# MASTER OF SCIENCE DEGREE PROGRAMMES & POSTGRADUATE DIPLOMA
# IN
# INDUSTRIAL AND ENVIRONMENTAL CHEMISTRY

# PROSPECTUS

**(2019-2021 Batch)**


**Department of Chemistry**
**University of Kelaniya**
**Kelaniya**
**Sri Lanka**

**Telephone : 94 011 2914486**
**Fax : 94 011 2903203**

## Postgraduate Programmes in Industrial and Environmental Chemistry:

## M.Sc. Degree in Industrial and Environmental Chemistry, Master of Industrial and Environmental Chemistry (MIEC), and Postgraduate Diploma in Industrial and Environmental Chemistry

# 1.0 Preamble

The Department of Chemistry at University of Kelaniya presently offers theory and laboratory course units in Industrial and Environmental Chemistry for undergraduates and postgraduates. Most of the undergraduate and postgraduate research at University of Kelaniya is focused on issues related to environmental pollution, pollution control, bio-pesticides, polymers, medicinal plants and food.

From the national development perspective, Sri Lanka has pursued a policy of selective industrialization to meet the local production as well as to promote export oriented industries. Industrial development, which is necessary to generate employment and the economic growth of the country, must be integrated with environmental protection. For the profitable development of industries proper utilization of natural resources is required. Environmental pollution will be a major problem with the development of industries if adequate steps are not taken for cleaner industrial production. Hence, there is a need for personnel with a sound knowledge of Industrial Chemistry and Environmental Chemistry for the betterment of industries in Sri Lanka.

Majority of graduates from Sri Lankan universities lack integrated understanding of the above two areas unless they pursue postgraduate studies. The opportunity to follow postgraduate studies in relevant areas is not available for a large number of graduates. In order to address the above issues **three** post graduate programmes in Industrial and Environmental Chemistry namely **M.Sc. Degree in Industrial and Environmental Chemistry Programme** (with course work and a research component , SLQF 10: 2 year duration, 60 credits), **Master of Industrial and Environmental Chemistry (MIEC) Degree Programme** (with course work only, SLQF 9: 1 year duration, 30 credits) and **Postgraduate Diploma in Industrial and Environmental Chemistry** (SLQF 8: 1 year duration, 25 credits) are proposed to be conducted by the Department of Chemistry, University of Kelaniya.

(**SLQF:** Sri Lanka Qualification Framework level)

# 2.0 Aims and Objectives of the Postgraduate Programmes

### 2.1 Aims of the M.Sc. Degree Programme with course work and a research component, MIEC Degree Programme with course work only and Postgraduate Diploma

Aims of the Postgraduate Diploma, MIEC and M. Sc. Degree Programmes are to produce graduates and professionals with scientific knowledge and laboratory skills required by industries and organizations dealing with environmental protection.

In addition, the M.Sc. Degree Programme with course work and a research component would enable graduates and professionals to develop the ability to carry out research independently, in an area related to Industrial and Environmental Chemistry.

### 2.2 Objectives of the M. Sc. and MIEC Degree Programmes and Postgraduate Diploma

On the completion of the Postgraduate Diploma and the MIEC and M.Sc. Degree Programmes the postgraduates will gain adequate knowledge and necessary skills to solve chemically related problems in the areas of Industrial and Environmental Chemistry.

Further, on completion of the M.Sc. Degree Programme with course work and a research component the postgraduates will be able to make a significant contribution to the research and development programmes and pollution control programmes in industries and other organizations.

## 3.0 Target Groups

The postgraduate courses (M. Sc. Degree Programme with course work and a research component, MIEC Degree Programme with course only and Postgraduate Diploma) are intended for graduates, who are engaged or seeking career opportunities in,

- Industries
- Academic Institutes
- Organizations dealing with Environmental Management and Pollution Control
- Scientific Services (Government, Corporation and other Statutory bodies)
- Research Institutes

## 4.0 Duration and Course Structure of the Postgraduate Programmes

Postgraduate Programmes will be operated in a credit based course unit system.

For a theory course unit, **one** credit is equivalent to **15** contact hours and will consist of interactive lectures, tutorials and assignments. For a laboratory course unit and course units on case studies and industrial training, one credit is equivalent to **45** contact hours involving laboratory work, assignments, report writing and presentations.

Postgraduate Programmes are conducted mainly by the academic staff of the Department of Chemistry, University of Kelaniya and when necessary visiting lecturers will be drawn from other Departments of the University of Kelaniya, other Universities, research institutes, industries, government departments, corporations and other statutory organizations.

Medium of instruction of the postgraduate programmes is **English**.

Lectures and most of the laboratory experiments will be conducted during weekends. The industrial training and some laboratory classes will be conducted during weekdays.

### 4.1 M.Sc. Degree in Industrial and Environmental Chemistry Programme

M. Sc. Degree in Industrial and Environmental Chemistry is a full time postgraduate degree programme of **two** year duration.
This M. Sc. Degree Programme consists of two parts namely **Part I** and **Part II**.
Each part is of **one** year duration and all course units in Part I and the research project to be carried out in Part II of the programme are compulsory.

For a candidate to qualify for the M. Sc. Degree Programme with course work and a research component he/she should accumulate **30** credits in Part I and **30** credits in Part II.

**Part I:**

- Part I of the programme (INEC 54712 to INEC 54831) involves theory courses, a laboratory course, seminars, industrial training and a case study.

**Part II:**

- To be eligible to proceed to Part II of the M. Sc Degree programme the student should sit for all examination papers at Part I examination.
- Part II of the programme (INEC 6384W) involves a research project.
- A student should carry out a research project of 10 to12 month duration on a selected topic and submit a dissertation incorporating the results of the research project. The research project has to be carried out at the University under the supervision of a senior member of the academic staff or at a research institute or an industry or any other organization acceptable to the Department of Chemistry, University of Kelaniya. In the event that the research is carried out at an organization other than the Department of Chemistry, University of Kelaniya a research scientist with a postgraduate degree should act as the supervisor and a senior member of the Department of Chemistry, University of Kelaniya should act as the co-supervisor.
- Before the commencement of the research project a student should make a presentation on the plan of work and methodology to the Department.
- During the Part II of the programme the student should submit quarterly, a brief progress report to the coordinator of the programme. The progress report should be certified by the supervisor. If a candidate fails to submit **two** consecutive progress reports without a valid reason he/she shall be deemed to have voluntarily withdrawn from the M. Sc. Degree Programme.
- The dissertation should be submitted at the end of the second academic year.
- A *Viva voce* examination will be held after evaluating the dissertation.
- A candidate who had submitted quarterly progress reports and has failed to submit the dissertation at the end of the second academic year will be considered as a repeat candidate unless the request for the extension is accepted by the Faculty of Graduate Studies. Extensions up to a maximum of **two** years may be granted under special circumstances on the recommendation of the Faculty of Graduate Studies.

### 4.2 Master of Industrial and Environmental Chemistry (MIEC) Degree Programme

Master of Industrial and Environmental Chemistry (MIEC) Degree Programme is a full time postgraduate programme of **one** year duration.

Course units (INEC 54712 to INEC 54831) in the Part I of the M.Sc. Degree in Industrial and Environmental Chemistry Programme (with course work and a research component) will be offered for the MIEC Degree Programme.

To complete the MIEC Degree Programme with course work a student should accumulate **30 credits from Part I.**

### 4.3 Postgraduate Diploma in Industrial and Environmental Chemistry

Postgraduate Diploma in Industrial and Environmental Chemistry is a full time postgraduate programme of **one** year duration.

Course units (INEC 54712 to INEC 54831) in the Part I of the M.Sc. Degree in Industrial and Environmental Chemistry Programme (with course work and a research component) will be offered for the Postgraduate Diploma. To complete the Postgraduate Diploma a student should accumulate **25 credits** from **Part I including all core courses.**

All course units offered in the Postgraduate Programmes are summarized in Table I.

**Table I: Course Units Offered for the Postgraduate Programmes**

| Code No. | Course Unit | No. of Credits | M.Sc. with course work and a research component (2 years) | MIEC with course work only (I year) | Diploma |
|---|---|---|---|---|---|
| INEC 54712 | Principles of Industrial Chemistry | 2 | Core | Core | Core |
| INEC 54723 | Polymers and Polymer Related Materials | 3 | Core | Core | Optional |
| INEC 54733 | Food Chemistry, Herbal Health Products and Agrochemicals | 3 | Core | Core | Core |
| INEC 54743 | Earth Resources and Metal Based Industries | 3 | Core | Core | Core |
| INEC 54753 | Management Concept in Industry | 3 | Core | Core | Optional |
| INEC 54762 | Soil Chemistry and Terrestrial Pollution | 2 | Core | Core | Core |
| INEC 54772 | Atmospheric Pollution and Air Quality Management | 2 | Core | Core | Core |
| INEC 54782 | Aquatic Pollution and Water Quality Management | 2 | Core | Core | Core |
| INEC 54792 | Environmental Toxicology and Environmental Regulations | 2 | Core | Core | Core |
| INEC 54802 | Industry, Environment and Biotechnology | 2 | Core | Core | Optional |
| INEC 54814 | Techniques in Industrial Chemistry and Environmental Chemistry (Laboratory) | 4 | Core | Core | Core |
| INEC 54821 | Case Studies | 1 | Core | Core | Optional |
| INEC 54831 | Industrial Training | 1 | Core | Core | Optional |
| INEC 6384W | Research Project | 30 | Core | ** | ** |
| **Total number of credits to be accumulated** | | | 60 | 30 | 25 |

** course not offered for the particular programme

## 5.0 Admission to Postgraduate Programmes

### 5.1 Intake

At least 20 students per batch will be enrolled for the M.Sc. and MIEC Degree Programmes and the Postgraduate Diploma in Industrial and Environmental Chemistry. The number of students admitted to the three Postgraduate Programmes will however be limited and determined annually by the Department.

### 5.2 Eligibility

Applicants with the following qualifications will be considered for admission to the MIEC and M.Sc. Degree programmes and Postgraduate Diploma.

i. B. Sc. Special or Honours Degree in Chemistry

or

ii. B. Sc. Special or Honours Degree with Chemistry as a subject

or

iii. B. Sc. General Degree with Chemistry as a subject

or

iv. B. Sc. Degree in Chemical Engineering or Environmental Science or Agriculture

or

v. Any other equivalent qualification acceptable to the Senate of the University of Kelaniya.

N.B. Provision is available for candidates registered for the MIEC Degree programme with course work only to register for the M.Sc. Degree programme with course work and

a research component in Industrial and Environmental Chemistry after completing the Part I (Refer 10.0 ii).

**5.3 Application Procedure**

Each applicant should submit a duly filled application form to the Assistant Registrar, Faculty of Graduate Studies, University of Kelaniya, Kelaniya together with the following documents by the stipulated deadline.

(a) Certified copies of academic records
(b) A letter of recommendation
(c) Letter from the employer confirming experience and leave to follow the postgraduate programmes (where appropriate)
(d) List of publications (if any)

Copies of the prospectus and the prescribed application form can be obtained by forwarding a self addressed stamped envelope (10" x 12'') together with a money order of Rs. 1000.00 (application fee) drawn in favour of the Registrar, University of Kelaniya, Kelaniya or application form could be downloaded from the Department of Chemistry website (www.kln.ac.lk/science/chemistry).

The applicant who has downloaded the application form from the website should send a money order of Rs. 1000.00 (application fee) drawn in favour of the Registrar, University of Kelaniya with a self addressed stamped envelope (10" x 12'') with the duly filled application form and the other relevant documents in order to process the application and to receive the prospectus.

**5.4 Selection Procedure**

Suitable applicants will be selected after an interview.

**5.5 Course Fees**

The following fees should be paid in full at the commencement of the M. Sc. Degree Programmes and Postgraduate Diploma.
Fees paid will not be refunded.

**Registration fee :** Rs. 2000.00
**Science fee :** Rs. 2500.00
**Library fee :** Rs. 2000.00
**Internet/Wi-Fi** : Rs. 2500.00
**Examination fee :** Rs. 2000.00 for the M. Sc. Degree Programmes and the Postgraduate Diploma

In addition the following tuition fees have to be paid depending on the selected programme.

**Tuition Fee for M.Sc. Degree Programme with course work and a research component:**

Part I **:** Tuition fee of Rs. 130,000.00 can be paid in two instalments. The first instalment of Rs. 80,000.00 should be paid at the commencement of the course and the balance Rs. 50,000.00 on or before three months after the commencement of the course. Those who do not pay the second instalment within 3 months will not be allowed to continue with the course.

Part II **:** Tuition fee of Rs. 50,000.00 should be paid in full at the

commencement of the second year.

**Tuition Fee for MIEC Degree Programme with course work only:**
Tuition fee is as for the Part I of the M.Sc. Degree Programme with course work and a research component.

**Tuition Fee for Postgraduate Diploma Programme:**
Tuition fee is as for the Part I of the M.Sc. Degree Programme with course work and a research component.

## 6.0 Evaluation Procedure

For the three postgraduate programmes (M.Sc. and MIEC Degree Programmes, and Postgraduate Diploma)

- All theory courses, the laboratory course, research project (where applicable), case study and the industrial training will be evaluated according to the criteria given in the syllabi.
- Each course unit will carry a maximum of 100 marks.
- A grade is assigned to each course unit depending on the overall performance of the course unit.
- The method of evaluation will be announced by the Department at the commencement of the particular course unit.

A candidate is entitled to receive a transcript giving grades obtained for each paper of the above examination after the confirmation of the results by the Senate of the University of Kelaniya.

### 6.1.1 M.Sc. Degree Programme with Course Work and a Research Component

**Part I**
A candidate registered for the M. Sc. Degree Programme with course work and a research component must obtain a minimum grade of **B**$^{-}$ in each prescribed course unit with a minimum cumulative **GPA** of 2.7 to pass Part I of M. Sc. Degree Programme with course work and a research component.

**Part II:**

- The research project in Part II will be evaluated through continuous assessments of the progress, presentations, quarterly progress reports, dissertation and *viva-voce* examination. The percentage weight of each component in the evaluation of Part II will be announced by the Department before the commencement of Part II.
- The dissertation should be submitted at the end of the second academic year.
- A candidate must obtain a minimum grade of **B**$^{-}$ to pass Part II of the M. Sc. Degree Programme with course work and a research component.

### 6.1.2 MIEC Degree Programme with Course Work Only

A candidate registered for the **MIEC** Degree Programme with course work must obtain a minimum grade of **B**$^{-}$ in each prescribed course unit (Part I of M.Sc. Degree Programme with course work and a research component) with a minimum cumulative **GPA** of 2.7 to pass MIEC Degree Programme with course work.

### 6.1.3 Postgraduate Diploma

A candidate registered for the Postgraduate Diploma must obtain a minimum grade of C in each prescribed course unit with a minimum cumulative GPA of 2.3 to pass the Postgraduate Diploma. To complete the Postgraduate Diploma a student should accumulate 25 credits from Part I including all core courses.

### 6.2 Grading System

Marks obtained in respect of a course unit will be graded according to Table II. A Grade Point Value as indicated in table II is assigned to each grade. Students should sit for the examinations in all the course units as indicated in Table I.

**Table II: Grading System**

| Range of Marks | Grade | Grade Point Value |
|---|---|---|
| 85- 100 | $A^+$ | 4.0 |
| 70-84 | A | 4.0 |
| 65-69 | $A^-$ | 3.7 |
| 60-64 | $B^+$ | 3.3 |
| 55-59 | B | 3.0 |
| 50-54 | $B^-$ | 2.7 |
| 45-49 | $C^+$ | 2.3 |
| 40-44 | C | 2.0 |
| 35-39 | $C^-$ | 1.7 |
| 30-34 | $D^+$ | 1.3 |
| 25-29 | D | 1.0 |
| 00-24 | E | 0.0 |

### 6.3 Re-sit Examination for Postgraduate Programmes

- A candidate who obtains a grade below $B^-$ in a particular course unit may re-sit the examination in respect of the course unit for the purpose of passing and the best grade obtainable at a re-sit examination is $B^-$.
- In the event a candidate obtains a lower grade while attempting to improve the grade he/she will be entitled to the previous grade.
- A candidate is required to pay Rs. 1000.00 for re-sitting of the examination for each theory course unit and Rs. 20,000.00 for repeating the laboratory course unit.
- A candidate repeating the examination or submitting the dissertation after the end of the second year is required to pay Rs. 5000.00 as registration fee for each year of extension.
- Candidates who are referred in a laboratory course unit should follow the laboratory course unit again with the following batch of students.
- Candidate should re-sit for the selected papers in the M.Sc. and MIEC Degree Programme or in the Postgraduate Diploma at the next examination and the maximum number of re-sit examinations permitted will be **three.**

### 6.4 Grade Point Average

Grade Point Average (GPA) is the credit-weighted arithmetic mean of the Grade Point Values, i.e. the GPA is determined by dividing the total credit-weighted Grade Point Value by the total number of credits.

GPA shall be computed to the second decimal place.

Example: A student who has completed one course unit with two credits, three course units each of three credits and two course units each of one credit with grades A, C, B, D, $C^+$, and $A^+$ respectively would have GPA of 2.48 as calculated below:

$$\text{GPA} = \frac{(2 \times 4.0) + (3 \times 2.0) + (3 \times 3.0) + (3 \times 1.0) + (1 \times 2.3) + (1 \times 4.0)}{2 + 3 + 3 + 3 + 1 + 1}$$

$$= \frac{32.3}{13} = 2.4846$$

$$= 2.48 \text{ (to the second decimal place)}$$

All the prescribed course units for the programme (table I) will be taken into account in calculating the GPA for the award of the M.Sc. Degrees (Part I and Part II) and the Postgraduate Diploma .

## 7.0 Criteria for the Award of the M.Sc. Degree in Industrial and Environmental Chemistry Programme

**Pass**

A student registered for the M.Sc. Degree Programme with course work and a research component will be awarded the **M.Sc. Degree in Industrial and Environmental Chemistry (**with course work and a research component) if he/she satisfies the following requirements:

(i) accumulated 30 credits in Part I and 30 credits in Part II.
(ii) obtained grades of **B**$^-$ or better in all course units in Part I and a minimum cumulative GPA of 2.7 in Part I.
(iii) obtained a grade of **B**$^-$ or better in Part II.
(iv) completed the relevant requirements within a period of **four academic** years.

**Merit Pass**

A student registered for the M.Sc. Degree Programme will be awarded the M.Sc. Degree in Industrial and Environmental Chemistry with distinction if he/she satisfies all the following conditions:

(i) accumulated 30 credits in Part I and 30 credits in Part II.
(ii) obtained grades **B** or better in all course units in Part I.
(iii) obtained a grade of **A** or better in Part II.
(iv) obtained a minimum cumulative GPA of 3.7 from all course units in Part I and Part II.
(v) completed the relevant requirements within a period of **two academic** years.

A candidate is entitled to receive a transcript giving grades obtained for each paper of the above examination after the confirmation of the results by the Senate of the University of Kelaniya.

## 8.0 Criteria for the Award of the Master of Industrial and Environmental Chemistry (MIEC) Degree Programme

**Pass**

A student registered for the Master of Industrial and Environmental Chemistry (MIEC) Degree Programme will be awarded the **Master of Industrial and Environmental Chemistry (MIEC)** Degree if he/she satisfies the following requirements:

(i) accumulated 30 credits in Part I

(ii) obtained grades of **B**$^{-}$ or better in all course units in Part I and a minimum cumulative GPA of 2.7 in Part I.

(iii) completed the relevant requirements within a period of **four academic** years.

**Merit Pass**

A student registered for the Master of Industrial and Environmental Chemistry (MIEC) Degree Programme will be awarded the Master of Industrial and Environmental Chemistry (MIEC) Degree with distinction if he/she satisfies all the following conditions:

(i) accumulated 30 credits in Part I and

(ii) obtained grades **B** or better in all course units in Part I.

(iii) obtained a minimum cumulative GPA of 3.7 from all course units in Part I

(iv) completed the relevant requirements within a period of **one academic** year.

A candidate is entitled to receive a transcript giving grades obtained for each paper of the above examination after the confirmation of the results by the Senate of the University of Kelaniya.

## 9.0 Criteria for the Award of the Postgraduate Diploma in Industrial and Environmental Chemistry

A student registered for the Postgraduate Diploma will be awarded the Postgraduate Diploma in Industrial and Environmental Chemistry if he/she satisfies the following conditions

(i) accumulated 25 credits in the registered course units from Part I including all core courses.

(ii) obtained grades of B- or better in 25 registered course units from Part I including all core courses.

(iii) obtained a minimum cumulative GPA of 2.7 from 25 registered course units from Part I including all core courses

(iv) completed the relevant requirements within a period of four academic years.

A candidate is entitled to receive a transcript giving grades obtained for each paper of the above examination after the confirmation of the results by the Senate of the University of Kelaniya.

## 10.0 Multiple Options in Postgraduate Programmes

(i) A student who had registered for the M.Sc. Degree in Industrial and Environmental Chemistry and had obtained a minimum grade of B- in all the prescribed course units

in Part I and accumulated a minimum cumulative GPA of 2.7 could apply for Master of Industrial and Environmental Chemistry (MIEC) Degree.

(ii) A student who had registered for the M.Sc. Degree in Industrial and Environmental Chemistry but not eligible to obtain MSc or MIEC Degree may apply for the Postgraduate Diploma in Industrial and Environmental Chemistry if he/she satisfies the conditions in 9.0.

## 11.0 Syllabi

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
**Course Code** **:** INEC 54712
**Title** **:** Principles of Industrial Chemistry

**Learning outcomes:**
By the end of this course the students will be able to
(i) describe and discuss the principles of process development, principles and applications of transport processes in industry and unit operations in chemical industries
and
(ii) demonstrate the knowledge and understanding of principles of chemical reactor design.

**Course content:**
**Process Development:** Development of a chemical process, material and energy balances, flow sheeting

**Principles and Applications of Transport Process:** Fluid flow and power requirement for pumping of fluids, heat transfer mechanisms and application of heat exchangers in chemical industry, principles of mass transfer (molecular diffusion, two film theory)

**Unit Operation in Chemical Industries:** Concept of unit operation, application of unit operation in chemical industries, design of process equipment: distillation, absorption, liquid – liquid extraction, evaporation, mixing

**Introduction to Chemical Reactor Design:** Chemical kinetics (kinetics of irreversible, reversible, parallel and series reactions), ideal reactors (batch reactors, plug-flow reactors, continuous stirred tank reactors),reactor design (bio-reactors, enzyme kinetics and enzyme reactor design, cellular kinetics, fermentor design etc.)

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.

**Assessments:** In-course assessments through evaluation of assignments and end of

course written examination.

**Recommended reading:**

(i) Coulson J.M. and Richadson J. F. (1983). Chemical Engineering Volume 1-6, Pergamon Press.
(ii) Levenspiel O. (1999). Chemical Reactor Engineering 3rd Edition, John Wiley, New York.
(iii) Anderson, L.B. and Wenzel L.A. (1961). Introduction to Chemical Engineering, McGraw- Hill.

**********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes) and Postgraduate Diploma)
Optional Course (Postgraduate Diploma)
**Course Code** **:** INEC 54723
**Title** **:** Polymers and Polymer Related Materials

**Learning outcomes:**

By the end of this course the students will be able to

(i) demonstrate the knowledge and understanding of the principles of polymer chemistry, latex technology, rubber technology, plastic technology and industrially important polymers

and

(ii) critically discuss the degradation, stability and recycling of [polymer based products.

**Course content:**

**Introduction to Polymer Chemistry:** The origin of polymer chemistry and the polymer industry, basic definition and nomenclature, molar mass and degree of polymerization, step-reaction polymerization, chain polymerization, ionic and coordination polymerization, copolymerization, polymerization process, properties of solution, thermodynamics, molecular weight determination, chemical structure determination, morphology, mechanical properties, thermal properties.

**Latex Technology:** Preservation, centrifuging process, compounding, vulcanization and manufacture of dipped products, latex foam products, casting.

**Rubber Technology:** Types of natural rubber (RSS, crepe etc.), compounding, vulcanization, fillers, derivatives of natural rubber (chlorinated rubber, epoxidized rubber etc.), polybutadiene rubber, butyl rubber, styrene-butadiene rubber, nitrile rubber, manufacture of dry rubber- based products.

**Plastic Technology:** Processing methods, multipolymer systems and composites, additives and compounding, coupling agents

**Industrially Important Polymers:** Polyethylene, polypropylene, polyvinyl chloride, polystyrene, engineering plastics, thermosetting plastics, natural and synthetic rubber, polyurethanes, high-temperature polymers, phenolic resins, polyesters, silicone resins, biodegradable polymers. Application of polymers in adhesives, coatings and paints, detergents, lacquers.

**Polymer Degradation, Stabilization and Recycling:** Practical significant of polymer degradation, thermal degradation, photo-degradation, oxidation of polymers, antioxidants

and stabilizers, degradation and fire hazard, degradation in special environment and recycling of polymers.

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.
**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading:**
(i) Rawe A. (1995). Principles of Polymer Chemistry, Plenum.
(ii) Billmeyer F.W. (1984). Text Book of Polymer Science, John Wiley.
(iii) Young R.J. and Lovell P.A. (1991). Introduction to Polymers, Chapman Hall.

**********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
**Course Code** **:** INEC 54733
**Title** **:** Food Chemistry, Herbal Health Products and Agrochemicals

**Learning outcomes:**
By the end of this course the students will be able to
(i) explain and discuss the chemistry in food processing industries, food regulations, quality control and quality assurance of processed food
(ii) explain and discuss the chemistry in relation to processing of herbal health product industry
and
(iii) demonstrate knowledge and understanding on types of agrochemicals , formulation, degradation and residual analysis of agrochemicals

**Course content:**
**(a) Food Chemistry:**
**Introduction:** Constituents in food (nutrients and non nutrients including toxic substances in food)

**Food ProcessingIndustry**: Unit operations in food processing, effect of food processing on nutrition, food storage, food spoilage and deterioration, post harvest technology, value addition to raw materials (milk, fruits, vegetables, cereals, legumes, root tubers, oil seeds, fish, meat, spices, essential oils, tea, coffee, cocoa, coconut, vegetable oils, sugars and confectionaries, sea weed polysaccharides, carbonated beverages), machinery and equipment used, functional food.

**Consumer Protection:** Food regulations, quality assurance including sensory evaluation, Hazard Analysis Critical and Control Points (HACCP), packaging and labeling including nutrition labeling.

**(b) Herbal Health Products:** Raw materials (collection, authentification and storage), processing technology, production, processing, formulation, standardization and quality control and quality assurance of natural herbal products including Ayurvedic products.

**(c) Agrochemical Industry:** Introduction (need for agrochemicals, classification), formulation, degradation and residual analysis of agrochemicals.

**Method of teaching and learning:** A combination of lectures, tutorials,

assignments and discussions.

**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading:**


(i) Manual of Chemical Industries in Sri Lanka (1986). Part I, Institute of Chemistry, Ceylon.
(ii) Richardson T. and Finley J.W. (1985). Chemical Changes in Food During Processing, Chapman and Hall.
(iii) Potter N. N. and Hotchkiss J.H. (1995). Food Science, Chapman and Hall.
(iv) Food Act No. 26 of 1980, Sri Lanka.
(v) Hassel K.A. (1990). The Biochemistry and Uses of Pesticides, 2nd Edition, Macmillan.
(vi) Green M.B., Hartley G.S. and West T. F. (1987). Chemicals for Crop Improvements and pest Management, 3rd Edition, Pergaman.
(vii) Coping, L.G. and Hewitt H.G. (1998). Chemistry and Mode of Action of Crop Protection Agents, Royal Society of Chemistry.
(viii) Pesticide Formulation, Recent Developments and Their Applications in Developing Countries (1998). Ed. Valkenburg W.V., Sugavanam B. and Khetan S. K., UNIDO, Vienna.


**********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
**Course Code** **:** INEC 54743
**Title** **:** Earth resources and Metal Based Industries

**Learning outcomes:**
By the end of this course the students will be able to explain and discuss the chemistry involved in processing of minerals and deposits of commercial value, petroleum based industries, textile and metal based industries.

**Course content:**

**(a)Earth Resources**

**Mineral Industry:** Chemistry and identification of mineral resources (ores and deposits) in Sri Lanka, physical and chemical processing of minerals and deposits of commercial value (clays, calcareous materials, siliconous materials, appetite, graphite, feldspar, mica, dimension stones, gems, salt and beach sand)

**Petrochemical Industry:** Petroleum cracking, refining, catalysts and petroleum based industries (coal, natural gas etc.)

**(b) Metal Based Industries:** Chemistry of alloying of steel, aluminum, copper, magnesium, nickel, titanium, zinc and electroplating industry.

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.

**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading:**

(i) Riegel's Handbook of Industrial Chemistry (1997). Ed. J. A. Kent, Chapmann and Hall
(ii) Budinski K.G. and Budinski M.K. (2006). Engineering Materials-Properties and Selection, Prentice Hall.
(iii) Wills B.A. (1992). Mineral Processing Technology, Pergamon Press.
(iv) Jones M.P. Applied Mineralogy – A Quantitative Approach, Graham and Trotman Publisher Group.
(v) The Petroleum Handbook (1983). Shell Co, Elsvier
(vi) Bird, C.L., The Theory of Coloration of Textiles (1975). Dyers Publication.

**********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes)
Optional Course (Postgraduate Diploma)
**Course Code** **:** INEC 54753
**Title** **:** Management Concepts for Industry

**Learning outcomes:**
By the end of this course the students will be able to demonstrate knowledge and understanding of principles of management, marketing management and new product development and appraise the benefits of proper management practices in industries.

**Course content:**
**Principles of Management :**An overview of management and the role of a manager in a competitive environment, motivation theories

**Marketing Management and New Product Development:** Growth of marketing concepts in the consumer and industrial markets, behaviour and trends in the two sectors, marketing mix and its application to industrial markets, basics in preparing a marketing plan and marketing research for industrialization,entrepreneurship and marketing.

**Accounting and Financial Management:** Introduction to Accounting,Analysis of financial statements,Project Evaluation: Time value of money, understanding of risk and return, financial planning and management.

**Quality Management:** Concept of total quality management systems, quality control systems, standardization and its principles, practices on quality control and standardization, 7 quality control tools.

**New Product Development and Industrial Economics:** Cost of producing chemicals, variable costs (e.g. raw materials), energy input costs, fixed costs, labour costs, depreciation. Direct, indirect and capital related costs, profits, effects of scale operation, effect of low rate operation, diminishing return, measuring profitability, time value of money, project evaluation, resources for R & D activities.

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.

**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading;**

**(**i) Cottler P. and.Keller K.L (2005). Marketing Management, Pronto Hall.
(ii) Wood F. (2005). Buisness Accounting Frank WoodPrentice Hall.

**********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
**Course Code** **:** INEC 54762
**Title** **:** Soil Chemistry and Terrestrial Pollution

**Learning outcomes:**
By the end of this course the students will be able to
(i) explain and discuss soil formation, constituent and properties of soil
and
(ii) critically analyse the terrestrial pollutants and issues of solid and hazard wastes
and
(iii) develop basic management plans for handling solid and hazardous wastes

**Course content:**

**Introduction:** General concepts of environment quality (air, water, soil interface), impact of climatic variables and human impacts (e.g. agriculture, industries, transport), overview of environmental policy, planning and management.

**Soil as an Environmental Component:** Soil formation, constituents (minerals, organic matter), properties and reactions (permeability, pH, redox conditions, water holding capacity, salinity, adsorption of cations, anions, adsorption and desorption of organic matters, acid – base reactions, ion-exchange reactions)

**Terrestrial Pollution and Management of Solid and Hazardous wastes:** Sources of land contaminants, interrelation between liquid and solid waste, status of solid waste management in Sri Lanka, capacity mobilization of solid waste, types of hazardous waste, impact of hazardous waste on environment, available technologies for solid waste and hazardous waste management, minimization of solid waste, methods of site investigation and interpretation of site investigation data, regulations on management of solid and hazardous waste, case study of handling solid waste from an industry.

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.
**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading:**
(i) Beer F.E. (1992). Chemistry of Soil, Oxford and IBH Publishing Group.
(ii) Evangelo V.P. (1998). Environmental Soil and Water Chemistry- Principles and Applications, John Wiley and Sons.
(iii) Bohn H.L., Mcneal B.L. and O'Connor (1979). Soil Chemistry, John Wiley

**********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)

**Course Code** **:** INEC 54772
**Title** **:** Atmospheric Pollution and Air Quality Management

**Learning outcomes:**
By the end of this course the students will be able to
(i) explain and discuss the chemistry of the atmosphere and critically discuss air pollution problems, radioactive pollution, noise pollution and thermal pollution
and
(ii) critically discuss and evaluate methodologies of air quality management.

**Course content:**
**Chemistry of Atmosphere**: Physical and chemical structure of the atmosphere (temperature structure, regions of the atmosphere, pressure profiles, mixing ratios), chemistry of stratosphere and troposphere, sources and transformations of tropospheric and stratospheric aerosols.

**Air Pollution:** Sources of natural and anthropogenic atmospheric pollutants and their sinks, gas laws governing the behaviour of pollutants in the atmosphere, significance of atmospheric pollutants, chemical and photochemical reactions of pollutants in the atmosphere (hydroxyl radicals, PAN, acid rain, oxidizing and reducing smog, ozone depletion, green house effect), transport and dispersion of pollutants, effect of air pollutants on health and ecosystem including indoor and urban air quality.

**Radioactive Pollution**: Sources of radioactive emissions (man-made, natural), measurement of radiation, biological effect of radiation, radioactive wastes and their disposal, use of radioactive sources in industry.

**Noise and Thermal Pollution:** Sources, measurement of noise levels and levels of thermal pollution and their control in industry, sound screen and their effect on atmospheric dispersion control, industrial standards for noise and thermal emission levels.

**Air Quality Management:** Trends and present status of air quality including indoor air, international air quality standards, air quality regulations in Sri Lanka, techniques in air sampling and pollution measurements, ambient air quality and emission standards, pollution control principles, dispersion in air, removal of gaseous pollutants (adsorption, absorption etc.), particulate emission control (settling chambers, cyclone separation, wet collectors, fabric filters, electrostatic precipitators etc.).

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.
**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading:**
(i) Barbara J. Finlayson-Pitts (1999). Chemistry of the Upper and Lower Atmosphere, Academic Press Inc.
(ii) Manahan S.E. (2000). Fundamentals of Environmental Chemistry, Lewis Publishers
(iii) Keith L.H. (1996). Principles of Environmental Sampling, American Chemical Society
(iv) Leiser K.H. (1970). Nuclear and Radiochemistry, VCH.

********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma),
**Course Code** **:** INEC 54782
**Title** **:** Aquatic Pollution and Water Quality Management

**Learning outcomes:**
By the end of this course the students will be able to
(i) explain and discuss the chemistry of aquatic pollution
and
(ii) critically discuss and evaluate methodologies of water quality management

**Course content:**
**Introduction to Aquatic Chemistry:** Effects of solutes (organic and inorganic including trace metals) on physical properties of rain water and ground water, dissolution and precipitation reactions. coordination, complexation and chelation reactions, water–air exchange and global distillation.

**Chemical Speciation:** Species distribution in fresh water, effect of pH and pε on species distribution.

**Pollutants in Water:** Sources and characteristics of industrial and agricultural waste water (inorganic, organic, algae, sewage, thermal, eutrophication and the effect on the environment, reactions due to pollutants (effect of pH and salinity on water pollution, oxidation and reducing reaction).

**Water Quality Management:** Water quality characteristics, methods of monitoring water quality, effluent discharge standards including ISO 14000 certification, water treatment technologies (physical, chemical and biological), primary, secondary, tertiary treatment of effluents from industry with special reference to rubber, desiccated coconut, electroplating, textile and food. Sewage and industrial waste water treatment plants. .

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.
**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading:**
(i) Stumm W. and Morgan J.J. (1981). Aquatic Chemistry, John Wiley.
(ii) Huang C.P., O'nelia C.P. and Morgan J.J. (1995). Aquatic Chemistry – Interfacial and Interspecies Process, American Chemical Society.
(iii) Williams I. (2001). Environmental Chemistry, John Wiley.
(iv) Harrison R. M. (1998). Understanding of Our Environment-Introduction to environmental Chemistry and Pollution, Royal Society of Chemistry.

*********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
**Course Code** **:** INEC 54792
**Title** **:** Environmental Toxicology and Environmental Regulations

**Learning outcomes:**
By the end of the course the students will be able to
(i) discuss the manner in which anthropogenic pollutants interact with humans and how they affect the quality of their lives.
(ii) assess, predict and evaluate the risks posed by toxic chemicals and energy in the management of the environment.
(iii)discuss environment policies and legislations in Sri Lanka

**Course content:**
**(a) Environnemental Toxicology:**
Introduction (terminologies used in toxicity evaluations, dose-response curves, bioaccumulation and biomagnification), metabolism of xenobiotics (phase I and II) reactions, biochemical and toxicology effects due to heavy metals, agrochemicals, oxides of carbon, nitrogen, sulphur, ozone, cyanides and organic pollutants, environmental factors affecting toxicity, testing of toxicity (bioassays, teratogenicity, carcinogenicity and mutagenicity), occupational health hazards, absorption, distribution and excretion of toxic chemicals, toxicological evaluation, air, water, soil and radioactive pollution (case study Pullmudai sands) on health effects, risk management and assessment, occupational safety, environmental impact on use of energy.

**(b) Environmental Regulations**
Constitutional provision relating to the protection of environment, principles and case laws relating to the environment, provision of the National Environmental Law, Environmental standards, role of Central Environmental Authority and contribution of judiciary towards protection of the environment.

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.
**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading;**
(i) Wright D.A. and Welbourn P. (2002). Environmental Toxicology, Cambridge.
(ii) Amdar O.M., Doull J. and Kalssen C. D. (1992). Toxicology; The Basic Science of Poisoning, McGraw-Hill.
(iii) National Environmental act No. 47 of 1980 as amended by Act Nos. 56 of 1988 and 53 of 2000.
(iv) SouthAsia Co-operative Environmental Programme, Report of the Regional Symposium on the Role Judiciary in promoting the Role of law in the Area of Sustainable Development.
(v) Relevant Articles of the Constitution of the Democratic Socialist Republic of Sri Lanka (article no. will be recommended during the course).

********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes)
Optional Course (Postgraduate Diploma)
**Course Code** **:** INEC 54802
**Title** **:** Industry, Environment and Biotechnology

**Learning outcomes:**

Bythe end of the course the students will be able to

(i) appraise the benefits of cleaner production concepts to minimize pollution in industry and

(ii) discuss the importance of biotechnology in industry and in protecting the environment

**Course content:**

**(a) Cleaner Production:**

Introduction (meaning of cleaner production, need for implementing cleaner production for industrialists), cleaner production audit methodology, benefits of cleaner production to industrialists and public, tools and techniques of cleaner production, resource mapping and material flow analysis, life cycle of products (ecodesign), other tools for protective environmental management, recycling and reuse of waste.

**(b) Biotechnology:**

**Introduction:** Scope and importance of biotechnology in industry and in environmental management, introduction to gene technology, bioethics and safety.

**Industrial Biotechnology:** Uses of enzymes in industry {enzyme engineering, bio-transformations and bioprocess (metabolic) engineering, bioreactors}, uses of microorganisms in industry and in agriculture (microbial transformations and fomenters, production of fermented food, chemicals, enzymes and medicines, biomineralization process, development of biofertilizers and biopesticides), applications of genetically modified bacteria in industry and food.

**Biotechnology and the Environment:** Use of plants and microbes in environmental clean up and in pollution control, biological waste water treatment systems, use of aerobic/anaerobic microbial degradation processes in industrial waste treatment, microbial composting process, biomarkers, biosensors to detect environmental pollutants, bioremediation and environmental sustainability, renewable source of energy, recycling of waste material, biogas and energy crops, biofuel and energy generation, need for energy conservation, reforestation, development of stress tolerant plants, use of beneficial microbes to improve soil quality and fertility, importance of maintaining biodiversity; extinct, endangered and threatened flora and fauna and need for their conservation.

**Method of teaching and learning:** A combination of lectures, tutorials, assignments and discussions.

**Assessments:** In-course assessments through evaluation of assignments and end of course written examination.

**Recommended reading**:


(i) Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production (1999).World Bank,U.S.

(ii) Higgins J., Best D.J. and Jones J. (1985). Biotechnology Principles and Applications, Ed, Blackwell Scientific Publishing.

(iii) Hill D.J., Keith S.M. Leach C.K, Middelbeek E, van Dam-Mieras C.E., Montgomery S.E, Shales S.W, and Miijnbeekh (1994). Biotechnological Innovations in Energy and Environmental Management, Butterworth-Heinemann.

(iv) Smith J.E, (1997). Biotechnology, Cambridge University Press.

(v) Priest F.G, (1987). Introduction to Biotechnology, Blackwell Publishing.

(vi) Dubey R.C. (1996). A Text Book of Biotechnology, Chand & Co Ltd.

(vii) Kumar H.D. (2001), Modern Concepts of Biotechnology, VikasPpublishing.

********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes and Postgraduate Diploma)
**Course Code** **:** INEC 54814
**Title** : Techniques in Industrial and Environmental Chemistry (Laboratory)

**Learning outcomes:**
By the end of the course unit the students will be able to
(i) demonstrate skills in sampling , processing, preservation of environmental samples, quality assurance and quality control procedures in performance of analytical instruments
(ii) use of analytical instruments in environmental pollution analysis and in the field of selected industries
(iii) critically analyse and interpret scientific data

**Course content:**
Sampling, handling and preservation of environmental samples calibration and performance check of analytical systems, quality management of laboratory equipment and supplies, selection of approved analytical methods, method development and their validation, data evaluation, statistical analysis, transformation of data and report presentation. Project designing, environmental assessments, monitoring, evaluation and prediction, modeling for environmental management. Use of flame photometry, atomic absorption spectrometry, gas liquid chromatography, high performance liquid chromatography, ion exchange chromatography, ultra violet–visible spectroscopy, infra red spectroscopy, x-ray fluorescence spectrometry, potentiometry, voltammetry, coulometry, radiochemistry, electrophoresis in environmental pollution analysis and in experiments in the fields of polymer chemistry, food chemistry, mineral chemistry, petroleum chemistry and biochemistry.

**Method of teaching and learning:** Laboratory experiments, field visits, assignments and laboratory reports

**Assessments:** Continuous assessments, laboratory reports, assignments

**Recommended reading:**
(i) Radojevic M. and Baslikin (1999). Practical Environmental Analysis, Royal Society of Chemistry.
(ii) Official Methods of AOAC International (1999). Vol I and II, AOAC International.
(iii) Skoog D.A., Holler F.J. and Nieman T.A. (1998)., Principles of Instrumental
(iv) Analysis, SaunderCollege Publishing
(v) Standard Methods for Water and Waste Water Analysis (1998),edited Clescri L.S., Greenber A.E. and Eaton A.D.

********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes)
Optional Course (Postgraduate Diploma)
**Course Code** **:** INEC 54821
**Title** **:** Case Studies

**Learning outcomes:**

By the end of the course students will be able to demonstrate skills to analyse a real world environmental and industrial problem in a scientific manner

**Course content:**
Students should identify, analyze, submit a report and make a presentation on an issue relating to environment pollution or a problem related to chemistry, in an industry and possible solutions to the problem investigated. Case study will be carried out under the guidance of a senior academic.

**Method of teaching and learning:** Literature survey, field study, discussions, data analysis, problem solving and report writing.
**Assessment:** Report, presentation and oral examination

**Recommended reading:** Reference material relevant to the case study

********

**Type/Status** **:** Core Course (M.Sc. Degree Programmes)
Optional Course (Postgraduate Diploma)
**Course Code** **:** INEC 54831
**Title** **:** Industrial Training

**Learning outcomes:**
By the end of the course the students will be able to discuss the functions of an industry, its management and suggest improvements by SWOT analysis.

**Course content:**
Students are expected to visit at least **three** industries acceptable to the Department of Chemistry and submit a report and a presentation on **one** such visit. The report should contain the manufacturing process including the chemistry involved, energy balance, waste management process, safety factors, suggestions for improvement by SWOT analysis, application of quality management and environmental management systems and process diagrams.

**Method of teaching and learning:** Self study, discussions, industrial visits.
**Assessment:** Report, presentation and oral examination.

**********

**Type/Status** **:** Core Course (M.Sc. Degree Programme with course work and a research component)
**Course Code** **:** INEC 6384W
**Title** **:** Research Project

**Learning outcomes:**
By the end of the course the students will be able to demonstrate skills to plan and carry out a research project independently according to the scientific method, analyse the experimental data, interpret and report the data in a scientific manner in the form of a dissertation.

**Course content:**

The research project in an area related to environment or industry is assigned to the student. Research should be carried out on full time basis for at least 10 months.

**Method of teaching and learning:** Literature survey, laboratory and/or field work, data analysis and interpretation, dissertation, presentations

**Assessment:** Continuous assessments, dissertation, progress reports, presentations, *viva - voce* examination.

**Recommended reading :** Reference material relevant to each research project.

********