Department of Agricultural Chemistry

Course Layout

Sl. No.	Course Code and Title	Cr. Hrs.
A. Compulsory Courses		
1	AGCH 501**:** Fertilizer Technology and Usage	03
2	AGCH 502**:** Instrumental Methods of Analysis	03
3	AGCH 503**:** Colloid Chemistry in Relation to Plant Nutrition	03
4	AGCH 504: Analyses of Fertilizer, Plant, Soil and Water	03
5	AGCH 505: Chemistry of Pesticide	03
6	AGCH506 : Environmental Chemistry	03
	Total	18
B. Elective Courses		
7	AGCH 507: Formulation and Safety of Pesticides	03
8	AGCH 508: Chemistry of Manures and Fertilizers	03
9	AGCH 509: Chemistry of Plant Products	03
10	AGCH 510: Mineral Nutrition and Plant Growth	03
11	AGCH 511: Water and Solution Chemistry	03
12	AGCH 512: Chemistry and Technology of Agro-industrial Crops	03
13	AGCH 513: Chemistry of Bio-farming	03
14	AGCH 514: Irrigation Water Quality	03
15	AGCH 515: Nuclear Chemistry and Tracer Techniques	03
16	AGCH 516: Research Methodology for Agricultural Chemistry	03
	Course credit to be earned (Minimum)	12
C. Seminar Course		
22	AGCH: 598	01
D. Thesis Research		
23	AGCH: 599	16

Compulsory Courses	**18**
Elective Courses	**12**
Seminar Course	**01**
Thesis Research	**16**
Total	**47**

Course Code: AGCH 501 **Course Title: Fertilizer Technology and Usage (Compulsory)**	**Credit Hours: 03**	**Semester: January -June**

Rationale:

This course is designed to provide comprehensive and balanced understanding of essential link between industrial manufacturing, chemistry and application techniques of different fertilizers. It is therefore vital for Agricultural chemists to understand flow diagram for industrial productions and its application techniques for variety of fertilizers including essential plant nutrients containing-fertilizers.

Course Outcomes:

- Demonstrate clear idea on different fertilizers' production technology, manufacturing process, quality specification and properties.
- Generalize and adopt manufacturing process of macro and micro nutrient fertilizers
- Summarize and justify different physical and chemical properties of fertilizers
- Predict the economic feasibilities of fertilizer manufacturing in Bangladesh and also formulate the compatibility among different agrochemicals.

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching Learning Strategies**	**Assessment Strategies**
• Demonstrate the clear concept of raw materials necessary for different fertilizers' manufacture • Predict the present scenario of worldwide fertilizer production	**Fertilizers:** Concepts of fertilizer development; raw materials and reserves	Lecture Demonstration Presentation Discussion	Quiz MCQ Short answer Essay type answer
• Compose, design and plan the production and refining technology of macronutrient fertilizers • Predict the best macronutrient fertilizers for certain (acidic, alkaline, saline etc.) soil conditions • Explain the mineralogy of potash ores, mining and refining of muriate of potash (MOP)	**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)	Lecture Demonstration Video tapes Factory visit	Quiz MCQ Short answer Essay type answer Report

• Describe the concept of secondary and micronutrient fertilizers • Design and plan the production or manufacturing technology of secondary and micronutrient fertilizers • Justify the appropriate secondary and micronutrient fertilizer for different crops and certain soil conditions	**Secondary and micronutrient fertilizers:** Chemistry and production technology of gypsum, magnesium sulphate, zinc sulphate, borax and ammonium molybdate fertilizers	Lecture Demonstration Factory visit Assignment	Quiz MCQ Short answer Essay type answer
• Describe mixed, liquid and controlled release fertilizers • Design and plan the production or manufacturing technology of mixed, liquid and controlled releasefertilizers • Justify and predict properties, uses, advantages and disadvantages of these fertilizers	**Mixed, liquid and controlled released fertilizers:** Preparation, properties, uses, advantages and disadvantages	Lecture Demonstration Factory visit Assignment	Quiz MCQ Short answer Essay type answer Report
• Identify the pollutions causing by fertilizer industry • Interpret/employ the remedy, fertilizers pollution	**Pollution related to fertilizer production and use**	Lecture Field visit Assignment	Quiz MCQ Short answer Essay type answer Report
• Describe ideas about physical and chemical properties of fertilizers • Justify the fertilizers quality depending on different physical and chemical properties • Illustrate the chemical compatibility of fertilizers analyses • Interpret fertilizers quality depending on specification	**Physical and Chemical Properties of Fertilizer:** Particle size, Segregation properties, Granule hardness, Angle of repose, Bulk Apparent specific gravity, Critical relative humidity, Moisture absorption-penetration characteristics, Caking of fertilizers, Chemical compatibility in blends, Dustiness and conditioner adherence, Melting point	Lecture Visual presentation Group Discussion	Quiz MCQ Short answer Essay type answer

	Physiological acidity and basicity of fertilizers, Salt index **Fertilizer Specification:** Concepts of fertilizer specification. Elements of fertilizer specification and specification of different fertilizers		
• Design the cost benefits of fertilizer production	**Economic feasibility of fertilizer**: Feasibility of establishment of fertilizer factory in Bangladesh and their use efficiency	Lecture Case study, Group discussion Assignment	Quiz MCQ Short answer Essay type answer Report
• Analyze the suitability of different mixed fertilizers	Compatibility among fertilizers with other agrochemicals.	Lecture Demonstration	Quiz MCQ Short answer Essay type answer Report

Reference Books:

1. Das, R.K. 1987. Industrial Chemistry, Part-2, Kalyani Publishers, New Delhi, India.
2. Gustafson A. F. 2010. Handbook of Fertilizers. Agrobios, India.
3. Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers, 6th edition,. Prentice-Hall, Inc., Upper Saddle River, New Jersey, USA.
4. Jain, B.K. and Sivashankaran, V.S. (Eds.) 1980. Handbook on Fertilizer Technology. Fertilizer Association of India, New Delhi-110067, India.
5. Jones, U.S. 1979. Fertilizers and Soil Fertility. Reston Publishing Com., Reston, Virginia, USA.
6. Kannaiyan S. 2002. Azolla Biofrtilizer for Sustainable Rice Production. Daya Pub. India.
7. Kannaiyan S. 2010. Biofertilizers Technology. Scientific Pub.
8. Millar, Charles E. 2012. Soil Fertility. Daya Pub. India.
9. Olsen, R.A. (Ed.) 1971. Fertilizer Technology and Use. 2nd edition, Soil Science Society of America, Inc. Madison, Wisconsin, USA.
10. UNIDO and IFDC (Eds.) 1998. Fertilizer Manual. Kluwer Academic Publishers. Dordrecht, The Netherlands.
11. Van Slyke. 2010. Fertilizers and Crop Production. Agrobios, India.
12. Van Vuren, J.P.J. 2002. Soil Fertility and Sewage. Agrobios, India.

Course Code: AGCH 502 **Course Title: Instrumental Methods of Analysis (Compulsory)**	**Credit Hours: 03**	**Semester: July-December**

Rationale: This course is designed to enrich knowledge and skill on the instrumental methods and analysis. This course will provide knowledge on the theory of operation, instrumental design, methodology and applications of instrumental techniques of different instruments for analysis.

Course Outcomes:

- Demonstrate a clear idea about different scientific methods of different instruments for nutrient analysis and characterization of different plant products
- Generalize the theoretical principles behind modern analytical instrumentation
- Organize knowledge on modern analytical instrumentation with deep idea in its core concepts and how to apply it in a range of situations
- Design the cognitive, technical and creative skills to enable the graduates to apply established knowledge and practice concerning modern analytical instrumentation and measurement techniques to a range of situations

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching - Learning Strategies**	**Assessment Strategies**
• Explain principles and related theories of colorimetry and spectrophotometry • Criticize, compare and summarize those principles and theories • Predict and outline the methods of colour measurements • Operate colorimeter and spectrophotometer for sample analysis	**Colorimetry and Spectrophotometry:** Principle and theory of spectrophotometry; methods of colour measurement; instrumentation and application of colorimetry and of spectrophotometry	Lecture Demonstration Presentation Group activities Assignment Project Discussion Lab Visit	Quiz MCQ Short answer Essay type answer Group performance Report
• Demonstrate clear concept of the principle and theory of FES, AAS, AFS, ICP, MS and NMR • Diagram the Instrumentation of above principles and theories • Apply and maintain FES,	**Atomic spectrometry:** Principle and theory of atomic emission and atomic absorption spectrophotometry; instrumentation and application of flame	Lecture Visual presentation Demonstration Group activities Group Practice Project Laboratory visit	Quiz MCQ Short answer Essay type answer Demonstration performance

AAS, AFS, ICP, MS and NMR. • Categorized and differentiate the use of individual instrument for specific analytical purpose • Design and generalize these techniques for higher research	emission spectrophotometer (FES) and atomic absorption spectrophotometer (ASS); 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		
• Show operation, analytical and maintenance skill of pH meter and conductivity meter • Operate, calibrate and maintain pH and conductivity meter • Describe the principle and analytical procedure of pH and EC determination	**pH and conductivity measurement:** Principle, calibration and maintenance of pH and conductivity meters	Lecture Discussion Demonstration Group activities/ Practice Projects	Quiz MCQ Short answer Essay type answer Practical examination Projects

• Describe concept of chromatography, working principle of different classes of chromatography, • Predict separation technique and related theories of CC, PC, TLC, IC, GC, HPLC etc. • Organize skill full analytical inference for identification, quantification as well as interpretation • Summarize the working principles of different chromatographic methods • Describe major steps of GC, HPLC operations and analytical procedures • Analyze samples by using CC, TLC, IC, GC and HPLC	**Chromatography:** Brief history, General Factors, Terminology , Classification, Separation Characteristics Column chromatography: Technique, Major Components, Method of separation, identification, Paper chromatography: phases, basic technique, Types of forces involved, Major steps involved in basic operations and their description, Thin layer chromatography (TLC): Why it is better than CC and PC, Recent advancement, major steps involved in basic operation, Ion chromatography (IC): phases, basic technique, Major steps involved in basic operations and their description, Gas chromatography (GC): Classification, Instrumentation, Basic theory, Different columns and detectors, merits and demerits.	Lecture Demonstration Visual presentation Group activities Group practice Assignment	Quiz MCQ Short answer Essay type answer Presentation performance Report

	High performance liquid chromatography (HPLC), Supercritical fluid chromatography (SFC). High performance anion exchange chromatography (HPAEC): Classification, Instrumentation, Separation process/ theory, merits, demerits.		
• Illustrate and elaborate preliminary knowledge for the maintenance and troubleshooting activities of laboratory instruments	**Laboratory instrumentation:** Maintenance and trouble shooting of laboratory instruments.	Lecture Visual presentation Demonstration Group work Assignment	Quiz MCQ Short answer Essay type answer Demonstration Presentation performance Report

Reference Books:

1. Ahuja, S. 2003. Chromatography and Separation Science.Vol.4, Academic Press, California, USA.
2. Chopra, L.S. and Kanwar, J.S. 1991. Analytical Agricultural Chemistry. 4th edition, Kalyani Publishers, Ludhiana, New Delhi. India.
3. Fritz, J.S. and Schenk, G.H. 1987. Quantitative Analytical Chemistry. 5th edition,Prentice Hall, Englewood Cliffs, New Jersey 07632, USA.
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G. and Tatchell, A.R. 2016. Vogel's Textbook of Practical Organic Chemistry. 5th edition, 15th impression, Pearson Education Ltd. India.
5. Mendham, J.; Denney, R.C.; Barnes, J.D. and Thomas, M. 2000. Vogel's Textbook of Quantitative Chemical Analysis. 6thedition, Pearson Education Pte. Ltd. New Delhi, India.
6. Patania, V.B. 2004. Spectroscopy. Campus Books Internationl, New Delhi, India.
7. Silverstein, R.M., Webster, F. X., Kiemle, D.J. and Bryce, D. L. 2015. Spectromertric Identification of Organic Compounds. 8th edition, John Wiley & Sons, Inc., Wiley India Pvt Ltd., New Delhi, India.
8. Singh, A.K. 2013. Encyclopaedia of Applied Spectroscopy. 1st Edition, Centrum Press, New

Delhi, India.

9. Sivasankar. 2015. Instrumental Method of Analysis. 2nd Impression, Oxford University Press, New Delhi, India.
10. Skoog, D.A.; West, D.M., Holler, F.J and Crouch, S.R. 2014. Fundamentals of Analytical Chemistry. 9th edition Cengage Learning India Pte Ltd., India.
11. Skoog, D.A.; West, D.M. and Holler, F.J. 2001. Fundamentals of Analytical Chemistry. 7th edition Harcourt Asia Pte Ltd., Singapore.
12. Tuzimski, T. and Sherma, J. 2015. High Performance Liquid Chromatography in Pesticide Residue Analysis. Chormatographic Science Series, V.109, CRC press, Taylor and Francis Group, Tj International Ltd, Padstow, Cornwall, Great Britain.
13. Willard, H.H.; Merritt, L.L. Jr, and Dean, J.A. 1988. Instrumental Methods of Analysis. 7th edition. Wadsworth Publishing Company, Belmont, California, USA.

Course No.: AGCH 503 **Course Title: Colloid Chemistry in Relation to Plant Nutrition (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: Colloid chemistry/ soil colloid plays an important role in the release, transfer, uptake and utilization of plant nutrients by the plant. This course will expertize the students regarding basic and applied knowledge on chemistry of colloids in relation to plant nutrition. Agricultural chemists are then projected to have knowledge on different types of colloids and their relationship between plant-soil systems.

Course Outcomes:

- Summarize the nature and types of colloids and their properties
- Generalize the cation and anion exchange in soils and plants
- Interpret the laws governing ionic reactions
- Describe nutrients accumulation and metabolism in plants

Intended Learning Outcomes (ILOs) The students will able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe different types of colloids • Gather knowledge about mineralogy of silicate clay and humic colloids • Achieve knowledge about charge development	**Colloid Chemistry:** Nature and types of colloids, properties and mineralogical organization of silicate clay and humic colloids; development of charges of soil colloids	Lecture Visual presentation Discussion Lab. Visit	MCQ//Quiz Short answer Essay type answer
• Interpret the cation and anion retentions • Illustrate about nutrient fluxes in soil –plant system	**Nutrients flux in soils and plants:** Nutrients absorption in soil-plant system; movement of nutrients from soil to plant roots. Nutrient uptake mechanism from soil to plant roots. Active and passive ion transport; root cell membrane integrity	Lecture Visual presentation Discussion	MCQ//Quiz Short answer Essay type answer Report
• Describe cation exchange capacity • Interpret the antagonistic and synergistic inter-action of nutrient ions in soil- plant system	**Cation and anion retention:** Cation selectivity and exchangeable cation with its cation exchange equations; diffuse double layer; specific and non-specific anion retentions; cation and anion	Lecture Exercise	MCQ/Quiz Short answer Essay type

	exchange. Antagonistic and synergistic interaction of nutrient ions in soil- plant system		
• Illustrate essential and beneficial nutrients • Summarize the functions of essential nutrient and their deficiencies and toxicities	**Essential and beneficial nutrients:** History of essential nutrients and plant nutrition; available forms of essential plant nutrients, their classification; dissociation of minerals and ionization of nutrients; deficiency and toxicity levels of nutrients	Lecture Presentation Exercise	MCQ/Quiz Short answer
• Evaluate nutrient accumulation and metabolism in plants • Discus about nutrients assimilation	**Nutrient accumulation and metabolism in plants:** Activation, transport and reduction of nutrients- Carbon, nitrogen, phosphorous, sulphur, and other nutrients; biosynthesis of starch, ATP, amino acid protein and their metabolism	Lecture Demonstration Assignment	MCQ/Quiz Short answer Essay type answer Report
• Assess the Laws of ionic reactions	**Laws governing ionic reactions:** Law of Mass action; ratio law and second law of thermodynamics, kinetic and molecular theory of gases and its application to absorption	Lecture Discussion	MCQ/Quiz Short answer

Reference Books:

1. Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers, 6th edition,. Prentice-Hall, Inc., Upper Saddle River, New Jersey, USA.
2. Jones, U.S. 1979. Fertilizers and Soil Fertility. Reston Publishing Com., Reston, Virginia, USA.
3. Fageria**,** N.K. Baligar, V.C. and Jones. 1997. Growth and Mineral Nutrition of Field Crops. Second edition. Marcel Dekker, Inc. New York, USA.
4. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. Third edition. Academic Press. ISBN 978-0-12-384905-2.
5. Mengel and Kirkby, 1978. Principles of Plant Nutrition.
6. 6. Brady, N.C. and Weil, R.R. 2008. The Nature and Properties of Soil. 14th edition. Pearson Prentice Hall, USA.

Course Code: AGCH 504 **Course Title: Analyses of Fertilizer, Plant, Soil and Water (Compulsory)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge and updated information on fertilizers, plant, soil and water and their residue analysis

Course Outcomes:

- Operate proper sampling method for collection of commercial fertilizers, crops, agricultural soil and water
- Compare and justify different analytical methods
- Demonstrate standard methods to analyze soil, water and commonly used fertilizers.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define sampling and frequency of sampling • Describe the procedures of different sampling • Interpret soil, plant, water, fertilizer and pesticide residue analysis	**Sampling**: Principles, time and frequency of sampling; procedures for obtaining soil, plant, water, fertilizer and pesticide samples; errors in sampling	Lecture Visual demonstration Exercise Lab Visit	Short answer MCQ T/F Essay type answer
• State different analytical techniques • Evaluate different analytical techniques • Compare different analytical techniques	**Analytical techniques**: Analytical techniques for titrimetry, colorimetry, flame emission, atomic absorption spectrophotometry, and chromatography	Lecture Problem based Learning (PBL) Group assignment	Short answer Assignment Essay type answer Report
• Describe the importance of moisture and nutrient content of different fertilizers • Analyze the moisture and nutrient content of major fertilizers in Bangladesh • Evaluate the fertilizer quality in Bangladesh	**Fertilizer analysis:** Moisture and nutrient contents in Urea, SSP, TSP, DAP, MOP, Zinc sulphate and borax	Lecture Demonstration Practice Lab. Visit	Short answer Descriptive Compare MCQ -Report
• Identify different group of pesticides • Distinguish different group of pesticide residue in	**Pesticide residue and plant analysis:** Residue analysis and identification of different group of pesticides; plant tissue analysis for different	Lecture Presentation Exercise Demonstration	Short answer Descriptive Compare

crops or vegetables • Demonstrate the plant tissue analysis for different nutrients	nutrients		MCQ Report
• Analyze the soil for different purposes • Describe soil macro and micro nutrients	**Soil analysis**: Available, exchangeable and total nutrient contents and toxic elements; fractionation of soil macro and micronutrients	Lecture Demonstration Group Discussion	Interview Descriptive Practical
• Define quality of water • Describe different levels of water for dissolved constituents • Prepare report on the factors of water quality analysis	**Water analysis**: Surface, ground and rain waters for dissolved constituents including As, Cr, Cd, Pb, Co and Hg; water quality analysis for irrigation	Lecture Presentation Assignment Seminar Lab. Visit	Essay Short answer Report Presentation

Reference Books:

1. 1APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21th edition. AWWA and WEF, Washington, USA.
2. 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. IITA and FAO of the United Nations, Land and Water Development Division, Rome.
3. Jackson, M.L. 1973. Soil Chemical Analysis. Prentice-Hall of India Private Limited, New Delhi, India.
4. Petersen, L. 2002. Analytical Methods: Soil, Water, Plant Material, Fertilizer, Soil Resources Management and Analytical Services, SRDI, Dhaka.
5. Singh, D.; Chhonkar, P.K. and Pandey, R.N. 1999. Soil Plant Water Anlaysis: A method manual. IARI, New Delhi, India.
6. Tandon, H.L.S. (Ed.) 1995. Methods of Analysis of Soils, Plants, Waters and Fertilizers. Fertilizers Development and Consultation Organization, New Delhi, India.
7. Westerman, R.L. (Ed.). 1990. Soil Testing and Plant Analysis, 3rd edition, Soil Science Society of America, Inc. Madison, Wisconsin, USA.
8. Horacio H, et. al.,2017. Multi residue Methods for the analysis of Pesticide Residues in food. CRC press. ISBN 9781315118352
9. 9. Leo M.L et.al., 2009. Hand book of pesticides; Methods of Pesticide Residues Analysis. CRC press. ISBN 9781420082456

Course Code: AGCH 505 **Course Title: Chemistry of Pesticide (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to address preparation, chemical properties, metabolism, mode of action, environmental fate and residual effects of pesticides. It will develop the skills, knowledge and expertise of the students to work with chemical pesticides, its compatibility with other agrochemicals and residual effects on the environment.

Course Outcomes:

- Conceptualize advances of different pesticides
- Explain mode of action, storage and uses of different pesticides
- Demonstrate of field performance of different pesticides
- Optimize of MRL level of different pesticides
- Construct of pesticide compatibility with other agrochemicals

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate and describe the classification of different pesticides • Demonstrate the field performance of pesticides • Implement the different uses of pesticides regarding field performance	**Classification, preparation and field performance of pesticides:** Classification, preparation, properties, field performance, storage, and uses of: Organochlorinated insecticide: Aldrin, Dieldrin, Endosulfan and Heptachlor	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essay type answer Report
• Explain nervous systems and defense mechanism of pests • Describe the enzymes responsible for metabolism of pesticides • Evaluate the importance and role of different enzymes	**Concepts of pesticide metabolism:** Defense system, nervous system; enzymes responsible for metabolism of pesticides and their role; acetylcholinesterase- its action and inhibition	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essay type answer Report
• Formulate the chemistry of different organophosphorus pesticides • Construct the conceptual idea and field application of organophosphorus pesticide	**Organophosphorus insecticide:** Chlorpyrifos, Diazinon, Dichlorvos, Dimethoate, Fenthion, Fenitrothion, Fenvalerate, Imidacloprid, Malathion, Phenthoate and Trichlorfon. Organocarbamate insecticides: Carbaryl, Carbofuradan and	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essay type answer Report

	Carbosulfan. Synthetic pyrethroids insecticides: Cypermethrin, Deltramethrin, Permethrin		
• Categorize different fungicides in respect of present agricultural field application • Scrutinize different herbicides in respect of present agricultural field application	**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	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essay type answer Report
• Evaluate the latest research findings and information of advanced technology of chemistry of pesticides	Advanced research findings and information regarding chemistry of pesticide	Assignment Factory Visit	Report

Reference Books:

1. Bollag, J.M. and Stotzky, G. (Eds.). Soil Biochemistry. Vol. 8 Marcel Dekker Inc., New York, USA.
2. Green, M.B.; Hartley, G.S. and West, T.F. 1987. Chemicals for Crop Improvement and Pest Management. 3rd edition, Pergamon Press. New York.
3. Hall, J.C.; Hoagland, R.E. and Zablotowicz, R.M. (Eds.) 2001. Pesticide Biotransformation in Plants and Microorganisms. American Chemical Society, Washingto DC, USA
4. Hassall, K.A. 1990. The Biochemistry and Uses of Pesticides. Structure, Metabolism, Mode of action and Uses in Crop Production. 2nd edition, ELBS/Macmillan Press Ltd. Hampshire, UK
5. Mathews, G. A. 1985. Pesticide Application Methods. Longman. England.
6. Ramulu, U.S.S. 1985. Chemistry of Insecticides and Fungicides, 2nd edition. Oxford and IBH Pub. Co., New Delhi. India.
7. Roberts, T. (Ed.) 2000.Metabolism of agrochemicals in Plants. John Wiley and Sons. Ltd., Chichester, England.
8. Tarradellas, J.; Bitton, G and Rossel, D. (Eds.) 1997. Soil Ecotoxicology. Lewis Publishers, Boca Raton, Florida, USA
9. Tomlin, C.D.S. (Ed.). 2003. The Pesticide Manual, 13thedition, British Crop Protection Council, Hampshire, UK.
10. Yu S. J. 2008. The Toxicology and Biochemistry of Insecticides. CRC Press

Course No.: AGCH 506 **Course Title: Environmental Chemistry (Compulsory)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge and update information about the chemistry of the major components of environment; detection and management of environmental pollutants.

Course Outcomes:

- Demonstrate detailed the concept and issues of environmental chemistry.
- Analyze the chemistry of pollution of geosphere, hydrosphere, atmosphere
- Interpret pollution prevention and control measures.

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Distinguish and describe the components and issues related to environmental chemistry • Illustrate factors affecting environmental toxicants and chemical hazards of toxicants	**Concepts and issues of environmental chemistry:** Concept of environment components chemical hazards and toxicants; factors affecting the environmental toxicants. Issues related to environment	Lecture Visual presentation Discussion Assignment Related Field Visit	Quiz/MCQ Short answer Essay type answer Report
• Demonstrate clear concept of Geosphere • Illustrate it formation • Explain the role of ground water in the environmental hazards of geosphere • Predict and explain the hazards related to geosphere, effect of heavy metals, waste and pollutants in geosphere, their degradation and remediation • Evaluate and analyze the degradation of pesticides in the geosphere	**Chemistry of geosphere:** Concept of Geosphere, Physical formation of Geosphere, Role of ground water in geosphere, Hazards related to geosphere: Natural and Anthropogenic Hazard.Heavy metal pollution in soil environment: Source, level, effect on human and environment. Air pollution caused by geosphere. Waste and pollutant in geosphere, Degradation of pesticides in the geosphere. Bioremediation	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Discuss the routes, metabolism and toxic effects of environmental pollutants	**Environmental toxicology:** Toxic substances with their routes and metabolism. Biochemical effect of chemical pollutants	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Describe concept of aquatic chemistry, water pollution, its treatment • Illustrate the fate and movement of water pollutants in soil-plant-water system • Generalize different water and waste water treatment procedure	**Aquatic chemistry:** Water pollution: Concept of aquatic chemistry, water pollution, Classification of water pollutant, fate and movement of water pollutant, Water treatment: Concept of Water treatment, Classification of water treatment: Reverse osmosis, ozone water treatment, electro-dialysis	Lecture Visual presentation Discussion Assignment Related Area/ Field Visit	Quiz/MCQ Short answer Essay type answer Report
• Summarize chemical and photochemical reactions, organic and inorganic pollutants in atmosphere • Predict and explain the effect of pollutants on plants and environment	**Atmospheric chemistry:** Chemical and photochemical reactions in the atmosphere; inorganic and organic pollutants with their effects on plants; acid rain, smog and greenhouse gases; ozone layer destruction	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Analyze the potentiality of different hazardous waste. • Apply different remediation techniques for correcting hazardous waste.	**Chemistry of hazardous wastes:** Sources, classification and properties of hazardous agricultural and non-agricultural wastes; fates and effects of agricultural hazardous wastes; hazardous waste reduction and treatment	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essaytype answer Report
• Analyze the potentiality of different hazardous waste. • Apply different remediation techniques for correcting hazardous waste.	**Environmental hazard monitoring and legislation:** Environmental protection effects, toxic substances control act, the risk and safety assessment programs for the environment, and international regulations on environmental problem	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essaytype answer Report

Reference Books:

1. Baird, C. and Cann, M. 2008. Environmental Chemistry. 4th edition. W. H. Freeman and Company, New York, USA.
2. 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.
3. Manahan, S.E. 2010. Environmental Chemistry. 9th edition. CRC Press LLC, Boca Raton, Florida, USA.
4. Mansour, M. (Ed) 1993.Fate and Predication of Environmental Chemistry in Soils, Plants and Aquatic Systems.Lewis publishers, Boca Raton, Florida, USA.
5. Rand, G.M. and Petrocelli, S.R. (Eds.) 1985.Fundamentals of Aquatic Toxicology-Methods and Applications.Taylor& Francis Publishers, Frost Road, Suite 101, Bristol.
6. Sarkar, B. (Ed.) 2002. Heavy Metals in the Environment.Marcel Dekker Inc., New York, USA.

Course No. : AGCH 507 **Course Title: Formulation and Safety of Pesticides (Compulsory)**	**Credit Hours: 03**	**Semester :January-June**

Rationale: This course is designed to provide knowledge and update information about the formulation of different pesticides and their safety handling, application and disposal.

Course Outcomes:

- Conceptualize classification of different groups of agrochemicals
- Discriminate different pesticide formulations
- Illustrate safe handling of different agrochemicals before and after application to minimize applier and environmental hazards
- Justify the existing laws and regulations governing the proper use of pesticides

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Justify the need of agrochemicals • Classify different groups of agropchemicls	**Introduction:** Needs, general properties and precautions of agrochemicals Grouping of agrochemicals	Lecture, Visual presentation Discussion	Short answer MCQ Essay
• Summarize the history of pesticide use in Bangladesh	**History:** Entrance of chemical pesticide in Bangladesh, present status and future predictions.	Lecture, Visual presentation Discussion	Short answer Descriptive Compare MCQ
• Explain and compare different types of pesticide formulations. • Categorize different pesticide formulation plants • Describe merits and demerits of different pesticide formulations	**Formulation:** Dust, wettable powder, granules, emulsifiableconcentrates, fumigants, aerosol, capsules and microcapsules, Preparation methods, composition, advantages and disadvantages of new-generation formulations: Oil-in-water emulsions,Microemulsions,Controlled-release Formulations, Water-dispersible granules	Lecture, Visual presentation Discussion Factory Visit	Short answer Descriptive Compare MCQ Report writing
• Describe the role of additives in pesticide formulations.	**Additives:** Surfactants for pesticides: General characteristics, Wetting Agents, Dispersion, Emulsification, Solubilization, Bioenhancement, Conventional Surfactants, Recent	Lecture, Visual presentation Discussion	Short answer Descriptive Compare MCQ

	surfactant developments		
• Describe the different routes of entry of agrochemicals in human body	**Routes of exposure:** Route of entry of toxic chemicals in the body	Lecture, Visual presentation Discussion Factory Visit	Short answer Descriptive Compare MCQ
• Discriminate different agrochemicals according to their types of hazard	**Agrochemicals classification:** Classification related to hazard of agrochemicals	Lecture, Visual presentation Discussion	Short answer Descriptive Compare MCQ
• Illustrate safe handling of agrochemicals during packaging, transport, transfer and storage	**Safe handling:** Safe handling during packaging, transport, transfer, storage	Lecture, Visual presentation Discussion Assignment	Short answer Descriptive Compare MCQ Report writing
• Justify the need of precaution measures before, during and after application of pesticide. • Judge the importance of re-entry after application of pesticide.	**Safe application:** Precautions of before, during and after pesticide application, Re-entry	Lecture, Visual presentation Discussion Assignment	Short answer Descriptive Compare MCQ Report writing
• Justify the need of proper disposal of containers • Select the best ways to manage pesticide waste	**Safe disposal:** Safety measures during disposal of containers and waste	Lecture, Visual presentation Discussion Assignment	Short answer Descriptive Compare MCQ Report
• Classify different personal protective equipment. • Determine different personal protective equipments to prevent poisoning of agrochemicals	**PPE:** Use of personal protective equipment	Lecture, Visual presentation Discussion	Short answer Descriptive Compare MCQ
• Discriminate different symptoms of poisoning • Exercise in first aid treatments	**Pesticide Poisoning:** Poisoning by agrochemicals and its management	Lecture, Visual presentation Discussion Assignment	Short answer Descriptive Compare MCQ Report

• Discriminate different antidotes for pesticide poisoning	**Antidotes:** Antidotes for pesticide poisoning	Lecture, Visual presentation Discussion	Short answer Descriptive Compare MCQ
• Estimate different cause of drift • Plan strategies for reducing drift	**Pesticide drift:** Pesticide chemical drift and its management	Lecture, Visual presentation Discussion	Short answer Descriptive Compare MCQ
• Describe the need and importance of pesticide ordinance. • Criticize the strong and weak points of pesticide ordinance	**Pesticide ordinance:** Agro-Chemicals regulations, quality control and management: Pesticide Ordinance 1971	Lecture, Visual presentation Discussion Assignment	Short answer Descriptive Compare MCQ Report
• Describe the need and importance of pesticide ordinance and rules • Criticize the strong and weak points of pesticide ordinance and rules	**Pesticide rules:** Agro-Chemicals regulations, quality control and management: Pesticide rules 1984	Lecture, Visual presentation Discussion Assignment	Short answer Descriptive Compare MCQ Report

Reference Books:

1. Ministry of Law and Justice, Govt. of the Peoples Republic of Bangladesh. 1984. The Pesticide Ordinance, Govt. Press. Dhaka.
2. Ramulu, U.S.S. 1985. Chemistry of Insecticides and Fungicides.Oxford and IBH Pub. New Delhi, India.
3. Srivastva, S.B. 1985. Agrobased Industries and Pesticides Formulations. S.I.R. Institute, New Delhi. India.
4. Tomlin, C.D.S. (Ed.). 2003. The Pesticide Manual, 13th edition, British Crop Protection Council, Hampshire, UK.
5. Valkenburg, W.V. (Ed.) 1972. Pesticide Formulations. Marcel Dekker Inc. New York.

Course Code: AGCH 508 **Course Title: Chemistry of Manures and Fertilizers (Elective)**	**Credit Hour: 03**	**Semester: July-December**	
Rationale: This course is designed to provide knowledge and update information on bio-fertilizers and their proper usage in the crop field			
Course Outcomes: • Conceptualize advances of organic wastes and their utilization • Explain production technology of biofertilizer • Evaluate different manures and fertilizers in the crop field using nutrient balance sheet • Investigate the misuse of fertilizers and their fates in the environment			
Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate aerobic and anaerobic decomposition of organic wastes • Identify the losses of plant nutrients • Represent the utilization of cow dung and different sludge	**Decomposition of wastes and Composts:** Aerobic and anaerobic decomposition of wastes; Biodynamics of nutrient elements; possible utilization of cowdung; sewage sludge; industrial and municipal wastes.	Lecture Visual presentation Factory Visit	-Quiz/MCQ -Short question
• Describe fertilizer formulation with different types of ingredients • Illustrate production technology of biofertilizer • Design fertilizer application method	**Fertilizer formulation and production technology of biofertilizer:**Fertilizer formulation with different types of ingredients; production technology of biofertilizer; legume-rhizobium and azolla anabaena symbiosis; mycorrhiza and blue green algae in plant nutrition.	Lecture Visual presentation Assignment Factory Visit	-Short question -Essay type -Report
• Analyze the misuse of fertilizers • Prepare nutrient balance sheet • Describe the fate of fertilizers in soil.	**Proper use of fertilizer and preparation of nutrient balance sheet:**Time and methods of fertilizer application; use, overuse and misuse of fertilizers; fate of applied fertilizers in soil; preparation of nutrient balance sheet for the evaluation of	Lecture Visual presentation Discussion Assignment Factory Visit	-Quiz/MCQ -Short question -Essay type -Report

	manures and fertilizers.		

Reference Books:

1. Elsas, J.D.V.; Trevors, J.T. and Wellington, E.M.H. (Eds) 1997. Modern Soil Microbiology.Marcel Dekker Inc., New York, USA.
2. Hall, A. D. Fertilizers and Manures.Daya Pub.
3. Ismail, S.A. 1997. Vermicology. The Biology of Earthworms Orient Longman Ltd. Chennai India.
4. Meelu, O.P;Singh, Y. and Singh, B. 2007. Green Manuring for Soil Productivity Improvement. Daya Pub. India.
5. Palaniappan, S.P. and Annadurai, K. 2003. Organic Farming: Theory & Practice, Scientific Publishers, Jodhpur, India.
6. Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press Inc., California, USA.
7. Sathe, T.V. 2004. Vermiculture and Organic Farming.Daya Pub. India.
8. SubbaRao, N.S. 1982. Biofertilizers in Agriculture. Oxford& IBH Publishing Co., New Delhi, India.
9. UNIDO and IFDC (eds.) 1998. Fertilizer Manual. Kluwer Academic Publishing. Dordrecht, The Netherlands.
10. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1981. Manures and Fertilizers, 5th edition, Agricultural Publishing House, Nagpur-440010, India.

Course Code: AGCH 509 **Course Title: Chemistry of Plant Products (Compulsory)**	**Credit Hour: 03**	**Semester: July-December**

Rationale: This course is designed to provide knowledge and updated information on various plant originated secondary metabolites. It will describe isolation, purification and structural elucidation of those plant products. This course also will forecast the significant role of plant-derived natural products in agriculture.

Course Outcomes:

- Assess critically and overview of preliminary idea of plant products
- Explain biosynthesis, chemical nature and mode of actions of different secondary metabolites
- Utilization of bio-pesticide regarding the significance of agricultural outcomes

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe preliminary ideas of natural products • Differentiate primary and secondary metabolites • Explain various classes of primary and secondary metabolites	**Introduction to the chemistry of natural products:** Natural products and sources in nature. Primary and secondary metabolites. Properties and purposes of secondary metabolites. Review of various classes of secondary metabolites. Characteristics of secondary metabolites.	Lecture Visual presentation Discussion Related Field Visit	Quiz/MCQ Short answer Essay type answer
• Illustrate extraction, isolation, separation and purification methods of natural products	**Extraction, isolation, separation and purification of secondary metabolites:** Techniques of extraction, isolation, purification and characterization of different bioactive substances from plants	Lecture Visual presentation Discussion Lab. Visit	Quiz/MCQ Short answer Essay type answer
• Justify the importance of natural products in agricultural aspects • Apply natural products in agriculture	**Importance of natural products in agriculture:** The use of natural products in agricultural practices, the impact of natural products on the development of new pesticides, and the future prospects for natural products-based pest management	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

• Prepare a plan of bio-synthesis of different natural products • Explain different properties and functions of different secondary metabolites	**Bio-synthesis of different natural products:** Biosynthesis, functions, chemical nature and properties, formulations and regulations of nicotine, pyrethrin, azadirachtin chlorophylls, carotenoids, flavonoids, tannins, auxins, gebberellins, cytokinins, abscisic acid, ethylene, phytochrome, vitamins and other biopesticides	Lecture Visual presentation Discussion Lab. Visit	Quiz/MCQ Short answer Essay type answer
• Formulate and design of mode of actions of different natural products • Describe translocation systems of different secondary metabolites	**Mode of actions of natural products:** Mode of action and translocations of nicotine, pyrethrin, azadirachtin, chlorophylls, carotenoids, flavonoids, tannins auxins, gebberellins, cytokinins, abscisic acid, ethylene, phytochrome, vitamins and other biopesticides	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report
• Justify the chemistry of different plant products	**Review of chemistry of plant -derived products:** Structure elucidation of alkaloids, flavonoids and tannins	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer

Reference Books:

1. Godfrey, C.R.A. (Ed) 1995. Agrochemicals from Natural Products. Marcel Dekker Inc., New York, USA.
2. Goodwin, T.W. and Mercer, E.I. 1985. Introduction to Plant Biochemistry. 2nd edition. Pergamon Press Ltd., New York.
3. Goodwin, T.W. 1980. The Biochemistry of the Carotenoids. 2nd edition. Chapman and Hall, New York.
4. Lehninger, A.L. 1987. Principles of Biochemistry. CBS Publishers & Distributors, New Delhi, India.
5. James, B. and Varner, J.E. 1985. Plant Biochemistry. Academic Press Inc., New York.
6. Harborne, J.B. 1987. Comparative Biochemistry of the Flavonoids. Academic Press Inc. London.
7. Pandey, S.N. and Sinha, B.K. 1993. Plant Physiology (Revised edition) Vikas Publishing House Pvt. Ltd. New Delhi, India.
8. Whittingham, C.P. 1984. The Chemistry of Plant Processes. Methuen & Co. Ltd., London.

Course No.: AGCH 510 **Course Title: Mineral Nutrition and Plant Growth (Elective)**	**Credit Hours: 03**	**Semester: January-June**

Rationale: Plant growth and development largely depend on the combination and concentration of mineral nutrients available in the soil. Plants often face significant challenges in obtaining an adequate supply of these nutrients to meet the demands of basic cellular processes or even fail to complete their life cycle. This course is designed to provide knowledge and updated information on the principles of plant nutrition specially on nutrient availability, uptake and distribution in plants, its functions in the plant and contributions to growth and yield.

Course Outcomes:

- Generalize the principles of plant nutrition
- Explain nutrient availability in the soil
- Summarize nutrient uptake and distribution in plants
- Explore nutrient functions in plant and contributions to growth and yield

Intended Learning Outcomes (ILOs) The students will be able to	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Summarize the functions of plant nutrient • Recognize the deficiency and toxicity levels and symptoms	**Essential and beneficial nutrients:** History of the essential nature of nutrients; definition, classification role and principal form of uptake; threshold of deficiency and toxicity levels of nutrients	Lecture Visual presentation Discussion	Quiz MCQ Short answer Essay type answer
• Explain and distinguish the nutrient uptake mechanisms by higher plants • Analyze short and long distance ion transport	**Nutrient absorption and translocation in plants:** Ion absorption/uptake and translocation mechanisms of individual cells and roots (short-distance and long distance ion transport); foliar application of nutrients	Lecture Visual presentation Discussion	Quiz MCQ Short answer Essay type answer
• Evaluate the ways of plant nutritional quality improvements	**Nutrition and quality:** properties determining plant quality; biofortification	Lecture Visual presentation Discussion	Quiz MCQ Short answer Essay type answer
• Point out the relationship between plant nutrition and insect & disease infestation	**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	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report

	conditions Nutrient fluxes in terrestrial agro-ecosystems	Related Field Visit	
• Elucidate the nutrient metabolism in plant • Demonstrate reduction of nutrients and formation of different compounds in plants	**Nutrient metabolism in plants:** Activation, transport and reduction of nutrient ions-nitrogen, sulphur and zinc; biosynthesis of amino acids and their metabolism	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report
• Compare nutrient interactions in plants • Differentiate antagonistic and synergistic interactions of nutrients ions	**Relationships of nutrients:** Antagonistic and synergistic interactions of nutrient ions in soil-plant system	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report
• Analyze the nutrient-water interactions • Explain the relation between fertilization and water extraction by plant roots	**Nutrient-water interaction:** Physiological effect of nutrients related to water requirement; fertilization and water extraction by plant roots	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and Essay type answer Report
• Summarize the growth factors • Predict the response and requirements of nutrients for different crops	**Growth and nutrients requirements:** Biotic and abiotic growth factors; response and requirements of nutrients for different crops; root exudates for plant nutrition	Lecture Visual presentation Discussion Assignment	Quiz /MCQ Short and essay type answer Report

Reference Books:

1. Brady, N.C. and Weil, R.R. 2007. The Nature and Properties of Soils, 14th edn. Pearson Publishing Ltd. USA.
2. Fageria, N.K.; Baligar, V.C. and Jones, C.A. 2012.Growth and Mineral Nutrition of Field Crops, 3rd edition.Marcel Dekker, Inc, New York.
3. 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.
4. Khan, M.S.;Zaidi, A. and Musarrat, J (Eds). 2009. Microbial Strategies for Crop Improvement. Springer-Verlag,Berlin,Germany.
5. Marschner, H. 1996. Mineral Nutrition of Higher Plants .2nd edition. Academic Press. .
6. Marschner, P. 2012. Marschner's Mineral Nutrition of Higher Plants. 3rd edition. Academic Press. ISBN978-0-12-384905-2.

7. Mortvedt, J.J.; Cox, F.R.; Shuman, L.M. and Welch, R.M. (eds.) 1991. Micronutrient in Agriculture.2nd edition.Soil Science Society of America, Inc. Madison, Wisconsin, USA.
8. Waisel Y., Eshel A. and Kafkafi U. 2005. Plant Roots: The Hidden Half. 3rd edition.Marcel Dekker, Inc, New York.

Course No.: AGCH 511 **Course Title: Water and Solution Chemistry (Elective)**	**Credit Hours: 03**	**Semester: July-December**

Rationale: This course is designed to provide knowledge and update information on water chemistry and water treatment for sustainable use in different agriculture sectors.

Course Outcomes:

- Judgment of the water quality for different uses
- Understanding of the sources and causes of water pollution and control measures
- Evaluation of the importance of geothermal energy utilization

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the qualities parameter of water • Determine the suitability of water for different use.	**Water quality:** Physical, chemical, biological and radiological qualities; quality assessment and criteria for drinking, domestic, livestock, poultry, aquaculture, irrigation and agro-industrial usage; ionic toxicity and plant tolerance	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer
• Describe sources and causes of water pollution and its control measure	**Water pollution:** Sources and causes of water pollution and its control measure; Transport and hydrochemical processes of pollutions-As, Cd, Pb and Zn, health contamination and safety	Lecture Demonstration Assignment	Quiz /MCQ Short and Essay type answer. Report
• Interpret about the different techniques for water purification	**Water treatment:** Water disinfection; physical, chemical and biological processes of water and wastewater treatment	Lecture Presentation Assignment Lab. Visit	Essay Short and essay type answer Report
• Describe the causes of corrosion in aqueous system • Explain the role of oxygen in corrosion.	**Water chemistry, material compatibility & corrosion:** Corrosion in aqueous system, deposit formation vs role of zeta potential, distribution	Lecture Presentation Assignment	Quiz /MCQ Short answer Essay type answer Report

	of impurities between water and steam.		
• Select appropriate methods of harvesting water	**Water harvesting:** Development of water harvesting and perspectives, water harvesting systems for agriculture and other usage	Lecture Presentation Assignment	Essay Short and easy type answer Report
• Explain the ways means of utilization of geothermal energy	**Geothermal power and water chemistry:** Geothermal energy utilization, chemical composition of geothermal waters, direct use of geothermal waters	Lecture Presentation Assignment	Essay Short and easy answer Report

Reference Books:

1. APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21th edition . AWWA and WEF, Washington, USA.
2. Ariyananda, T. N. 2003. Sustainable Rainwater Harvesting and Groundwater Recharge in Developing Countries. Daya Pub.
3. Karanth, K.R. 1987. Groundwater Assessment Development and Management. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
4. Sharma, P. 2007. Agricultural Drainage and Water Quality. Daya Pub.
5. Tandon, H.L.S. (Ed.) 1995. Methods of Analysis of Soils, Plants, Waters and Fertilizers. Fertilizers Development and Consultation Organization, New Delhi, India.
6. Venkateswariu S.K. (Ed.). 1996. Water chemistry, industrial and power station water treatment. 1996, New Age International (P) Ltd. India.

Course Code: AGCH 512 **Course Title: Chemistry of Technology of Industrial Crops (Elective)**	**Credit Hour: 03**	**Semester: July-December**
Rationale: This course is designed to provide knowledge and update information on Agro-industrial crops and their manufacturing process		
Course Outcomes: • Conceptualize advances of rubber derivatives and processing • Explain manufacturing technology of raw sugar • Evaluate tea manufacturing process and their composition • Optimize the different grade of tobacco leaves and their chemical changes		

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate different methods of rubber collection • Demonstrate micro tapping puncture method • Compare different kinds of rubber properties	**Exploitation of Hevea:** Evolution of tapping methods; stimulants their methods and practices; microtapping-puncture method; natural and synthetic rubbers; production, properties and uses of synthetic rubbers; rubber derivatives and processing	Lecture Visual presentation Discussion Factory Visit	Quiz/MCQ Short answer Essay type answer
• Describe recovery and refining process of sugar • Illustrate physical and chemical properties of sugar • Utilize sugar mill by-products	**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	Lecture Visual presentation Discussion Factory Visit	Quiz/MCQ Short answer Essay type answer
• Apply advanced technology of Tea manufacturing • Describe different kinds of tea and their composition • Evaluate the qualities of tea, aroma and food value	**Chemistry and technology of black tea manufacturing processes:** Withering, rolling, roll breaking and fermentation; biochemical changes; preparation process of green tea; composition of tea leaves and shoots; liquoring qualities,	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essay type answer Report

	infusion, aroma and food value of tea		
• Explain curing process of tobacco leaves • Evaluate the quality of tobacco leaves • Minimize the loss of quality yield of tobacco leaf	**Curing processes of tobacco leaves and characteristic features:** Chemical changes; chemical composition of leaf and its relation to type and quality, fermentation and aging processes	Lecture Visual presentation Discussion Assignment Factory Visit	Quiz/MCQ Short answer Essay type answer Report
• Illustrate different methods of rubber collection • Demonstrate micro tapping puncture method • Compare different kinds of rubber properties	**Exploitation of Hevea:** Evolution of tapping methods; stimulants their methods and practices; microtapping-puncture method; natural and synthetic rubbers; production, properties and uses of synthetic rubbers; rubber derivatives and processing	Lecture Visual presentation Discussion Factory Visit	Quiz/MCQ Short answer Essay type answer

Reference Books:

1. Barnes, A.C. 1974. The Sugarcane. Intersciences Publishers Inc; New York.
2. Chaudhury, M.S.H. 1989. Tea growing. Ananda Printers, Motijheel, Dhaka.
3. Das, R.K. 1987. Industrial Chemistry, Part-2, Kalayani Publishers, New Delhi, India.
4. Dhingra, K.C. 1984. Hand Book on Rubber and Rubber Goods Industries. Small Industry Research Institute, New Delhi, India
5. Garner, W.W. 1981. The Production of Tobacco. McGraw Hill Book, London.
6. Harler, C.R. 1982. Tea Culture and Marketing of Tea. Oxford University Press, UK
7. Harler, C.R. 1984. Tea Manufacture, Oxford University Press, UK
8. Jain, N.K. (Ed.) 1999. Global Advances in Tea Science. Aravali Books International Pvt. Ltd., New Delhi, India.
9. Mathur, R.B.L. 1987. Hand Book of Cane Sugar Technology. Oxford and IBH Publishing Co. Calcutta. India
10. Shreve, R.N. 1985. Chemical Process Industry. McGraw Hills, New York. USA.

Course Code: AGCH 513 **Course Title: Chemistry of Bio-farming (Elective)**	**Credit Hour: 03**	**Semester: Jan-June/July-Dec**

Rationale: This course is designed to provide knowledge and update information on bio-farming and their chemical properties in Agriculture

Course Outcomes:

- Conceptualize advances of Bio-farming
- Explain bio-farming condition in Bangladesh and other countries
- Evaluate the role of compost and vermicompost in Bangladesh Agriculture
- Formulate the use of supplemental plant nutrients through fertilizers

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Illustrate the potentiality of Bio-farming • Describe the prospect of Bio-farming in Bangladesh • Compare Bio-farming in developed and developing countries • Demonstrate the achievements of bio-farming	**Bio-farming and its achievements:** Status, potential role, scope and prospect of bio-farming in Bangladesh; bio-farming in developed and developing countries; bio-farming achievements in different countries	Lecture Visual presentation Factory Visit	Quiz/MCQ Short answer Essay type
• Describe the components of Bio-farming • Explain Bio-farming condition in Bangladesh • Analyze microbial, thermal and vermicomposting of different bio-wastes	**Prospect, components and reaction of bio-farming:** Components of bio-farming; bio-farming prospect in Bangladesh; reaction, kinetics involved in microbial, thermal, and vermicomposting of different bio-wastes	Lecture Visual presentation Assignment Factory Visit	Short answer Essay type answer Report
• Discuss the role of organic waste in Bangladesh Agriculture • Use of supplemental plant nutrients through fertilizers • Apply Bio-farming in different crop production	**Role of vermicompost and use of supplemental plant nutrients:** Role of organic waste in Bangladesh agriculture; supplemental plant nutrient uses through fertilizers; bio-farming application in different crop field	Lecture Visual presentation Assignment Factory Visit	Short answer Essay type answer Report

Reference Books:

1. Training manual for organic agriculture 2015, Food and Agriculture Organizations
2. Hall, A. D. Fertilizers and Manures. Daya Pub.
3. Havlin, J.L.; Beaton, J.D.; Tisdale, S.L. and Nelson, W.L. 1999. Soil Fertility and Fertilizers 6th edition. Prentice-Hall, Inc. Upper Saddle River, New Jersey, USA.
4. Ismail, S.A. 1997. Vermicology. The Biology of Earthworms Orient Longman Ltd. Chennai India.
5. Meelu, O.P; Singh, Y. and Singh, B. 2007. Green Manuring for Soil Productivity Improvement. Daya Pub. India.
6. Palaniappan, S.P. and Annadurai, K. 2003. Organic Farming: Theory & Practice, Scientific Publishers, Jodhpur, India.
7. Paul, E.A. and Clark, F.E. 1989. Soil Microbiology and Biochemistry. Academic Press Inc., California, USA.
8. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya Pub. India.
9. SubbaRao, N.S. 1982. Biofertilizers in Agriculture. Oxford & IBH Publishing Co., New Delhi, India.
10. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1981. Manures and Fertilizers, 5th edition, Agricultural Publishing House, Nagpur-440010, India.

Course Code: AGCH 514 **Course Title: Irrigation Water Quality (Elective)**	**Credit Hour: 03**	**Semester: Jan-June/July-Dec**

Rationale: This course is designed to provide knowledge and updated information on quality of irrigation water, identify the different routes of pollutants and their impact on aquatic environment, treatment for purification of those waters against the pollutants for effective harvesting

Course Outcomes:

- Measure the irrigation water quality for different usages
- Identify the sources and causes of irrigation water pollution and control measures
- Propose the efficient technique for the treatment of irrigation water
- Detect different ways of irrigation water harvesting

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Discuss the assessment of for different criteria for the judgment of irrigation water quality • Develop the suitability of water for different usages	**Irrigation water:** Water quality: Physical, chemical, biological and radiological qualities; quality assessment and criteria for drinking, domestic, livestock, poultry, aquaculture, irrigational usage; SAR, SSP, EC, pH, RSC, HT etc, agroindustrial usage; ionic toxicity and plant tolerance	Lecture Discussion Presentation Demonstration Factory Visit	Quiz/MCQ Short answer Essay type answer
• Predict the impact of irrigation water on soil quality • Justify the chemical management and reclamation of irrigated soils	**Irrigated soils:** Chemistry, management and reclamation of irrigated soils; salt tolerance and plant growth	Lecture Discussion Visual presentation	Quiz/MCQ Short answer Essay type answer
• Illustrate of different pollutants and their nature of irrigated water • Identify the pollutants and their impact on aquatic environment	**Irrigated 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.	Lecture Discussion Visual presentation Field Visit	Quiz/MCQ Short answer Essay type answer

• Propose the suitable technique for water purification Detection of the major parameters of water quality	**Water treatment:** Water disinfection; physical, chemical and biological processes of water and wastewater treatment.	Lecture Visual presentation Discussion	Quiz/MCQ Short answer Essay type answer
• Describe precision agriculture and their usage • Construct different ways of water harvesting	**Precision and detection of analytical result and Water harvesting:** Precision and detection of water analytical result: Anion-cation balance; measured and calculated TDS to EC ratio. Development of water harvesting and perspectives, water harvesting systems for agriculture and other usage.	Lecture Visual presentation Discussion Assignment	Quiz/MCQ Short answer Essay type answer Report

Reference Books:

1. APHA (American Public Health Association) 2005. Standard Methods for the Examination of Water and Wastewater. 21th edition . AWWA and WEF, Washington, USA.
2. Ariyananda, T. N. 2003. Sustainable Rainwater Harvesting and Groundwater Recharge in Developing Countries. Daya Pub.
3. Ayers, R.S. and Westcot, D.W. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 Rev. Rome, Italy.
4. 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.
5. Freeze, R.A. and Cherry, J.A. 1979. Groundwater. Prentice-Hall Inc., Englewood Cliffs, New Jersey.
6. James, D.W.; Hanks, R.J. and Jurinak, J.J. 1982.Modern Irrigated Soils. John Wiley & Sons, Inc. New York, USA.
7. Karanth, K.R. 1987. Groundwater Assessment Development and Management. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
8. Lal, R. and Stewart, B.A. (Eds.) 1994. Soil Processes and Water Quality (Advances in Soil Science). CRC Pess, Inc., Boca Raton, Florida, USA.

9. Manahan, S.E. 2005. Environmental Chemistry. 8th edition CRC Press LLC, Boca Raton, Florida, USA.
10. Sharma, P. 2007. Agricultural Drainage and Water Quality. Daya Pub.
11. Todd, D.K. 1980. Groundwater Hydrology. 2nd edition. John Wiley & Sons, Inc. New York.

Course No.: AGCH 515 **Course Title: Nuclear Chemistry and Tracer Techniques (Elective)**	**Credit Hours: 03**	**Semester: Jan-June/July-Dec**

Rationale: This course is designed to provide knowledge and update information on nuclear chemistry and tracer technique; their properties and use in agriculture.

Course Outcomes:

- Conceptualize different sources of radioactive substances and their interaction with matter
- Explain the use of radioisotopes in agriculture
- Justify and evaluate regulations related to radioactive substances

Intended Learning Outcomes (ILOs) The students will be able to -	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Describe the structure of atom and it's stability • Understand decay of atom	**Structure of the atom and decay:** Structure of an atom; stability of atomic nuclei; radionuclides; decay and	Lecture Visual demonstration Exercise	Quiz /MCQ Short and Essay type answer
• Describe different sources of radioactive substances with their application • Illustrate X-ray generation and imaging	**Sources:** Sealed and open sources of radioactive substances. Their application. Generation of X-rays and X-rays imaging.	Lecture Visual demonstration Practice Assignment	Quiz /MCQ Short and Essay type answer Presentation Report
• Interpret the interaction of different radiations with matter and how to shield them.	**Interaction of radiation with matter:** Interaction of alfa, beta and gamma radiations; shielding of radiation.	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer
• Determine different technique of radiation detection, • Assess detection equipment for radiation protection	**Radiation detection:** Ionization detection, scintillation detection, X-ray imaging and application of detection equipment in radiation protection.	Lecture Visual demonstration Exercise Lab. Visit	Quiz /MCQ Short and Essay type answer
• Assess need of radioisotopes for the development of agriculture.	**Application of radioisotopes in agriculture:** Use of radio isotopes for the development of new varieties, use of radiation for product safety.	Lecture Visual demonstration Exercise	Quiz /MCQ Short and Essay type answer

• Illustrate various effects of radiation of human health. • Evaluate the risk of radiation	**Biological effect of radiation:** Effects of radiation in molecular and cellular levels, in humans, deterministic effects, stochastic effects, evaluation risks	Lecture Visual demonstration Exercise Assignment	Quiz /MCQ Short answer Essay type answer Report
• Describe different terminology used in regulation, • Understand the dose limits	**Regulation:** Terminology, Dose limits, legislation	Lecture Visual demonstration	Quiz /MCQ Short and Essay type answer
• Justify the ways of collecting different radioactive waste • Verify different processing and storage systems. • Identify ways of reducing waste	**Radioactive waste:** Collection of different dry and liquid radioactive waste from an institute, Processing and storage of radioactive waste, Reduction of radioactive waste	Lecture Visual demonstration Field Visit	Quiz /MCQ Short and Essay type answer

Reference Books:

1. LaChance, L., Aslam J. and Langer C. 1990. Nuclear techniques in agriculture. IAEA bulletin. Vienna, Austria.
2. International Atomic Energy Agency. 1976. Tracer manual on crops and soils. Vienna, Austria.
3. Brouwer, G. and van den Eijnde J. 2008. Practical radiation protection. Syntax Media. Arnhem, The Netherlands.

Course Code: AGCH-516 **Course Title: Research Methodology for Agricultural Chemistry (Elective)**	**Credit Hour: 03**	**Semester: January-June**

Rationale: This course is designed to provide knowledge and updated information on research, research methodology and advanced works on Agricultural Chemistry

Course Outcomes:

- Conceptualize about research planning and methodology
- Explain experimental design for latest research of Agricultural Chemistry
- Interpret different data for advanced research analysis using modern software's
- Prepare a Scientific report and Power point presentation following the rules and regulations

Intended Learning Outcomes (ILOs) The students will be able to-	**Course Content**	**Teaching-Learning Strategies**	**Assessment Strategies**
• Define experiment and experimental design • Describe research methodology • Interpret multiple comparisons test for crop production and residue analysis	**Research, experimental design and multiple comparison test**: Concept, characteristics of research, types of research, units of analysis in research, Research methodology and tests of multiple comparison test	Lecture Reading assignment Brain storming	Short answer MCQ T/F Report Essay type answer
• Identify research topics and problems • Formulate research plan • Describe steps in research project design • Review and selected literature, writing-up the literature reviewed references	**Research planning and literature review**: Steps in planning a research project, 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. Develop a theoretical framework, how to structure a literature review? Writing-up the literature	Lecture Problem based Learning (PBL) Group Assignment	Short answer Essay type answer Report
• Describe experimental designs • Compare different experimental designs	**Data processing:** Experimental design and analysis of variance: Simple and factorial experiment- Field plot technique; basic principles of experimental designs; completely randomized design;	Lecture Demonstration Practice Training/ Workshop	Short answer Descriptive answer Compare MCQ Report

	randomized block design; latin square design and split-plot design; Mean separation test- Duncan's multiple range test; least significant difference.		writing
• Define Correlation and regression • Describe Correlation and regression • Compare Correlation and regression • Exercise correlation and regression	**Correlation and regression analysis:** Exercise and implication.	Lecture Exercise Training/ workshop	Short answer Descriptive Compare MCQ Report writing Exercise
• Analyze the data • Exercise different secondary data, used data processing software's • Interpret the results	**Data analysis and presentation**: Collection and analysis of data, transformation, presentation and interpretation of the experimental results using commonly used data processing softwares (R, SPSS and MiniTab).	Lecture Demonstration Group Discussion	Short answer Descriptive answer Exercise
• Define scientific report • Describe scientific report • Prepare a scientific report report • Evaluate a scientific article	**Report writing and evaluation of Scientific report**: Principles and procedures of scientific report writing. Preparation and evaluation of a scientific report.	Lecture Reading Assignment Seminar	Essay type answer Short answer Presentation Report

Reference Books:

1. Anonymous, 2004. A Handbook of Scientific Report Writing. Graduate Training Institute, BAU, Mymensingh.
2. Mondal, M.R.I., Islam, M.S.,Jalil, M.A.B., Rahman,M.M., Alam, M.S. and Rahman, M.H.H. 2011. Krishiprojuktihatboi (Handbook on agro-technology) (5^{th} edition). Bangladesh Agricultural Research Institute, Gazipur.
3. Gowda, C. L. L. and Kaul, A. K. 1982. Pulses in Bangladesh. Bangladesh Agricultural Research Institute, Gazipur and FAO, Rome.
4. Riley, K. W., Gupta, S. C., Seetharam, A. and Mushonga, J. N. 1983. Advances in small millets. Oxford & IBH publishers Co. Pvt. Ltd. New Delhi, India.
5. Kaul, A. K. and Das, M. L. 1986. Oilseeds in Bangladesh. Bangladesh-Canada Agriculture Sector Team, Ministry of Agriculture, Govt. of the Peoples' Republic of Bangladesh,

Bangladesh.

6. Miah, A. A., Maniruzzaman, A. F. M. and Rahman, M. M. 1991. Problems and prospects of pulses
7. production. In: Advances in pulses research in Bangladesh. Proceed. Second National Workshop on pulses. Gazipur.