement. Springer-Verlag, Berlin, Germany.

Stanforth, S. P. 2006. Natural Product Chemistry at a Glance. Blackwell Publishing Ltd.

Taiz, L. and Zeiger, E. 2010. Plant Physiology. 5th edition, Sinauer Associates, Inc. Publishers, USA.

Verma, A. and Chincholkar, S. (eds.) 2007. Microbial Siderophores. Springer-Verlag Publications, New York.

Course No. ACHEM 527 (Aquatic Geochemistry)

2 Credit hours (Total marks 100)

Benthic Cycling of Nutrients: Distribution of O₂, NO₃, PO₄, Mn, Fe and trace elements in seawater; Role of O₂, N₂ and phosphorus in marine sediments; Determination of consumption rates and benthic fluxes; Pathways of iron input to marine sediments; The early diagenesis of Fe in sediments; Sulfur cycling and methane oxidation; Sulfate reduction and the degradation of organic matter; Effects of sulfate reduction on sedimentary solid phases; Aquatic carbonates- their formation and destruction; The calcite-carbonate equilibrium in marine aquatic systems; Quantification and regionalization of benthic refluxes. Seawater intrusion into aquifers.

The Chemistry of Aquatic Sediments: Sources and components of aquatic sediments; Lakes, rivers and estuaries; Classification of marine sediments; Global patterns of sediment distribution; Physical & chemical properties of marine sediments; Sediment echosounding; Quantification of early diagenesis, sedimentation rates.

Aquatic Biogeochemistry: Approaches in aquatic biogeochemistry; Role of microorganisms; Regulation and limits of microbial processes; Energy metabolism of prokaryotes; Pathways of organic matter degradation; Methods in biogeochemistry.

Aquatic Pollution: Pollution and conservation issues; Marine debris; Petroleum pollution, organic pollutants and heavy metals; Ecotoxicological assessment of contaminated sediments; Pollution assessment indices- Marine sediment pollution index (MSPi), Pollution load index (PLI), Geoaccumulation index (Igeo), Enrichment factor, Principal component analysis (PCA), Risk assessment code (RAC).

RECOMMENDED BOOKS AND PERIODICALS

Adriano, D. C. 1992. Biogeochemistry of Trace Metals. Lewis Publishers.

Chester, R. 2003. Marine Geochemistry. Wiley-Blackwell, New York

Hester, R. E. and Harrison, R. M. (eds.) 2000. Chemistry in the Marine Environment. Royal Society of Chemistry, United Kingdom.

Hofer, T. N. (ed.). 2008. Marine Pollution: New Research. Nova Science Publishers Inc., New York.

Holland, H. D. and Turekian, K. K. (eds.) 2010. Geochemistry of Earth Surface Systems. 2nd edition, Academic Press, United Kingdom.

Libes, S. A. 2009. An Introduction to Marine Biogeochemistry. 2nd edition, Academic Press, United Kingdom.

Sadiq, M. 1992. Toxic Metal Chemistry in Marine Environments. Marcel Dekker Publisher, New York.

Schulz, H. D. and Zabel, M. 2006. Marine Geochemistry. 2nd edition, Springer-Verlag, Berlin, Germany.

Turekian, K. K. (ed.) 2010. Marine Chemistry and Geochemistry. 2nd edition, Academic Press, United Kingdom.