MINISTRY OF SCIENCE AND HIGHER EDUCATION

# CURRICULUM OF BACHELOR OF SCIENCE IN CHEMISTRY

## Revised by Jimma University Chemistry Department Staffs


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## Table of Contents

## 1. Introduction

Chemical sciences play key role in improving the living standard of the society in the world. Particularly, the knowledge of chemistry is indispensable in understanding many areas of related disciplines such as biology, medicine, materials science, etc. The achievement means depend on the educational system that able to produce professionals acquaint with chemical knowledge. Therefore, the education system of a country must be established with well-structured curriculum that able to achieve the mission, vision and goals of the country with regard to the development of modern industrialization. Over the years, since the beginning of modern education in Ethiopia, chemistry curriculums have been prepared and implemented in schools and universities all over the country. But, in line with time to time progress of the science and development of the country, the demand of chemists in different sectors such as manufacturing, regulatory, research centers, etc are increased. Thus, to produce highly qualified and upgraded graduates the curriculum needs to be revised and harmonized.

For more than a decade, harmonized chemistry curriculum has been used to offer bachelor degree in three academic year's program. But, the curriculum has several limitations in terms of course contents and study durations. To alleviate these limitations, the ministry of Science and Higher Education (MoSHE) has taken the initiative to revise the existing harmonized curriculum, as also recommended in the new educational road map of the country. This revision involves change of study duration from three to four academic years, incorporation of additional common courses and modification of major chemistry course contents that can fill the observed limitations.

In general, this revised curriculum contains:

1. A total of 146 cr. hrs/241 ECTS from four different classes of core courses: Core common courses (48 cr hrs/76 ECTS), Core major chemistry courses (74 Cr. Hrs/125 ECTS), Core elective course (3 Cr. Hrs/5ECTS) and Core supportive courses (21 Cr. Hrs/35 ECTS).
2. Several new core common courses, for example Global affairs, Economics, Inclusiveness, General psychology, History of Ethiopia and the Horn, etc.; a new major chemistry course

introduction to material chemistry; a new elective course which is given the following courses (Chemistry of Consumer Products, Food Safety and Analysis**,** Chemistry of Natural Products. Synthetic Organic Chemistry, Forensic Chemistry, or Agricultural Chemistry) c based on the choice/interest students'), and

3. Industrial attachment for about 4 – 6 weeks (during summer vacation) is recommended as a partial fulfillment of industrial chemistry II course.

In conclusion, this revised harmonized curriculum is designed and updated to provide chemistry BSc graduates with a strong foundation in principles, formulations, and applications of chemical knowledge during theoretical presentations and practical works. Besides, it also fills the observed gaps of the graduates' knowledge about the history of their country, socio-economic interaction, geo-economic blended nature, diversified and integrated culture, as well as unity of the people of Ethiopia from where they originate.

## 2. Rationale for the Curriculum

One of the major challenges of Ethiopian higher education is the relevance of the existing curriculum as indicated in the roadmap. The existing curriculum has several drawbacks as mentioned in the roadmap as well as the curriculum framework. For instance, the curriculum could not properly address national unity among graduates, critical thinking, important non-cognitive skills, employability skills, communication skills, global outlook, digital literacy and so on. Moreover, duration of the training program, i.e., the three years undergraduate (BSc) program, has also highly criticized, to offer quality education. To alleviate such problems Ministry of Science and Higher Education MoSHE has taken the initiative to revise the higher education curriculum. Accordingly, chemistry curriculum is revised to fill the gaps that have been mentioned in the roadmap. Besides, attention should be given on the core major chemistry contents to produce competent BSc chemistry graduates both in theoretical knowledge and practical skills.

In general, the currently used curriculum for chemistry BSc program need revision for several reasons including:

- The curriculum lacks the 21$^{st}$ century competencies of the graduates

- The curriculum lacks knowledge about the history, socio-economic, cultural and political environments, geo-economic integration and unity of the people of Ethiopia
- The curriculum lacks awareness creation on historical basis as well as the values of building and promoting national unity
- Low values and less maturations of psychological, moral and ethical characters
- Unsatisfactory chemical knowledge
- Incapability of applied (experimental) skills
- Poor communication skills
- Incompetence and poor desire in team works
- Poor comprehensive skills (critical thinking, analytical skills, creativity, and problem solving skills), etc.
- Lack of opportunities to visit selected historical areas and living styles of the people of Ethiopia other than where they came from
- Uneven coverage of content and allocated credit hours
- Lack of relevant teaching materials
- Lack of tailored supportive courses
- Less emphasis was given for science subjects in the university entrance examination
- Lack of interface between preparatory program and university
- Unavailability of institutions that train and produce laboratory technicians
- Mismatch between laboratory groups and existing facilities

Therefore, this new revised chemistry BSc curriculum is aimed to alleviate the aforementioned shortcomings. Furthermore, it will change the characteristics and competencies of the BSc graduates in chemistry in:

- Enhancing students positive understanding and commitment about the future of their country, Ethiopia
- Understanding the essentials of Ethiopian geography, society, cultures as well as the dynamic interrelationship of people
- Cultivate skills of leadership, communication, collaboration, negotiation and adaptability to new situations
- Interaction with other disciplines

- Increasingly complex problems
- More advanced techniques and instrumentation
- Global context and due to new research in how students learn (e.g., inquiry-based and active learning, team experiences)
- Ensuring production of quality graduates capable of satisfying the stakeholders' requirements.

## 3. Vision, Missions and Objectives

### 3.1. Vision

To see rational, productive and motivated chemistry graduates who explore and create knowledge to contribute to the national development and become globally competent by 2030.

### 3.2. Mission

To produce knowledgeable, skilled, morally matured and internationally competent chemistry graduates who contribute to the national development and solve societal problems through training, research and community engagement.

### 3.3. Objectives of the Program

The objectives of undergraduate program in chemistry are:

1. Produce well trained and skilled chemists those are capable of taking up positions in the growing demand of the various sectors of the economy such as various industries, learning institutions, and research institutions, as well as various environmental conservation endeavors of the country;
2. Disseminate knowledge in chemistry and related areas through active participation in related professional activities, such as Chemical Society of Ethiopia, Regional Networking, Workshops, Symposia and Publications
3. Develop capabilities for the provision of consultancy and technical services as well as short term specialized training to both public and private sectors

4. To produce chemists who create job opportunities by applying the acquired knowledge and skills.

## 4. Resource

### Staff profile

To teach chemistry undergraduate program, the academic staff should have at least a master's degree in chemistry or related field of study. Technical assistant should hold at least first degree in chemistry.

### Books

All the references and text books listed in the curriculum should be made available in the library.

### Laboratories

There should be separate working rooms for General, Analytical, Inorganic, Organic, Physical chemistry, Instrumental analysis, Computational and Research laboratories. The laboratory design (facilities and equipment) must consider the curricular details of the laboratory courses intended to be taught, the number of students per session, the services (electricity, water, gas, ventilation/ extraction, exhaust hood, waste disposal and computer facilities) required and the concerns about safety in the laboratory.

In addition to the main laboratory area for the arrangement of benches, teaching laboratory design must also consider media and sample preparation areas, housekeeping (e.g. glassware washing) facilities, emergency shower, eye wash, hand washing and storage locations. Further, staff room, office area, bathroom facilities and a centralized store for chemicals, consumables and spare parts are part of a comprehensive design.

## 5. Professional Profile

Upon completing the undergraduate study program in Chemistry, a graduate should develop scientific concepts, critical thinking and problem solving ability, effective communication skills and ethical responsibility with the appreciation of chemical concepts.

Successful graduates of chemistry generally can serve as

- Academicians serving as graduate assistant/teachers at secondary and tertiary levels.
- Research assistant in various research institutes related to agricultural, medical, environmental areas, etc.
- Analyst in various industries (chemical, food, pharmaceutical, leather, textile, mining etc), water quality analysis and forensic laboratories.
- Job creator by applying their chemical knowledge and skill.
- Resource person during design of policy related to chemical use.

## 6. Graduate Profile

Students who have completed an undergraduate degree in chemistry will have acquired education at advanced level, including: **Knowledge of chemistry, General intellectual and life skills and Values** that equip them for employment, citizenship and lay the foundations for a lifetime of continuous learning and personal development. The chemistry graduates are expected to have the following competencies:

### 6.1. Knowledge of Chemistry

- Master the fundamentals of chemistry including an understanding of broad conceptual and theoretical elements
- Possess an understanding and appreciation of the theoretical bases, methodologies and characteristics of learning of chemistry, research and creative work in chemistry
- An understanding and appreciation of current issues and debates in chemistry
- Continue further specialized educations
- Work as an industrial chemist in chemical processing industries
- Be a potential candidate of a chemistry teacher
- Serve as a research/graduate assistant in research / higher education institutions\
- Create job opportunities by the acquired chemical knowledge
- Contribute to the development of chemical industries with other professionals
- Enthusiastic about scientific ideas, discovery and learning
- Analyze and solve complex problems on chemistry issues

- Synthesize, characterize and study chemical compounds
- Have critical understanding of technical and scientific tools
- Mange and perform projects activities

## 6.2. General Intellectual and Life Skills

- Possess critical, conceptual and reflective thinking, intellectual openness and curiosity, creativity and originality
- Recognize when information is needed and locate, evaluate and use this information effectively
- An ability to access, identify, organize and communicate chemical knowledge effectively
- An ability to work independently as well as part of a team or group
- An ability to lead in the community, professional associations etc.
- An ability to undertake numerical calculations and understand quantitative information
- Perform qualitative and quantitative chemical analysis in chemical laboratories
- Work as quality controllers in industries
- Knowledgeable in IT and data processing skills in relation to chemical information
- Knowledge about the history, cultural and socital geo-economic integration of the people of Ethiopia

## 6.3. Values

- Value intellectual integrity, respect for truth and for the ethics of research and scholarly activity
- Demonstrate environmentally conscious attitude
- Conduct assigned and professional activities with integrity and professional ethics
- Contribute to the development of chemical industries with other professionals
- Disseminate chemical knowledge
- Enthusiastic about scientific ideas, discovery and learning
- Self-discipline and an ability to plan and achieve personal and professional goals
- Willingness to engage in constructive public discourse and to accept social and civic responsibilities

- Respect for the values of other individuals and groups, and an appreciation of human and cultural diversity
- An awareness of international and global dimensions of intellectual, political and economic activities, and behaving as a responsible citizen

## 7. Program Profile

Main aims of the program:

- To provide students with a broad and balanced foundation of chemical knowledge and practical skills
- To develop in students the ability to apply their chemical knowledge and skills to the solution of theoretical and practical problems in chemistry
- To encourage originality of thought
- To instill in students an appreciation of the importance of chemistry in an industrial, economic, environmental and social context
- To provide students with the fundamentals of chemistry so that they can proceed to further studies in specialized areas of chemistry or multidisciplinary areas involving chemistry

### 7.1. Admission Requirements

1) Minimum of 50% score on general education completion examination
2) Entrance exam prepared and administered by the university.
3) Diploma in chemistry from higher learning institutions fulfillment of the general University's admission requirements; and

### 7.2. Duration of the Study

The program shall be on the basis of four academic years of study and has 146 credit hours (241 ECTS).

### 7.3. Mode of Delivery

Parallel /semester

### 7.4. Method of Teaching

Teaching and learning process should be the blend of theoretical, practical, services learning and work place attachment. To achieve this, the following methods will be used:

- Lecture
- Tutorial and seminars
- Practical classes, field work, industrial visits
- Group or individual assignments
- Independent, web-based and computer assisted learning,
- Presentations and group discussion,
- Project work/Work place attachment
- Demonstration and observation

### 7.5. Assessment and Evaluation

Different assessment strategies will be employed to gather evidence about students' learning performances. Assessment of learning will be used in the program, classified into Diagnostic assessment, Formative assessment and Summative assessment

**1. Classroom diagnostic assessment**: are used to provide educators with information about students' prior knowledge, skills, attitudes, learning styles and motivation to assist them to develop an effective learning program that suits the educational needs of the learns.

**2. Formative assessment/Assessment for learning**

Assessment is a process where students are assessed as the teacher proceeds with a lesson or unit to provide ongoing feedback to the teachers and students. Example informal observation, checklist, listening to students' responses, class participation, self and peer assessment, quiz, test, home take activities, group work.

### 3. Summative evaluation/Assessment of learning

It is usefully done at certain point of the academic year or certain components such as completion of units to judge the appropriateness of what is being taught. Some of the methods used for summative assessment are chapter tests or unit tests, final examinations, term papers, projects and national examinations. Therefore students must take at least one quiz, one test, one mid examination and one final examination for each course. In addition, laboratory based and courses will be addressed accordingly. Assessment should focus on measuring as to whether students have achieved the required competencies (higher order skills, i.e. why, how, etc)

### 7.6. Class size

- For lectures: 40 - 60 students per class
- For practical (laboratory) activities: 25 – 35 students per class

### 7.7. Grading System

| Mark Interval [100 %] | Corresponding Fixed Number Grade | Corresponding Letter Grade | Status Description |
|---|---|---|---|
| [90,100] | 4 | A+ | Excellent |
| [85, 90) | 4 | A | |
| [75, 85) | 3 | B | Very Good |
| [50, 75) | 2 | C | Good |
| [40, 50) | 1 | D | Satisfactory |
| <40 | 0 | F | Fail |

***NB**: Assessment of achievement should focus on individual competence*

### 7.8. Graduation Requirement

| S. N | Description | Minimum Requirement |
|---|---|---|
| 1 | Cumulative GPA | 2.00 |
| 2 | Major GPA | 2.00 |
| 3 | No "F" in any course | |

### 7.9. Degree Nomenclature

#### i. In English

Bachelor of Science Degree (B. Sc) in Chemistry

#### ii. In Amharic

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## 8. Program Content and Organization

### 8.1. Categories of Courses

In this modern era, a Bachelor of Science in Chemistry program should contain different courses that will make the graduates competent in the field of the study. Accordingly, in this curriculum various courses including common courses which will be given to all bachelor degree programs in natural Sciences fields; Core chemistry Compulsory and Elective courses as well as Core Supportive Courses, which are so crucial for B. Sc. in chemistry are included. Details of the list of courses with their categories are presented in section 8.2.1.

### 8.2. Course coding (numbering) System

All chemistry courses including core compulsory and elective courses are coded with a four letters, **"Chem"**, with only the first letter in capital, followed by four-digit numbers, indicating:

a) The first digit indicates the year in which the courses are taken and thus, numbered as 1, 2, 3 and 4 for first, second, third and fourth year courses, respectively.

b) The 2nd and 3rd digits indicate module number/course categories.
   -01- for General Chemistry
   -02- for Analytical Chemistry
   -03- for Inorganic Chemistry
   -04- for organic Chemistry
   -05- for Physical Chemistry
   -11- for elective course
   -12- for applied chemistry courses
c) The last digit indicates the semester in which the course is delivered: “odd” for first semester and “even” for second semester;
d) For practical courses offered in the same semester with its lecture course, the next odd or even number is used;
e) For applied chemistry courses offered in the same semester, the next odd or even number is used.
d) There is single space between the letters code and the four digit numbers.

### 8.2.1. List of Courses

| Type of Courses | Course Name | Course code | Cr. Hrs | ECTS |
|---|---|---|---|---|
| **Core Common Courses** | Communicative English Language Skills I | FLEn 1011 | 3 | 5 |
| | General Physics | Phys-1011 | 3 (2 + 1) | 5 |
| | General Psychology | Psch 1011 | 3 | 5 |
| | Mathematics for Natural Sciences | Math 1011 | 3 | 5 |
| | Logic and Critical Thinking | Phil 1011 | 3 | 5 |
| | Physical Fitness | SpSc 1011 | P/F | 2 contact Hrs |
| | Geography of Ethiopia and the Horn | GeES 1011 | 3 | 5 |
| | Communicative English Language Skills II | FLEn 1012 | 3 | 5 |
| | Anthropology of Ethiopian Societies and Cultures | Anth 1012 | 2 | 4 |
| | General Biology | Biol 1012 | 3 (2+1) | 5 |
| | History of Ethiopia and the Horn | Hist. 1012 | 3 | 5 |
| | Introduction to Emerging Technologies | EmTe 1012 | 3 | 5 |
| | Moral and Civic Education | MCiE 1012 | 2 | 3 |
| | General Chemistry | Chem 1012 | 4 (3 + 1) | 7 |
| | Inclusiveness | Incl 2012 | 2 | 4 |
| | Economics | Econ 1105 | 3 | 5 |
| | Global Affairs | GlaF 2012 | 2 | 3 |
| | Entrepreneurship and Business Development | MGMT 4011 | 3 | 5 |
| | | **Sub-total** | **48** | **76** |
| **Core Major Courses** | Analytical Chemistry | Chem 2021 | 3 | 5 |
| | Practical Analytical Chemistry | Chem 2023 | 1 | 2 |
| | Instrumental Analysis I | Chem 3021 | 3 | 5 |
| | Practical Instrumental Analysis I | Chem 3023 | 1 | 2 |

| | | | | |
|---|---|---|---|---|
| | Instrumental Analysis II | Chem 3022 | 3 | 5 |
| | Practical Instrumental Analysis II | Chem 3024 | 1 | 2 |
| | Real Sample Analysis | Chem 4022 | 2 | 3 |
| | Inorganic Chemistry I | Chem 2032 | 3 | 5 |
| | Inorganic Chemistry II | Chem 3032 | 3 | 5 |
| | Practical Inorganic Chemistry I | Chem 3034 | 1 | 2 |
| | Inorganic Chemistry III | Chem 4031 | 4 | 7 |
| | Practical Inorganic Chemistry II | Chem 4033 | 2 | 3 |
| | Organic Chemistry I | Chem 2042 | 3 | 5 |
| | Practical Organic Chemistry I | Chem 2044 | 1 | 2 |
| | Organic Chemistry II | Chem 3042 | 3 | 5 |
| | Practical Organic Chemistry II | Chem 3044 | 1 | 2 |
| | Physical Organic Chemistry | Chem 4041 | 3 | 5 |
| | Practical Organic Chemistry III | Chem 4043 | 2 | 3 |
| | Chemical Thermodynamics | Chem 2052 | 3 | 5 |
| | Kinetics and Electrochemistry | Chem 3051 | 3 | 5 |
| | Practical physical Chemistry I | Chem 3053 | 1 | 2 |
| | Quantum Chemistry | Chem 4051 | 4 | 7 |
| | Statistical Thermodynamics and Surface Chemistry | Chem 4052 | 3 | 5 |
| | Practical physical Chemistry II | Chem 4053 | 1 | 2 |
| | Industrial Chemistry I | Chem 3121 | 3 | 5 |
| | Industrial Chemistry II | Chem 3122 | 3 | 5 |
| | Biochemistry | Chem 3124 | 3 | 5 |
| | Research Method and Scientific Writing | Chem 3126 | 2 | 3 |
| | Environmental Chemistry and Toxicology | Chem 4122 | 3 | 5 |
| | Introduction to Material Chemistry | Chem 4124 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| | Student Senior Project | Chem 4126 | 3 | 5 |
| | | **Sub-total** | **74** | **125** |
| **Core Elective Courses** | Chemistry of Consumer Products | Chem 4112 | 3 (2 +1) | 5 |
| | Food Safety and Analysis | Chem 4112 | 3 (2 +1) | 5 |
| | Chemistry of Natural Products | Chem 4112 | 3 (2 +1) | 5 |
| | Synthetic Organic Chemistry | Chem 4112 | 3 (2 +1) | 5 |
| | Forensic Chemistry | Chem 4112 | 3 (2 +1) | 5 |
| | Agricultural Chemistry | Chem 4112 | 3 (2 +1) | 5 |
| | | **Sub-total** | **3** | **5** |
| **Core Supportive Courses** | Introductory Statistics | Stat 2011 | 3 | 5 |
| | Calculus I for Chemist | Math 2021 | 3 | 5 |
| | Calculus II for Chemists | Math 2022 | 3 | 5 |
| | Applied Mathematics | Math 3022 | 3 | 5 |
| | Mechanic and Heat for Chemists | Phys 2241 | 3 | 5 |
| | Electricity and Magnetism for Chemists | Phys 3241 | 3 | 5 |
| | Introduction to Geochemistry | Geol 2012 | 3 | 5 |
| | | **Sub-total** | **21** | **35** |
| | | **Grand Total** | **146** | **241** |

### 8.2.2. Course Breakdown

| Year | Semester | No | Courses | Course | Cr. Hr | ECT |
|---|---|---|---|---|---|---|
| Year I | Semester I | 1 | Communicative English Language Skills | FLEn 1011 | 3 | 5 |
| | | 2 | General Physics | Phys-1011 | 3 (2 + 1 | 5 |
| | | 3 | General Psychology | Psch 1011 | 3 | 5 |
| | | 4 | Mathematics for Natural Sciences | Math 1011 | 3 | 5 |
| | | 5 | Logic and Critical Thinking | Phil 1011 | 3 | 5 |
| | | 6 | Physical Fitness | SpSc 1011 | P/F | 2 |
| | | 7 | Geography of Ethiopia and the Horn | GeES 1011 | 3 | 5 |
| | | | | **Total** | **18** | **32** |
| Year I | Semester II | 1 | Communicative English Language Skills | FLEn 1012 | 3 | 5 |
| | | 2 | Anthropology of Ethiopian Societies and | Anth 1012 | 2 | 4 |
| | | 3 | General Biology | Biol 1012 | 3 (2+1) | 5 |
| | | 4 | History of Ethiopia and the Horn | Hist. 1012 | 3 | 5 |
| | | 5 | Introduction to Emerging Technologies | EmTe 1012 | 3 | 5 |
| | | 6 | Moral and Civic Education | MCiE 1012 | 2 | 3 |
| | | 7 | General Chemistry | Chem 1012 | 4 (3+1) | 7 |
| | | | | **Total** | **20** | **34** |
| Year II | Semester I | 1 | Analytical Chemistry | Chem 2021 | 3 | 5 |
| | | 2 | Practical Analytical Chemistry | Chem 2023 | 1 | 2 |
| | | 3 | Mechanic and Heat for Chemists | Phys 2241 | 3 | 5 |
| | | 4 | Inclusiveness | Incl 2011 | 2 | 4 |
| | | 5 | Economics | Econ1105 | 3 | 5 |
| | | 6 | Calculus I for Chemist | Math 2021 | 3 | 5 |
| | | 7 | Introductory Statistics | Stat 2011 | 3 | 5 |
| | | | | **Total** | **18** | 31 |
| Year II | Semester II | 1 | Inorganic Chemistry I | Chem 2032 | 3 | 5 |
| | | 2 | Organic Chemistry I | Chem 2042 | 3 | 5 |
| | | 3 | Practical Organic Chemistry I | Chem 2044 | 1 | 2 |
| | | 4 | Chemical Thermodynamics | Chem 2052 | 3 | 5 |
| | | 5 | Global Affairs | GlaF 2022 | 2 | 3 |
| | | 6 | Introduction to Geochemistry | Geol 2012 | 3 | 5 |
| | | 7 | Calculus II for Chemist | Math 2022 | 3 | 5 |
| | | | | **Total** | **18** | **30** |
| | **Semester** | 1 | Instrumental Analysis I | Chem 3021 | 3 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Year III** | **I** | 2 | Practical Instrumental Analysis I | Chem 3023 | 1 | 2 |
| | | 3 | Inorganic Chemistry II | Chem 3031 | 3 | 5 |
| | | 4 | Practical Inorganic Chemistry I | Chem 3033 | 1 | 2 |
| | | 5 | Kinetics and Electrochemistry | Chem 3051 | 3 | 5 |
| | | 6 | Practical physical Chemistry I | Chem 3053 | 1 | 2 |
| | | *7 | Industrial Chemistry I | Chem 3121 | 3 | 5 |
| | | 8 | Electricity and Magnetism for Chemists | Phys 3241 | 3 | 5 |
| | | | | **Total** | **18** | **31** |
| **Year III** | **Semester II** | 1 | Organic Chemistry II | Chem 3042 | 3 | 5 |
| | | 2 | Practical Organic Chemistry II | Chem 3044 | 1 | 2 |
| | | 3 | Instrumental Analysis II | Chem 3022 | 3 | 5 |
| | | 4 | Practical Instrumental Analysis II | Chem 3024 | 1 | 2 |
| | | 5 | Applied Mathematics | Math 3022 | 3 | 5 |
| | | 6 | Industrial Chemistry II | Chem 3122 | 3 | 5 |
| | | 7 | Biochemistry | Chem 3124 | 3 | 5 |
| | | 8 | Research Method and Scientific Writing | Chem 3126 | 2 | 3 |
| | | | | **Total** | **19** | **322** |
| **Year VI** | **Semester I** | 1 | Inorganic Chemistry III | Chem 4031 | 4 | 7 |
| | | 2 | Practical Inorganic Chemistry II | Chem 4033 | 2 | 3 |
| | | 3 | Physical Organic Chemistry | Chem 4041 | 3 | 5 |
| | | 4 | Practical Organic Chemistry III | Chem 4043 | 2 | 3 |
| | | 5 | Quantum Chemistry | Chem 4051 | 4 | 7 |
| | | 6 | Entrepreneurship and Business Development | MGMT 4011 | 3 | 5 |
| | | | | **Total** | **19** | **32** |
| **Year VI** | **Semester II** | 1 | Statistical Thermodynamics and Surface Chemistry | Chem 4052 | 3 | 5 |
| | | 2 | Practical physical Chemistry II | Chem 4054 | 1 | 2 |
| | | 3 | Real Sample Analysis | Chem 4022 | 2 | 3 |
| | | 4 | Environmental Chemistry and | Chem 4122 | 3 | 5 |
| | | 5 | Introduction to Material Chemistry | Chem 4124 | 2 | 3 |
| | | 6 | Elective | Chem 4112 | 3 | 5 |
| | | 7 | Student Senior Project | Chem 4126 | 3 | 5 |
| | | | | **Total** | **17** | **28** |

## 9. Course Description and Outline

### 9.1. Common Courses

#### 9.1.1. Communicative English Language Skills I

| | |
|---|---|
| **Course Title:** | Communicative English Language Skills I |
| **Course Code:** | ELEn 1011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course description**:

Communicative English Skills is a course designed to enable students to communicate in English intelligibly with acceptable accuracy, fluency and ability to use English appropriately in different contexts. The course exposes students to English language learning activities designed to help students use English for their academic and social needs. Students would be engaged in language learning development activities through doing and reflection on action. This includes grammar and vocabulary as used in communicative events and all skills and their sub-kills: speaking, listening, reading and writing. The language and skills are integrated where one becomes a resource to the other. There are six units covering topics related to the life world of students as well as of societal relevance.

**Course Objectives:**

At the end of this course, students will be able to:

- Express themselves in social and academic events in English--Use English intelligibly with reasonable level of curacy and fluency
- Listen and comprehend to talks related to social and academic events given in English
- Read and understand texts written in English –texts on academic and social matters
- Write in English as academically and socially desirable.

- Learn and develop their English on their own—learning to learn: the language and Write clear reports and assignments in academic contexts, and the skills

**Course Outline:**

**1. Introducing Oneself**

1.1. Listening

1.1.1. Introducing oneself (who you are, where you came from, where you finished your primary and secondary school), what you intend to study and why Vocabulary

1.2. Reading

1.2.1. Reading a short biography written in simple English: using background knowledge, reading with comprehension, making notes while reading, guessing meanings, attending to reference words & discussing notes,

**2. Study Skills**

2.1. Listening

2.1.1. listening to a talk on habits of successful students: reflecting on one's study skills, taking notes while listening, discussing notes, answering listening comprehension questions, discussing answers

2.1.2. Giving advice using tips from the listening text: using the language of giving advice

2.2. Reading

2.2.1. Reading an expository essay on study skills: reading with comprehension, attending to new vocabulary, writing notes while reading, writing brief summaries from notes

2.2.2. Studying the present perfect tense and the past perfect tense: form, use and meaning of conditionals

**3. Sports and Health**

3.1. Listening

3.1.1. Listening about Zinedine Zidan (who he is, his childhood, his professional career): using prior knowledge (talking about a famous football player), predicting what comes next and checking prediction, taking notes while listening, discussing notes, presenting oral summary), asking and answering Wh-questions

3.1.2. Studying conditionals (form, use and meaning)

3.2. Reading

3.2.1. Reading a short expository passage on sports and health: discussing how sports improve health, reading for main ideas, making notes while reading, developing notes into short summaries, comparing summaries

3.2.2. Working on vocabulary: using word formation

**4. Cultural Values**

4.1. Listening

4.1.1. Listening about cultural tourism: discussing how culture attracts tourists, listening with comprehension, taking notes while listening, discussing notes, developing notes into one-paragraph summaries

4.2. Reading

4.2.1. Reading an expository text on cultural values: reading with comprehension, writing notes while reading, answering comprehension questions, summarizing the text based on notes made while reading, discussing summaries

4.2.2. Revision simple present, simple past, present perfect and past perfect tenses: revising form, use and meanings of these tenses, writing short meaningful sentences using simple present, simple past, present perfect and past perfect forms of verbs

**5. Tourism and Wildlife**

5.1. Listening

5.1.1. Listening about human-wildlife conflict (argumentative text): using prior knowledge, listening with comprehension, making notes while reading, writing summaries using the notes, discussing the summaries

5.2. Reading

5.2.1. Reading a text on tourism and wildlife: using visual, reading with comprehension, guessing meanings of words based on context, writing brief notes while reading, discussing notes and developing them into summaries, discussing summaries

5.2.2. Working on denotative and connotative meanings

5.2.3. Revising conditionals: constructing meaningful sentences based on pictures

**6. Population**

6.1. Listening

6.1.1. Listening about population density: learning the meanings of ‘population’, ‘density’ and ‘population density’, predicting what comes in the talk and checking prediction, listening with comprehension, taking notes while listening, discussing notes, writing short paragraphs using the notes and discussing them

6.2. Reading

6.2.1. Reading a text on population pyramid: interpreting tables, graphs and pie charts, reading with comprehension, making notes while reading, discussing notes, developing notes into paragraphs, discussing and improving paragraphs

6.2.2. Studying collocation: learning the definition of collocation, identifying words that collocate with ‘population’, doing exercise on collection, using collection in vocabulary study

6.2.3. Working on active and passive constructions (form, use, meaning): noticing grammar pattern in example sentences, listening to a brief lecture, writing lectures notes, discussing notes, identifying active and passive constructions, completing contextualized exercise, reading independently and compiling portfolio on passive constructions

**Instructional Methods and Strategies**: Providing brief introductory notes, Pair and group discussions, Presentation, independent reading, Encouraging independent learning, Giving individual and group works are some of the major teaching methods to be used**.**

**Teacher’s activities:** Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice and defend their own opinions and enhancing the students’ commitment to individual study and acquiring knowledge are among the activities.

**Students’ activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, Valuing Active Participation, Oral presentation, Valuing Attendance and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


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### 9.1.2. General Physics

| | |
|---|---|
| **Course Title:** | General Physics |
| **Course Code:** | Phys 1011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 2 Lecture plus 3 Laboratory Hours per Week |
| **Year:** | I |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description:**

This module will be taught in an introductory undergraduate level and is primarily designed for a broader audience of science students. The goal of the course is to give an overview of the various physics based analysis and dating techniques used in science and technology. High school mathematics and physics concepts are enough as prerequisite for this course. Laws, principles, and methods of physics will be taught in a more descriptive manner using simple mathematics. The course covers preliminaries, mechanics, fluid mechanics, electromagnetism and electronics, thermodynamics, oscillations and waves, and cross-cutting applications of physics in different areas of science and technology.

**Course Objectives:**

Upon completion of this course students should be able to:

- Discuss basic physics by refreshing and summarizing the previous preparatory physics concepts before tackling the advanced physics courses.
- Explain the kinematics and dynamics of particles in one and two dimensions.
- State principles of fluids in equilibrium and solve problems applying Pascal‘s principle, Archimedes‘s, principles and Bernoulli‘s equation in various situations.
- Explain the basic concepts of charges, fields and potentials.
- Analyze direct and alternating current circuits containing different electric elements and solve circuit problems.
- Demonstrate the use and the working system of cells (batteries), resistors, generators, motors and transformers.
- Explain the first law of thermodynamics for a closed system and apply it to solve problems.
- Discuss systems that oscillate with simple harmonic motion.
- Explain the application of physics in different sciences and technology fields.
- Apply and describe a variety of experimental techniques and grasp the general guidelines of laboratory.
- Develop the skill of laboratory work.

**Course Outline:**

**1. Preliminaries**

1.1. Physical Quantities and Measurement

1.1.1. Physical quantities

1.1.2. SI Units: Basic and Derived Units

1.1.3. Conversion of Units

1.2. Uncertainty in Measurement and Significant Digits

1.2.1. Significant digits

1.3. Vectors: composition and resolution

1.3.1. Vector Representation

1.3.2. Vector Addition

1.3.3. Components of Vector

1.4. Unit Vector

1.4.1. Vector addition in Unit Vector Notation

1.4.2. Finding a Unit Vector

**2. Kinematics and Dynamics of Particles**

2.1. Kinematics in One and Two Dimensions

2.1.1. Displacement, velocity and Acceleration in 1D and 2D

2.1.2. Motion with Constant Acceleration

2.1.3. Free Fall Motion

2.1.4. Projectile Motion

2.2. Particle Dynamics and Planetary Motion

2.2.1. The Concept of Force as A Measure of Interaction

2.2.2. Type of Forces

2.2.3. Newton‘s Laws of Motion and Applications

2.2.4. Uniform Circular Motion

2.2.5. Newton‘s Law of Universal Gravitation

2.2.6. Kepler‘s Laws, Satellites Motion and Weightlessness

2.3. Work, Energy and Linear Momentum

2.3.1. Work and Energy

2.3.2. Power

2.3.3. Linear Momentum

2.3.4. Collisions

2.3.5. Center of Mass

**3. Fluid Mechnics**

3.1. Properties of Bulk Matter

3.2. Density and Pressure in Static Fluids

3.3. Buoyant Force and Archimedes‘ Principles

3.3.1. Archimedes‘ principle

3.4. Moving Fluids and Bernoulli Equations (Fluid Dynamics)

3.4.1. Bernoulli‘s Equation

**4. Heat and Thermodynamics**

4.1. The concept of Temperature and the Zeroth law of Thermodynamics

4.2. Thermal Expansion

4.3. The Concept of Heat, Work and Internal Energy

4.4. Specific Heat and Latent Heat

4.5. Heat Transfer Mechanisms

4.6. The First Law of Thermodynamics

**5. Oscillations, Waves and Optics**

5.1. Simple Harmonic Motion

5.1.1. Periodic and Oscillatory Motion

5.1.2. Displacement, Velocity and Acceleration in a SHM

5.2. The simple Pendulum

5.3. Wave and Its Characteristics

5.4. Resonance

5.5. The Doppler Effect

5.6. Image Formation by Thin Lenses and Mirrors

**6. Electromagnetism and Electronics**

6.1. Coulomb‘s Law and Electric Fields

6.2. Electric Potential

6.3. Current, Resistance and Ohm‘s Law

6.4. Electrical Energy and Power

6.5. Equivalent Resistance and Kirchhoff‘s Rule

6.6. Magnetic Field and Magnetic Flux

6.7. Electromagnetic Induction

6.8. Insulators, Conductors and Semiconductors

6.9. Diodes

6.10. Transistors

**7. Cross Cutting Applications of Physics**

7.1. Physics in Agriculture and Environment

7.2. Physics in Industries

7.3. Physics in Health Sciences and Medical Imaging

7.4. Physics and Archeology

7.5. Application in Earth and Space Sciences

7.6. Applications in Power

**Instructional Methods and Strategies**:

**Students' Activities**: Students should read the module and/or reference materials and do the assignments on time. Practice with solved problems and come to office hours to get concepts clarified. Review and extra problems will be given through worksheets. Students are also expected to have worked through the problems in the worksheets before the tutorial sessions. Attendance at lectures and Laboratory is expected for all students. Attendance records will be taken at all times. It is the students chance to ask questions, solve problems and work in team.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Recommended Laboratory Activities**

For this course a total of 10 experiments relevant to Mechanics, Electricity and Magnetism, and Electronics will be carried out.

**I. List of Experiments from Mechanics**

- Measurements of basic constants, length, .mass and time
- Free fall
- Hook‘s law
- Density of liquids
- Simple pendulum

**II. List of Experiments from Electricity and Magnetism**

- Calibration of voltmeter and ammeter from galvanometer

- Ohm‘s law, parallel and series combination of resistors

**III. List of Experiments from electronics**

- V-I characteristics of diode
- Rectification
- Logic gate

From these recommended experiments, at least six experiments to be performed. Simulation Experiments from the Internet can be used to supplement laboratory activities whenever possible.

**References**


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5. College Physics by Hugh D. Young Sears Zemansky, 9th Ed., Herman Cember and Thomas A. Johnson, Introduction to Health Physics, 4th ed., (2008).
6. William R. Hendee and E. Russell Ritenour, Medical Imaging Physics, 4th Ed., (2002).
7. Tayal D.C. Basic Electronics. 2nd ed. Himalaya Publishing House Mumbai, (1998).
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10. Stacey, Frank D.: Physics of the earth. 2nd Ed., Wiley, 1977.


### 9.1.3. General Psychology

| | |
|---|---|
| **Course Title:** | General Psychology |
| **Course Code:** | Psch 1011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |

**Year:** I

**Semester:** I

**Pre-Requisite:** Does not Require Pre-Requisite

**Course Description**:

This General Psychology course has multifaceted significances. Students will investigate theories, topics, and applications in the field of psychology across biological, cognitive, social, developmental and clinical areas. Students learn to identify ways in which the science of psychology affects everyday lives and gain knowledge in multiple areas of psychology that provides a foundation for future courses with the major and across campus. The course will highlight connections among different areas of psychology and identify ways in which different perspectives contribute to a fuller understanding of human behavior.

**Course Objectives:**

Up on the completion of this course, students will be able to:

- Describe basic psychological concepts;
- Compare and contrast the major theoretical perspectives in psychology;
- Discuss different aspects of human development;
- Compare and contrast different learning theories;
- Summarize motivational and emotional processes;
- Demonstrate social and interpersonal skills in everyday life;
- Set an adaptive goal and plan for future;
- Apply knowledge of psychology in their life; and
- Develop their life skills.

**Course Outline:**

1. **Essence of Psychology**
   1.1. Definition of Psychology and Related Concepts

1.2. Goals of Psychology

1.3. Historical Background and Major Perspectives in Psychology

1.4. Early schools of psychology

1.5. Modern schools of psychology

1.6. Branches/Sub Fields of Psychology

1.7. Research Methods in Psychology

**2. Sensation and Perception**

2.1. The meanings of sensation and perception

2.2. The sensory laws: Sensory thresholds and sensory adaption

2.3. Perception

2.4. Selectivity of perception: Attention

2.5. From perception

2.6. Depth perception

2.7. Perceptual Constancies

2.8. Perceptual Illusion

**3. Learning and Theories of Learning**

3.1. Definition, Characteristics and Principles of Learning

3.2. Definitions of learning

3.3. Characteristics of learning

3.4. Principles of learning

3.5. Factors Influencing Learning

3.6. Theories of Learning and their Applications

3.7. Behavioral Theory of Learning

3.8. Social Learning Theory (observational learning) theory

3.9. Cognitive Learning Theory

**4. Memory and Forgetting**

4.1. Memory

4.2. Meaning and Processes of Memory

4.3. Stages/Structure of Memory

4.4. Factors Affecting Memory

4.5. Forgetting

4.6. Meaning and Concepts of Forgetting

4.7. Theories of Forgetting

4.8. Improving Memory

**5. Motivation and Emotions**

5.1. Motivation

5.2. Definition and types of motivation

5.3. Approaches to motivation (theories of motivation)

5.4. Conflict of motives and frustration Emotions

5.5. Definition of emotion

5.6. Theories of emotion

**6. Personality**

6.1. Meaning of Personality

6.2. Theories of Personality

6.3. The psychoanalytic theory of personality

6.4. The trait theory of personality

6.5. Humanistic theory of personality

**7. Psychological Disorders and Treatment Techniques**

7.1. Nature of Psychological Disorders

7.2. Causes of Psychological Disorders (Based on Perspectives)

7.3. The Biological Perspective

7.4. Psychological Perspectives

7.5. Types of Psychological Disorders

7.6. Treatment Techniques

**8. Nature and Definition of Life Skills**

8.1. Components of Life Skills

8.2. Goals of Life Skills

**9. Intra-Personal and Interpersonal Skills**

9.1. Self-Concept and Self-Awareness

9.2. Self-esteem and self-confidence

9.3. Self-Control

9.4. Anger Management

9.5. Emotional Intelligence and Managing

9.6. Stress, Coping with Stress and Resilience

9.7. Critical and Creative Thinking

9.8. Problem Solving and Decision Making

**10. Academic Skills**

10.1. Time Management

10.2. Note-taking and Study Skills

10.3. Test-Taking Skill

10.4. Test Anxiety and Overcoming Test Anxiety

10.5. Goal Setting

10.6. Career Development Skill

**11. Social Skills**

11.1. Understanding cultural Diversity

11.2. Gender and Social Inclusion

11.3. Interpersonal Communication Skills

11.4. Social Influences

11.5. Peer Pressure

11.6. Assertiveness

11.7. Conflict and Conflict

11.8. Team Work

11.9. Overcoming Risky Behavior

**Teaching methods**: lecture, independent learning, case study, jigsaw, presentation, questioning, group learning, seminar, workshop, role play, and others could be implemented **Assessment mode**: individual assignment (10%); mid-exam (40%) and final exam (50%)

**REFERENCES**


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8. Kuusela, K. (2013). Diversity management: Challenges and possibilities. Metropolia University of Applied Sciences.
9. Moldes, V. M., Biton, Ch. L., Gonzaga, D. J., & Moneva, J. C. (2019). Students, Peer Pressure and their Academic Performance in School. International Journal of Scientific and Research Publications, 9, 1, 2250-3153.

### 9.1.4. Mathematics for Natural Sciences

| | |
|---|---|
| **Course Title:** | Mathematics for Natural Sciences |
| **Course Code:** | Math 1011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

The course intends to prepare science students in the basic concepts and materials from mathematics that necessitate a good foundation to treat basic mathematical models in science.

This course rigorously discusses the basic concepts of logic and set theory, the real and complex number systems, mathematical induction, least upper bound and greatest lower bound, functions and types of functions, polynomial and rational functions, logarithmic and exponential functions, trigonometric functions, hyperbolic functions and their graphs and analytic geometry.

**Course Objectives:**

Upon completion of the course, successful students will be able to:

- Understand mathematical logic,
- Apply logic in reasoning and mathematical proofs,
- Use quantifiers in open propositions, understand concepts of sets and set operations,
- Understand the fundamental properties of real and complex numbers,
- Find least upper bound and greatest lower bound,
- Use mathematical induction in proofs,
- Write polar representation of complex numbers,
- Understand different types of functions, their inverses and their graphs,
- Find zero's of some polynomials,
- Identify various forms of conic sections and derive their equations,
- Use basic properties of logarithmic, exponential, hyperbolic, and trigonometric functions.

**Course Outline:**

**1. Propositional Logic and Set Theory**

1.1. Propositional Logic

1.1.1. Definition and examples of Propositions

1.1.2. Logical connectives

1.1.3. Compound (or complex) proposition

1.1.4. Tautology and contradiction

1.2. Open propositions and quantifiers

1.3. Arguments and Validity

1.4. Set Theory

1.4.1. The Concept of a set

1.4.2. Description of sets

1.4.3. Set operations and Venn diagrams

**2. The Real and Complex Number Systems**

2.1. The real number system

2.1.1. The natural numbers, principle of mathematical induction and the well ordering axiom

2.1.2. The set of integers

2.1.3. The set of rational numbers

2.1.4. The set of real numbers, upper bound and lower bound, least Upper bound and greatest lower bound; completeness property of real numbers

2.2. The set of complex numbers

2.2.1. Plotting complex number

2.2.2. Operations on complex numbers

2.2.3. Conjugate of a complex number

2.2.4. Modulus (Norm) of a complex number

2.2.5. Additive and multiplicative inverse

2.2.6. Argument of a complex number

2.2.7. Polar form of a complex numbers

2.2.8. Extraction of roots

**3. Functions**

3.1. Review of relations and functions

3.2. Real valued functions and their properties

3.3. Types of functions and inverse of a function

3.4. Polynomials, zeros of polynomials, rational functions and their graphs

3.5. Definition and basic properties of logarithmic, exponential, trigonometric and hyperbolic functions, and their graphs

**4. Analytic Geometry**

4.1. Distance Formula and Equation of Lines

4.1.1. Distance between two points and division of segments

4.1.2. Equations of lines

4.1.3. Distance between a point and a line

4.2. Circles

4.2.1. Definition of a circle

4.2.2. Equation of a circle

4.2.3. Intersection of a circle with a line and tangent line to a circle

4.3. Parabolas

4.3.1. Definition of parabola

4.3.2. Equation of parabolas

4.4. Ellipse

4.4.1. Definition of ellipse

4.4.2. Equation of ellipse

4.5. Hyperbola

4.5.1. Definition of a hyperbola

4.5.2. Equation of a hyperbola

4.6. The general second degree equation

4.6.1. Rotation of coordinate axes

4.6.2. Analysis of the general second degree equations

**Instructional Methods and Strategies**:

**Students' Activities**:

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**

1. Alemayehu Haile and Yismaw Alemu, *Mathematics an Introductory Course*, Department of Mathematics, Addis Ababa University
2. Demisu Gemeda and Seid Mohammed, Fundamental Cocepts of Algebra, AAU

3. Semu Mitiku Kassa, Berhanu Guta Wordofa and Tilahun Abebaw Kebede, Engineering Mathematics I, Galaxy University Books Series, 2017.
4. Edwin J. Purcell, Dale Varberg, Calculus with Analytic Geometry
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7. James Ward Brown and Ruel V. Churchill: Complex Numbers and Applications, 7th edition
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### 9.1.5. Logic and Critical Thinking

| | |
|---|---|
| **Course Title:** | **Logic and Critical Thinking** |
| **Course Code:** | **Phil** 1011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description:**

This course is designed to help students to develop not only the ability to construct reliable and logically defendable arguments of their own and rationally evaluate the arguments of others, but also the abilities and skills of critical thinking. All education consists of transmitting two different things to students: (1) the subject matter or discipline content of the course ("what to think"), and (2) the correct way to understand and evaluate this subject matter ("how to think"). We may do an excellent job of transmitting the content of our respective academic disciplines, but we often fail to teach students how to think effectively about this subject matter, that is, how to properly understand and evaluate it. That means, we often fail to teach how to think critically. Hence, the primary aim of this course is to teach students essential skills of analyzing, evaluating, and constructing arguments, and to sharpen their ability to execute the skills in thinking and writing, and thus better prepare them to succeed in the world. The understanding of

the methods by which we develop our own arguments, form beliefs, weigh evidence, assess hypotheses and arguments, and analyze reasoning will help you rationally evaluate the credibility of claims and arguments you encounter in media, in everyday conversation, and in the classroom. You will also learn to become aware of errors in reasoning and judgment, which we all occasionally commit. Finally, you will learn to develop your own arguments with clarity and precision.

**Course objectives:**

After the successful completion of this module students will be able to:

- Recognize the components and types of arguments;
- Develop the skill to construct and evaluate arguments;
- Understand the relationship between logic and language;
- Recognize the forms of meanings of words and terms;
- Comprehend the types, purposes and techniques of definitions;
- Understand the concept, principles, and criteria of critical thinking;
- Cultivate the habits of critical thinking and develop sensitivity to clear and accurate usage of language;
- Recognize the various forms of formal and informal fallacies; and
- Understand the components, attributes and representations of categorical propositions.

**Course Outline:**

**1. Introducing Philosophy**

1.1. Meaning and nature of philosophy

1.2. Basic features of philosophy

1.2.1. Core fields of philosophy

1.3. Metaphysics and epistemology

1.3.1. Metaphysics

1.3.2. Epistemology

1.4. Axiology and logic

1.4.1. Axiology

1.4.2. Logic

1.5. Importance of learning philosophy

**2. Basic Concepts of Logic**

2.1. Basic concepts of logic: arguments, premises and conclusions

2.2. Techniques of recognizing arguments

2.2.1. Recognizing argumentative passages

2.2.2. Recognizing non-argumentative passages

2.3. Types of arguments: deduction and induction

2.3.1. Deductive arguments

2.3.2. Inductive arguments

2.3.3. Differentiating deductive and inductive arguments

2.4. Evaluating arguments

2.4.1. Evaluating deductive arguments: validity, truth, and soundness

2.4.2. Evaluating inductive arguments: strength, truth, and cogency

**3. Logic and Language**

3.1. Philosophy of language: an overview

3.1.1. What is philosophy of language?

3.1.2. A brief note on the debates and history of philosophy of language

3.1.3. Some philosophical approaches to the nature of meaning

3.2. Logic and meaning

3.2.1. The functions of language: cognitive and emotive meanings

3.2.2. The intension and extension of terms

3.2.3. Logic and definition

3.3. Meaning, types, and purposes of definitions

3.3.1. The meaning of definition

3.3.2. The types and purposes of definitions

3.4. Techniques of definition

3.4.1. The extensional (denotative) definitional techniques

3.4.2. The intensional (connotative) definitional techniques

3.5. Criteria for lexical definitions

**4. Basic Concepts of Critical Thinking**

4.1. Meaning of critical thinking

4.2. Standards of critical thinking

4.3. Codes of intellectual conduct for effective discussion

4.3.1. Principles of good argument

4.3.2. Principles of critical thinking

4.4. Characteristics of critical thinking

4.4.1. Basic traits of critical thinkers

4.4.2. Basic traits of uncritical thinkers

4.5. Barriers to critical thinking

4.6. Benefits of critical thinking

**5. Informal Fallacies**

5.1. Fallacy in general

5.1.1. The meaning of fallacy

5.1.2. Types of fallacies

5.1.3. Informal fallacies

5.2. Fallacies of relevance

5.3. Fallacies of weak induction

5.4. Fallacies of presumption

5.5. Fallacies of ambiguity and grammatical analogy

5.5.1. Fallacies of ambiguity

5.5.2. Fallacies of grammatical analogy

**6. Categorical Propositions**

6.1. General introduction

6.1.1. Standard-forms of categorical proposition

6.1.2. The components of categorical propositions

6.2. Attributes of categorical propositions: quality, quantity, and distribution

6.3. Venn diagrams and the modern square of opposition

6.3.1. Representing categorical propositions in diagrams

6.3.2. Squares of opposition: traditional and modern squares of opposition

6.3.3. The traditional square of opposition

6.4. Evaluating immediate inferences: using venn diagrams and square of oppositions

6.4.1. Logical operations: conversion, obvers ion, and contraposition

**Instructional Methods and Strategies**: Lecture, Peer/ group Discussion and Reflection, Reading Assignment. ....are some of the major teaching methods to be used**.**

**Teacher's activities:** Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice and defend their own opinions and enhancing the students' commitment to individual study and acquiring knowledge are among the activities.

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Copi, Irving M. and Carl Cohen, (1990) Introduction to Logic, New York: Macmillan Publishing Company.
2. Damer, Edward. (2005). Attacking faulty reasoning. A practical guide to fallacy free argument. Wadsworth Cengage learning, USA.
3. Fogelin, Robert, J, (1987) Understanding Arguments: An Introduction to Informal Logic, New York: Harcourt Brace Jvanovich Publisher.
4. Guttenplan, Samuel: (1991) The Language of Logic. Oxford: Blackwell Publishers
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6. Stephen, C. (200) The Power of Logic. London and Toronto: Mayfield Publishing Company. Walelign, Emuru, (2009) Freshman Logic, Addis Ababa

### 9.1.6. Physical Fitness

| | |
|---|---|
| **Course Title:** | Physical Fitness |
| **Course Code:** | SpSc 1011 |
| **Credit Hours/ECTS:** | P/F |
| **Contact Hours:** | 2 Contact Hours per Week |
| **Year:** | I |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

This course will provide the students with basic concepts of the five components of health related physical fitness (cardiovascular, muscular strength and endurance, flexibility, and body composition), conditioning, hypokinetic disease and general principles of training. It is mainly practical oriented. As a result, the students will be exposed to various exercise modalities, sport activities, minor and major games, and various training techniques as a means to enhance health related physical fitness components. In addition, they will develop the skills to assess each component of fitness and will practice designing cardiovascular, muscular strength and endurance, and flexibility programs based on the fitness assessment. The course serves as an introduction to the role of exercise in health promotion, fitness, performance including the acute and chronic responses of the body to exercise.

**Course Objectives:**

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

- Recognize the immediate and long term responses of the body to various types of exercise.
- Understands the basic concepts of physical fitness and conditioning exercises.
- Understand the concept of hypokinetic disease and conditions.
- Distinguish the general principles of fitness training
- Develop conditioning programs to enhance the components of health related physical finesses.

- Participate in conditioning programs which may help to develop the components of health related physical finesses.
- Understand health issues in relation to excess body fatness and excessively low body fat.
- Develop skills to assess health related physical fitness components.
- Develop healthy body weight management skill.
- Appreciate and value the benefits of regular physical exercise to healthy living.
- Develop interest to engage in a regular physical exercise program as a life time activity.
- Develop self-confidence and effective communication skills in and out of the school environment.

**Course Outline:**

**1. Concepts of physical fitness and conditioning**

1.1. Meanings and definitions of terms

1.1.1. physical fitness

1.1.2. physical conditioning

1.1.3. Physical Activity,

1.1.4. Physical exercise and

1.1.5. Sport

1.2. General principles of fitness training

**2. The Health Benefits of Physical Activity**

2.1. Physical Activity and Hypokinetic Diseases/Conditions

2.2. Physical Activity and Cardiovascular Diseases

2.3. physical activity and postural deformity

**3. Making Well-Informed Food Choices**

3.1. Sound Eating Practices

3.2. Nutrition and Physical Performance

**4. Health Related Components of Fitness**

4.1. Cardiovascular fitness

4.1.1. Meaning and concepts of cardiovascular fitness

4.1.2. Means and methods of developing cardiovascular fitness

4.2. Muscle fitness

4.2.1. Meaning and concepts of muscle fitness

4.2.2. Means and methods of developing muscle fitness

4.3. Flexibility

4.3.1. Meaning and types of flexibility

4.3.2. Means and methods of developing flexibility

4.4. Body composition

4.4.1. Meaning of body composition

4.4.2. Health risks associated with over fatness

4.4.3. Health risks associated with excessively low body fatness

**5. Assessment of Fitness Components**

5.1. Assessment of cardiovascular fitness

5.2. Assessment of muscle fitness

5.3. Assessment of flexibility

5.4. Assessment of body composition

**6. Development and Assessment of the Health Related Components of Fitness**

**Instructional Methods and Strategies**: The course will involve deploying different teaching methods that attempt to make the teaching-learning process as effective as possible. the course delivery techniques will generally involve the following items: Lecture, Questioning and answering , Group discussions, Field Practice, Explanation and Demonstration

**Teacher's activities:** Provide maximum physical activity time within the class period, Promote equal participation of all students in the course, Teach skills and activities that transfer in to lifetime physical activity, Motivate students to be active participants in the course and Praise for active participation

**Students' activities:** The success of this course and students learning experience is dependent on active engagement and participation of the students in all the spectrum of the course. Students are expected to come well prepared/dressed and constructively engage in class. **Class Discipline:** "In each and every aspect of life, discipline comes first and worth a lot". This is what department of Sport Science reflects. As a result of this, any noise, chatting, chewing gum and the like are

prohibited in every sessions of the course. In addition to these portable electronic media and communicative devices such as cell phones, pagers, MP3 players, I pods etc are not be used during the class for any reason. Thus, these devices should be switched off and kept out of sight.

**Assessment Strategies and Techniques**: At least 60% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 40% Final exam practical group assignment (peer training on the five components of fitness)

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster, Sport field, and fitness equipments.

**References**


1. Charles B. Corbin, Gregory J. Weik, William R. Corbin and Karen A. Welk. (2006). Concepts of fitness and wellness: a comprehensive lifestyle approach. 6th Ed.
2. Schott k. Powers, Stepheen L. Dod and Virginia J. (2006), Total Fitness and Wellness.
3. Paul M, and Walton T. (2006), Core Concepts in Health, 10th Ed.
4. Charles B. Corbin and Ruth Lindsey (1990), Fitness for life, 3rd Ed., Scott.


### 9.1.7. Geography of Ethiopia and the Horn

| | |
|---|---|
| **Course Title:** | Geography of Ethiopia and the Horn |
| **Course Code:** | GeES 1011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Contact Hours per Week |
| **Year:** | I |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

This course attempts to familiarize students with the basic geographic concepts particularly in relation to Ethiopia and the Horn of Africa. It is also intended to provide students a sense of place and time (geographic literacy) that are pivotal in producing knowledgeable and competent

citizens that are able to comprehend and analyze problems and contribute to their solutions. The course consists of four parts. The first part provides a brief description on the location, shape and size of Ethiopia as well as basic skills of reading maps. Part two introduces the physical background and natural resource endowment of Ethiopia and the Horn which includes its geology and mineral resources, topography, climate, drainage and water resources, soil, fauna and flora. The third part of the course focuses on the demographic characteristics of the country and its implications on economic development. The fourth component of the course offers treatment of the various economic activities of Ethiopia and the Horn which include agriculture, manufacturing and service sectors. Moreover, Ethiopia in a globalizing world is treated in the perspectives of the pros and cons of globalization on its natural resources, population and socio economic conditions.

**Course objectives:**

At the end of this course, students will be able to:

- Acquire basic knowledge on the geographic attributes of Ethiopia and Horn
- Develop a sense of appreciation and tolerance of cultural diversities and their interactions
- Acquire general understanding of physical geographic processes, and human-environment relationships
- Develop ethical aptitudes and dispositions necessary to live in harmony with the natural environment
- Develop an understanding of national population distributional patterns and dynamics
- Conceptualize the comparative advantages of economic regimes; and understand the impacts of globalization.
- Understand their country's overall geographic conditions and opportunities; and be proud of the natural endowments and cultural richdom that help them develop a sense of being an Ethiopian.

**Course Outline:**

**1. Introduction**

1.1. Geography: Definition, scope, themes and approaches

1.2. Location, Shape and Size of Ethiopia and the Horn

1.2.1. Location and its effects

1.2.2. The shape of Ethiopia and its implication

1.2.3. The size of Ethiopia and its implications

1.3. Basic Skills of Map Reading

**2. The Geology of Ethiopia and the Horn**

2.1. Introduction

2.2. The Geologic Processes: Endogenic and Exogenic Forces

2.3. The Geological Time scale and Age Dating Techniques

2.4. Geological Processes and the Resulting Landforms

2.4.1. The Precambrian Era geologic processes and resultant features

2.4.2. The Paleozoic Era geologic processes and resultant features

2.4.3. The Mesozoic Era geologic processes and resultant features

2.4.4. The Cenozoic Era geologic processes and resultant features

2.5. Rock and Mineral Resources of Ethiopia

**3. The Topography of Ethiopia and the Horn**

3.1. Introduction

3.2. Physiographic Divisions

3.2.1. The Western Highlands and Lowlands

3.2.2. The Southeastern Highlands and Lowlands

3.2.3. The Rift Valley

3.3. The Impacts of Relief on Biophysical and Socioeconomic Conditions

**4. Drainage Systems and Water Resources of Ethiopia and the Horn**

4.1. Introduction

4.2. Major Drainage Systems of Ethiopia

4.3. Water Resources: Rivers, Lakes, and Subsurface Water

4.4. General Characteristics of Ethiopian Rivers

4.5. Water Resources Potentials and Development in Ethiopia

**5. The Climate of Ethiopia and the Horn**

5.1. Introduction

5.2. Elements and Controls of Weather and Climate

5.3. Spatiotemporal Patterns and Distribution of Temperature and Rainfall in Ethiopia

5.4. Agro-ecological Zones of Ethiopia

5.5. Climate and its Implications on Biophysical and Socioeconomic Aspects

5.6. Climate Change/Global Warming: Causes, Consequences and Response Mechanisms

**6. Soils, Natural Vegetation and Wildlife Resources of Ethiopia and the Horn**

6.1. Introduction

6.2. Ethiopian Soils: Types, Degradation and Conservation

6.3. Types and Distribution of Natural Vegetations in Ethiopia

6.4. Natural vegetation: Uses, Degradation and Conservation Strategies

6.5. Wildlife Resources of Ethiopia: Types, Importance, and Conservation Strategies

**7. Population of Ethiopia and the Horn**

7.1. Introduction

7.2. Population Data: Uses and Sources

7.3. Population Dynamics: Fertility, Mortality and Migration

7.4. Population Distribution and Composition

7.5. Sociocultural Aspects of Ethiopian Population: Education, Health and Languages

7.6. Settlement Types and Patterns

**8. Economic Activities in Ethiopia**

8.1. Introduction

8.2. Mining**,** Fishing and Forestr**y**

8.3. Agriculture in Ethiopian

8.3.1. Contributions, potentials and characteristics of agriculture in Ethiopia

8.3.2. Agricultural systems in Ethiopia

8.3.3. Major problems of Ethiopian agriculture

8.4. Manufacturing in Ethiopia

8.4.1. Manufacturing: essence and contributions

8.4.2. Types, characteristics and distribution of manufacturing

8.4.3. Industrial development in Ethiopia: Challenges and Prospects

8.5. The Service Sector in Ethiopia

8.5.1. Transportation and communication in Ethiopia: types, roles and characteristics

8.5.2. Trade in Ethiopia: types, contributions and characteristics

8.5.3. Tourism in Ethiopia: Types, major tourist attraction sites, challenges and prospects

**Instructional Methods and Strategies**: Gap Lecture, Peer/ group Discussion and Reflection, Reading Assignment, etc are some of the major teaching methods to be used**.**

**Teacher's activities:** Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice and defend their own opinions and enhancing the students' commitment to individual study and acquiring knowledge are among the activities.

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. A.D. Tathe. (2012). Lecture Notes on Climatology: For Intermediate Met Training Course, Indian Meteorological Department. Addis Ababa University (2001). Introductory Geography of Ethiopia, Teaching Text, Department of Geography.
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4. CSA 1994 & 2007. Population and Housing Census Results. CSA: A.A.

5. Diao, Xinshen 2007. The Role of Agriculture in Economic Development: Implications for Sub Saharan Africa. Sustainable Solutions for ending Hunger and Poverty, Research Report 153. IFPRI.Ethiopia.
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8. Hartshorne, T. & J. Alexander (1988). Economic Geography, 3rd Ed.
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18. Plant genetic resource center (1995). Ethiopia: country report to the FAO International Technical Conference on Plant Genetic Resource, Addis Ababa
19. Robert, E.G, James, F. P & L. Michael T. (2007). Essentials of Physical Geography. Thomson Higher Education, Belmont, 8th edition.

20. UNDP, FAO (1984) Ethiopia Forest Resources and Potential for Development; An assistance to land use planning.
21. United Nations Framework Convention on Climate Change (2007). Climate Change; Impacts Vulnerabilities and Adaptations in Developing Countries.
22. Waugh, D. (1990). Geography: An Integrated Approach. Nelson: London.

### 9.1.8. Communicative English Language Skills

| | |
|---|---|
| **Course Title:** | Communicative English Language Skills |
| **Course Code:** | ELEn 1012 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Communicative English Language Skills (FLEn 1011) |

**Course Description**:

A Writing Proficiency course is one in which the development of writing skills is an integral part of the course objectives. These/This courses/course provide/provides students with opportunities to develop basic writing skills and learn the process of writing as practiced by a particular academic discipline or profession. The course predominantly focuses on academic writing, presentation, reports, and appraisal of academic discourses. The course intends to introduce students to the basic functions of English in the areas stated below: note taking from lectures, identifying structure of lectures, identifying focuses of lectures, discriminating major and minor ideas in lectures, distinguishing lecturers opinions from academic facts, writing reports, writing summaries and reviews in academic writing, showing probability and certainty in academic reports, describing and reporting visuals such as tables, graphs etc

**Course Objectives:**

At the end of this course, students will be able to:

- Identify the structure and emphasis of academic lectures,
- Distinguish the different meaning levels in academic texts,

- Interpret visuals like tables, charts, graphs etc in academic texts,
- Conduct oral presentations in academic contexts with confidence,
- Debate logically about different issues with their friends,
- Express their ideas effectively in various communicative contexts,
- Master skills of persuasive arguments
- Describe visuals in paragraphs,
- Write clear reports and assignments in academic contexts, and
- Summarize, review and critique academic texts.

**Course Outline:**

**7. Indigenous Knowledge**

7.1. Speaking

7.1.1. Discussing on the term 'Indigenous Knowledge'

7.2. Listening

7.2.1. Predicting and checking the prediction

7.3. Vocabulary

7.3.1. Dealing with words that collocate

7.4. Reading

7.4.1. Finding out inferences and references

7.5. Writing

7.5.1. Writing for or against "Indigenous Knowledge"

7.6. Grammar

7.6.1. Using appropriate tenses for planning and reporting

**8. Environmental Protection**

8.1. Listening

8.1.1. Listening text

8.1.2. Discourse markers showing contrast and addition

8.2. Reading

8.2.1. An article on measures to protect the environment

8.2.2. Gap-fill exercises for verbs formed form adjectives and the adjectives themselves

8.2.3. Comprehension questions

8.3. Speaking

8.3.1. Words and phrases for expressing cause and effect

8.3.2. Conditional sentence type

8.3.3. Future tense

8.3.4. Simple present

8.3.5. Expressions of hopes and fears, agreeing and disagreeing

8.4. Writing

8.4.1. A five-paragraph essay

8.4.2. An article to be summarized

**9. Digital Technology**

9.1. Listening

9.1.1. A TED Talk on the dangers of digital technology

9.2. Reading

9.2.1. Magazine article

9.3. Speaking

9.3.1. Phrases for asking for and giving reasons.

9.3.2. Comparative and superlative forms

9.3.3. 'Wh' questions

9.3.4. Modals

9.4. Writing

9.4.1. Questionnaire for a survey

9.4.2. A 2-3 pages long report on the results of a questionnaire

9.4.3. Oral presentations of the results of the survey

9.4.4. Sample survey report for analysis

**10. Lifelong Learning**

10.1. Speaking and listening

10.2. Listening

10.3. Vocabulary

10.4. Grammar

10.5. Reading

10.6. Writing

**11. Wonders of the World**

11.1. Listening

11.1.1. Listening text describing a wonder of the world

11.2. Reading

11.2.1. A story about national heritage that the government of Ethiopia is campaigning for its recognition by UNESCO

11.2.2. An article that contains the history of world heritage sites registered by UNESCO

11.2.3. A table containing nouns, verbs and adverbs used to describe statistical information

11.3. Speaking

11.3.1. Expressions for suggestions or recommendations, agreement and disagreement

11.3.2. Language of descriptions

11.3.3. A sample descriptive essay

11.4. Writing

11.4.1. Gap-fill exercise on prepositions

11.4.2. Sample descriptive essay

**12. Mindset**

12.1. Listening

12.2. Reading

12.3. Speaking

12.4. Writing

**Instructional Methods and Strategies**: Providing brief introductory notes, Pair and group discussions, Facilitating interactive work, encouraging independent learning, Giving individual and group works are some of the major teaching methods to be used**.**

**Teacher's activities:** Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice and defend their own opinions and enhancing the students' commitment to individual study and acquiring knowledge are among the activities.

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work, Valuing Active Participation, Valuing Attendance and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


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### 9.1.9. Anthropology of Ethiopian Societies and Cultures

| | |
|---|---|
| **Course Title:** | Anthropology of Ethiopian Societies and Cultures |
| **Course Code:** | Anth 1012 |
| **Credit Hours/ECTS:** | 2/4 |
| **Contact Hours:** | 2 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

This course is designed to introduce the anthropology of Ethiopian societies and cultures to first year students' of Higher Learning Institutions (HLIs). It covers basic concepts of anthropology such as culture, society and humanity. It also discusses themes including unity and diversity; kinship, marriage and family; indigenous knowledge systems and local governance, identity, multiculturalism, conflict, conflict resolution and peacemaking system; intra and inter-ethnic

relations of Ethiopian peoples. In addition, the course explores culture areas of Ethiopia such as plough culture, *enset* culture and pastoralism. The course further covers marginalized minority and vulnerable groups in terms of age, gender, occupation and ethnicity by taking ethnographic case studies into account and discuss ways of inclusive growth.

**Course objectives:**

Up on the successful completion of the course, students will be able to:

- Develop an understanding of the nature of anthropology and its broader scope in making sense of humanity in a global perspective;
- Understand the cultural and biological diversity of humanity and unity in diversity across the world and in Ethiopia;
- Analyze the problems of ethnocentrism against the backdrop of cultural relativism;
- Realize the socially constructed nature of identities & social categories such as gender, ethnicity, race and sexuality;
- Explore the various peoples and cultures of Ethiopia;
- Understand the social, cultural, political, religious& economic life of different ethnolinguistic & cultural groups of Ethiopia;
- Understand different forms marginalization and develop skills inclusiveness;
- Appreciate the customary systems of governance and conflict resolution institutions of the various peoples of Ethiopia;
- Know about values, norms and cultural practices that maintain society together;
- Recognize the culture area of peoples of Ethiopia and the forms of interaction developed over time among themselves; and
- Develop broader views and skills to deal with people from a wide variety of socioeconomic and cultural backgrounds.

**Course Outline:**

**1. Introducing Anthropology and Its Subjects**

1.1. What is anthropology – a Mirror for Humanity?

1.1.1. Sketching the subject matter, scope and concerns of anthropology

1.1.2. Anthropological imagination: asking questions and seeing the world anthropologically.

1.1.3. Defining Features of Anthropology- holism, relativism & comparative perspectives

1.1.4. Methods of Research in anthropology: ethnography & ethnographic methods

1.2. Sub-fields of Anthropology: Four Mirrors for Understanding Humanity

1.3. The relation between anthropology and other disciplines

**2. Human Culture and Ties that Connect**

2.1. Conceptualizing Culture: What Culture Is and What Culture Isn't?

2.2. Characteristics features of culture: what differentiates culture from other traditions?

2.3. Aspects of Culture –Material & Non-material (values, beliefs & norms)

2.4. Levels of culture: universality, generality and particularity (cultural diversity)

2.5. Ethnocentrism, Cultural relativism, and human rights

2.5.1. Discussion- Debating cultural relativism: Human rights law and the demonization of culture and anthropology along the way

2.6. Cultural Change: what is cultural change?

2.6.1. Cultural Diffusion versus Cultural Assimilation

2.6.2. Innovation

2.6.3. Discussion - Contesting culture as sharply bounded versus unbounded 'cultural flows' or as 'fields of discourse' in the context of globalization.

2.7. Ties that Connect: Marriage, Family and Kinship

2.7.1. Marriage -rules, functions and forms of Marriage

2.7.2. Family -types and functions of Family

2.7.2.1. Q. How families and marriage differ in different societies?

2.7.3. Kinship System -types of kin groups and rules of descent

2.7.4. Kinship and Gender Across Cultures

2.7.4.1. Sex and Gender: Mapping differences in cross cultural perspective

2.7.4.2. Gender –as power relations

2.8. Cultural practices, norms and values that maintain society together

**3. Human Diversity, Culture Areas, and Contact in Ethiopia**

3.1. Human Beings & Being Human: What it is to be human? (a bio-cultural animal?)

3.2. Origin of the Modern Human Species: Homo sapiens sapiens (that's you!)

3.2.1. Religious, biological & evolutionary (paleo-anthropological) explanations

3.3. The Kinds of Humanity: human physical variation

3.3.1. Q. Why isn't everyone the same?

3.3.2. Q. Why do people worldwide have differences in their phenotypic attributes?

3.4. Human Races: the history of racial typing

3.4.1. The Grand Illusion: Race, turns out, is arbitrary

3.4.2. Q. What can we say for sure about human races?

3.5. Why is Everyone Different? Human Cultural Diversity - anthropological explanations

3.5.1. Q. Why don't others do things the way we/I do?

3.6. Culture areas and cultural contacts in Ethiopia

3.6.1. Plough culture area

3.6.2. Enset culture area

3.6.3. Pastoral societies culture area

3.6.4. Historical and social interactions between culture areas

**4. Marginalized, Minorities, and Vulnerable Groups**

4.1. Gender based marginalization

4.2. Occupational cast groups

4.3. Age based vulnerability (children and old age issues)

4.4. Religious and ethnic minorities

4.5. Human right approaches and inclusive growth, anthropological perspectives

**5. Theories of Inter-Ethnic Relations and Multiculturalism in Ethiopia**

5.1. The Scales of Human Identity: Who am I?- Understanding 'self' & 'other'

5.1.1. Q- What are the ways we tell for others who we are?

5.2. Ethnicity and Race: What's in a name?

5.3. Ethnic Groups & Ethnic Identity

5.3.1. Q. What is the basis of one's ethnic identity?

5.3.2. Q. Is ethnicity a fundamental aspect of human nature & self-consciousness, essentially unchanging and unchangeable identity? Or

5.3.3. Q. Is it, to whatever extent, socially constructed, strategically or tactically manipulable, and capable of change at both the individual and collective levels?

5.4. Race –the social construction of racial identity

5.4.1. Q. Do the claims of some people/groups about superior & inferior racial groups have any scientific validity?

5.5. Primordialism; Instrumentalism; Social constructivism

5.6. Debates on inter-ethnic relations and identities

**6. Customary and Local Governance Systems and Peace Making**

6.1. Indigenous knowledge systems and local governance

6.2. Intra and inter-ethnic conflict resolution institutions Ethnographic cases: commonalities and shared practices (e.g., Oromo and Somali, Afar and Tigray; Gedeo and Oromo; Guraghe and Siltie; Amara and Tigray)

6.3. Customary/Local governance systems Ethnographic cases: Oromo Geda; Somali-Gurti; Gamo, Gofa, Wolayita-Woga; Guraghe-Sera

6.4. Legal pluralism: interrelations between customary, religious and state legal systems

**Instructional Methods and Strategies**: This course will be delivered based on learner centered approach. Therefore, the main instructional strategies of the course are pair & group discussions; interactive teaching; brainstorming; icebreaker; debating & role-play.

**Teacher's activities:** An instructor of this course is expected to be honest to the content, policies and guidelines of this course. He/she is also expected to be well prepared on the course as well as prepare course outlines & teaching materials, follow up and assess students as per the guidelines.

**Students' activities:** Students are expected to attend regularly. If students miss more than 20% of the classes, he/she will not sit for final exam. Punctuality is mandatory and late coming student should not be allowed to enter the class.

**Assessment Strategies and Techniques**: Based on the progressive understandings of the course, students will be evaluated continuously through both non-graded assignments / activities, like (reading assignments) and graded assignments/activities and assessments including class discussion & participation, Test, Term Paper & presentation, Home Taken Exam/case studies and Final Exam. At least 50% continuous assessments (quizzes, tests, assignments, and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


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### 9.1.10. General Biology

| | |
|---|---|
| **Course Title:** | General Biology |
| **Course Code:** | Biol 1012 |
| **Credit Hours/ECTS:** | 3(2+1) |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

The primary goal of this course is to provide the basic information about general biology. Biology is an introductory college text that covers the concepts and principles from the structure and function of the cell to the organization of the biosphere. It draws up on the entire world of living things to bring out an evolutionary theme that is introduced from the start.

**Course Objectives**

At the end of the course, the student will be able to:

- Explain the scope of biology and molecular basis of life
- Describe life activities from the cellular point of view
- Manipulate basic biological tool, record data and draw conclusions
- Develop scientific attitude, skill and conduct biological experiments using scientific procedures

- Outline basic processes of energy transduction and synthesis of intermediate or final products in living cells
- Understand the basic concepts of genetics and inheritance
- Understand the concepts of infection and immunity
- Classify organisms based on their cellular organization and complexity
- Explain components, processes and interrelationships within a given ecosystem
- Know the general features of invertebrate and vertebrate animals
- Appreciate the practical uses of biological knowledge and its application in the wider society

**Course outline**

**1. Introduction**

1.1. The meaning and scope of biology

1.2. The origin and nature of life

1.3. Scientific methods

**2. Biological Molecules**

2.1. Carbohydrates

2.2. Lipids

2.3. Proteins

2.4. Nucleic acids

2.5. Vitamins

2.6. Water

2.7. Minerals

**3. The cellular basis of life**

3.1. The cell theory

3.1.1. Cell organelles

3.1.2. Structure and function of organelles

3.1.3. Cellular diversity

3.1.4. Cell Shape

3.1.5. Cell Size

3.1.6. Transport across the cell membranes

**4. Cellular Metabolism and Metabolic Disorders**

4.1. Cellular metabolism

4.1.1. Enzymes and their role in metabolism.

4.1.2. Chemical nature and classification of enzymes

4.1.3. Mechanisms of enzyme action

4.1.4. Factors affecting enzymatic activities

4.1.5. Enzyme inhibitors

4.2. Bioenergetics and biosynthesis

4.2.1. Cellular respiration

4.2.2. Biosynthesis

4.2.2.1. The photosynthetic apparatus

4.2.2.2. The photosynthetic process

4.3. Metabolic disorders, diagnosis and treatments

4.3.1. Risk factors of metabolic disorders

4.3.2. Diagnosis of metabolic disorders

4.3.3. Treatments of metabolic disorders

**5. Genetics and Evolution**

5.1. Basic Principles of Mendelian genetics and patterns of inheritance

5.2. Molecular genetics and inheritance

5.2.1. DNA, Gene, Chromosomes and Cell division

5.3. Protein synthesis

5.3.1. ABO blood groups and Rh Factors

5.4. Introduction to Evolution

5.4.1. Theories on the origin of life on Earth

5.4.2. Theories of Evolution

**6. Infectious diseases and Immunity**

6.1. Principles of infectious diseases

6.2. Types of infectious disease and their causative agent

6.2.1. Bacteria

6.2.2. Viruses

6.2.3. Fungi

6.2.4. Protozoa

6.2.5. Helminths

6.2.6. Prions

6.3. Modes of transmission

6.4. Host defenses against infectious diseases

6.5. Adverse immune reactions (responses)

6.5.1. Hypersensitivity reactions

6.5.2. Autoimmunity and autoimmune disease

6.5.3. Immune Deficiencies

6.6. Tumor Immunolology

6.6.1. Evidence for immune reactivity to tumor

6.6.2. Tumor associated antigens

**7. Taxonomy of organisms**

7.1. Early Attempts to Classify Organisms

7.2. Modern Views of Classification (Schemes of Classification)

7.3. Domains of Life and the Hierarchical System of Classification

7.4. Binomial Nomenclature

7.4.1. The Purpose of giving names to organisms

7.5. Operative Principles of Nomenclature

**8. Ecology and Conservation of Natural Resources (3 Hrs)**

8.1. Definition of ecological terms and Basic concepts of Ecology

8.2. Branches of ecology

8.3. Aquatic and terrestrial ecosystems

8.4. Energy flow through ecosystems

8.4.1. The food chains

8.5. Cycling of Materials (Nutrients)

8.6. Conservation of natural resources

8.6.1. Principles of conservation of natural resources

8.7. Environmental pollution and public health

**9. Introduction to Botany and Zoology**

9.1. Introduction to Botany

9.1.1. Algology

9.1.2. Bryology and Pteridology

9.1.3. Seed plants

9.2. Introduction to zoology

9.2.1. Invertebrates

9.2.1.1. General Characteristics of Invertebrates

9.2.1.2. Classification of Invertebrates

9.2.1.3. Services Provided by Invertebrates

9.2.2. Subphylum Vertebrates

9.2.2.1. Classification of Vertebrates

**10. Applications of Biological Sciences**

10.1. Application of Biology in medicine and other health sciences (Fast diagnosis tools, drug and vaccine production, gene therapy, immuno-diagnosis, immunotherapy, transplantation, medicinal plants, etc)

10.2. The application of Biology in technology

10.3. Application of Biology in agriculture (soil fertility, tissue culture, animal breeding and transgenic animals, plant disease and pest management)

10.4. Application of Biology in industries (Food, brewery, pharmaceuticals, tannery and textile, single cell production, preservation)

10.5. Application of Biology in waste treatments and recycling (Bioenergy, bioremediation, water treatment, biomining)

10.6. Application of Biology in forensic Science

10.7. Biological warfare

**Instructional Methods and Strategies**:

**Students' Activities**:

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Recommended Laboratory Activities**

**References**

### 9.1.11. History of the Ethiopia and the Horn

| | |
|---|---|
| **Course Title:** | History of Ethiopia and the Horn |
| **Course Code:** | Hist 1012 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

This course is a common course given to Higher Learning Institutions Students/HLIS. Students will learn about the role of history in human life and goals of studying history. Students will also learn the importance of history in nation building and the making of identity in time and space. This course covers the major historical processes in Ethiopia and the Horn. The course is also concerned with how the sociocultural, religious, economic and political experiences of the past are interwoven in the making of the current Ethiopia and the Horn. It is useful to know how personalities helped change the scenario, and how societies, peoples and the world that we live in have changed over time and its implication for history of Ethiopia and the Horn. It is helpful to understand history as a base for shaping and bettering of the future. It gives more emphasis to the history of peoples, instead of narrating only the history of the ruling elites.

**Course Objectives:**

At the end of this course, students will be able to:

- comprehend the general concepts of history
- analyze relevant sources for History of Ethiopia and the Horn
- understand Ethiopia and the Horn in relation to Human Evolution and Neolithic Revolution
- trace origin, developments and achievements of states in the region during the ancient period
- examine the long term effect of the ‘’Solomonic’’ dynasty in the region
- scrutinize dynamics of territorial expansion of the Christian kingdom and rivalry between the Christian Kingdom and Muslim Sultanates in the region
- know the role of foreign relations and interventions from ancient to modern times in the region
- realize the interplay between local developments and foreign influences
- explicate the role of population movements in shaping the modern Ethiopia and the Horn
- illustrate the major socio-economic, religious & political achievements of Gondar period
- discuss salient characteristic features and effects of “Zemene Mesafint*”*
- assess developments in Eastern, Central, Southern & Western parts of Ethiopia & the Horn
- expound the political process for formation of Modern Ethiopia and the Horn
- discern the move towards modernization and the challenges encountered
- point out legacies of major battles, victories and the roles of patriots
- elaborate the socio-economic and political progresses of the post 1941 imperial period
- differentiate the major changes, and challenges that led to the demise of the monarchy
- reveal the political momentum, reforms and oppositions during the Derg period
- clarify historical developments from 1991-1994

**Course Outline:**

**1. Introduction**

1.1. Concepts of History: Meaning, Nature and Uses

1.2. Sources & Methods of Historical Study

1.3. Origin and Development of Historiography of Ethiopia and the Horn

1.4. Introducing and Understanding Ethiopia and the Horn

**2. Peoples and Cultures in Ethiopia and the Horn**

2.1. Human Evolution

2.2. Neolithic Revolution

2.3. The Peopling of the Region

2.3.1. Languages and Linguistic Processes: Afro-Asiatic Super-Family (Cushitic, Semitic and Omotic Families) and Nilo-Saharan Super-Family (Chari-Nile & Koman Families)

2.3.2. Settlement Patterns

2.3.3. Economic Formations

2.4. Religion and Religious Processes

2.4.1. Indigenous

2.4.2. Judaism

2.4.3. Christianity

2.4.4. Islam

**3. Polities, Economy & Socio-Cultural Processes in Ethiopia & the Horn to the End of the 13th Century**

3.1. Evolution of States

3.2. Ancient Polities

3.2.1. North and Northeast: Punt, Damat, Axum, Zagwe…

3.2.2. East, Central, Southern and Western

3.2.2.1. Bizamo, Damot, Enarya, Gafat…

3.2.2.2. Muslim Sultanates: Shewa, Ifat, Dawaro, Fatagar, Bali, Hadiya, Arebabani, Shirka, Dera…

3.2.3. External Contacts

3.3. Economic Formations: Agriculture, Handicraft, Trade…

3.4. Socio-cultural achievements: Architecture, Writing, Calendar, Numerals…

**4. Politics, Economy & Socio-Cultural Processes from Late 13th –the beginning of the 16th Century**

4.1. "Restoration" of the "Solomonic'' Dynasty

4.2. Power Struggle, Consolidation, Territorial and Religious Expansion of the Christian Kingdom

4.2.1. Succession Problem and the Establishment of Royal Prison

4.2.2. Territorial Expansion towards Agaw, Bizamo, Damot, Red Sea, Bete-Israel/"Falasha…"

4.2.3. Evangelization and Religious Movements

4.3. Social, Economic and Political Dynamics of Muslim Sultanates

4.3.1. Political Developments in the Muslim Sultanates and the Rise of Adal

4.3.2. Trade and the Expansion of Islam

4.4. Rivalry between the Christian Kingdom and the Muslim Sultanates

4.5. External Relations

**5. Politics, Economy & Socio-Cultural Processes from Early 16th –the End of the 18th Century**

5.1. Interaction and Conflicts of the Christian Kingdom and the Sultanate of Adal

5.2. Foreign Interventions and Religious Controversies

5.3. Population Movements

5.3.1. Population Movements of the Afar, Somali and Argobba

5.3.2. Gadaa System and Oromo Population Movement (1522- 1618)

5.4. Interaction and Integration across Ethnic and Religious Diversities

5.5. Peoples and States in Eastern, Central, Southern and Western Regions

5.5.1. Cushitic: Qafár, Somali, Oromo, Sidama, Hadya, Kembata, Gedeo,, Konso, Burji, Derashe…

5.5.2. Semitic: Harari Emirate, Shewan Kingdom, Gurage Polity…

5.5.3. Omotic: Kefa, Wolayitta, Gamo, Gofa, Dawro, Konta, Yem, Hamar…

5.5.4. Nilotic: Anywa, Nuer, Majang, Berta, Gumuz, Kunama…

5.6. The Period of Gondar (1636-1769) and "Zemene Mesafint/Era of Princes" (1769-1855)

5.6.1. The Revival of the Christian Kingdom

5.6.2. Gondar Achievements: architecture, painting, music, literature, urbanization, trade etc.

5.6.3. Gondar Political Developments: "Close Door Policy," Reforms, "Byzantine Politics"…

5.6.4. Major Features of Era of Princes (1769-1855) and Yejju Dynasty (1786-1853)

**6. Internal Interactions and External Relations from the 1800–1941**

6.1. The Nature of Interactions among peoples and states of Ethiopia and the Horn

6.1.1. Peoples and states of Qabena, Five Gibe, Two Leqa, Aqoldi, Khomosha, Belashangul…

6.1.2. The Role Trade and Trade Routes in the Interaction

6.2. Power Rivalry

6.3. The Making of Modern Ethiopian State (Territorial Expansion, Centralization process..)

6.4. Modernization Attempts: administration, military, innovation, education, road construction, railway, transportation & communication, constitution…

6.5. Socio-Economic Issues: agriculture, disease & famine, trade, slavery, manufacturing…

6.6. External Relations, Challenges and Threats

6.6.1. External Diplomatic Relations and Treaties

6.6.2. The Major Battles (Debarki, Meqdela, Gundet, Gura, Dogali, Mattama, Adwa, Maychew…)

6.6.3. Italian Occupation (1936-1941) and the Patriotic Resistance

**7. Internal Interactions and External Relations from the 1941–1994**

7.1. Post 1941 Imperial Period

7.1.1. Political Scene: Restoration & Consolidation of Imperial Power and External Relations

7.1.2. Socio-economic Conditions: agriculture & tenancy, famine, factories, education, health, transportation, religion, welfare institutions (idir, iqub…) etc.

7.1.3. Opposition: Conspiracies, Revolts and Downfall of the Monarchical Regime

7.2. The Derg Regime (1974-1991)

7.2.1. The Rise of Derg and the Political Momentum

7.2.2. Attempts at Reforms: Land Reform, Development through Cooperation Campaign, Collectivization, Agricultural Marketing Corporation, Resettlement, Villagization, Literacy…

7.2.3. Internal oppositions, Ethio-Somali War, International Changes & End of the Derg

7.3. Historical Developments, 1991-1994 (transitional charter: language & identity issues…

**8. Cross-Cutting Issues in History of Ethiopia and the** Horn

8.1. The Role of Women in Ethiopian History (economic, political, cultural and social)

8.2. Environmental Dynamics: changes and continuities (deforestation, drought, pollution…)

8.3. Indigenous Knowledge: folk medicine, conflict resolution mechanisms (Amhara-Shemgelenna, Gurage-Yajoka, Kembata-Seera, Oromo-Gumaa, Qafár-Makabanto, Sidama-Gudu'emale, Somali-Dayad, Tigray-Bayto…)

**Instructional Methods and Strategies**: This course will be delivered based on learner centered approach. Therefore, the main instructional strategies of the course are pair & group discussions; interactive teaching; brainstorming; icebreaker; debating & role-play.

**Teacher's activities:** An instructor of this course is expected to be honest to the content, policies and guidelines of this course. He/she is also expected to be well prepared on the course as well as prepare course outlines & teaching materials, follow up and assess students as per the guidelines.

**Students' activities:** Students are expected to attend regularly. If students miss more than 20% of the classes, he/she will not sit for final exam. Punctuality is mandatory and late coming student should not be allowed to enter the class.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Abir, Mordechai. Ethiopia and the Red Sea: The Rise and Decline of the Solomonic Dynasty and MuslimEuropean Rivalry in the Region. Frankcass, 1980.
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4. Alemayehu Haile et al. History of the Oromo to the Sixteenth Century. Finfinne**:** OCTB, 2006.

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**NB:** Historical Maps of Ethiopia, relevant historical documents, relevant internet web pages, museums and other relevant materials can also be used.

### 9.1.12. Introduction to Emerging Technologies

| | |
|---|---|
| **Course Title:** | Introduction to Emerging Technologies |
| **Course Code:** | EmTe 1012 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

This course will enable students to explore current breakthrough technologies in the areas of Artificial Intelligence, Internet of Things and Augmented Reality that have emerged over the past few years. Besides helping learners become literate in emerging technologies, the course will prepare them to use technology in their respective professional preparations.

**Course Objectives:**

Up on the successful completion of the course, students will be able to:

- Identify different emerging technologies
- Differentiate different emerging technologies
- Select appropriate technology and tools for a given task
- Identify necessary inputs for application of emerging technologies

**Course Outline:**

**1. Introduction to Emerging Technologies**

1.1. Evolution of Technologies

1.1.1. Introduction to Industrial revolution (IR)

1.1.2. Historical Background (IR 1.0, IR 2.0, IR 3.0)

1.1.3. Fourth Industrial Revolution (IR 4.0)

1.2. Role of Data for Emerging Technologies

1.3. Enabling devices and network (Programmable devices)

1.4. Human to Machine Interaction

1.5. Future Trends in Emerging Technologies

**2. Introduction to Data Science**

2.1. Overview for Data Science

2.1.1. Definition of data and information

2.1.2. Data types and representation

2.2. Data Value Chain

2.2.1. Data Acquisition

2.2.2. Data Analysis

2.2.3. Data Curating

2.2.4. Data Storage

2.2.5. Data Usage

2.3. Basic concepts of Big data

**3. Artificial Intelligence (AI)**

3.1. Introduction to AI

3.1.1. What is AI

3.1.2. History of AI

3.1.3. Levels of AI

3.1.4. Types of AI

3.2. Applications of AI

3.2.1. Agriculture

3.2.2. Health

3.2.3. Business (Emerging market)

3.2.4. Education

3.3. AI tools and platforms (e.g.: scratch/object tracking)

3.4. Sample application with hands on activity (simulation based)

**4. Internet of Things (IoT)**

4.1. Overview of IoT

4.1.1. What is IoT?

4.1.2. History of IoT

4.1.3. Advantage of IoT

4.2. How IoT Works

4.2.1. Architecture of IoT

4.2.2. Device and Network

4.3. IOT tools and platforms (e.g.: KAA IoT /Device Hive/Zetta/Things Board…)

4.4. Sample application with hands on activity (e.g. IOT based smart farming)

**5. Augmented Reality (AR)**

5.1. Introduction to AR

5.2. Virtual reality (VR), Augmented Reality (AR) vs mixed reality (MR)

5.3. Architecture of AR systems.

5.4. Application of AR systems (education, medical, assistance, entertainment) workshop-oriented hands demo

**6. Ethics And Professionalism of Emerging Technologies**

6.1. Technology and ethics

6.2. Digital privacy

6.3. Accountability and trust

6.4. Treats and challenges

**7. Other Emerging Technologies**

7.1. Nanotechnology

7.2. Biotechnology

7.3. Blockchain technology

7.4. Cloud and quantum computing

7.5. Autonomic computing

7.6. Computer vision

7.7. Embed systems

7.8. Cyber security

7.9. Additive manufacturing (3D Printing) Etc. …

**Instructional Methods and Strategies**: This course will be delivered based on learner centered approach. Therefore, the main instructional strategies of the course are pair & group discussions; interactive teaching; brainstorming; icebreaker; debating & role-play.

**Teacher's activities:** An instructor of this course is expected to be honest to the content, policies and guidelines of this course. He/she is also expected to be well prepared on the course as well as prepare course outlines & teaching materials, follow up and assess students as per the guidelines.

**Students' activities:** Students are expected to attend regularly. If students miss more than 20% of the classes, he/she will not sit for final exam. Punctuality is mandatory and late coming student should not be allowed to enter the class.

**Assessment Strategies and Techniques**: Based on the progressive understandings of the course, students will be evaluated continuously through both non-graded assignments / activities, like

(reading assignments) and graded assignments/activities and assessments including class discussion & participation, Test, Term Paper & presentation, Home Taken Exam/case studies and Final Exam. At least 50% continuous assessments (quizzes, tests, assignments, and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**

### 9.1.13. Moral and Civic Education

| | |
|---|---|
| **Course Title:** | Moral and Civic Education |
| **Course Code:** | MCiE 1012 |
| **Credit Hours/ECTS:** | 2/3 |
| **Contact Hours:** | 2 Lecture Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description:**

The Ethiopian government has designed and implemented moral and civic education curricula to aim at educating students about democratic culture, ethical values and principles, supremacy of constitution, and the rule of law and so on. These elements are imperative in the process of producing self-confident citizens and a generation who has the capability to shoulder responsibility. Accordingly, this module is basically aspires to equip the learners with relevant knowledge, respect for the worth and human dignity of every individual, right attitudes and requisite skills to enable them perform their roles as a credible members of their society. Through the module, learners will also acquire nature of Ethiopian federalism and parliamentary system of government, ways of making responsible decisions, solve problems, care about others, contribute to society, and be tolerant and respectful of diversity.

**Course Objectives:**

After the successful completion of this module students will be able to:

- Conceptualize what morality, ethics and civics mean.
- Comprehend the goals of civics and ethics as well as the competences of a good citizen.
- Discuss the relations between society, state and government.
- Differentiate federal state structure from unitary and discuss the advantages and disadvantages of the state structures.
- Discuss the processes of modern Ethiopian state formation and nation building.
- Comprehend the features of Ethiopian federalism.
- Conceptualize constitution, its classification and unique features.
- Define the term human rights, the unique features and its classifications.
- Differentiate the teleological, deontological and virtue theories.

**Course Outline:**

1. **Understanding Civics and Ethics**
   1.1.Chapter introduction
   1.2.Defining Civics, Ethics and Morality
   1.3.Ethics and Law
   1.4.The importance/goal of moral and civic education
2. **Approaches to Ethics**
   2.1.Chapter introduction
   2.2.Normative ethics
   2.3.Non-normative ethics
3. **Ethical Decision Making and Moral Judgements**
   3.1.Chapter introduction
   3.2.How can we make ethical decisions and actions?
   3.3.To whom or what does morality apply?
   3.4.Who is morally/ethically responsible?
   3.5.Why should human beings be moral?

4. **State, Government and Citizenship**
    4.1.Chapter introduction
    4.2.Understanding state
    4.3.Rival theories of state
    4.4.The role of the state
    4.5.Understanding government
    4.6.Understanding citizenship
5. **Constitution, Democracy and Human Rights**
    5.1.Chapter introduction
    5.2.Constitution and constitutionalism
    5.3.Constitutionalism
    5.4.The constitutional experience of Ethiopia: Pre and post 1931.
    5.5.Democracy and democratization
    5.6.Human Rights: concepts and theories

**Instructional method and strategies**

**Teacher's activities:** Introducing objectives to the students, Asking brain storming questions, Defining terms and concepts in global affairs, brief introduction to the sub topics, Giving class room and home based works, Checking, evaluating, and giving feedback to students' work and Summarizing the chapters

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, brainstorming, reflection, reporting, solving problems associated to the respective topics.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**

1. Bunbongkarn, S., 2001. The role of civil society in democratic consolidation in Asia. Center for International Exchange, p.230.
2. Camara, M. S. (2008). Media, civil Society and political culture in West Africa, African Journalism Studies, 29(2), 210-229.
3. Dorsen, N., Rosenfeld, M., Sajó, A., & Baer, S. (2003). Comparative constitutionalism: cases and materials.
4. Gashaw, A. (2015) Constitution, constitutionalism and foundation of democracy in Ethiopia.
5. Getahun, K. (2007). Mechanisms of Constitutional Control: A preliminary observation of the Ethiopian system. Afrika Focus, 20(1-2).

### 9.1.14. General Chemistry

| | |
|---|---|
| **Course Title:** | General Chemistry |
| **Course Code:** | Chem 1012 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | I |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course description**:

Nature and applications of chemistry in different fields of study will be demonstrated. Properties of matter including intensive and extensive, physical and chemical properties will be explored. Units and measurements, composition of matter, chemical reactions, reaction stoichiometry, atomic structure, periodic table, chemical bonding, structure of molecules, properties of solutions, concept of chemical equilibrium, introduction of functional groups and their typical reactions will be discussed.

Practical General Chemistry parts deals with introduction of laboratory conditions, safety in chemistry laboratory, laboratory report writing and data handling, and the various experiments that are related to chemistry courses at high school. Moreover, experiments related to the basic chemistry concepts will be comprehensively addressed. Experimental works on measuring mass

and volumes, experimental errors, systematic and random errors, significant digits, Digital balance, mean, mean deviation, bunsen burner, luminous and non-luminous flame, physical and chemical changes, properties and reaction of substances, diffusion of gases, kinetic theory of gases, Graham's law of diffusion; colorimetric analysis, investigation of heat involved in a chemical reaction; basic laboratory operations such as recrystallization, simple distillation, and fractional distillations will be explored.

**Course Objectives**

Upon completion of the course the students will be able to:

- Express the role of chemistry in science fields
- Mention the different properties of matter
- Explain solution types and measurement units
- Describe the effect of different factors on solubility
- Discuss the mixture of liquids and their Laws
- Apply the different units and measurements
- Discuss atoms, ions, and their structures
- Describe the periodic table trends
- Discuss the stoichiometry of chemical reaction
- Apply the mole concept
- Describe the electronic structure of elements
- Explain the chemical bonding and molecular geometry
- Discuss the concept of acids and bases
- Examine the concept of hydrocarbons
- Explain the different types of functional groups
- Grasp the general guidelines of laboratory
- Develop the skill of mass and volume measurement
- Differentiate experimental errors
- Discuss the difference between physical and chemical changes
- Operate Bunsen burner and discuss on parts and description of each part
- Discus on the property of the flame of Bunsen burner

- Observe limiting reagents
- Verify the Graham's law of diffusion and observe the motion of the molecules
- Determine the percentage of water of hydration
- Perform solution preparations and define concentrations
- Discuss quantitative analysis using instruments
- Explain the difference between exothermic and endothermic reactions
- Carry out recrystallization, simple, and fractional

**Course outline**

**1. Nature and Essence of Chemistry**

1.1. Role of chemistry

1.2. Scientific methods of analysis

1.3. The domains of chemistry

1.4. State and classification of matter

1.4.1. State of matter

1.4.2. Classification of matter

1.5. Physical and chemical properties

1.6. Extensive and intensive property of matter

**2. Properties of Solutions**

2.1. Measures of concentration

2.2. Emphasizing the amounts of solute in solution

2.3. Emphasizing relative amounts of solute and solvent molecules

2.3.1 Solubility

2.3.2. Saturation and solubility

2.3.3. The effect of pressure on gas solubility

2.3.4. The effect of temperature on solubility

2.4. Colligative properties

2.4.1. Changes in vapor pressure, boiling points, and freezing points

2.4.2. Osmosis

2.5. Mixtures of liquids

2.5.1. Raoult's law for mixtures of liquids

2.5.2. The distillation of mixtures of liquid

**3. Measurements and Units**

3.1. Si base units

3.2. Derived units

3.3 Molarity and other concentration units

3.3.1. Molarity

3.3.2. Dilution of solutions

3.3.3. Percentage of (w/w, w/v and v/v)

3.3.4. Parts per million (ppm) and part per billion (ppb)

3.4. Measurement uncertainty

3.5. Significant figures in measurement

3.5.1. Significant figures in calculations

3.6. Accuracy and precision

3.7. Conversion factors and dimensional analysis

**4. Atoms, Molecules and Ions**

4.1. Atomic structure and symbolism

4.1.1. Chemical symbols and isotopes

4.1.2. Atomic mass unit and average atomic mass

4.2. Chemical formulas

4.3. The periodic table

4.3.1. Historical development of the periodic table

4.3.2. Classification of elements in the periodic table

4.4. Ionic and molecular compounds

4.4.1. Formation of ionic compounds

4.4.2. Formation of molecular compounds

4.5. Chemical nomenclature

4.5.1. Ionic compounds

4.5.2. Molecular compounds

**5. Stoichiometry of Chemical Reactions and the Mole Concept**

5.1. Writing and balancing chemical equations

5.1.1. Writing chemical equations

5.1.2. Balancing chemical equations

5.1.3. Equations for ionic reactions

5.2. Classification of chemical reactions

5.2.1. Acid-base reactions

5.2.2. Precipitation reactions and solubility rules

5.2.3. Oxidation-reduction reactions

5.3. Reaction stoichiometry

5.4. Mole concept and calculations

5.4.1 Mole and molar mass

5.4.2. Determining empirical and molecular formulas

5.4.3. Percent composition

5.4.4. Determination of empirical formulas

5.4.5. Determination of molecular formulas

5.4.6. Reaction yield/percent yield

5.4.7. Limiting reactant

**6. Electronic Structure and Periodic Properties of Elements**

6.1. Electromagnetic energy

6.1.1. Characteristics of light

6.1.2. Quantization and photons

6.2. The Bohr model

6.3. Development of quantum theory

6.3.1. The quantum–mechanical model of an atom

6.3.2. Quantum theory of electrons in atoms

6.3.3. The Pauli Exclusion Principle

6.4. Electronic structure of atoms

6.4.1. Orbital energies and atomic structure

6.4.2. The Aufbau principle

6.4.3. Electron configurations and the periodic table

6.4.4. Electron configurations of ions

6.5. Periodic variation in element properties

6.5.1. Variation in covalent radius

6.5.2. Variation in ionic radii

6.5.3. Variation in ionization energies

6.5.4. Variation in electron affinities

**7. Chemical Bonding and Molecular Geometry**

7.1. Ionic bonding

7.1.1. The formation of ionic compounds

7.1.2. Electronic structures of cations and anions

7.2. Covalent bonding

7.2.1. Formation of covalent bonds

7.2.2. Polarity of covalent bonds

7.3. Lewis structures

7.3.1. Writing Lewis structures with the octet rule

7.3.2. Exceptions to the octet rule

7.4. Formal charges and resonances

7.4.1. Calculating formal charge

7.4.2. Predicting molecular structure using formal charge

7.4.3. Resonance

7.5. Strengths of ionic and covalent bonds

7.5.1. Ionic bond strength and lattice energy

7.5.2. Bond strength of covalent bond

7.6. Molecular structure and polarity

7.6.1. Vsepr theory

7.6.2. Molecular structure and dipole moment

**8. The Concepts of Acids and Bases**

8.1. Arrhenius concept

8.2. BrØnsted-Lowery concept

8.3. Lewis concept

8.4. p-function in chemistry: pH and pOH

8.5. Relative strength of acids and base

**8. Organic Chemistry**

8.1. Functional groups

8.1.1. Hydrocarbons

8.1.2. Alkanes

8.1.3. Alkenes

8.1.4. Alkynes

8.2. Aromatic hydrocarbons

8.3. Alcohols and ether

8.3.1. Alcohols

8.3.2. Ethers

8.4. Aldehydes, ketones, carboxylic acids and esters

8.4.1. Aldehydes and ketones

8.4.2. Carboxylic acids and esters

8.5. Amines and amides

8.5.1. Amines

8.5.2. Amides

**Instructional Methods and Strategies**: Instructional methods and strategies including gapped lecture, inquiry, homework, assignment, group discussion etc., in general, student-centered approach will be implemented in the course.

**Students' Activities**: Active participation in discussion and team works; active listening during lecturing; taking notes on the lessons; asking questions and answering to questions; submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time. PowerPoints, white boards, demonstration videos etc., and

**Assessment Strategies and Techniques**: The theoretical section take 70% share of the course evaluation. Formative and summative assessments should be employed in students' assessments. At least 40% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 30% final examination

**Instructional Materials**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Text book**:

A course module for General Chemistry (Chem1012). (2019). Ministry of Science and higher education (as prepared by: Yiheyis Bogale (PhD), Habdolo Esatu (MSc), and Tamene Beshaw (MSc).

**References**


1. Peter Atkins and Julio de Paula. Physical Chemistry for the Life Sciences, co-published with Oxford University Press, 2006.
2. P.W. Atkins and J.A. Beran, General Chemistry, 2nd Ed., 1992.
3. R. Chang, General Chemistry: The Essential Concepts, 5th Ed., 2008
4. J.W. Hill and R.H. Petrucci, General Chemistry: An Integrated Approach, 2nd Ed., 1999.
5. J. E. Brady, J. W. Russel and J.R. Holum, General Chemistry: Principles and Structure, 5th Ed., 2006.
6. S. S. Zumdahal and S.A. Zumdahal, Chemistry, 7th Ed., 2007
7. A course module for General Chemistry (Chem.1012). (2019). Ministry of Science and higher education (as prepared by: Yiheyis Bogale (PhD), Habdolo Esatu (MSc), and Tamene Beshaw (MSc).
8. David Harvey-1st ed. Modern analytical Chemistry, publisher: *James M. Smith, year 2000.*


**Suggested Practical Activities**

Experiment 1: Preparation of solutions and concentration calculation

Experiment 2: Mass and volume measurements to define Density

Experiment 2: Bunsen burner

Experiment 3: Physical and chemical changes

Experiment 4: Diffusion of gases: Determination of Graham's rate laws

Experiment 5: Acid-base reactions: use of acid-base indicators

Experiment 6: Determination of solubility of salts: Investigating the solubility of ionic and covalent compounds

Experiment 7: Simple and Fractional distillations

Experiment 8: Separation of mixtures: Extraction; Distinguishing compounds and mixtures; Separation of a mixture using a magnet; Recrystallization; and Filtration

Experiment 9: Instrumental analysis: Colorimetric Determination of Acetaminophen

Experiment 9: Investigating the heat involved in a chemical reaction (Calorimetry): Investigating endothermic reaction; Investigating exothermic reaction; and Effect of temperature on reaction rate

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments; listen and observe demonstration and lecture; Take notes on the lessons treated; Ask questions on unclear idea**;** Active participation in discussion; Preparing flow charts for the experiment for every laboratory sessions; Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the laboratory throughout the laboratory sessions: Recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: The practical section take 30% share of the course evaluation. The modes of Assessment: Up to 20% continuous assessment (quizzes, practical assessments (in group and/or individual), laboratory report, project work etc.)), and 10% final examination. Missing of more than two experiments lead to repeating the course.

**References**


1. Silberberg, M. Principles of General Chemistry: Student Solutions Manual. Publisher: MGH, 2006
2. Jo A. Beran. Laboratory Manual for Principles of General Chemistry, Edition [8 ed.], Publisher: Wiley, 2007.
3. Kenneth W. Whitten. General Chemistry - Textbook Only [6th Ed.], Publisher: Cengage learning, 2000.

### 9.1.15. Inclusiveness

| | |
|---|---|
| **Course Title:** | Inclusiveness |
| **Course Code**: | Incl 2011 |
| **Credit Hours/ECTS:** | 2/3 |
| **Contact Hours:** | 2 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description:**

Development efforts of any organization need to include and benefit people with various types of disabilities, people at risks of exclusion/discrimination and marginalization, through providing quality education and training, creating equity, accessibility, employability, promoting prosperity, reducing poverty and enhancing peace, stability and creating inclusive society. Unfortunately, this has not been the practice for the majority of people with disabilities and vulnerable groups, due to unfavorable attitude, negligence, inaccessibility and exclusion from all development endeavors. It is obvious that people with disabilities are the large stand most disadvantaged minority in the world. They are about 15 percent of the global population (about one billion people), and 17.6 million in Ethiopia, with most extended families including someone with a disability (World Health Organization and World Bank and 2011). An exclusion practice of this large number of persons with disabilities in Ethiopia is an indicator of violating fundamental human rights that undermines their potential/ability to contribute to poverty reduction and economic growth within their household, their community and the country. It is clear that it is not impairment, but the exclusion practices that has contributed for insecurity (conflict), poverty aggravation for persons with disabilities and vulnerabilities, that has highly demanding inclusive practices. Exclusion practices of persons with disabilities have a long history, affecting the life of people with disabilities and the society at large. In the past and even today people have been discriminated due to their disabilities. Inclusiveness promotes effective developments through full participation of all members of a population, people with disabilities and vulnerabilities, where all are equal contributors of development and equitable

beneficiaries. Through inclusive practices, it is possible to identify and remove social and physical barriers so that people with disabilities and vulnerabilities can participate and benefit from all developments. Genuine inclusion of people with disabilities and vulnerabilities allow of them to actively participate in development processes and eliminate dependence syndrome, leads to broader benefits for families and communities, reduces the impacts of poverty, and positively contributes to a country's economic growth, development and ultimately create inclusive society. All stages of development processes of any organization should be inclusive through creating equal access to education, health care services, work and employment, social protection and all development center of human being. Hence, in this course, the higher education students will learn how to assess, understand and address the needs of persons with disabilities and vulnerabilities; and provide relevant support or seek extra support from experts. He/she also learns how to adapt and implementing services for an inclusive environment that aimed to develop holistic development such as affective, cognitive and psychosocial skills of the population with disabilities and vulnerabilities. Identification and removal/management of environmental barriers would find a crucial place in the course. The students learn how to give more attention and support for persons with; hearing impairments, visual impairment, deaf-Blind, autism, physical and health impairments, intellectually challenged, emotional and behavior disorders, learning difficulty, communication disorders, vulnerable persons including gifted and talented, and those at risk due to different reason (persons who are environmentally and culturally deprived, abused, torched, abandoned, and orphaned..etc.). All University students should be given the chance to study the specific developmental characteristics of each group of persons with disabilities and vulnerabilities. Furth more, they also identify the major environmental and social barriers that hinder the development of individuals; and come up with appropriate intervention strategies in inclusive settings of their respective professional environment and any development settings where all citizens are equally benefited.

**Course Objectives:**

After completing introduction to economics, students will be able to:

- Identify the needs and potentials of persons with disabilities and vulnerabilities.

- Identify environmental and social barriers that hinder the needs, potentials and full participations, in all aspects of life of persons disabilities and vulnerabilities
- Demonstrate desirable inclusive attitude towards all persons with disabilities and vulnerabilities in full participations
- Apply various assessment strategies for service provisions for evidence-based planning and implementation to meet the needs of persons with disabilities and vulnerabilities
- Adapt environments and services according to the need and potential of the persons with disabilities and vulnerabilities
- Utilize appropriate assistive technology and other support mechanisms that address the needs of persons with disabilities and vulnerabilities
- Respect and advocate for the right of persons with disabilities and vulnerabilities
- Collaboratively work with special needs experts and significant others for the life success of all persons with disabilities and vulnerabilities in every endeavor and in all environments.
- Create and maintain successful inclusive environment for persons with disabilities and vulnerabilities
- Promote the process of building inclusive society

**Course Outline**

1. **Understanding Disabilities and Vulnerabilities**
   - 1.1. Definitions of disability and vulnerability
   - 1.2. Types of disabilities and vulnerabilities
   - 1.3. Causes of disability and vulnerability
   - 1.4. Historical movements from segregation to inclusion
   - 1.5. The effects of attitude on the move towards inclusion
   - 1.6. Models of disability
2. **Concept of Inclusion**
   - 2.1. Definition inclusion
   - 2.2. Principles of inclusion
   - 2.3. Rationale for inclusion
   - 2.4. Features inclusive environment
3. **Identification, Assessment and Differentiated Services**

3.1. Level of disabilities for support

3.2. Needs and potentials of persons with disabilities

3.3. Needs and potentials of persons with vulnerabilities

3.4. Assessment and evaluation availability of legal frameworks in line with inclusion

3.5. Assessment and evaluation inclusiveness of the sector plans

3.6. Assessment and evaluation attitude towards inclusion

3.7. Assessment and evaluation of accessibilities of social and physical environments

3.8. Assessment and evaluation of strategies and plans that remove social and physical barriers to facilitate inclusiveness

3.9. The components and purpose of differentiated service plans

3.10. Assistive technologies and software to enhance inclusion

**4. Promoting Inclusive Culture**

4.1. Definition of inclusive culture

4.2. Dimensions of inclusive culture

4.3. Policy related to inclusive culture

4.4. Building inclusive community

4.5. Means of establishing inclusive culture

4.6. Inclusive values

4.7. Indigenous inclusive values and practices

**5. Inclusion for Peace, Democracy and Development**

5.1. Definition of peace, democracy and development from the perspective of Inclusiveness

5.2. Sources of exclusionary practices

5.3. Exclusionary practices in the community

5.4. Respectingdiverse needs, culture, values, demands and ideas

5.5. Conflict emanated from exclusion

5.6. The full participation of the marginalized group of people

5.7. The democratic principles for inclusive practices

5.8. The importance of inclusion for psychosocial development

5.9. The importance of inclusion for economic development

5.10. The importance of inclusion for peace

**6. Legal frame work**

6.1. Components of legal framework

6.2. International legal frame works in relation to inclusiveness

6.3. National legal frame works in relation to inclusiveness

**7. Resources Management for Inclusion**

7.1. Resources for inclusion

7.2. Planning for inclusion services

**8. Collaborative Partnerships with stakeholders**

8.1. Definition of collaboration, partnership and stack holder

8.2. Key elements of successful collaboration

8.3. The benefits and challenges of collaboration for various stakeholders for the success of inclusion

8.4. The strategies for effective co-planning and team working

8.5. Characteristics of successful stockholders' partnerships

8.6. Strategies for community involvement

**Instructional Methods and Strategies**: he course will involve deploying different teaching methods that attempt to make the teaching-learning process as effective as possible. For most part of the course, delivery method will be arranged as to make the process student-centered. There shall be full and active participation from students and they are strongly encouraged to ask questions, to reflect on brain-storming queries, and be involved actively and attentively in take-home assignments and peer discussions that appear during the semester both within and outside class-room sessions.

While there is no limit to the imagination and flexibility of the instructor, the course delivery techniques will generally involve the following items: Lecture, Brain-storming sessions, Group discussions and Individual and group assignments

**Students' Activities**: **Preparedness**: You must come to class prepared by bringing with you the appropriate materials like handouts, worksheets and exercises given, text books and completed assignments. Complete the individual and group assignments and other activities on time. You must plan your own learning through reading various course related materials and chapters in books. You are expected to work much individually to meet the requirement of the course. You

have to use your time for group work and home study effectively. Generally, students should attend at least 85% of the classes, take all continuous assessments and mid Exam, take final examination, respect all rules & regulations of the university

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References:**


1. Alemayehu Teklemariam and TemsegenFereja (2011). Special Need Education in Ethiopia: Practice of Special Needs Education around the World. Washington: Gallaudet University Press.
2. Alemayehu Teklemariam (2019). Inclusive Education in Ethiopia: WILEY and Blackwell: Singapore
3. A Teachers Guide (2001). UNESCO. Inclusive Education and Classroom Practice in Secondary Education
4. Berit H. Johanson and Alemayehu Teklemariam (2006). Towards Special Needs Education as a University Discipline: An Important step on the way to Education for All. In When All Means All. Hakapaino Oy: Helsinki
5. TirussewTeferra and Alemayehu Teklemariam (2007). Including the Excluded: Integrating disability into EFA Fast Track Initiative Process and National Education Plans in Ethiopia. World Vision
6. MOE (2007). School Improvement Program
7. MOE (2010). Special Needs Program strategies implementation guide.
8. MOE (Ministry of Education). (2006). Special *Needs Education Program Strategy*. Addis Ababa
9. Understanding and responding to children's need in inclusive classroom (2010). www.european-agency.org
10. **ዓለማየሁ·ትክለማርያም** (2009). **በመተባበርመማር፡- አንድለሁሉም፣ ሁሉምለአንድ፣ አዲስአበባ፡- ፋርኢስትአታሚ**

11. ዓለማየሁ ትክለማርያም (2011). አካቶ ትምህርት ለምን፣ ምን፣ ለነማንእንዴት፤ አዲስአበባ፡ ፋርኢስት አታሚ

**9.1.16. Economics**

| | |
|---|---|
| **Course Title:** | Economics |
| **Course Code**: | Econ 1105 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description**:

This course provides a general introduction to economics combining elements of micro and macro fundamentals. The first part of the course focuses on partial equilibrium aspects of theories of consumer behaviour, producer behaviour as well as on the arrangements and implications of different market structures. It will also cover the neoclassical theory of product and/or service pricing for perfectly competitive, monopolistic, oligopoly, and monopoly market structures. In addition, topics covered will include factor market pricing, general equilibrium analysis and distortions which relate to asymmetric information and moral hazard problems. The second part will discuss elements of macroeconomics that revolve around issues of measurement of aggregate economic activities, unemployment, and inflation. Emphasis will also be given to sources, consequences and policy responses to economic fluctuations. In the first part the course commences by highlighting the underlying assumptions behind each theory followed by in-depth analyses of the decisions of economic units subject to resource constraints in an effort to realize their respective objectives assuming the prevalence of market clearing situation. Finally, students will be able to contextualize the key analytical instruments with stylized facts from the Ethiopian economy.

**Course Objectives:**

After completing introduction to economics, students will be able to:

- Describe the major economic units constituting a given society and their corresponding roles
- Explain the objective functions of consumers and how they attain this objective under resource constraints
- Define producers' objective functions, describe their cost structures in the short and the long run, and apply partial equilibrium approaches to find optimal prices and quantities under different degrees of competition.
- Tabulate markets into different categories on the basis of the number of buyers and sellers and outline the various social welfare implications of each market structure.
- Elaborate the concept of general equilibrium analysis, identify its merits and demerits, and discuss the various market failures due to distortions arising from imperfect information and cultivate the corresponding possible remedial measures
- Understand how aggregate economic measures are constructed, their weaknesses, and alternative measures of national wellbeing
- Identify the sources and adverse effects of economic crises and describe the pool of policy instruments that can be deployed to mitigate the consequences of these crises.
- Contextualize the key analytical instruments with stylized facts from the Ethiopian economy

**Course outline**

**1. Theory of Consumer Behavior and Demand**

1.1. consumer preferences and choices

1.1.1. Consumer preference

1.1.2. Utility

1.2. Approaches to measuring utility

1.2.1. The cardinal utility approach

1.2.2. Assumptions of cardinal utility theory

1.2.3. Total and marginal utility

1.2.4. Law of diminishing marginal utility (LDMU)

1.2.5. Equilibrium of a consumer

1.2.6. Derivation of the cardinalist demand

1.3. The ordinal utility approach

1.3.1. Assumptions of ordinal utility approach

1.3.2. Indifference set, curve and map

1.3.3. Properties of indifference curves

1.3.4. The marginal rate of substitution (MRS)

1.3.5. Types of indifference curves

1.4. The budget line or the price line

1.4.1. Factors affecting the budget line

1.4.1.1. Effects of changes in income

1.4.1.2. Effects of changes in price

1.5. Optimum of the consumer

1.5.1. Effects of changes in income and prices on consumer optimum

1.5.1.1.Changes in income: income consumption curve and the Engel curve

1.5.1.2.Changes in price: price consumption curve (PCC)

1.5.2. Decomposition of income and substitution effects (normal, inferior or giffen goods)

1.5.3. Derivation of market demand curve

1.6. Elasticity of demand

**2. The Theory of Production**

2.1. Production function

2.2. Stages and laws of production

2.3. The law of variable proportions

2.4. Laws of returns to scale

2.5. Choice of optimal combination of factors of production

2.6. Short run and long run production functions

**3. Theory of Costs.**

3.1. Definition and types of costs

3.2. Short-run costs

3.3. Long-run costs

3.4. Derivation of cost functions from production functions

3.5. Dynamic changes in costs- the learning curve

**4. Perfect Competition Market**

4.1. The concept of market in physical and digital space (e.g. Amazon, Alibaba,etc..)

4.2. The welfare costs, benefits of e-markets and their implication for regulatory mechanisms

4.3. Competitive markets, short- run equilibrium of the firm, industry, and market

4.4. The long-run equilibrium of the firm, industry and market

**5. Pure Monopoly Market**

5.1. Characteristics and source of monopoly

5.2. Short run and long-run equilibrium

5.3. Price discrimination

5.4. Multi-plant monopolist

5.5. Social cost of monopoly power

**6. Monopolistic Competition**

6.1. Assumptions

6.2. Product differentiation, the demand curve and cost of the firm

6.3. The concept of industry and product 'group'

6.4. Short-run and long-run equilibrium of the firm excess capacity and welfare loss

6.5. Brief introduction to oligopoly markets

**7. Fundamentals of Macroeconomics**

7.1. The concepts of GDP and GNP

7.2. Approaches of measuring national income (GDP/GNP)

7.3. Other social accounts (GNP, NNP, NI, PI and DI)

7.4. Nominal versus real GDP

7.5. The GDP deflator and the consumer price index

7.6. GDP and welfare

7.7. The business cycle

7.8. Unemployment and inflation

7.9. Technology (.e.g. Robots) and unemployment

7.10. Role of exchange rate, terms of trade, and other external shocks

7.11. Brief introduction to the Ethiopian Economy

**Instructional Methods and Strategies**: The course will involve deploying different teaching methods that attempt to make the teaching-learning process as effective as possible. For most part of the course, delivery method will be arranged as to make the process student-centered. There shall be full and active participation from students and they are strongly encouraged to ask questions, to reflect on brain-storming queries, and be involved actively and attentively in take-home assignments and peer discussions that appear during the semester both within and outside class-room sessions. While there is no limit to the imagination and flexibility of the instructor, the course delivery techniques will generally involve the following items: Lecture, Brain-storming sessions, Group discussions and Individual and group assignments

**Students' Activities**: **Preparedness**: You must come to class prepared by bringing with you the appropriate materials like handouts, worksheets and exercises given, text books and completed assignments. Complete the individual and group assignments and other activities on time. You must plan your own learning through reading various course related materials and chapters in books. You are expected to work much individually to meet the requirement of the course. You have to use your time for group work and home study effectively. **Participation:** Make active participation during discussions (you must participate in class). You are not participating if you are simply talking to a friend, doing homework, daydreaming, or not doing what the rest of the class is doing. If you are working in a group or with a partner, you must talk to your group members or partner and be a part of the group. Always be ready and willing to give constructive feedback to partners'/group members and to listen to their comments on your work

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References:**


1. Koutsoyiannis, Modern Microeconomics
2. D.N. Dwivedi, 1997, Micro Economic Theory, 3rd Ed., Vikas Publishing
3. R.S. Pindyck& D.L. Rubinfeld, Microeconomics.
4. Hal R. Varian, Intermediate Microeconomics: A Modern Approach, 6th Ed.
5. C.L. Cole, Micro Economics: A Contemporary Approach.
6. Ferguson & Gould's, 1989, Microeconomic Theory, 6th Ed.
7. N. Gregory Mankiw, 2007, Macroeconomics 4th edition
8. William H. Branson, 2006 Macroeconomic Theory and Policy


### 9.1.17. Global Affairs

| | |
|---|---|
| **Course Title:** | Global Affairs |
| **Course Code**: | Glaf 2012 |
| **Credit Hours/ECTS:** | 2/3 |
| **Contact Hours:** | 2 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | II |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course Description:**

The course is designed to equip students with the basics of international relations so that they will be exposed to global challenges and perspectives. The course is very comprehensive, broad and multidisciplinary in its nature. Perhaps you may find it as an ice-breaking course since it touches up on wide range of issues, concepts, theories, approaches and debates that are helpful in understanding the contemporary international relations. Concepts, such as national interest, foreign policy, actors, globalization, balance of power, cold war, multi-polar systems, international law and other relevant concepts are being introduced. Different debates and approaches to the study of international relations including realism, liberalism are also given due emphasis.

**Course Objectives:**

After completing this course, students will be able to:

- Understand nations, nationalism and states
- Explain the nature and historical development of international relations
- Examine the extent and degree of influence of state and non-state actors in the international system
- Gain basic knowledge of the major theories of International Relations and develop the ability to critically evaluate and apply such theories
- Elucidate national interest, foreign policy and diplomacy
- Assess the overriding foreign policy guidelines of Ethiopia in the past and present
- Explicate the nature and elements of international political economy
- Examine the roles major international and regional institutions play in world politics
- Explore Ethiopia‘s role in regional, continental and global institutions and affairs
- Critically evaluate the major contemporary global issues

**Course Outline:**

6. **Understanding International Relations**
   - 6.1.Conceptualizing Nationalism, Nations and States
   - 6.2.Understanding international relations
   - 6.3.The nature and evolution of international relations
   - 6.4.Actors in international relations
   - 6.5.Levels of analysis in international relations
   - 6.6.The structure of international relations
   - 6.7.Theories of international relations
7. **Understanding Foreign Policy and Diplomacy**
   - 7.1.Defining national interests
   - 7.2.Understanding foreign policy and foreign policy behaviors
   - 7.3.Overview of foreign policy of Ethiopia
8. **International Political Economy (IPE)**
   - 8.1.Meaning and nature of international political economy (IPE)

8.2.Theoretical perspectives of IPE

8.3.Survey of the most influential national political economy systems in the world

8.4.Core issues, governing institutions and governance of international political economy

8.5.Exchange rates and the exchange rate system

**9. Globalization and Regionalism**

9.1.Defining globalization

9.2.The globalization debates

9.3.Globalization and its impacts on Africa

9.4.Ethiopia in a globalized world

9.5.Pros and Cons of globalization

9.6.Defining regionalism and regional integration

9.7.Major theories of regional integration

9.8.Selected cases of regional integration

9.9.Regionalization versus globalization and states

9.10. The relations between regionalization and globalization

9.11. Regionalization, globalization and the state

**10. Major Contemporary Global Issues**

10.1. Survey of major contemporary global issues

**Instructional method and strategies:** Introducing objectives to the students, Asking brain storming questions, Defining terms and concepts in global affairs, brief introduction to the sub topics, Giving class room and home based works, Checking, evaluating, and giving feedback to students' work and Summarizing the chapters

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, brainstorming, reflection, reporting, solving problems associated to the respective topics.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Balaam, David N., and Bradford Dillman. 2011. *Introduction to International Political Economy*. Boston: Longman.
2. Bates, R. (1982). Markets and States in Tropical Africa. Berkeley: University of California Press.
3. Baylis, J. and Steve S. 2001. The Globalization of World Politics: *An Introduction to International Relations.* Oxford University Press: New York.
4. Booth, K. and Smith, S. (eds), International Relations Theory Today (Cambridge: Polity)
5. Brown, Chris, Understanding International Relations (London, Macmillan, 1977)


### 9.1.18. Entrepreneurship and Business Development

| | |
|---|---|
| **Course Title:** | Entrepreneurship and Business Development |
| **Course Code**: | MGMT 4011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Plus 2 Tutorial Hours per Week |
| **Year:** | IV |
| **Semester:** | I |
| **Pre-Requisite:** | Does not Require Pre-Requisite |

**Course description**

This interdisciplinary course is designed to introduce students to meaning and the concept of entrepreneurship vs entrepreneur, creativity and innovation and their manageable processes that can be applied across careers and work settings. It focuses on building entrepreneurial attitudes and behaviors that will lead to creative solution within community and organizational environments. Course topics include the history of entrepreneurship, the role of entrepreneurs in the 21st century global economy, and the identification of entrepreneurial opportunities. The elements of creative problem solving, the development of a business ideas, products and

services, marketing and developing new ventures, the examination of feasibility studies and the social and moral implications of entrepreneurship will be incorporated. Besides, issues related to starting and financing a new venture are included. Finally, managing growth and through merger, acquisitions, licensing, outsourcing, franchising etc. And forms of business organizations, legal and regulatory frameworks of governing the whole system are also encompassed in the course syllabus.

**Course objectives:**

After completing the course learners will be able to understand:

- Meaning of the term entrepreneurship within the context of society; organizations and individuals.
- The role of entrepreneurship on the economy.
- Developing a concept for an innovative idea, product or service in one's own area of interest.
- How to develop elements of the entrepreneurial mindset and discuss the implications for functioning as a successful entrepreneur.
- The way how to prepare business plan as roadmap.
- The basic concepts of risk, its type & classification
- How to develop market and new venture
- How to explore alternative sources of financing the new venture
- How to form business organizations and consider practical ethical issues during the process

**Course Outline:**

1. **Overview of Entrepreneurship**
   1.1. What is entrepreneurship?
   1.2. Definition and philosophy of entrepreneurship vs entrepreneur
   1.3. Historical origin of entrepreneurship
   1.4. Role within the economy
   1.5. Entrepreneurship, creativity and innovation

2. **Business Development**
    2.1. Definition and importance
    2.2. Economic, social & political aspects of business enterprises
    2.3. Business Failure factors.
    2.4. Problems of small scale businesses in Ethiopia
    2.5. Setting up small scale businesses
        2.5.1. Basic business ideas
        2.5.2. the ways of organizing business ideas that an entrepreneur should have
        2.5.3. Definition of industry and small scale industry
        2.5.4. Steps in setting up a small scale business
3. **Business Planning**
    3.1. The concept of business planning
    3.2. Feasibility planning
    3.3. The business plan
    3.4. Developing a business plan
4. **Conception of Idea, Product or Services**
    4.1. Idea, Product or Service Technology
    4.2. Idea, product or service development process
    4.3. Idea, product or service protection
        4.3.1. Patents
        4.3.2. Trademarks
        4.3.3. Copyrighting
5. **Marketing and new venture development**
    5.1. What is market?
    5.2. Marketing research
    5.3. Marketing intelligence
    5.4. Competitive analysis
    5.5. Marketing strategies
    5.6. International markets
6. **Organizing and financing the new venture**
    6.1. Entrepreneurial team and business formation

6.2. Sources of financing

6.2.1. Asset management

6.2.2. Equity Financing

6.2.3. Venture Capital

6.2.4. Debt financing

6.2.5. Government financing eg Omo, Dev't Bank etc…

6.2.6. NGO financing eg. Germany supports for disabilities interest free loan disbursement

**7. Managing Growth and Transaction**

7.1. Preparing for the launch of the venture

7.2. Managing early growth of venture

7.3. New venture expansion strategies and Issues (Mergers, Acquisitions, licensing and Franchising)

7.4. Legal and regulatory frameworks of growth & transaction of new venture

**Instructional Methods and Strategies:** The course will involve deploying different teaching methods that attempt to make the teaching-learning process as effective as possible. For most part of the course, delivery method will be arranged as to make the process student-centered. There shall be full and active participation from students and they are strongly encouraged to ask questions, to reflect on brain-storming queries, and be involved actively and attentively in take-home assignments and peer discussions that appear during the semester both within and outside class-room sessions. While there is no limit to the imagination and flexibility of the instructor, the course delivery techniques will generally involve the following items: Lecture, Brain-storming sessions, Group discussions and Individual and group assignments

**Students' Activities: Preparedness:** You must come to class prepared by bringing with you the appropriate materials like handouts, worksheets and exercises given, text books and completed assignments. Complete the individual and group assignments and other activities on time. You must plan your own learning through reading various course related materials and chapters in books. You are expected to work much individually to meet the requirement of the course. You have to use your time for group work and home study effectively. **Participation:** Make active

participation during discussions (you must participate in class). You are not participating if you are simply talking to a friend, doing homework, daydreaming, or not doing what the rest of the class is doing. If you are working in a group or with a partner, you must talk to your group members or partner and be a part of the group. Always be ready and willing to give constructive feedback to partners'/group members and to listen to their comments on your work

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References:**


1. Hailay Gebretinsae, Entrepreneurship and Small Business Management, 2nd Edition.
2. Hodgetts, Richard M. Kurakto, Donald, F. "Entrepreneurship: A contemporary approach ". Fourth Edition, the Dryden Press, 1998.
3. Hirsh Robert D. D. and Peters Michael P. "Entrepreneurship" Fifth Edition, Tata McGraw Hill Edition, 2002.
4. Holt David H. "Entrepreneurship – New venture Creation "Eastern Economy Edition, 2000.
5. Donald F. Kutatko and Richard M. Hodgetts, "Entrepreneurship: A Cotemporary Approach Fourth Edition.

## 9.2. Core Major Courses

### 9.2.1. Analytical Chemistry Courses

#### 9.2.1.1. Analytical Chemistry

| | |
|---|---|
| **Course Title:** | Analytical Chemistry |
| **Course Code:** | Chem 2021 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Prerequisite:** | General Chemistry (Chem 1012) |

**Course Description**:

The course "Analytical Chemistry" is designed to make the students develop competencies of chemical analysis (qualitative and quantitative) by using various chemical analysis techniques including gravimetric and titrimetric techniques. The course also deals about: introduction to the subject matter of analytical chemistry; statistical evaluation of analytical data; ionic equilibria; solutions; titrimetric methods of analysis; and gravimetric analysis.

**Objective of the Course**

Upon completion of this course the students will be able to:

- Express the role of analytical chemistry in the society and everyday life;
- Mention the different methods of chemical analyses;
- Explain steps of the analytical process;
- Compare and contrast different schemes of systematic cation and anion analysis;
- Prepare solutions of different concentrations
- Describe the properties of solutions and chemical equilibria
- Describe the effect of different factors on solubility of a substance;
- Discuss the application of solubility product principle and complex ion formation reactions in chemical analyses;

- Discuss principles of redox reactions and their applications.
- Explain different ways of validating analytical methods;
- Apply different statistical tests to analytical data and indicate the reliability of experimental results;
- Distinguish between neutralization, precipitation, complexation and redox reactions and use them as bases for quantitative determinations;
- Select appropriate indicator for detecting the end point of a given titration;
- Carry out different titrimetric and gravimetric analyses.

**Course Outline:**

**1. Introduction**

1.1. Definition of analytical chemistry
1.2. Roles of analytical chemistry
1.3. Classification of analytical chemistry
1.4. Methods of chemical analysis
1.5. Steps in quantitative chemical analysis

**2. Statistical Evaluation 0f Analytical Data**

2.1. Mean, Standard deviation, Variance
2.2. Accuracy and precision of measurements
2.3. Errors in analytical results
2.4. Confidence limit
2.5. Testing for significance (t-test and F-test)
2.6. Rejection test (Q-test)

3. **Ionic Equilibria**

3.1. Acid-base equilibria
3.1.1. Theories of acids and bases
3.1.2. Dissociation of strong monoprotic acids and bases
3.1.3. Dissociation of weak monoprotic acids and bases
3.1.4. Dissociation of water and pH of aqueous solutions
3.1.5. Common ion effect

3.1.6. Buffer solutions

3.1.7. Hydrolysis of salts

3.2. Solubility product principle

3.2.1. Solubility, solubility equilibria and solubility product

3.2.2. Common ion effect and salt effect on solubility

3.2.3. Effect of acidity on solubility

3.3. Complexation equilibria

3.3.1. Complex ion and ligands

3.3.2. Complex formation equilibria with unidentate and multidentate ligands

3.3.3. Factors affecting stability of complexes

3.3.4. Effect of complexation on solubility

3.4. Oxidation-reduction equilibria

3.4.1. Redox reactions, reducing and oxidizing agents

3.4.2. Redox reactions in electrochemical cells and electrode potential

3.4.3. Dependence of electrode potential on concentration

3.4.4. Calculating equilibrium constant from electrode potential

**4. Solutions and Their Concentrations**

4.1. Types of solutions

4.2. Different ways of expressing concentration

4.3. Preparation of solutions

4.4. Activity and activity coefficient

**5. Titrimetric Methods of Analysis**

5.1. Fundamentals of titrimetry

5.1.1. Definition of terms

5.1.2. Ideal requirements for standard solutions

5.1.3. Volumetric calculations

5.2. Acid-base titration

5.2.1. Acid-base titration curves

5.2.2. Acid-base indicators

5.3. Precipitation titration

5.3.1. Titration curves

5.3.2. End point detection methods

5.4. Complexometric titration

5.4.1. Titration with aminopolycarboxylic acids (EDTA and its species)

5.4.2. The EDTA titration curve

5.4.3. End point detection methods

5.5. Redox titration

5.5.1. Derivation of redox titration curves

5.5.2. Oxidation-reduction indicators

**6. Gravimetric Analysis**

6.1. Principle and types of gravimetric analysis

6.2. Properties of precipitates and precipitating agents

6.3. Steps in gravimetric analysis

6.4. Gravimetric calculations

**Instructional Methods and Strategies**:

In general the instructional methods and strategies to be used should be student-centered approach so as to make students participatory throughout the course and to get the necessary knowledge and skills in fostering the ideas stated in the course in particular and in mastery of the concepts in chemistry. Some of the instructional methods and strategies could be used include gapped lecture, role playing, case study, questing and answering, demonstration, individual or group assignments, discussion, collaborative learning and so on.

**Students' Activities**:

Active participation in discussion and team works; active listening during lecturing; taking notes on the lessons; asking questions and answering to questions; presentations; working and submitting group or- individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**:

At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**:

LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Text Book**

Harris, D. C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, 2010

**References**


1. Harris, D. C. Exploring Chemical Analysis, 5th ed.; W.H. Freeman and Company New York, 2013.
2. Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch S. R. Fundamentals of Analytical Chemistry, 9th Ed., Brooks/Cole, Cengage Learning, USA, 2014.
3. Christian, G. D. Analytical Chemistry, 6h ed., John Wiley and Sons, Inc., New York, 2004.
4. Harvey, D. Modern Analytical Chemistry, The McGraw-Hill Companies, USA, 2000.
5. Jeffery, G. H.; Bassett, J.; Mandham, J.; Denney, R.C. Vogel's Text Book of Quantitative Chemical Analysis, John Wiley and Sons, Inc., New York 1991.


### 9.2.1.2. Practical Analytical Chemistry

| | |
|---|---|
| **Course Title:** | Practical Analytical Chemistry |
| **Course Code:** | Chem 2023 |
| **Credit Hours ECTS:** | 1/2 |
| **Contact Hours:** | 3 Laboratory Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Prerequisite:** | General Chemistry (Chem 1012) |

**Course Description/Overview of the Course**

The course "Practical Analytical Chemistry" is designed to acquaint the students with quantitative chemical analysis. The course also include various experiments: preparation of solutions from liquid and solids; acid-base (neutralization), precipitation, complex formation and redox titrations; and gravimetric analysis.

**Objective of the Course**

Upon successful completion of the course students will be able to:

- Acquire the skills to perform the experiment in the real laboratories;
- Distinguish between neutralization, precipitation, complexation and redox reactions and use them as bases for quantitative determinations;
- Select appropriate indicator for detecting the end point of a given titration;
- Carry out different practical titrimetric and gravimetric analyses;
- Interpret quantitative analytical results and draw titration curves
- Discuss and conclude qualitative and quantitative analytical results;
- Compare the theoretical and practical aspects of analytical chemistry;
- Apply the different quantitative techniques in their future career

**Course Outline:**

Experiment 1: Preparation of solutions from solids
Experiment 2: Preparation of solutions from liquids
Experiment 3: Standardization of sodium hydroxide solution
Experiment 4: Determination of NaOH and $Na_2CO_3$ in the same solution
Experiment 5: Determination of $Na_2CO_3$ and $Na_2HCO_3$ in the same solution
Experiment 6: Determination of hardness of water
Experiment 7: Determination of halides argentometrically
Experiment 8: Determination of Potassium dichromate using Sodium thiosulphate
Experiment 9: Determination of oxalate permanganometrically
Experiment 10: Gravimetric determination of calcium

Experiment 11: Gravimetric determination of iron

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments/demonstration**;** listen and observing demonstration and lecture**;** take notes**;** ask questions on unclear idea**;** active participation in discussion; preparing flow charts for each experiment; bringing laboratory manuals; wearing laboratory coats and other safety materials throughout the laboratory sessions; recording experimental procedures and results; write and submit laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment such as quizzes, laboratory report, as well as group add/or individual project works; and 30% final examination.

Note: Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment/s he/she missed.

**Instructional Resources (Materials and Equipment's)**: Separate laboratory class; different chemicals, reagents and glass wares; laboratory manual; markers; flip charts, white board, chalk board, duster.

**Text Book**

Practical analytical Chemistry Laboratory Manual.

**References**


1. N. Retta, Quantitative Chemical Analysis Experiments for University Students (manual), 2nd Ed., Addis Ababa University, 2000.
2. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016
3. Harris, D. C. Exploring Chemical Analysis, 5th ed.; W.H. Freeman and Company New York, 2013.

4. Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch S. R. Fundamentals of Analytical Chemistry, 9th Ed., Brooks/Cole, Cengage Learning, USA, 2014.
5. JefferY, G. H.; Bassett, J.; Mendham, J.; Denney, R. C. Vogel's: Textbook of Quantitative Chemical Analysis, 5th Ed., Thames Polytechnic, London, 1989.
6. Harvey, D. Modern Analytical Chemistry, The McGraw-Hill Companies, USA, 2000.
7. Christian, G. D. Analytical Chemistry, 6h ed., John Wiley and Sons, Inc., New York, 2004.
8. Georg Schwedt. The essential guide to Analytical Chemistry, 2nd ed., Stuttgart-New York, 1996.
9. J. Mendham. Quantitative Chemical Analysis, 6th ed., August 1999.

### 9.2.1.3. Instrumental Analysis I

| | |
|---|---|
| **Course Title:** | Instrumental Analysis I |
| **Course Code:** | Chem 3021 |
| **Credit Hours/ECS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | III |
| **Semester:** | I |
| **Prerequisite:** | Analytical Chemistry (Chem 2021) |

**Course Description**:

The course “Instrumental Analysis I” is designed to make the students develop competency in basic instrumental methods of analysis. The course will acquaint the students with the basic principles of chromatographic separations and instrumentations like planer chromatography, gas chromatography, high performance liquid chromatography, supercritical fluid chromatography, size exclusion chromatography, and ion exchange chromatography. It also deals about various electroanalytical methods such as conductometry, potentiometry, coulometry, electrogravimetry and voltammetry. Basic principles, instrumentations and applications of electrophoresis techniques will also be addressed in the course. The knowledge that students will acquire from this course are widely applicable in various fields like, toxicology, environmental science, pharmaceuticals, quality control, chemical industry, clinical chemistry, medicine and the like.

**Objective of the Course**

Upon successful completion of the course students will be able to:

- Compare and contrast classical and instrumental methods with respect to speed, sensitivity, precision, ease of automation, etc;
- Describe underlying principle governing the chromatographic techniques;
- Distinguish the various chromatographic methods and their applications;
- Define electrophoresis and describe its application in chemical analysis.
- Describe underlying principles, instrumentations and applications of the various electroanalytical methods;

**Course Outline:**

**1. Analytical Separation Techniques and Classical Method of Analysis**

**2. Introduction to Chromatographic Separation**

2.1. Historical background

2.2. Types of chromatography

2.3. Paper chromatography

2.4. Thin layer chromatography

2.5. Column chromatography

2.6. Efficiency of separation

2.7. Application (Qualitative and quantitative information)

**3. Gas Chromatography (GC)**

3.1. Principle of GC

3.2. Instruments for GC

3.3. Applications

**4. Liquid Chromatography (LC)**

4.1. Principle of LC

4.2. Instruments for LC

4.3. Parts of liquid (liquid) chromatography

4.3.1. Liquid (partition) chromatography

4.3.2. Liquid – solid (adsorption) chromatography

4.3.3. Ion-exchange chromatography

4.3.4. Molecular exclusion chromatography

**5. Introduction to Electroanalytical Chemistry**

5.1. Electrochemical cells and cell potential

5.2. Current in electrochemical cells

5.3. Types of electro-analytical methods

**6. Potentiometry**

6.1. Basic principles

6.2. Types of electrodes

6.3. Instrumentation

6.4. Potentiometric titration

**7. Voltammetry**

7.1. Excitation signals in voltammetry

7.2. Types of voltammetry

7.3. Polarography and amperometry

**8. Coulometry and Electrogravimetric Analysis**

8.1. Types of coulometry

8.2. Separation of cathode and anode reactions

8.3. Current effect on voltages

**9. Conductometry**

9.1. Basic principles and instrumentation

9.2. Application

9.3. Conductometric titration

**10. Electrophoresis**

10.1 Basic principles of electrophoresis

10.2 Types and application of electrophoresis

**Instructional Methods and Strategies**:

The instructional methods and strategies throughout the course should be student-centered approach so as to make students participatory in the course delivery and to get the necessary

knowledge and skills in fostering the ideas stated in the course in particular and in mastery the concepts in chemistry. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities**: Active participation in discussion and team works, listening during lecturing, taking notes, asking questions and giving answer for questions, presentations, working and submitting group and/or individual assignments on time, reading reference books, regularly attending classes and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, group and/or individual assignments, project work and/or mid-examination) and 50% written final examination.

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, and white board, chalk board, duster chromatographic instruments (paper, thin layer, gas and liquid chromatography).

**Text Book**

Skoog, D. A. Holler, F. J. and Crouch, S. R. Principles of Instrumental Analysis, Cengage Learning, Boston, USA, 2018.

**References**


1. Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques. 2nd ed., Wiley & Sons Ltd, Chichester, England, 2007.
2. Harris, D. C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, 2010
3. Monk, P. Fundamentals of Electroanalytical Chemistry, John Wiley & Sons Ltd, England, 2001.

4. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016
5. Harris, D. C. Exploring Chemical Analysis, 5th ed.; W.H. Freeman and Company New York, 2013.
6. Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch S. R. Fundamentals of Analytical Chemistry, 9th Ed., Brooks/Cole, Cengage Learning, USA, 2014.
7. Christian, G. D. Analytical Chemistry, 6h ed., John Wiley and Sons, Inc., New York, 2004.
8. Harvey, D. Modern Analytical Chemistry, The McGraw-Hill Companies, USA, 2000.
9. Robards, K.; Haddad, P. R.; Jackson, P. E. Principles and Practice of Modern Chromatographic Methods, Elsevier Ltd, UK, 2004.
10. Braithwaite, A., Smith, F. J. Chromatographic Methods, 5th ed., Kluwer Academic Publishers, Dordrecht, The Netherlands, 1999.
11. Ahuja, S. Chromatography and Separation Science, Academic Press, USA, 2003.

### 9.2.1.4. Practical Instrumental Analysis I

| | |
|---|---|
| **Course Title:** | Practical Instrumental Analysis I |
| **Course Code:** | Chem 3023 |
| **Credit Hours/ECS:** | 1/2 |
| **Contact Hours:** | 3 Laboratory Hours per Week |
| **Year:** | III |
| **Semester:** | I |
| **Prerequisite:** | Practical Analytical Chemistry (Chem 2023) |

**Course Description:**

The course "Practical Instrumental Analysis I" is designed in order to make the students' develop the practical competencies and skills in carrying out chemical analysis by using chromatographic, electrophoresis and electroanalytical techniques. The practical activities include the experiments in chromatography (thin layer chromatography, paper chromatography, gas chromatography and high performance liquid chromatography), electrophoresis and

electroanalytical methods (potentiometry, voltametry, Cconductometry, coulometry and electrogravimetry).

**Course objective:**

At the end of the course the students would be able to:

- Describe different methods of chromatographic techniques;
- Describe the correct choice of the instrument for a given analysis;
- Separate, identify and determine the quantity of a given mixture components using different chromatographic techniques.
- Acquire the skills to perform separation of a mixture using a electrophoresis technique
- Apply the different qualitative and quantitative techniques in their future career
- Identify different parts of selected instruments and describe their respective functions.
- Describe the similarities and differences that exist among various elactroanalytical methods.
- Perform different experiments using electroanalytical techniques (conductometry, potentiometry, voltametry, etc) for the quantitative determination of components in a given sample

**Course outline:**

Experiment 1: Determination of retardation factor ($R_f$) of the given substance (amino acid) using an organic solvent using paper chromatography

Experiment 2: Determination of $R_f$ of a given dye (thymol blue, bromocresol, phenol red etc) using a solvent by thin layer Chromatography

Experiment 3: Determination of hydrocarbons in a sample by gas chromatography (GC*)*

Experiment 4: Determination of caffeine by high performance liquid chromatography (HPLC)

Experiment 5: Determination of the charge and distance moved by an amino acid by the application of 300 V for a period of 1 hour using an electrophoretic power supply

Experiment 6: Determination of the number of amino acids in the given mixture by electrophoresis method.

Experiment 7: Determination of single electrode potential; (silver, zinc and copper electrodes may be used).

Experiment 8: Potentiometric estimation of ferrous ammonium sulphate using 0.1 potassium dichromate solution as a standard solution.

Experiment 9: Determination of dichromate by a coulometric redox titration

Experiment 10: Estimation of hydrochloric acid potentiometrically using a calomel electrode.

Experiment 11: Voltammetric determination of total iron using a 1,10-phenantroline

Experiment 12: Estimation of Hydrochloric acid conductometrically using 0.5 N sodium hydroxide.

Experiment 13: Determination of cell constant of a given conductivity cell using a conductivity meter

Experiment 14: Determination of equivalent conductance of a given strong electrolyte

**Instructional Methods and Strategies**:

Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments/demonstration**;** listen and observing demonstration and lecture**;** take notes on the lessons treated**;** ask questions on unclear idea**;** active participation in discussion; preparing flow charts for the experiment for every laboratory sessions; bringing laboratory manuals; wearing laboratory coats; following safety rules in the laboratory throughout the laboratory sessions: recording experimental procedures and results; writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes, laboratory report, project work, etc) and 30% final examination.

Note: Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources (Materials and Equipment's)**: Separate laboratory class; different chemicals, reagents, and glass wares; different electroanalytical and chromatographic

instruments and apparatus; laboratory manual; markers; flip charts; white board' chalk board. and duster.

**Text Book**

Practical Instrumental I Laboratory Manual

**References**


1. Harris, D. C. Exploring Chemical Analysis, 5th ed.; W.H. Freeman and Company New York, 2013.
2. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016
3. Skoog, D. A. Holler, F. J. and Crouch, S. R. Principles of Instrumental Analysis, Cengage Learning, Boston, USA, 2018.
4. Reddy, A. V. R.; Swain, K. K.; Venkatesh, K. Experiments in Analytical Chemistry, Association of Environmental Analytical Chemistry of India, Perfect Prints. 2012
5. Monk, P. Fundamentals of Electroanalytical Chemistry, John Wiley & Sons Ltd, England, 2001.
6. Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques. 2nd ed., Wiley & Sons Ltd, Chichester, England, 2007.
7. Harris, D. C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, 2010
8. Robards, K.; Haddad, P. R. Jackson. P. E. Principles and Practice of Modern Chromatographic Methods, Elsevier Ltd. 2004


### 9.2.1.5. Instrumental Analysis II

| | |
|---|---|
| **Course Title:** | Instrumental Analysis II |
| **Course Code:** | Chem 3022 |
| **Credit Hours/ECS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | III |

**Semester:** II

**Prerequisite:** Instrumental Analysis I (Chem 3021)

**Course description**

The course “Instrumental Analysis II” is designed to make the students develop the theoretical competency in using spectroscopic techniques for analytical purposes. The course familiarizes the students with the theoretical background of the principles of spectroscopic techniques like atomic absorption, atomic emission, ultraviolet-visible and infrared spectroscopy; nuclear magnetic spectroscopy; and mass spectroscopy.

**Objective of the Course**

Upon successful completion of the course students will be able to:

- Describe the underlying principles governing spectroscopic analysis;
- Employ the absorption laws (Lambert-Beer's law) for quantitative analysis of substances from a sample;
- Identify the components of optical instruments;
- Discuss the different spectroscopic methods and discuss their applications;
- Identify the different parts of selected spectroscopic instruments;
- Draw block diagrams for different spectroscopic instruments and describe their respective functions;
- Explain the similarities and differences between absorption and emission spectroscopy;
- Discuss the working principles of IR, UV-Vis, NMR and MS;
- Narrate the underlying principles of spectral analysis;
- Use the basic information emanating from the spectra of different spectroscopic methods;
- Discuss the qualitative and quantitative applications of different spectral analysis;
- Distinguish the similarities and differences between MS and other spectroscopic techniques (AAS, UV-Vis, IR and NMR);
- Elucidate the structure of compounds using the spectral data (UV-Vis, IR, NMR and MS).

**Course Outline:**

**1. Introduction to Spectroscopy**

1.1 Electromagnetic Radiation and its interaction with matter

1.2 Electromagnetic radiation and its quantum mechanical property

1.3 Absorption and emission of radiation

1.4 The electromagnetic spectrum

**2. Absorption Laws (Quantitative Analysis)**

2.1 Lambert-Beer's Law

2.2 Deviation from Beer's Law

2.3 Errors associated with Beer's Law

**3. Instrumentation for Optical Spectroscopy**

3.1 Components of optical instruments

3.1.1 Source of Radiation

3.1.2 Wave-length selectors

3.1.3 Sample containers

3.1.4 Radiation detectors

3.1.5 Readout detectors and signal amplification systems

3.2 Optical systems used in spectroscopy: single beam versus double beam instruments

**4. Atomic Absorption and Emission Spectroscopy**

4.1 Intorduction

4.2 Atomic Absorption spectroscopy

4.2.1 Principles

4.2.2 Instrumentation

4.2.3 Analytical Applications

4.3 Atomic Absorption and emission spectroscopy

4.3.1 Principles

4.3.2 Instrumentation

4.3.3 Analytical Applications

**5. Ultraviolet and Visible (UV-Vis) Spectroscopy**

5.1 Introduction

5.2 Basic principles

5.3 Absorption characteristics of some chromopores

5.4 Instrumentation

5.5 Application

**6. Infrared Spectroscopy**

6.1 Introduction

Basic principles

6.2 Energy levels in vibrating and rotating molecules

6.3 Characteristic vibrational frequencies

6.4 Factors affecting group frequencies

6.5 Instrumentation

Application

6.6 Interpretation of some spectra

**7. Nuclear Magnetic Resonance Spectroscopy (NMR**)

7.1 Basic principle of NMR

7.2 Instrumentation

7.3 Proton NMR

7.4 C–13 NMR

Application

11.5 Interpretation of NMR spectra.

**8. Mass Spectroscopy (MS)**

8.1 Basic principle

8.3 Instrumentation

8.3 Application

8.4 Interpretation of MS spectra

**9. Structure Elucidations by Joint Application of Different Spectroscopic Methods: UV, IR, NMR and Mass Spectrometry.**

**Instructional Methods and Strategies**: Generally the instructional methods and strategies throughout the course should be student-centered approach so as to make students participatory in the course delivery and to get the necessary knowledge and skills in fostering the ideas stated

in the course in particular and in mastery the concepts in chemistry. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities**: Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques**: About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Books**


1. Robinson, J. W.; Frame, E. M. S., Frame II, G. M. Undergraduate Instrumental Analysis, 2nd Ed., Marcel Dekker, New York, 2005.
2. Hollas, J. M. Modern Spectroscopy, 4th Ed., y John Wiley & Sons Ltd, England, 2004.


**References**


3. Pavia, D. L.; Lampman, G. M Kriz, G. S.; Vyvyan, J. R. Introduction to Spectroscopy, 4th Ed., Brooks/Cole, Cengage Learning, USA, 2009.
4. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016
5. Skoog, D. A. Holler, F. J. and Crouch, S. R. Principles of Instrumental Analysis, Cengage Learning, Boston, USA, 2018.
6. Harris, D. C. Exploring Chemical Analysis, 5th ed.; W.H. Freeman and Company New York, 2013.

7. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016
8. C.N. Banwell and E.M. McCash, Fundamentals of Molecular spectroscopy, McGraw Hill, 1994.
9. Smith, R. M. Understanding Mass Spectra: A Basic Approach, 2nd Ed., John Wiley & Sons, Canada, 2004.
10. H. Gunter, NMR Spectroscopy, 2nd Ed., John Willey and Sons, 1995.
11. J. Hollas, Modern Spectroscopy, 3rd Ed. John Willey and sons, 1996.
12. J. D. Ingle and S.R. Crouch, Spectrochemical analysis, Prentice Hall, 1988.
13. L. D. Field, S. Sternhell and S. Kalman, Organic structure from spectra, 2nd Ed., John Willey and sons, 1995.

### 9.2.1.6. Practical Instrumental Analysis II

| | |
|---|---|
| **Course Title:** | Practical Instrumental Analysis II |
| **Course Code:** | Chem 3024 |
| **Credit Hours/ECTS:** | 1/2 |
| **Contact Hours:** | 3 Laboratory Hours per Week |
| **Year:** | III |
| **Semester:** | II |
| **Prerequisite:** | Practical Instrumental Analysis I (Chem 3023) |

**Course Description:**

The course, practical instrumental Analysis II, is designed in order to make the students develop the practical competency and skills in carrying out chemical analysis by using spectroscopic techniques. The practical activities include experiments on refractometry, atomic absorption spectroscopy, flame photometry, ultraviolet-visible and infrared spectroscopic.

**Objective of the Course**

Upon successful completion of the course students will be able to:

- Describe the practical applications of the refractive index measurement;

- Distinguish the similarities and differences between absorption and emission spectroscopic analysis;
- Identify different parts of selected spectroscopic instruments and describe their respective functions;
- Operate and run different spectroscopic instruments and generate spectrum of a given substance;
- Acquire the skills to perform qualitative and quantitative analysis using various spectroscopic techniques;
- Elucidate structure of a compound using joint spectroscopic techniques.
- Narrate the applications of UV-Vis spectroscopic methods for the determination of organic and inorganic substances;
- Acquire the skills to prepare solid and liquid samples for IR analysis;
- Interpret quantitative analytical results from spectroscopic spectra
- Utilize UV-Vis spectroscopic methods for quantitative determinations a given species from biological samples

**Course Outline:**

Experiment 1: Determination of refractive index and molar refraction

Experiment 2: Determination of the persentage composition of a mixture (mixture of water and ethanol).

Experiment 3: Determination of sodium by flame emission spectrometry

Experiment 4: Determination of calcium by atomic absorption spectrometry

Experiment 5: Determination of complex Ion Composition by Job's Method of Continuous Variation

Experiment 6: Spectroscopic determination of manganese and chromium in mixture

Experiment 7: Spectrophotometric determination of iron by 1, 10-phenanthroline

Experiment 8: Absorption Spectrum of an Indicator in Dependence on the pH Value

Experiment 9: Ultraviolet Spectrum of organic molecules (conjugation and substituent effects)

Experiment 10: Fluorometric determination of riboflavin (Vitamin $B_2$) or quinine.

Experiment 11: IR spectroscopy of solids and solutions

Experiment 12: Investigation of a chemical bond by infrared spectroscopy

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments/demonstration**;** Listen and observing demonstration and lecture**;** Take notes on the lessons treated**;** Ask questions on unclear idea**;** Active participation in discussion; Preparing flow charts for the experiment for every laboratory sessions; Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the laboratory throughout the laboratory sessions: Recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes (practical and theoretical in group and/or individual), laboratory report, project work) and 30% final examination.

Note: Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources (Materials and Equipments):** Chemicals, reagents, and glass wares; different Spectroscopic instruments; laboratory manual; markers; flip charts; white board' chalk board and duster.

**Text Book**

Practical Instrumental II Laboratory Manual

**References**


1. Harris, D. C. Exploring Chemical Analysis, 5$^{th}$ ed.; W.H. Freeman and Company New York, 2013.
2. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016

3. Skoog, D. A. Holler, F. J. and Crouch, S. R. Principles of Instrumental Analysis, Cengage Learning, Boston, USA, 2018.
4. Reddy, A. V. R.; Swain, K. K.; Venkatesh, K. Experiments in Analytical Chemistry, Association of Environmental Analytical Chemistry of India, Perfect Prints. 2012
5. Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques. 2nd ed., Wiley & Sons Ltd, Chichester, England, 2007.

### 9.2.1.7. Real Sample Analysis

| | |
|---|---|
| **Course Title:** | Real Sample Analysis |
| **Course Code:** | Chem 4022 |
| **Credit Hours/ECTS:** | 2/3 |
| **Contact Hours:** | 6 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Practical Instrumental Analysis II (Chem 3024) |

**Course Description:**

The course "Real sample analysis" introduces about systematic analysis of real samples: sampling, preservation and preparation of samples for the determination of the major, trace elements, inorganic compounds (speciation) and organic compounds; biological samples; food and beverages; water and waste water samples; soils and related samples.

**Objective of the Course**

Upon successful completion of the course students will be able to:

- Select appropriate sampling and preservation of a particular real sample;
- Identify preparation methods for analysis of metals by different methods;
- Perform experiments on food, water, and soil;
- Familiarize the students with the techniques of sampling, storage, and analysis of real samples.

**Course Outline:**

**Suggested Experiments**

Experiment 1: Determination of moisture, ash content and total solids
Experiment 2: Determination of calcium in foods by permanganate titration

Experiment 3: Determination of lactose in cheese by the phenol colorimetric method

Experiment 4: Determination of ascorbic acid by titration

Experiment 5: Determination of the iodine value of fats and oils

Experiment 6: Determination of the salt content of dairy products (Volhard method)

Experiment 7: Colorimetric determination of nitrates and nitrites in meat products and brine

Experiment 8: Titratable acidity of fruit juices

Experiment 9: Determination of the acetic acid content of vinegar

Experiment 10: Spectrophotometric Determination of Iron in Vitamin Tablets

Experiment 11: Spectrophotometric Analysis of a Mixture: Caffeine and Benzoic Acid in a Soft Drink

Experiment 12: Analysis of BOD and DO in Waste Water Sample

Experiment 13: Determination of Chemical Oxygen Demand (COD)

Experiment 14: Analysis of Fluoride in Ground Water and Potable Water

Experiment 15: Spectrophotometric determination of Pb, Cd and Cr (VI) in waste water and/or soil sample

Experiment 16: Analysis of moisture content, particle size and pH of soil

Experiment 17: Analysis of organic carbon, nitrogen, carbonate, and gypsum contents of the soil.

Experiment 18: Determination of soluble salts and acidity of soil

Experiment 19: Determination of available phosphorus in soil.

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments/demonstration**;** listen and observing demonstration and lecture**;** take notes on the lessons treated**;** ask questions on unclear idea**;** active participation in discussion; preparing flow charts for the experiment for every laboratory sessions; bringing laboratory manuals; wearing laboratory coats; following safety rules in the laboratory throughout the laboratory sessions: recording experimental procedures and results; writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes, laboratory report, project work, etc) and 30% final examination.

Note: Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources (Materials and Equipment's)**: Separate laboratory class; different chemicals, reagents, and glass wares; different electroanalytical, chromatographic and spectroscopic instruments and apparatus; laboratory manual; markers; flip charts; white board' chalk board and duster.

**Text Book**

Laboratory Manual

**References:**


1. James, c. s. Analytical Chemistry of Food, Springer-Science+Business Media, B.v, 1995.
2. Nielsen, S. S. (Ed). Food Analysis Laboratory Manual, 3rd, Ed., Springer, 2017.
3. Reddy, A. V. R.; Swain, K. K.; Venkatesh, K. Experiments in Analytical Chemistry, Association of Environmental Analytical Chemistry of India, Perfect Prints. 2012
4. Harris, D. C. Exploring Chemical Analysis, 5th ed.; W.H. Freeman and Company New York, 2013.
5. Ham, B. M. Maham, A. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, John Wiley & Sons, Canada, 2016.
6. Van Reeuwijk, L. P. Procedures for Soil Analysis, 6th Ed., International Soil Reference and Information Center, The Netherland, 2002

### 9.2.1. Inorganic Chemistry Courses

#### 9.2.2.1. Inorganic Chemistry I

| | |
|---|---|
| **Course Title:** | Inorganic Chemistry I |
| **Course Code:** | Chem 2032 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | II |
| **Prerequisite:** | General Chemistry (Chem1012) |

**Course Description**:

The course "Inorganic Chemistry" is generally known as the chemistry of elements other than carbon, but more accurately, it is the chemistry of all the elements and molecules excluding hydrocarbon-based rings and chains. This is a course covering the theoretical and semi-empirical concepts of fundamental of inorganic chemistry such as the atomic structure, periodic trends, chemical bonding, Acid-base theory and solvent system, chemistry of main group elements; chemistry of hydrogen, *s*-block, *p*-block and noble gases; compounds of main group elements: synthesis, reactions and applications.

**Course Objectives:**

After completion of this course, students will be able to:

- Discuss the current view of atomic structure
- Write & explain the electronic configurations of representative elements
- Relate electronic configuration to the classification of elements in the periodic table and their properties
- Explain the basic concepts of chemical bonding and structure
- Describe various acid-base theories
- Explain the descriptive chemistry of representative elements

**Course Outline**

**1. Overview of Atomic Theory and Periodic Table**

1.1. Some principles of quantum mechanics

1.2. Radial and Angular wave functions and the quantum numbers

1.3. The periodic table and chemical periodicity

**2. Chemical Bonding and Molecular Structure**

2.1. Types of chemical bonding

2.2. Shape of simple covalent molecules

2.3. Theories of bonding for covalent molecules

2.4. Ionic solids

2.5. Metallic bonding and bonding theories

**3. Acid Base Theory and the Solvent System**

3.1. Basic definitions

3.1.1. Strength of binary acids

3.1.2. Strength of Oxyacids

3.1.3. Strength of Lewis acid and base

3.2 Solvent systems

3.3 Hard –Soft acid and bases

**4. The Chemistry of Hydrogen**

4.1 Compounds of hydrogen

4.2 Synthesis

4.3 Reactivity of hydrogen

4.4 Application of hydrogen

**5. The Chemistry of S-Block Elements**

5.1 The chemistry of alkaline metals

5.1.1 General trends

5.1.2 Some compounds of alkali metals

5.1.3 Occurrences, reactivity and extraction of the metals

5.2 The chemistry of alkaline earth metals

5.2.1 General trends

5.2.2 Occurrences, reactivity and extraction of the metals

**6. The Chemistry of P-Block Elements**

6.1 The chemistry of boron group elements

6.1.1 Trends and some compounds of the group elements

6.1.2 Occurrences, reactivity and extraction of the elements

6.2 The chemistry of carbon group elements

6.2.1 Trends and some compounds of the group elements

6.2.2 Occurrences, reactivity and extraction of the metals

6.3 The chemistry of nitrogen group elements

6.3.1 Trends and some compounds of the group elements

6.3.2 Occurrences, reactivity and extraction of the elements

6.4 The chemistry of oxygen group elements

6.4.1 Trends and some compounds of the group elements

6.4.2 Occurrences, reactivity and extraction of the elements

6.5 The chemistry of halogen group elements

6.5.1 Trends and some compounds of the group elements

6.5.2 Occurrences, reactivity and extraction of the elements

6.6 The chemistry of noble gases

6.6.1 Trends and some compounds of the group elements

6.6.2 Occurrences, reactivity and extraction of the elements

**Instructional Methods and Strategies:**

Generally the instructional methods and strategies throughout the course should be student-centered approach so as to make students throughout the course and to get the necessary knowledge and skills in fostering the ideas stated in the course in particular and in mastery the concepts in chemistry. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Individual assignment and presentation, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:**

Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:**

About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):**

LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

J. D. Lee., A new concise inorganic chemistry, 5$^{th}$ edition

**References:**

1. Basic Inorganic Chemistry, F. A Cotton, G. Wilkinson, and P. L. Gaus.
2. An Introduction to Inorganic Chemistry, Purcell and Kotz.
3. Modern Aspect of Inorganic Chemistry, H. J. Emeleus and A. G. Sharpe.
4. Inorganic Chemistry, Principles of Structure and Reactivity, J. E. Huheey.
5. A Text Book of Inorganic Chemistry, K. N Upadhyaya 3$^{rd}$ edition.
6. Introduction to Inorganic Chemistry, G. I Brown.

### 9.2.2.2. Inorganic Chemistry II

| | |
|---|---|
| Course Title: | Inorganic chemistry II |
| Course Code: | Chem, 3031 |
| Credit Hours/ECTS: | 3(5) |

| | |
|---|---|
| Contact Hours: | 3 Lecture Hours per Week |
| Year: | III |
| Semester: | I |
| Prerequisite: | Inorganic Chemistry I (Chem, 2032) |

**Course Description:**

The course "Inorganic Chemistry II" will describe group properties of transition elements (general, physical and chemical properties, variable oxidation states, stoichiometric and non-stoichiometric compounds, catalytic properties, etc); coordination compounds (historical development, nomenclature, isomerism, VBT, CFT, MOT), metals and metallurgical processes; descriptive chemistry of transition and inner transition elements (electronic structure, oxidation states, occurrences, isolations, reactions and uses of selected *d*-block and *f*-block elements, and chemistry of their compounds).

**Course Objectives:**

After completion of this course, students will be able to:

- Have a clear understanding of the group properties of the transition elements;
- Explain coordination compounds with respect to their formation, nomenclature, geometry, isomerism and bonding theories (VBT, CFT and MOT)
- Describe metallurgical process in transition elements;
- Have a general overview of the descriptive chemistry of transition elements.

**Course Outline:**

**1. Chemistry of d-Block Elements**

1.1 General physical properties of the elements

1.1.1. Density, melting and boiling points

1.1.2. Trends in the periodic table: size, IE, EN, etc.

1.2 General chemical properties

1.2.1. The inherent variable oxidation states and reactivity

1.2.2. Non-stoichiometric compounds

1.3 Catalytic properties of the metals in the synthesis of:

1.3.1. Organic compounds

1.3.2. Inorganic compounds

1.4 Studies with specific reference to first series of transition metals

1.4.1 Occurrence

1.4.2 Importance

1.4.3 Compounds of the metals

2. **Chemistry of f-Block Elements**

2.1. General physical and chemical properties

2.1.1 Density, melting and boiling points, spectra, etc.

2.1.2 Trends in the periodic table: size, IE, EN, etc.

2.1.3 Reactivity

2.1.4 Occurrence and separation of their compounds

2.1.5 Catalytic properties of the metals in synthesis

2.2. General physical & chemical properties of the actinides

2.2.1 Density, melting & boiling points, spectra….etc

2.2.2 Trends in the periodic table: size, IE, EN…..etc

2.2.3 Reactivity

2.2.4 Occurrence and separation of their compounds

**3. Coordination Chemistry of Transition Metals**

3.1 Definition, nomenclature and isomerism

3.2 Valence bond theory

3.3 Crystal field theory

3.4 Molecular orbital theory

**Instructional Methods and Strategies:**

Generally the instructional methods and strategies throughout the course should be student-centered approach so as to make students throughout the course and to get the necessary

knowledge and skills in fostering the ideas stated in the course in particular and in mastery the concepts in chemistry. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

F.A cotton, G. Wilkinson, and P.L. Gaus. Basic Inorganic Chemistry.

**References:**

**1.** Purcell and Kotz, An Introduction to Inorganic Chemistry.
2. H.J.Emeleus and A.G.Sharpe, Modern Aspect of Inorganic Chemistry.
3. J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity.
4. K N Upadhyaya, A Text Book of Inorganic Chemistry, 3rd edition.
5. G.I. Brown, Introduction to Inorganic Chemistry.

### 9.2.2.3. Practical Inorganic Chemistry I

Course Title: Practical Inorganic Chemistry I

| | |
|---|---|
| Course Code: | Chem 3033 |
| Credit Hours/ECTS: | 1/2 |
| Contact Hours: | 3 Lecture Hours per Week |
| Year | III |
| Semester: | I |
| Prerequisite: | General Chemistry (Chem 1012) |

**Course Description:**

The course "practical inorganic chemistry I "is designed to give student's competency in chemistry of the transition elements. This course deals with the chemistry of selected transition elements: titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, silver, cadmium, and mercury. Generally, the course equips the students with the required competency to work in areas like the chemical industries, agriculture, environmental chemistry, geology, biology and others

**Course Objectives**:

After completing this course, students will be able to:

- Explain the group properties of the selected transition elements
- Prepare, and identify properties of compounds of selected transition elements.
- Explain reactions of various oxidation states of the selected transition elements and study the properties of the known compounds under different kinds of media (acidic, alkaline, and neutral).

**Course Outline:**

**Experiment 1. The Chemistry of Titanium**

1.1. Reaction of titanyl sulphate with aqueous NaOH and ammonia; preparation of Orthotitanic acid

1.2. Reaction of titanyl sulphate with ammonium sulphide

1.3. Behaviour of Orthotitanic acid with respect to dilute sulphuric acid and sodium hydroxide

1.4. Conversion of Orthotitanic acid in to Metatitanic acid

**Experiment 2. The Chemistry of Vanadium**

2.1. Reaction of Vanadium (V) compounds

2.2. Preparation of vanadium penta oxide

2.3. Dissolution of vanadium pentoxide in sulphuric acid and aqueous alkali; amphoteric behaviour

2.4. Reaction of vanadium pentoxide with water,"Metavanadic acid"

2.5. Conversion of tetra vanadate in to Hexa vanadate

2.6. Preparation of sparingly soluble vanadates

2.7. Synthesis of ammonium Thiovanadate and vanadium penta sulphide

2.8. Identification of vanadium (V) by means of the peroxo vanadium (V) reaction

2.9. Reaction of vanadium (IV) compounds

2.9.1. Preparation of vanadium dioxide

2.9.2. Amphoteric properties of vanadium dioxide

2.9.3. Reaction of vanadium (IV) by sulphite in aqueous solution

2.9.4. Hydroxide of tetravalent vanadium

2.9.5. Reducing properties of tetravalent vanadium; reduction of permanganate in acidic medium

2.9.6. Identification of vanadium (v) by reduction with hydrochloric acid and reoxidation with iron (III)

**Experiment 3. The Chemistry of Chromium**

3.1. Preparation and reactions of Chromium (III) compounds

3.1.1. Preparation of chromium (III) oxide

3.1.2. Preparation of Chromic hydroxide

3.1.3. Amphoteric character of Chromium (III) hydroxide

3.2. Oxidation of tetravalent chromium to dichromate (VI) by peroxodisulphate in acidic medium

3.2.1. Introversion of chromium and dichromate

3.2.2. Oxidation of iodide by dichromate in acidic medium

**4. The Chemistry of Manganese**

4.1. Manganese (II) compounds

4.1.1. Preparation of manganese (II) hydroxide and its oxidation by atmospheric oxygen

4.1.2. Action of ammonia on divalent manganese salts in the absence and in the presence of ammonium salts

4.1.3. Oxidation of manganese (II) to its tetravalent state by bromine in alkaline medium

4.1.4. Oxidation of manganese (II) to heptavalent manganese by bromine in alkaline solution with Cu (II) as a catalyst

4.2. Manganese (IV) compounds

4.2.1. Preparation and properties of permanganic anhydride

4.2.2. Thermal decomposition of potassium permanganate

4.2.3. pH dependence of the Oxidizing properties of potassium permanganate, Reaction with sodium sulphite in acidic, neutral and alkaline medium

4.2.4. Oxidation of hydrogen peroxide by potassium permanganate

4.2.5. Oxidation of alcohol by potassium permanganate in acidic and alkaline medium

4.2.6. Synproportionation of manganese (II) and manganese (VII)

**Experiment 5. The Chemistry of Iron**

5.1. Preparation and properties of pyrophoric iron

5.2. Reaction of iron with acids

5.3. Preparation of ferrous hydroxide and its oxidation by atmospheric oxygen

5.4. Basic character of ferrous hydroxide

5.5. Reaction of iron (II) with potassium hexacyanoferrate (III); Trundle's rule

5.6. Preparation and properties of ferric hydroxide

**Experiment 6. The Chemistry of Cobalt**

6.1 Reaction of Co(II) With Alkalis

6.2 Semi-Amphoteric behavior of cobalt(II) Hydroxide

6.3 Reaction of Co(II) with Ammonia

6.4 Oxidation of Cobalt(II) Hydroxide with Hydrogen peroxide

6.5 Oxidation of Cobalt(II) Hydroxide with Chlorine

6.6 Reaction of Cobalt(II) with Ammonium Thiocyanate

6.7 Identification of Cobalt(II) as Hexanitrocobaltate(III)

**Experiment 7. The Chemistry of Nickel**

7.1 Oxidation of Nickel(II) Hydroxide by Potassium Peroxodisulphate

7.2 Oxidation of Nickel(II) Hydroxide by Chlorine

7.3 Reaction of Nickel(II) with Aqueous Ammonia

7.4 Precipitation of Nickel(II) Sulphate

7.5 Reaction of Nickel(II) with Sodium Cyanide(Poisonous!!)

7.6 Reaction of Tetracyanonickelate(II) with $NaOH/Br_2$

**Experiment 8. The Chemistry of Copper and Silver**

8.1 Preparation of Copper from Copper (II) Oxide

8.2 Action of Dilute and Concentrated Acids on Copper

8.3 Reaction of Copper (II) Oxide with Dilute Acids

8.4 Preparation of Copper (II) hydroxide and Its Thermal Decomposition

8.5 Action of Acids and Aqueous Alkali Hydroxide on Copper (II) Hydroxide

8.6 Preparation of Copper Carbonate

8.7 Preparation of Cuprous Iodide

8.8 Preparation of Silver (I) Oxide

8.9 Sparingly Soluble Salts of Silver (I); Silver Sulphide

8.10 Dissolution of Silver Halides by Ammonia and Thiosulphate

8.11 Oxidizing Properties of Silver (I); Reduction with Zinc in Acidic Medium

8.12 Oxidizing Properties of Silver (I); Silver Mirror

**Experiment 9. The Chemistry of Zinc, Cadmium and Mercury**

9.1 Dissolution of Zinc in Sulphuric Acid

9.2 Reducing properties of Zinc; Reduction of Nitrite to Ammonia

9.3 Reducing properties of Zinc; Reduction of Nitrate

9.4 Preparation and Properties of Zinc (II) Hydroxide

9.5 Sparingly Soluble Zinc Salts; Zinc Carbonate

9.6 Preparation of Zinc Sulphide by Precipitation with Hydrogen Sulphide

9.7 Reaction of Cadmium (II) with Aqueous Sodium Hydroxide

9.8 Preparation of Basic Cadmium Carbonate

9.9 Precipitation of Cadmium Sulphide

9.10 Displacement of Mercury from its Salts

9.11 Reaction of Mercurous Salts with Sodium Hydroxide

9.12 Reaction with Hydrochloric Acid; Calomel

9.13 Reaction with Potassium Iodide

9.14 Reaction of Mercuric Iodide with Ammonia; Nessler's Reagent

9.15 Reaction with Hydrogen Sulphide

**Experiment 10. The Chemistry of Molybdenum**

10.1. Preparation and reactions of molybdenum (VI) compounds

10.2. Preparation and properties of molybdic acid

10.3. Amphoteric properties of molybdic acid

10.4. Preparation of molybdenyl hexacyanoferate (II)

10.5. Preparation of sparingly soluble molybdates

10.6. Preparation of thiomolybdate and molybdenum (VI) sulphide

10.7. Peroxomolybdates

10.8. Identification of molybdenum by its red hexathiocyanate molybdate (III) complex

**Instructional Methods and Strategies:** Active learning methods like gapped lecturing, experimentation, questioning, group work, and laboratory report in group or individually.

**Students' Activities:** Observation the practical experiments/demonstration**;** Listen and observing demonstration and lecture**;** Take notes on the lessons treated**;** Ask questions on unclear idea**;** Active participation in discussion; Preparing flow charts for the experiment for every laboratory sessions; Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the laboratory throughout the laboratory sessions: Recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques:** Mode of Assessment: 70% continuous assessment (quizzes (practical and theoretical in group and/or individual), laboratory report, project work) and 30% final examination at the end of the semester.

**Note:** Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources (Materials and Equipments):** Required and Recommended Readings or Supplementary Books/Readings/Websites and Links.

**Text Book:**

Manual of Practical Inorganic Chemistry I

**References:**


1. J. D. Lee., A new concise inorganic chemistry, $5^{th}$ edition.
2. F.A cotton, G. Wilkinson, and P.L. Gaus, Basic inorganic Chemistry.
3. Purcell and Kotz, An introduction to Inorganic chemistry.
4. H. J. Emeleus and A.G. Sarpe, Modern aspect of Inorganic chemistry.
5. G.I Brown, Introduction to inorganic chemistry.


### 9.2.2.4. Inorganic Chemistry III

| | |
|---|---|
| Course Title: | Inorganic Chemistry III |
| Course Code: | Chem 4031 |
| Credit Hours/ECTS: | 4/7 |
| Contact Hours: | 4 Lecture Hours per Week |
| Year: | IV |
| Semester: | I |
| Prerequisite: | Inorganic Chemistry II (Chem.3031) |

**Course Description:**

The course “Inorganic Chemistry III” deals with Symmetry and Group Theory; magneto chemistry; reaction mechanisms: inert and labile complexes; substitution in octahedral and square planar complexes; trans effect; electron transfer reactions: outer sphere and inner sphere mechanisms; Bioinorganic chemistry: metal ions and their biological importance;

photosynthesis; nitrogen fixation; oxygen carriers; transition metals; organo-transition metal chemistry: synthesis, structure and bonding, reactions, applications.

**Course Objectives:**

After completing this course, students will be able to:

- Describe the basic principles of symmetry and group theory;
- Apply the main concepts of symmetry and group theory;
- Demonstrate clear understanding of the concepts of Coordination Chemistry;
- Describe organometallic chemistry and Bioinorganic Chemistry;
- Determine the magnetic property of organometallic complexes;
- Describe the structure, properties and classification of organometallic complexes

**Course Outline:**

**1. Symmetry and Group Theory**

1.1. Symmetry elements and operations

1.2. Point groups and molecular symmetry

1.3. Uses of point group symmetry

**2. Coordination Chemistry**

2.1. Introduction (Bonding in coordination compounds: Historical perspective, VBT, CFT, MOT, LFT)

2.2. Formation and Stabilities of coordination compounds

2.3. Preparation of coordination compounds

2.4. Reactivity of coordination compounds

2.5. Kinetics and reaction mechanisms

2.5.1. Substitution reactions

2.5.2. Addition reactions

2.5.3. Electron transfer reactions

2.6. Spectral properties of transition metal compounds

2.6.1.. Energy levels in an atom

2.6.2. Spin –orbit coupling

2.6.3. Russel -Sounder's coupling

2.6.4. Spectroscopic terms and their determination

2.6.4.1. Terms of non-equivalent electrons

2.6.4.2. Terms of equivalent electrons

2.6.5. Electronic spectra of transition metal complexes

2.6.5.1. Selection rules

2.6.5.2. Nature of electronic transitions in complexes with $d^1$-$d^9$ configuration in octahedral and tetrahedral complexes

2.7. Magnetochemistry

**3. Organometallic chemistry**

3.1. Introduction

3.1.1. Historical background

3.1.2. Properties

3.1.3. Classifications of organometallic compounds by bond type

3.1.4. The 'stability' of organometallics compounds

3.2. Structure and bonding in organometallic compounds

3.2.1. Ionic

3.2.2. Covalent

3.2.3. Electron deficient complexes

3.3. Methods of formation of metal-carbon bonds

3.3.1. The reaction between a metal and an organic halogen compound

3.3.2. Metal exchange

3.3.3. Reactions of organometallic compounds with metal halides

3.3.4. Addition of metal hydrides to alkenes and alkynes

3.3.5. Formation of metal-carbon bonds by other insertion reactions

3.3.6. Preparation of π-bonded complexes

3.4. Catalytic applications of organometallic compounds

3.4.1. Description of catalysis

3.4.2. Properties of catalysis

3.4.3. Homogeneous catalysis

3.4.4. Heterogeneous catalysis

**4. Bioinorganic Chemistry**

4.1. Introduction

4.2. Essential elements

4.3. Oxygen utilization

4.4. Supply and storage of iron

4.5. Oxidation reduction processes

4.6. Metalloenzymes

4.7. Vitamin B12

4.8. Nitrogenase

4.9. Photosynthesis

4.10. Roles of $Na^{+}$, $K^{+}$, $Mg^{2+}$, $Ca^{2+}$ and iron pumps

**Instructional Methods and Strategies:**

Generally, the instructional methods and strategies throughout the course should be student-centered approach so as to make students throughout the course and to get the necessary knowledge and skills in fostering the ideas stated in the course in particular and in mastery the concepts in chemistry. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book**:

G. Miessler and D. Tarr. Inorganic Chemistry. 3rd ed.

**References:**


1. J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity, 4th ed., 1993.
2. Shriver & Atkins. Freeman, Inorganic Chemistry, 5th ed., 2006.
3. J. D. Lee. A New Concise Inorganic Chemistry, 5th ed., 1996.
4. Catherine E. Housecroft and Alan G. Sharpe, Inorganic Chemistry, 2nd ed., 2001
5. F. A. Cotton and G. Wilkison, Basic inorganic chemistry.3rd ed., 1930.
6. Robert H. Crabtree. The organometallic chemistry of the transition metals 4th ed. 2005.
7. Alan Vincent. Molecular symmetry and group theory. 2nd ed. 2002.
8. Wolfgang KaiM, Brigitte Schwederski. Axel Klein. Bioinorganic chemistry: inorganic elements in the chemistry of life. 2nd ed. 2013.


### 9.2.2.5. Practical Inorganic Chemistry II

| | |
|---|---|
| Course Title: | Practical Inorganic Chemistry II |
| Course Code: | Chem 4033 |
| Credit Hours/ECTS: | 2/3 |
| Contact Hours: | 6 Laboratory Hours per Week |
| Year: | III |
| Semester: | II |
| Prerequisite: | Practical Inorganic Chemistry I (Chem,3033) |

**Course Description:**

The course "practical inorganic chemistry II" is designed to give student's competency in synthesis and characterization of some inorganic metal complexes. The course deals with

synthesis, isolation and characterization of a variety of inorganic compounds and the study of their chemical properties.

**Course Objectives:**

After completing this course, students will be able to:

- Design the preparation of inorganic metal complexes
- Prepare inorganic metal complexes
- Characterize inorganic metal complexes through physicochemical and spectrometric techniques
- Identify inorganic metal complexes using their characteristic spectral and physical properties

**Course Outline:**

**Experiment 1.** Synthesis of inorganic complexes and their characterization by various physicochemical and spectroscopic techniques; selection can be made from the following list or from current literature.

1.1. Metal acetylacetonates

1.2. Cis and trans isomers of $[Co(en)_2Cl_2]Cl$

1.3. Ion-exchange separation of oxidation states of vanadium.

1.4. Preparation of Ferrocene.

1.5. Preparation of triphenyl phosphene $Ph_3P$, and its transition metal complexes.

1.6. Determination of Cr (III) complexes.

1.7. Tin (IV) iodide, Tin (IV) chloride, Tin (II) iodide.

1.8. (N, N)-bis(salicyldehyde)ethylenediamine Salen $H_2$; and its cobalt complex [Co(Salen)].

1.9. Reaction of Cr (III) with multidentate ligands, a kinetics experiment.

1.10. Vanadyl acetylacetonate.

1.11. Mixed valence dinuclear complex of Mangenese (III, IV).

1.12. Other new novel synthesis reported in literature from time to time II (a) Analysis of ores, alloys and inorganic substances by various chemical methods.

**Experiment 2.** Analysis of the samples by instrumental methods such as flame photometer, atomic absorption spectrophotometer, pH-meter, potentiometer, turbidimeter, and electrochemical methods.

**Experiment 3.** Separation of mixtures of metal ions by ion exchange chromatography

**Experiment 4.** Synthesis and thermal analysis of group II metal oxalate hydrates

**Instructional Methods and Strategies:** Active learning methods like gapped lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments/demonstration**;** Listen and observing demonstration and lecture**;** Take notes on the lessons treated**;** Ask questions on unclear idea**;** Active participation in discussion; Preparing flow charts for the experiment for every laboratory sessions; Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the laboratory throughout the laboratory sessions: Recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes (practical and theoretical in group and/or individual), laboratory report, project work) and 30% final examination at the end of the semester.

**Note:** Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources (Materials and Equipments):** Required and Recommended Readings or Supplementary Books/Readings/Websites and Links.

**Text Book:**

Manual of Practical Inorganic Chemistry II

**References:**

1. J. D. Lee., A new Concise inorganic chemistry, 5th edition.
2. F.A cotton, G. Wilkinson, and P. L. Gaus, Basic inorganic Chemistry.
3. Purcell and Kotz, An introduction to Inorganic chemistry.
4. H. J. Emeleus and A. G. Sarpe, Modern aspect of Inorganic chemistry.
5. G. I Brown, Introduction to inorganic chemistry.

### 9.2.3. Organic Chemistry Courses

#### 9.2.3.1. Organic Chemistry I

| | |
|---|---|
| **Course Title:** | Organic Chemistry I |
| **Course Code:** | Chem 2042 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | II |
| **Prerequisite:** | General Chemistry (Chem 1012) |

**Course Description:**

This course is primarily designed to offer basic understanding of structures, reactivities, synthesis of simple organic compounds and the relationships between structure and properties. Although the course follows mechanistic approach to reactions of organic compounds (substitution, elimination, addition, rearrangement reactions), a chapter is devoted to brief discussion of functional groups, their typical reactions and synthesis. The course also introduces the concept of stereochemistry and stereoisomerism (configurational and conformational isomerism) and its importance in organic reactions.

**Course objectives:**

Individuals who successfully complete this course will be able to:

- Describe historical development of organic chemistry,
- Draw reasonable and acceptable structural representations of organic molecules,
- Explain the modern bonding concepts in organic compounds and their influence on properties of compounds,
- Identify various functional groups in organic molecules
- devise the preparation and reactions of common organic functional groups,
- Explain importance of stereochemistryand identify different types of isomers in organic molecules

- Employ stereochemical considerations when analyzing mechanisms and transformationsof organic molecules
- Recognize the major types of heterolytic organic reactions,
- Describe mechanisms of addition, substitution, elimination and rearrangement reactions.

**Course Outline:**

**1. Bonding, Structure and Reactivity**

1.1 Historical background of organic chemistry

1.2 Energy Levels and Atomic Orbitals

1.3 Bonding in carbon compounds:

1.3.1 Valence Bond Concept

1.3.2 Orbital Hybridizations

1.3.3 Molecular Orbital Concept

1.4 Factors influencing electron availability and reactivity of organic compounds

1.4.1 Inductive effect

1.4.2 Resonance effect

1.4.3 Steric effect

**2. Functional groups in organic chemistry**

2.1. The importance of classification of organic compounds according to their functionality

2.2. Introduction to the common functional groups in organic chemistry, their typical properties, preparations and reactions.

2.1.1 Alkanes, alkenes, alkynes,

2.1.2 Aromatic hydrocarbons,

2.1.3 Alcohols, ethers, and epoxides

2.1.4 Aldehydes and ketones,

2.1.5 Amines, nitriles

2.1.6 Carboxylic acids and their derivatives.

**3. Stereochemistry**

3.1 Definitions: Symmetry, Dissymmetry and Chirality

3.2 Elements of Symmetry

3.3 Stereoisomerism: Definition and Classes (Geometric, Configurational, Conformational Isomerism)

3.4 Configurational (Optical) Isomerism

3.4.1 Common Criterion for Chirality: The Asymmetric Carbon

3.4.2 Enantiomers and their Properties

3.4.3 Optical Activity and Plane Polarized Light

3.4.4 Optical Rotation

3.4.5 Measurement of Optical Rotation: The Polarimeter

3.4.6 Specific Rotation

3.4.7 Racemic mixtures and their Properties

3.4.8 Configuration of Chiral Compounds

3.4.8.1 The Cahn-Ingold-Prelog (CIP) sequence rules for assigning configurations

3.4.9 Fischer Projections

3.4.10 Multiple Stereogenic Centres

3.4.11 Diastereomers

3.4.12 Meso compounds

3.4.13 Resolution of Racemic Mixtures

3.5 Conformational Isomerism

3.5.1 Conformational Analysis in alkanes: Ethane and n-Butane

3.5.2 Cycloalkanes: Cyclopropane, cyclobutane, cyclopentane and Cyclohexane

3.5.3 Substituted Cycloalkanes: mono, di and trisubstituted cyclohexanes

**4. Major Organic Reactions**

4.1 Substitution reactions

4.1.1 Introduction

4.1.2 $S_N2$ and $S_N1$ mechanism

4.1.3 Factors affecting $S_N2$ and $S_N1$ reactions

4.1.4 Applications of substitution reactions

4.2 Elimination reactions

4.2.1 Introduction

4.2.2 $E_2$ and $E_1$ mechanism

4.2.3 Elimination versus substitution

4.2.4 Zaistev's and Hoffman rules

4.2.5 Applications of elimination reactions

4.2.6 Other elimination reactions

4.3 Addition reactions

4.3.1 Mechanism and reactivity

4.3.2 Markovnikove's rule

4.3.3 Anti-Markovnikove (Radical) addition

4.3.4 Michael addition

4.3.5 Examples of addition reactions

4.3.6 Other reactions of double bonds

4.3.6.1 Ozonization

4.3.6.2 Diels-Alder reaction

4.3.6.3 Glycol formation

4.3.6.4 Addition polymerization

4.4 Rearrangement reactions

4.4.1 Migration to electron deficient carbon- Wagner-Meerwien Rearrangement

4.4.2 Migration to electron deficient oxygen-The Bayaer-Villiger Oxidation

4.4.3 Migration to electron deficient nitrogen-Beckmann Rearrangement Hofmann Rearrangement

**Instructional Methods and Strategies**: To motivate students to take part in the teaching-learning process of the course Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, questioning and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (Oral questions, quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References:**


1. J. Clayden, N. Greeves, S. Warren, "Organic Chemistry", 2nd Ed., 2012
2. F.M. Menger, D. J. Goldsmith, L. Mondev, "Organic Chemistry", A concise approach, 2nd Ed., 1975.
3. F.A. Carey, "Organic Chemistry", 5th Ed., 2003.
4. T.W.G. Solomons, Organic Chemistry, 7th Ed., 2004.


### 9.2.3.2. Practical Organic Chemistry I

| | |
|---|---|
| **Course Title:** | Practical Organic Chemistry I |
| **Course Code:** | Chem 2044 |
| **Credit Hours/ECTS:** | 1/2 |
| **Contact Hours:** | 3 laboratory Hours per Week |
| **Year:** | II |
| **Semester:** | II |
| **Prerequisite:** | General Chemistry (Chem 1012) |

**Course description:**

The course “Practical organic chemistry” is designed to develop the students’ practical competency and skills in carrying out practical activities such as survey of some functional groups, determination of three dimensional structures of the compounds, and chromatography techniques. In addition preparation of simple organic compounds like soap, and aspirin will be practiced.

**Objective of the Course:**

Upon successful completion of the course students will be able to:

- Train in performing organic chemistry experiments that have relevance in industrial, teaching medical and biological fields.
- Discuss the techniques used to purify contaminated organic compounds
- Study characteristics of organic compounds
- Synthesize different organic compounds
- Design and interpret different experiments
- Use various techniques to separate organic compounds from a mixture
- Identify sources of errors in organic chemistry experiments

**Course Outline:**

Experiment 1: Survey of Some Functional Groups
Experiment 2: Molecules in Three Dimensions (Stereochemistry)
Experiment 3: Nucleophilic Substitution at a Saturated Carbon: Preparation of N-Butyl Bromide
Experiment 4: Cyclohexene from Cyclohexanol
Experiment 5: Preparation of Aspirin
Experiment 6: Fats, Oils and Soaps: Preparation and Properties of Soap
Experiment 7: Olefins from Alcohols
Experiment 8: Introduction to Chromatography
Experiment 9: Diels-Alder Reactions
Experiment 10: Qualitative Organic Analysis

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation, take note; Active participation in discussion; Preparing flow charts for the experiment Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes, practical and theoretical aspects of experiments), laboratory report, project work) and 30% final examination.

**Note:** Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources**: Materials, Equipments, Laboratory manual, separate laboratory room, etc

**References**


1. Ermias Dagne. Experiments in organic Chemistry I: Addis Ababa University; 1978
2. Wendimagegn Mammo. Practical Organic Chemistry II Laboratory manual: Addis Ababa University; 1996.
3. Hassan Bakr Amin, Riyadh. Practical Organic Chemistry: King Saud University, 2007
4. Vogel, A. I.; Furniss, B. S.; Vogel, Arthur Israel. Vogel's Textbook of practical organic Chemistry; Longman Scientific & Technical; Wiley: London; New York, 1989.
5. Richard C. Larock. Comprehensive Organic Transformations: A Guide to Functional Group Preparations. 1989.
6. Corey, E. J., Angew. Catalytic Enantioselective Diels-Alder reactions: Methods, mechanistic fundamentals, pathways, and applications. Chem, Int. Ed. Engl., 2002, 41, 1650.


### 9.2.3.3. Organic Chemistry II

| | |
|---|---|
| **Course Title:** | Organic Chemistry II |
| **Course Code:** | Chem 3042 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | III |
| **Semester:** | II |
| **Prerequisite:** | Organic Chemistry I (Chem 2042) |

**Course description:**

This course is designed to make students aware of organic reactions in detail and depth. It will elaborate chemistry of aromatic compounds, amine, carbonyl compounds, carboxylic acid, and oxidation– reduction reactions. In addition, biological molecules such as carbohydrates, amino acids, peptides, lipid, and nucleic acids are introduced to address basic concepts about natural product chemistry.

**Objectives of course:**

At the end of the course the students will be able to:

- Elaborate the concept of the aromaticity
- Distinguish aromatic compounds from the non-aromatic ones
- Describe the mechanism of electophilic and nucliophilic aromatic substitution reactions
- Describe the various chemical properties and reactions of carbonyl compounds
- Describe the various chemical properties and reactions of amines
- Classify various preparative methods of biological molecule such as carbohydrates, lipids, amino acids and proteins, and their important chemical properties

**Course Outline:**

**1. The Chemistry of Aromatic Compounds**

1.1 Aromaticity

1.2 Properties of Benzene and its Derivatives

1.3 Heterocyclic Aromatic Compounds

1.4 Aromatic Substitution Reactions and their Mechanism

1.4.1 Halogenation

1.4.2 Nitration

1.4.3 Friedel-Crafts Alkylation

1.4.4 Acylation

1.4.5 Sulphonation

1.4.6 Directing Effects of Substituents

1.4.7 Examples of Electrophilic Aromatic Substitution Reactions

1.4.8 Representative Reactions of pyrrole, furane, thiophen and pyridine

1.5 Nucleophilic Aromatic Substitution Reactions

1.5.1 Reactions of Aryl halides

1.5.2 Mechanisms of Nucleophilic Aromatic Substitution Reactions

1.6 Reactions of Aromatic Side Chains

1.6.1 Oxidation and Substitution of Alkyl Side-Chains

1.6.2 Reduction of Nitro Groups and Aryl Ketones

1.6.3 Conversion of Halogens to Organometallic Reagents

1.6.4 Hydrolysis and Fusion of Sulphonic Acids

1.6.5 Modifying the Influence of Strong Activating Groups

1.6.6 Diazotization of Primary Aromatic Amines and their Usefulness in Synthesis of Aromatic Derivatives

**2. Amines**

2.1 Nomenclature & Structure

2.2 Properties of Amines: Physical and chemical properties

2.3 Basicity of Nitrogen Compounds

2.4 Acidity of Nitrogen Compounds

2.5 Reactions of Amines

2.6 Electrophilic Substitution at Nitrogen

2.7 Preparation of 1º-, 2º & 3º-Amines

2.8 Reactions with Nitrous Acid

2.9 Reactions of Aryl Diazonium Intermediates (See Diazotization Reactions)

2.10 Elimination Reactions of Amines (See Hofmann Eliminations)

**3. Reactions of Carbonyl Compounds**

3.1 Addition Reactions

3.1.1 Hydrates

3.1.2 Hemiacetals

3.1.3 Cyanohydrins

3.1.4 Carbinolamines

3.1.5 Addition of Grignard Reagents

3.1.6 Addition of Hydrogen

3.1.7 Hydride Additions (lithium-aluminum hydride and sodium-borohydride)

3.2 Addition-Elimination Reactions

3.2.1 Imines and related compounds

3.2.2 Wittig reaction

3.2.3 Acetals

3.2.4 Ester hydrolysis and formation

3.2.5 Reactions of acid chlorides

3.2.6 Reactions of acid anhydrides

3.2.7 Reactions of amides

3.2.8 Reductions of acid derivatives

3.3 Enolization-Ketonization reactions

3.3.1 Haloform Reaction of Methyl Ketones

3.3.2 Alkylations at the α-Carbon

3.3.3 Aldol and Related Condensation reactions

**4. Oxidation–Reduction Reactions**

4.1 Oxidation Reactions

4.1.1 Alcohols

4.1.2 Aldehydes

4.1.3 Multiple Bonds

4.2 Reduction Reaction

4.2.1 Catalytic Hydrogenation

4.2.2 Hydride Reduction

4.2.3 Dissolving metal reduction

**5. Introduction to Chemistry of Biomolecules**

5.1 Carbohydrates

5.1.1 Glucose

5.1.2 The Structure and Configuration of Glucose

5.1.3 Anomeric forms of Monosaccharides

5.1.4 Glycosides

5.1.5 Disaccharides

5.1.6 Polysaccharides

5.2 Lipids

5.2.1 Fatty Acids

5.2.2 Fats & Oils

5.2.3 Waxes

5.2.4 Phospholipids

5.2.5 Prostaglandins

5.2.6 Terpenes

5.2.7 Steroids

5.3 Proteins and Amino Acids

5.3.1 α-Amino Acids

5.3.2 Reactions of Amino Acids

5.3.3 Synthesis of Amino Acids

5.3.4 Peptides & Proteins

5.3.5 The Primary Structure of Peptides

5.3.6 Secondary & Tertiary Structure of Large Peptides and Proteins

5.3.7 Peptide Synthesis

5.4 Nucleic Acids

5.4.1 Introduction to the chemistry of Nucleic Acids (Structure and Chemistry)

**Instructional Methods and Strategies**:

To motivate students to take part in the teaching-learning process of the course Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, questioning and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities**: Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques**: About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**References**


1. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., 2012.
F.M. Menger, D.J. Goldsmith; L. Mandle, Organic chemistry: A Concise Approach, 2nd Ed., 1974
2. T.W G. Solomons, Organic Chemistry, 7th Ed., 2004.
3. J. McMurry, Organic Chemistry, 4th Ed., 1996.
4. F. A. Carey, Organic Chemistry, 3rd Ed., 1996.


### 9.2.3.4. Practical Organic Chemistry II

| | |
|---|---|
| **Course Title:** | Practical Organic Chemistry II |
| **Course Code:** | Chem 3044 |
| **Credit Hours/ECTS:** | 1/2 |
| **Contact Hours:** | 3 Laboratory Hours per Week |
| **Year:** | III |
| **Semester:** | II |
| **Prerequisite:** | Practical Organic Chemistry I (Chem 2044) |

**Course description:**

This course designed to integrate the theoretical organic reaction with small-scale laboratory practice. The course enable students to perform organic reactions such as Esterification reactions; dehydration, acetylation, oxidation, aldol condensation, Friedel-Crafts reaction; and the Diels-Alder reaction. To introduce some Extraction technique, extraction of limonene from citrus fruit and isolation of caffeine from tea are included to introduce basic extraction skills. In addition to this, students will practice dying process.

**Course objectives:**

At the end of the course the students will be able to:

- Carry out small-scale laboratory synthesis involving esterifications, dehydrations, acetylations, oxidations, aldol condensation, Friedel-Crafts reactions; and the Diels Alder reactions;
- Synthesize various dyes; and
- Interconvert one class of organic compounds to others.

**Course Outline:**

Experiment 1: p-Nitroaniline

Experiment 2: Acetylation of Aromatic-Amines: Preparation of Acetanilide

Experiment 3: Oxidation of Alkylarenes

Experiment 4: Azo Dyes and Ingrain Dyeing

Experiment 5: Kobel-Schmitt reaction: Preparation of β-Resorcyclic Acid (2, 4-Dihydroxybenzoic Acid) Experiment 6: Esterification: Preparation of Amyl Acetate

Experiment 7: The Aldol Condensation and Cannizzaro Reaction

Experiment 8: Preparation of Aldehydes and Ketones by Oxidation of Alcohols

Experiment 9: Introduction to Proteins

Experiment 10: Introduction to Carbohydrates

Experiment 11: Polymers

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and demonstration will be employed.

**Students' Activities**: Observation, take note, **;** Ask questions , Active participation in discussion, Preparing flow charts for the experiments, Bringing laboratory manuals, Wearing laboratory coats, Following safety rules in the laboratory, recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes (practical and theoretical in group and/or individual), laboratory report, project work) and 30% final examination. Note: Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources**: Materials and Equipments

**References**


1. Ermias Dagne. Experiments in organic Chemistry I: Addis Ababa University; 1978
2. Wendimagegn Mammo. Practical Organic Chemistry II Laboratory manual: Addis Ababa University; 1996.
3. Vogel, A. I.; Furniss, B. S.; Vogel, Arthur Israel. Vogel's Textbook of practical organic, Chemistry; Longman Scientific & Technical; Wiley: London; New York, 1989.
4. Whitford, D. Proteins: structure and function; John Wiley & Sons: Hoboken, NJ, 2005.
5. Richard C. Larock. Comprehensive Organic Transformations: A Guide to Functional Group Preparations. .1989.
6. Kürti, L.; Czakó, B. Strategic applications of named reactions in organic synthesis: background and detailed mechanisms; Elsevier Academic Press: Amsterdam; Boston, 2005.
7. E. J. Corey, Angew. Catalytic enantioselective Diels-Alder reactions: Methods, mechanistic fundamentals, pathways, and applications. Chem, Int. Ed. Engl., 2002, 41, 1650.\


### 9.2.3.5. Physical Organic Chemistry

| | |
|---|---|
| **Course Title:** | Physical Organic Chemistry |
| **Course Code:** | Chem 4041 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | IV |
| **Semester:** | I |

**Prerequisite:** Organic Chemistry II (Chem 3042)

**Course description:**

This course is designed to broaden the concepts of organic reaction mechanism. It will elaborate correlation of structure with reactivity, methods of establishing reaction mechanisms, and the chemistry of reactive intermediates. It also emphasizes applications of Frontier Orbital Theory in electrocyclic reactions, cycloaddition and sigmatropic rearrangements. The course will enable the students to explain organic reactions with reasonable mechanism. A chapter on spectroscopic methods of structure elucidation is included to enable the students to elucidate structures of organic molecules.

**Objective of the Course:**

At the end of this course, students will be able to:

- Explain the mechanism of different types of reaction
- Explain factors influencing electron availability
- Correlate reactivity with structure
- Investigate reaction mechanism using kinetics
- Discuss energetic of reactions
- Discuss methods of establishing reaction mechanism
- Propose reaction mechanism for different reaction
- Understand pericyclic reactions.

**Course Outline:**

**1. Structure, Reactivity and Mechanism**

1.1 Atomic orbital

1.2 Hybridization

1.3 Bonding in Carbon compound (Single, Double, Triple bonds)

1.4 The breaking and forming of bond

1.5 Factors influencing electron availability

1.5.1 Inductive effects

1.5.2 Mesomeric effects

1.5.3 Steric effects

1.5.4 Effects of the medium

1.6 Correlation of structures with reactivity.

1.6.1 Electron demand

1.6.2 The Hammett equation

1.6.3 Substituent constant (σ)

1.6.4 Reaction constant (ρ)

**2. Energetic, Kinetics and Investigation of Reaction Mechanisms**

2.1 Energetics of a Reaction: Thermodynamic Requirement for a Reaction

2.2 Kinetics of reaction

2.2.1 Reaction rate and free energy of activation

2.2.2 The rate-determining step

2.2.3 Molecularity

2.2.4 Kinetic Requirement for a Reaction

2.2.5 Kinetic and Thermodynamic Control

2.2.6 The Hammond Postulate

2.3 Methods of establishing reaction mechanism

2.3.1 The nature of the products

2.3.2 Kinetic data

2.3.3 The use of isotopes (kinetic use of isotopes and non-kinetic use of isotopes)

2.3.4 The study of the reactive intermediates (Isolation, detection and trapping of intermediates)

**3. The Chemistry of Reactive Intermediates**

3.1 Carbinions

3.1.1 Carbanion generation

3.1.2 Carbanion stability

3.1.3 Typical reation of carbanions (Addition, Elimination, Substitution and Rearrangements)

3.2 Carbocations

3.2.1 Carbocations

3.2.2 generation,

3.2.3 Carbocations stability,

3.2.4 Typical reactions of carbocations, (Addition, Elimination, Substitution and Rearrangement)

3.3 Carbenes and Nitrenes

3.3.1 Generation and reactions of Carbenes and Nitrenes

3.4 Free Radical Reactions

3.4.1 Free radicals, stability and generation ,

3.4.2 Chain free-radical reactions

3.4.3 Nonchain free-radical reactions

**4. Pericyclic Reactions**

4.1 Introduction

4.2 Classes of Pericyclic reactions

4.3 Electrocyclic reactions

4.3.1 Typical reactions

4.3.2 Stereospecificity

4.3.3 stereoselectivity

4.4 Cycloadditions.

4.4.1 Typical reactions

4.4.2 Regioselectivity

4.4.3 Stereospecificity

4.4.4 stereoselectivity

4.5 Sigmatopic arrangements

4.5.1 Typical reactions

4.5.2 Stereospecificity

4.5.3 stereoselectivity

4.6 Ene Reactions

**5. Structure Elucidation of Organic Compounds**

5.1 Combustion Analysis for Determination of Elemental Composition

5.2 Ozonolysis for Determination of Sites of Unsaturations

5.3 Molecular Spectroscopy

5.3.1 Ultraviolet-Visible Spectroscopy

5.3.2 Infrared Spectroscopy

5.3.3 Nuclear Magnetic Resonance Spectroscopy

5.4 Mass Spectrometry

**Instructional Methods and Strategies**: To motivate students to take part in the teaching-learning process of the course Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, questioning and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities**: Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques**: About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Reference**


1. P. Sykes; Guide Book to Mechanism in Organic Chemistry, 1982.
2. R. B. Grossmann; The Art of Writing Reasonable Organic Reaction Mechanism, 2nd Ed., 2003.


### 9.2.3.6. Practical Organic Chemistry III

**Course Title:** Practical Organic Chemistry III

**Course Code:** Chem 4043

| | |
|---|---|
| **Credit Hours/ECTS:** | 2/3 |
| **Contact Hours:** | 6 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | I |
| **Prerequisite:** | Practical Organic Chemistry II (Chem 3044) |

**Course Description:**

The course, Practical Organic Chemistry III, is designed to make student to develop competency and skills of measurement and physical characterization of organic compounds including melting point, boiling point, specific gravity, index of refraction of liquids; separation of mixtures; classification of organic compounds by solubility; preparation of derivatives; use of spectroscopic methods for structure determination; and use of the chemical literature.

**Objective of the Course:**

Upon successful completion of the course students will be able to:

- Explain techniques in the systematic identification of organic compounds.
- Measure the physical constants of different organic sample with minimum error.
- Determine the functional group of unknown organic sample
- Interpret IR, mass and NMR spectra of an organic compound.
- Determine the structure of unknown organic sample

**Course Outline:**

Experiment 1: Introduction to systematic identification of organic compounds
Experiment 2: Test for unsaturation
Experiment 3: Test for alcoholic (R–OH) group.
Experiment 4: Test for phenolic (AR-OH) group
Experiment 5: Test for carbonyl (-CO-) group
Experiment 6: Test for carboxylic (-COOH) group
Experiment 7: Test for amino ($-NH_2$, -NHR, $-NR_2$)
Experiment 8: Preparation of derivatives for alcohols

Experiment 9: Preparation of derivatives for Phenols

Experiment 10: Preparation of derivatives for carbonyl

Experiment 11: Preparation of derivatives for Carboxylic acids

Experiment 12: Preparation of derivatives for Amines

Experiment 13: Group discussion on the chemical test and preparation of derivatives.

Experiment 14: Overview of spectroscopy and unknown identification using all techniques

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and demonstration will be employed.

**Students' Activities**: Observation, take note, **;** Ask questions , Active participation in discussion, Preparing flow charts for the experiments, Bringing laboratory manuals, Wearing laboratory coats, Following safety rules in the laboratory, recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: 70% continuous assessment (quizzes (practical and theoretical in group and/or individual), laboratory report, project work) and 30% final examination.

**Note:** Attendance is mandatory for every practical session. If the student misses the practical session, he/she must present evidence and must perform the experiment.

**Instructional Resources (Materials and Equipments):**

**References**


1. Systematic identification of organic compounds, 8th ed, Shriner, fuson curtin, Merrill, John Wiley & Sons, 2004.
2. "Spectrometric Identification of Organic Compounds, 6th Ed.",R.M. Silverstein and F.X. Webster, John Wiley & Sons, 2003.
3. "Organic Spectroscopic Analysis", R.J. Anderson, D.J. Bendell and P.W. Groundwater, RSC, 2004
4. "Organic Chemistry, 7th Ed.", John McMurry, Brooks/Cole, 2007.

### 9.2.4. Physical Chemistry Courses

#### 9.2.4.1.Chemical Thermodynamics

| | |
|---|---|
| **Course Title:** | Chemical Thermodynamics |
| **Course Code:** | Chem 2052 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture hours per week |
| **Year:** | II |
| **Semester:** | II |
| **Pre-Requisites:** | Calculus I for chemists (Math 2021) |

**Course Description:**

The course "Chemical thermodynamics" introduces the in the fundamental concepts of thermodynamics. It also explores the ideal and real gases, Zeroth's, First, Second, and Third Laws of Thermodynamics. States of matter and transformations, phase equilibrium, chemical equilibrium, Gibbs free energy and prediction of spontaneous reaction are to be discussed.

**Objectives of the Course:**

Upon completion of the course the students would be able to:

- Describe properties of gases
- Predict reaction spontaneity using relevant thermodynamic systems
- Explain the laws of thermodynamics
- Apply the laws of thermodynamics
- Explain the thermodynamic interpretation of phase equilibria
- Model simple and complex reactions using reaction rates and integrated rate laws
- Explain reaction rates in terms of transition state theory
- Calculate rate constants and activation energies
- Explain the effect of solutes on solvent in solution system

**Course Outline:**

**1. Ideal and real gases**

1.1. The equation of state

1.2. Ideal gases and Ideal gas laws

1.3. Real gas laws

**2. Units and Mathematics**

2.1 Basic SI units

2.2 Derived Units

2.3 Logarithms and Exponents

2.4 Differentials and Integrals

**3. Thermodaynamics**

3.1 Thermodynamic terms

3.1.1 System and surroundings

3.1.2 State of a system

3.1.3 Properties of a system

3.1.4 Thermodynamic equilibrium, Zeroth's law of thermodynamics

3.1.5 Thermodynamical process

3.1.6 State functions

3.1.7 Mathematical techniques interconnecting the state functions

3.1.8 Heat and work

3.2. First law of thermodynamics

3.2.1. Pressure volume work

3.2.2. Enthalpy (Heat content)

3.2.3. Heat capacities

3.2.2.1. Heat capacities (CP and CV) relationships

3.2.2.2. Heat capacity and temperature relationship

3.2.4. Reversible isothermal process

3.2.5. Reversible adiabatic process

3.2.6. Thermochemistry

3.2.6.1. Internal energy and enthalpy

3.2.6.2. The law of thermochemistry

3.3. Second law of thermodynamics

3.3.1. The Carnot cycle

3.3.2. Entropy

3.3.2.1. Entropy change in a reversible process

3.3.2.2. Entropy changes in an irreversible process

3.2.3. Entropy changes for an ideal gas

3.2.4. Entropy change in a chemical reaction

3.3. Free Energy

3.3.1. Dependence of Helmholtz free energy on volume and Temperature

3.3.2. Helmholtz and Gibbs energies: Spontaneous processes

3.3.3. Fugacity

3.3.4. Dependence of Gibbs free energy on pressure and temperature

3.3.5. Maxwell relations

3.3.6. Chemical potential

3.3.6.1. Gibbs-Duhem equation

3.3.6.2. Chemical potential for an ideal gas and gas mixture

**4. Third law of thermodynamics**

4.1. Chemical equilibrium and phase equilibrium

4.2. Chemical equilibrium

4.2.1. Standard Gibbs free energy of reaction and equilibrium

4.2.2. Relationship between Kp and Kc

4.2.3. Variation of equilibrium constant with temperature and pressure

4.2. Phase equilibrium

4.2.1. Clapeyron and Clausius Clapeyron equation

4.2.2. Phase, components, degrees of freedom and phase rule

4.2.3. Phase diagram

4.2.3.1. A single component systems

4.2.3.2 .A two component systems

4.2.3.3. A three component systems

**5. Non-Electrolyte Solutions**

5.1. Solutions of gases in liquids (Henry's law)

5.2. Solutions of gases in gases (Dalton’s law of partial pressure)

5.3. Solutions of liquids in liquids (Raoult's law)

5.3.1. Completely miscible liquids

5.3.1.1. An ideal solution and vapour pressure of ideal solutions

5.3.1.2. Vapour pressure of non-ideal solutions

5.3.1.3. Boiling point diagrams of an ideal and real solutions

5.3.1.4. Fractional distillation

5.3.2. Partially miscible liquids

5.4. Solutions of non-volatile solutes (Colligative Properties)

5.4.1. Vapour pressure lowering

5.4.2. Boiling point elevation

5.4.3. Freezing point depression

5.4.4. Osmotic pressure

**Instructional Methods and Strategies**: Instructional methods and strategies should be student-centered approach laid-back with, gapped lecture, inquiry, case study, demonstration, individual or group assignments, discussion, collaborative learning and so on.

**Students' Activities**: Active participation during lecturing, discussion and team works; taking notes on the lessons; asking and answering questions; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. P.W. Atkins, Physical Chemistry, Oxford University Press, Oxford-New York, 2002.
2. T.R. Forester, Introductory Physical Chemistry, Addis Ababa University, 1990.
3. G.M. Barrow, Physical chemistry, 5th Ed., TATA McGraw-Hill Edition, New Delhi, 1992.

4. K. K. Sharma, A textbook of Physical Chemistry, Vicas Publishing House, New Delhi, 1981.
5. R.A. Alberty and R.J. Silbey, Physical Chemistry, Wiley and Sons Inc., New York, 1997.
6. Silbey, R., R. Alberty, and M. Bawendi. Physical Chemistry. 4th ed. New York, NY: John Wiley & Sons, 4th ed. 2005.
7. Castellan, G. Physical Chemistry. 3rd ed. Reading, MA: Addison-Wesley, 1983.
8. Houston, P. Chemical Kinetics and Reaction Dynamics. New York, NY: McGraw-Hill, 2001.

### 9.2.4.2. Chemical Kinetics and Electrochemistry

| | |
|---|---|
| **Course Title:** | Chemical Kinetics and Electrochemistry |
| **Course Code:** | Chem 3051 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture hours per week |
| **Year:** | III |
| **Semester:** | I |
| **Prerequisites:** | Chemical Thermodynamics (Chem 2052) |

**Course description:**

The course "Chemical Kinetics and Electrochemistry" helps to introduce kinetics theory of gases, chemistry kinetics and electrolyte solutions. It also provides the basic information about interfacial electrochemistry through leaning theoretical laws and principles.

**Course objective:**

Upon completion of this course the students would be able to:

- Explain electrochemistry
- Apply the concept of conductance for analysis
- Explain the principle of electrolytic conduction
- Apply the concept of chemical kinetics to predict mechanism of reaction
- Discuss gaseous properties, rate of chemical reactions and electrochemistry

- Describe the theoretical law and principles

**Course outline:**

**1. Electrolytic solutions**

1.1. Transport properties

1.2. Activity and activity coefficients

1.3. Theory of electrolytic conductance

1.5. Application of electrolytic cells

**2. Electrochemical Cells**

2.1. Introduction

2.2. Reversible electrodes

2.3. Thermodynamics of electrochemical cells

2.4. Determination of standard electrode potential

2.5. Classes of electrochemical cells

2.6. Liquid junction potential

2.7. Measurement of pH

2.8. Membrane potentials

2.9. Examples of electrochemical cells

**3. Interfacial Electrochemistry**

3.1. Potential differences across interfaces

3.2. The electrical double layer

3.3. Thermodynamics of electrified interface

3.4. Electrochemical kinetics

**4. Kinetic Theory of Gases**

4.1. Postulates of the kinetic theory of gases

4.2. Ideal gas laws

4.3. Barometric formula

4.4. Distribution of molecular velocities

4.5. Molecular collisions

4.6. Collisions with a surface or hole

4.7. Transport phenomena

**5. Chemical Kinetics**

5.1. The rates of chemical reactions

5.2. Reaction rate laws

5.2.1. Reversible or opposing reactions

5.2.2. Consecutive or sequential reactions

5.2.3. Parallel or side reactions

5.2.4. Chain reactions

5.2.5. Acid-base catalysed reactions

5.2.6. Enzyme catalysed reactions

5.3. Analysis of kinetic results

5.4. Reaction rate theories

5.4.1. Collision theory

5.4.2. Transition state theory

**Instructional Methods and Strategies**: Instructional methods and strategies should be student-centered approach including gapped lecture, inquiry, , demonstration, individual or group assignments, discussion, collaborative learning and so on.

**Students' Activities**: Active participation during lecturing, in discussion and team works; taking notes on the lessons; asking questions and answering to questions; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Materials**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**

1. Hill, Terrill L. An Introduction to Statistical Thermodynamics. New York, NY: Dover, 1987.
2. P.W. Atkins, Physical Chemistry, Oxford University Press, Oxford-New York, 2002.

3. T.R. Forester, Introductory Physical Chemistry, Addis Ababa University, 1990.
4. G.M. Barrow, Physical chemistry, 5th Ed., TATA McGraw-Hill Edition, New Delhi, 1992.
5. K. K. Sharma, A textbook of Physical Chemistry, Vicas Publishing House, New Delhi, 1981.
6. R.A. Alberty and R.J. Silbey, Physical Chemistry, Wiley and Sons Inc., New York, 1997.
7. R.A. Alberty, R.J. Silbey, and M. G.Bawendi, Physical chemistry, Wiley and Sons Inc., New York,4th ed. 2005.

### 9.2.4.3. Practical Physical Chemistry I

| | |
|---|---|
| **Course Title:** | Practical Physical Chemistry I |
| **Course Code:** | Chem 3053 |
| **Credit Hours/ECTS:** | 1/2 |
| **Contact Hours:** | 3 Laboratory Hours per Week |
| **Year:** | III |
| **Semester:** | II |
| **Prerequisites:** | Chemical Thermodynamics (Chem 2052) |

**Course Description:**

The course "Practical Physical Chemistry I" is designed to correlated students' theoretical understanding with practical science via delivering different experimental works including solubility, viscosity, phase rule, partition coefficient, adsorption, surface tension, transition temperature and freezing point, kinetics of reaction and thermochemistry.

**Objectives of the Course:**

At the end of the course the student will able to:

- Determine physical properties of matter
- Develop some techniques of determination of physical properties matter
- Extract model parameters from experimental data sets
- Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors
- Present the results of a practical investigation in a concise manner

- Calculate the equilibrium constants, standard Gibbs energy of reactions, and standard cell potentials for Galvanic cells
- Define the terms and determine the enthalpy and entropy change associated with a reaction
- Explain the concept of spontaneity of a reaction and determine the Gibbs energy change associated with a reaction
- Explain and apply the concept of thermodynamic equilibrium

**Course Outline:**

Experiment 1: Enthalpy of solution: Determine the enthalpy of solution, $\Delta H$ of a salt (e.g. $KNO_3$)

Experiment 2: Differential Scanning Calorimetry: Determine the molar heat of vaporization (e.g. Oxalic acid)

Experiment 3: Boiling Point Diagram of Binary System: Draw a boiling point diagram of a binary system at ambient pressure.

Experiment 4: Partial Miscibility of a Binary System: Draw a phase diagram of a partially miscible system; and to determine the critical temperature Tc (e.g. Phenol in Water).

Experiment 5: Phase Equilibria: Determine the enthalpy of solution of an organic acid (e.g. Benzoic acid).

Experiment 6: Elevation of Boiling Point: Determine the apparent molecular weight of a non-volatile solute (e.g. NaCl); Or Determination of the molar mass of organic compounds by steam distillation

Experiment 7: Ionic Equilibrium: Draw the titration curve (pH vs. base) and to determine the buffer capacity $\beta$ of a polyprotonic acid (e.g. $H_3PO_4$).

Experiment 8: Hydrolysis reaction of a solute with concentrated and diluted base solution: Determine the reaction orders and rate constants k of the reactions (e.g. Crystal violet with NaOH); Equilibrium constant

Experiment 9: Thermodynamics of an Electrochemical Cell: Determine the cell potential E; and the free Gibbs energy, enthalpy and entropy of reaction of an electrochemical cell (e.g. Daniel Cell).

Experiment 10: Conductance of Strong and Weak Electrolytes: Determine the molar conductance Λm of strong and weak electrolytes, and dissociation constant of weak electrolytes (e.g. HCl and $CH_3COOH$); Determination of equivalent conductance at infinite dilution of strong electrolytes.

Experiment 11: Adsorption from solution

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Observation the practical experiments/demonstration; Listen and observing demonstration and lecture; Take notes on the lessons treated; Ask questions on unclear idea**;** Active participation in discussion; Preparing flow charts for the experiment for every laboratory sessions; Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the laboratory throughout the laboratory sessions: Recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: Up to 60% continuous assessment (quizzes, practical assessments (in group and/or individual), laboratory report, project work etc.)), and 40% final examination. Missing of more than two experiments lead to repeating the course.

**Textbook**:

Practical Physical Chemistry I, D. Ohms and T. Solomon, AAU (Lab manual)

**References**


1. John B Russel. General chemistry. (McGraw-Hill series in chemistry) Publisher**:** McGraw-Hill Education (ISE Editions); 2nd Ed edition (January 1, 1992)
2. M. Baus, Carlos F. Tejero. Equilibrium statistical physics: phases of matter and phase transitions [1 ed.], Springer, 2008.

### 9.2.4.4.Quantum Chemistry

| | |
|---|---|
| **Course Title:** | Quantum chemistry |
| **Course Code:** | Chem 4051 |
| **Credit Hours/ECTS:** | 4 /7 |
| **Contact Hours:** | 4 Lecture Hours per Week |
| **Prerequisite:** | Kinetics and electrochemistry (Chem 3051) and Calculus II for Chemists (Math 2022) |

**Course Description:**

Experimental foundation of chemistry; Schrodinger equation; Operators in quantum mechanics; Solution of Schrodinger equation for some simple systems; Atomic structure; Molecular structures; chemical bond.

**Objectives of the Course**

Upon completion of this course the students would be able to:

- Distinguish between classical and wave mechanics
- Apply quantum mechanics to simple systems
- Identify the physical meanings of quantum numbers
- Apply quantum mechanical operators
- Describe molecular and atomic structure

**Course Outline:**

1. Introduction
2. Experimental Foundation of Quantum Theory
   2.1. Black Body Radiation
   2.2. Photoelectric Effect
   2.3. The Compton Effect
   2.4. Line Spectra of Atoms
   2.5. Rutherford Model of the Atom

8.1.2. Ionic Bond

8.1.3. Covalent Bond

8.2. Quantum Chemical Bond Description

8.3. Molecular Orbital Theory

8.3.1. The LCAO-MO Approximation

8.3.2. The Hydrogen Molecular Ion

8.3.3. The Hydrogen Molecule

8.4. Valence Bond Theory

8.4.1. Hydrogen Molecule: Heitler-London Theory

8.4.2. The Shape of Polyatomic Molecules

8.4.3. Electronegativity

8.5. The Electronic Structure of Diatomic Molecules - MO Theory

8.6. Valence Bond Theory of π-electron Systems

8.7. Molecular Orbital Theory of π-electron Systems

8.8. Comparison of MO and VB Theories

**Instructional Methods and Strategies**: Active teaching methods including gapped lecture, inquiry, group work, assignments etc., and formative and summative assessments should be employed.

**Students' Activities**: Active listening, participation, and team works; taking notes on the lessons; asking and answering questions; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, markers, duster.

**Text Book**:

H. Zewdie, Introductory Quantum Chemistry, AAU, A.A., 1999.

**References**

1. D.A. McQuarrie and J.D. Simon, Physical Chemistry: A Molecular Approach, University Science Books, Sausalito, California 2006.
2. P.W. Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford 1997.
3. A.K. Chandra Introductory Quantum Chemistry, Tata McGraw-Hill, 1979.
4. I.N. Levin, Quantum Chemistry, Ally Bacon Inc., 1974.
5. D.A. McQuarrie, Quantum Chemistry, University Science Books, 1983.

### 9.2.4.5. Statistical Thermodynamics and Surface Chemistry

| | |
|---|---|
| **Course Title:** | Statistical Thermodynamics and Surface Chemistry |
| **Course Code:** | Chem 4052 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Prerequisite:** | Quantum Chemistry (Chem 4051) |

**Course Description:**

Introduction to electromagnetic radiation and its interaction with matter, statistical thermodynamics, Terminology and basic concepts, Distribution function, Surface chemistry: Interfacial structure, Surface tension and surface free energy, Methods of surface tension measurement, Nature and thermodynamics of liquid-gas interface, the surface tension of solution, the two dimensional ideal gas laws, adsorption at the solid solution interface will be demonstrated.

**Objectives of the Course**

At the end of the course the students will be able to:

- Describe molecular spectroscopy
- Discuss the basic concepts in statistical thermodynamics;
- Explain the surface phenomena by applying their chemical knowledge;

- Explain about adsorption phenomena;
- Describe the solid solution interface
- Describe interaction of electromagnetic radiation and matter

**Course Outline**

**1. Molecular Spectroscopy**

1.1. Introduction

1.2. The Electromagnetic Radiation

1.3. The Width and Intensity of Spectral Transitions

1.4. Electronic Spectroscopy

1.5. Vibrational Spectroscopy

1.4. Raman Spectroscopy

1.6. Rotational Spectroscopy

1.7. Vibrational-Rotational Spectra of Diatomic Molecules

1.8. Electron-Spin Resonance

1.9. Nuclear Magnetic Resonance

**2. Statistical Thermodynamics**

2.1 Introduction

2.2 Terminology and Basic Concepts

2.3 Basic Statistics

2.4 Statistics of Particles

2.5 Distribution Functions

2.6 Partition Function

2.7 Thermodynamic Functions

2.8 Statistical Mechanics of Ensembles

2.9 Thermodynamic Properties of Ideal Gas

2.10 Statistical Derivation of the Equation of State for Non-ideal Fluids

2.11 Equilibrium Constants for Gas Phase Reactions

**3. Physical Chemistry of Surfaces**

3.1 Interfacial Structure

3.2 Surface Tension and Surface Free Energy

3.3 Methods of Surface Tension Measurement

3.4 Nature and Thermodynamics of Liquid-Gas Interface

3.5 The Surface Tension of Solutions

3.6 Surfaces of Solids

3.7 Absorption at the Solid Solution Interface

3.8 Adsorption at solid Interfaces

**Instructional Methods and Strategies**: Active teaching methods including gapped lecture, inquiry, group work, assignments class works etc., and formative and summative assessments should be employed.

**Students' Activities**: Active listening, participation, and team works; taking notes on the lessons; asking questions and answering to questions; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: Continuous assessments up to 50% (quizzes, tests, assignments, project work and/or mid-exam.) and 50% final examination

**Instructional Materials**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, markers, duster

**References**


1. Richard Pashley, Marilyn Karaman. Applied Colloid and Surface Chemistry, 1st Ed. Published in J. Wiley, 2004
2. R.P. Rastogi and R.R. Misra, Introduction of Chemical Thermodynamics, Vikas Publishing House, New Delhi, 1978.
3. D.A. McQuarrie, Statistical Thermodynamics, Harper & Row, 1976.
4. P.W. Atkins, Physical Chemistry, Oxford University Press, Oxford-New York, 2002
5. G.M. Barrow, Physical chemistry, 5th Ed., TATA McGraw-Hill Edition, New Delhi, 1992
6. K. K. Sharma, A textbook of Physical Chemistry, Vicas Publishing House, New Delhi, 1981.
7. R.A. Alberty and R.J. Silbey, Physical Chemistry, Wiley and Sons Inc., New York, 1997.

8. R.A. Alberty, R.J. Silbey, and M. G.Bawendi, Physical Chemistry, Wiley and Sons Inc., New York, 4th ed.2005.

### 9.2.4.6.Practical Physical Chemistry II

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|---|---|
| **Course Title:** | Practical Physical Chemistry II |
| **Course Code:** | Chem 4054 |
| **Credit Hours/ECTS:** | 1/2 |
| **Contact Hours:** | 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisites:** | Practical Physical Chemistry I (Chem 3053) |

**Course Description:**

The course "Practical physical chemistry II" is designed to develop students practical competency and skill in performing practical activities of Kinetic of Reaction, Conductance, electrochemistry, Spectroscopy, Computational software.

**Objectives of the Course**

At the end of this practical section, students will be able to:

- Determine rate of any chemical reaction; Kinetics of Decomposition
- Measure conductance of electrolyte in solution
- Develop skill of using chemistry software to predict some properties of compounds theoretically
- Analyze samples with different electrochemical methods
- Develop the skills of analysis of compounds based on the electrochemical and optical characteristics of substances
- Explain the use of spectroscopic methods for qualitative and quantitative analysis
- Determine the Time Domain Spectroscopy - measurement of wavelength-time-dependent fluorescence
- Describe the relationship between the free energy and the cell potential

- Describe the relationship between cell potential and the equilibrium constant
- Develop the skills of using chemistry software to predict some properties of compounds theoretically
- Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors

**Course Outline:**

Experiment 1: Derivation of Frank-Condon progression from UV-Vis measurement
Experiment 2: Effect of concentration and solvent polarity on UV-Vis absorption spectra of compounds
Experiment 3: Measurement of fluorescence spectra of some selected compounds and effect of conjugation UV-Vis spectra
Experiment 4: Analyze samples with different electrochemical methods
Experiment 5: Develop the skills of analysis of compounds based on the electrospectrochemical characteristics of substances
Experiment 6: Quantum mechanical prediction of dipole moment, heat content, Gibb`s free energy of molecules.
Experiment 7: Quantum mechanical prediction of NMR, IR-spectra of compounds.
Experiment 8: Rate of decomposition study using UV-Vis or titrimetric methods

**Instructional Methods and Strategies**: Active learning methods like lecturing, experimentation, group work, and laboratory report in group or individually.

**Students' Activities**: Participate in the practical experiments/demonstration**;** Listen and observing demonstration and lecture**;** Take notes on the lessons treated**;** Ask questions on unclear idea**;** Active participation in discussion; Preparing flow charts for the experiment for every laboratory sessions; Bringing laboratory manuals; Wearing laboratory coats; Following safety rules in the laboratory throughout the laboratory sessions: Recording experimental procedures and results; Writing and submitting laboratory reports on time.

**Assessment Strategies and Techniques**: Mode of Assessment: Up to 60% continuous assessment (quizzes (practical and theoretical in group and/or individual), laboratory report,

project work) and 40% final examination. Missing of more than two experiments leading to repeating the course.

**References**


1. P. W. Atkins, Physical Chemistry, 6th Ed., Oxford University Press, New York, 2004.
2. R. J. Silbey and R. A. Alberty, Physical Chemistry 3rd Ed., Massachusetts Institute of Technology, 2001.
3. J. R. Lakowicz, Principle of Fluorescence Spectroscopy, 2nd Ed., University of Maryland
4. School of Medicine, 1999.
5. A. J. Bard and L. R. Faulkner, Department of Chemistry and Biochemistry, University of Texas at Austin, 2000.

### 9.2.5. Applied Chemistry Courses

#### 9.2.5.1.Industrial Chemistry I

| | |
|---|---|
| **Course Title:** | Industrial Chemistry I |
| **Course Number:** | Chem3121 |
| **Credit Hours/ECTS:** | 3/5 |
| **Year:** | III |
| **Semester:** | II |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Prerequisite:** | Inorganic Chemistry I (Chem 2032) |

**Course Description:**

The course "Industrial Chemistry I" introduces industrial process and process variables, unit operations, material and energy balance, hardness of water and water treatment processes. Furthermore, the course incorporates the industrial production of some important chemicals like caustic soda, sulfuric acid, nitric acid. The course equips the students with the required competency to work in areas like in the chemical processing industries, Environmental Protection Agency (EPA), International standard organizations, Quality Control Authorities, Water and Wastewater treatment plants, Water and Sewerage Authorities, occupational hazard and research institutions. The course deals with Water in the chemical industry; basic inorganic industrial processing (acids, alkalis, salts; gases, fertilizers, ceramics, glass, cement, metals, pigments).

**Course Objective:**

By the end of this course students should be able to:

- Explain unit operations and material balances
- Describe the basic industrial activities
- Identify the temporary and permanent hardness of water
- Discuss the different types of wastewater treatment processes
- Explain the causes of hardness and alkalinity of water
- Discuss about the typesof fertilizer and manufacturing methods

- Identify types of materials and their corresponding applications

**Course Outline:**

**1. General Introduction**

1.1. Introduction to Industrial Processes and Process Variables

1.2. Introduction to Unit Operations

1.3. Introduction to Material Balance and Energy Balance

**2. Water in the Chemical Industry**

2.1. Sources of water

2.2. Dissolved solids, suspended solids, Hardness and alkalinity in water

2.3. Requisites of water for industries

2.4. Treatment of water by sedimentation, Filtration and membrane filtration (reverse osmosis)

2.5. Water treatment by Ion-exchange Process and electro-dialysis

2.6. Water treatment using electrochemical methods

**3. Hydrochloric, Hydrofluoric and Sulphuric Acids**

3.1. Methods of manufacture of hydrochloric acid and its uses

3.2. Industrial manufacture of hydrofluoric acid and its uses

3.3. Chamber process and contact process of manufacture of sulphuric acid and its handling

**4. Common Salts and the Chlor-alkali industry**

4.1. Common salt and its resources

4.2. Chlor-alkali Industry – Introduction

4.3. Leblanc Process

4.4. Deacon Process

4.5. Electrolytic Processes

4.6. The Solvay process

**5. Industrial Derivatives of Nitrogen**

5.1. Cyanamide Process and Haber Process of Ammonia synthesis

5.2. Manufacture of Nitric acid and its uses

5.3. Manufacture of TNT, Nitrocellulose and Nitroglycerine

**6. Fertilizers and Phosphoric Acids**

6.1. Chemistry of manufacture of phosphoric acid

6.2. Phosphoric acid series

6.3. Essential and trace elements for plant growth

6.4. Manufacture of nitrogenous fertilizers – calcium cyanamide, ammonium nitrate and urea

6.5. Potash Fertilizers

6.6. Manufacture of super phosphate and triple super phosphate fertilizers

**7. Silicate Industry**

7.1. Types of ceramics

7.2. Manufacture of structural clay products, white wares and stone wares

7.3. Glass and its properties

7.4. Manufacture of glass

7.5. Types of glasses

7.6. Classification of cement

7.7. Manufacture of Portland cement

7.8. Setting and hardening of Portland cement

**8. Metallurgical Processes**

8.1. Minerals and Ores

8.2. Concentration of ores

8.3. Roasting, calcination and smelting of ores

8.4. Refining of impure metal

8.5. Extraction of Iron and copper

**9. High Temperature Materials**

9.1. Refractories and their characteristics

9.2. Classification of refractories

9.3. Properties of refractories

9.4. Manufacture of refractories

9.5. Fire-Clay, Magnesite and Graphite bricks

**10. Miscellaneous Products**

10.1. Abrasives and their classification

10.2. Grinding wheels and abrasive paper

10.3. Dielectric materials and their characteristics

10.4. Thermal Insulators and their characteristics

10.5. Classification of thermal insulators and examples

**Instructional Methods and Strategies:** Generally. the instructional methods and strategies throughout the course should be student-centered approach including Gapped lecture, Role playing, Case study, Field trip/industrial visit, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, writing field trip report and submission, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**References:**


1. P.C. Jain and M. Jain, Engineering Chemistry by; Dhanpatrai& sons, 11th ed, 1996.
2. B.K. Sharma, Industrial Chemistry, Goel publishing house; 11th ed, 2004.
3. K.H. Buchel, H.H Moretto and P. Woditsch, Industrial Inorganic Chemistry, 2nd Ed., Wiley-VCH, 2000.
4. Colin Baird and Michael Cann, Environmental Chemistry, 5th Edition, 2012.
5. John Houghton, Global Warming: The Complete Briefing, 4th Edition, 2009, Cambridge Univ. Press.
6. Water Quality and Treatment, 5th edition, R. Letterman, Editor, American Water Works Association, Denver, CO, 1999.

### 9.2.5.2. Industrial Chemistry II

| | |
|---|---|
| **Course Title:** | Industrial Chemistry II |
| **Course Number:** | Chem 3122 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | IV |
| **Semester:** | I |
| **Prerequisite:** | Industrial Chemistry I (Chem.3121) |

**Course Description:**

The course "Industrial Chemistry II" with the basic organic industrial processes (coal, petroleum, main petrochemicals, basic organic products, plastics, rubber and fibers; sugar; oils and fats, detergents, paper; foodstuff, pharmaceuticals, agrochemicals; dye stuff,; leather). The course incorporates the industrial production of some important chemicals like sucrose, food stuffs, plastics and detergents, pharmaceuticals, leather, and petrochemicals.

**Course Objectives:**

After successful completion of the course students will be able to:

- Process coal and petroleum into value added products.
- Explain industrial organic synthesis
- Discuss the properties of plastics, rubber, fibers
- Explain the chemistry of Oils, fats, Soaps, detergents, Pharmaceuticals, Dyestuffs and Insecticides
- Describe Sucrose, Paper, Leather and Food processing.

**Course Outline:**

**1. Coal and Petroleum Processing**

1.1. Origin of coal and its ranking

1.2. Carbonisation of coal

1.3. Gasification of coal

1.4. Hydrogenation of coal

1.5. Petroleum – origin, Classification and mining

1.6. Distillation of petroleum

1.7. Rating of Petrol and Diesel

1.8. Cracking, Alkylation, Hydrotreating and Reforming

**2. Main Petrochemicals**

2.1. Introduction to petrochemicals

2.2. Chemical conversions for manufacture of petrochemicals

2.3. Petrochemicals from Methane, Ethylene, Propylene, Butylene and BTX

2.4. Manufacture of Acetylene, Ethylene oxide, Acrylonitrile, Dimethyl terephthalate

**3. Basic Organic Products**

3.1. Introduction to Industrial organic synthesis

3.2. Manufacture of Methanol and Isopropanol

3.3. Manufacture of Formaldehyde and Acetaldehyde

3.4. Manufacture of Acetic acid

3.5. Manufacture of Acetone

3.6. Manufacture of Phenol and Styrene

**4. Plastics, Rubber and Fibers**

4.1. Introduction to polymers

4.2. Nomenclature of polymers

4.3. Addition and condensation polymerization

4.4. Methods of Polymerization

4.5. Effect of polymer structure on properties

4.6. Plastics-Properties and classification

4.7. Moulding constituents of plastics

4.8. Moulding of plastics into articles

4.9. Preparation, properties and uses of PE, PVC and Bakelite

4.10. Rubber – properties

4.11. Natural and synthetic rubber

4.12. Natural and synthetic fibers

**5. Sucrose Industry**

5.1. Manufacture of cane sugar

5.2. Manufacture of sucrose from Beet Root

5.3. Testing of sugar

**6. Oils, Fats and Detergents**

6.1. Introduction to oils and fats

6.2. Properties of oils and fats

6.3. Classification of oils

6.4. Manufacture of vegetable oils

6.5. Animal fats and oils

6.6. Analysis of oils and fats

6.7. Hydrogenation of oils

6.8. Manufacture of soap

6.9. Introduction to detergents

**7. Paper Industry**

7.1. Manufacture of pulp by mechanical and chemical process

7.2. Refining of pulp

7.3. Manufacture of paper

**8. Chemical Foodstuff Processing**

8.1. Introduction to fermentation

8.2. Alcohol Beverages

8.3. Manufacture of Beer, Spirit and wines

**9. Pharmaceuticals**

9.1. Sulfonamide drugs

9.2. Antimalarial, antibacterial and antiviral agents

9.3. Antibiotics

**10. Chemicals for Agriculture**

10.1. Introduction to Insecticides

10.2. DDT, BHC and Parathion

10.3. Fungicides – Baygon and 2,4,6-Trichloro Phenol

10.4. Herbicides–2,4-D and 2,4,5–T

10.5. Pesticides pollution

**11. Dyestuff**

11.1. Introduction to dyes

11.2. Colour and constitution

11.3. Methods of dyeing

11.4. Classification of dyes

**12. Leather Industry**

12.1. Animals skin

12.2. Preparation of skin for tanning

12.3. Vegetable tanning

12.4. Chrome tanning

12.5. Leather finishing

**Instructional Methods and Strategies:**

Generally the instructional methods and strategies throughout the course should be student-centered approach and could be (but not limited to): Gapped lecture, Role playing, Case study, Field trip/industrial visit, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:**

Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, writing field trip report and submission, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

***NB:*** *Industrial attachment for 4 – 6 weeks (during summer vacation after completion of year three) is mandatory as a partial fulfillment of the course.*

**Assessment Strategies and Techniques:**

About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

To be designated at the commencement of the course.

**References:**

1. P.C. Jain and M. Jain, Engineering Chemistry by; Dhanpatrai& sons, 11th ed, 1996.
2. B.K. Sharma, Industrial Chemistry, Goel publishing house; 11th ed, 2004.
3. J.N. Delgado and W.A. Remers, Text book of organic medicinal and pharmaceutical chemistry
4. Colin Baird and Michael Cann, Environmental Chemistry, 5th Edition, 2012.

**9.2.5.3. Biochemistry**

| | |
|---|---|
| **Course Title:** | Biochemistry |
| **Course Number:** | Chem 3124 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Organic Chemistry II (Chem 3042) |

**Course Description:**

The course biochemistry introduces the unique properties of Water as applied to Life, Structure and chemistry of biomolecules (proteins, carbohydrates, lipids, nucleic acids, Minerals and Hormones); enzymology; intermediary metabolism and generation and storage of metabolic

energy; oxidative-reductive processes; selected metabolic pathways of carbohydrates and fats; integration of metabolism. **Course Objectives:**

At the end of the course the students will be able to:

- Identify the four classes of polymeric biomolecules and their monomeric building blocks.
- Explain the role of biomolecules biological systems
- Describe physical and chemical properties of water, acids, bases and buffer.
- Discuss the structures and functions of biomolecules
- Explain the properties of enzymes, and the chemistry involved in enzyme action.
- Describe Enzyme kinetics and different modes of enzyme inhibition.
- Explain the role of thermodynamics dictates the direction and regulation of metabolic pathways.
- Discuss Glycolysis, Krebs Cycle, electron transport and oxidative phosphorylation
- Describe how fats and amino acids are metabolized,

**Course Outline:**

**1. Introduction to Biochemistry**

1.1. Definition and scope of biochemistry

1.2. Chemical and biochemical reactions

1.3. Chemistry of organelles (hierarchical organization of organelles in living cells, composition, properties, and function of organelles)

**2. Water, pH, and Buffer**

2.1. Introduction

2.1.1. Unique properties of water to be used as a biological solvent

2.1.2. Role of water in biological system

2.1.3. Intermolecular forces (forces responsible for interaction of biomolecules with water and those responsible for the integration of biomolecules)

2.1.4. Colligative properties

2.2. Hydronium ion and pH

2.3. Physiological Buffers and buffering agent

2.4. Buffers used by cells

2.5. Some common Buffers used in biochemical reactions

**3. Protein Structure and Function**

3.1 Structure and function of Amino Acids

3.1.1 Introduction to Amino acids (essential and non-essential amino acids)

3.1.2 Structure of Amino Acids

3.1.3 Amino Acids as Buffers

3.1.4 Peptide Bond Formation (Peptide linkage)

3.2 Structure and function of Proteins

3.2.1. Primary Structure of Proteins

3.2.2. Secondary Structure of Proteins

3.2.3. Tertiary Structure of Proteins

3.2.4. Quaternary Structure of Proteins

3.2.5. Denaturation of Proteins

3.2.6. Uses of proteins

**4. Enzymes**

4.1. Definition of Enzymes

4.2. Properties of Enzymes

4.3. Major Classes of Enzymes

4. 4. Enzyme Kinetics

4.5. Enzyme Mechanism (mechanism of catalysis)

4.6. Regulation of Enzyme activity (Activation/Inhibition)

**5. Lipids**

5.1. Definition of lipids

5.2. Fatty acids (saturated and unsaturated)

5.3. Triacylglycerols

5.4. Steroids and other lipids

5.5. Biological membranes

5.6. Membrane transports

**6. Carbohydrates**

6.1 Definition and Classification,

6.2 Monosaccharides

6.3 Disaccharides

6.4 Polysaccharides

**7. Introduction to Metabolism**

7.1 Metabolic Pathways

7.2 Bioenergetics

7.3 Regulations

8. **Nucleotides and Polynucleotides**

8.1 Structural components of nucleotides

8.2 Polynucleotides (DNA and RNA)

8.3 Biological role of nucleotides and polynucleotides

9**. Carbohydrate Metabolism**

9.1 Structure of Carbohydrate

9.1.1 Overview

9.1.2 Digestion of Carbohydrate

9.2 Glycogen Metabolism/Starch

9.2.1 Overview

9.2.2 Degradation of Glycogen

9.3 Metabolism of Monosaccharides and Disaccharides (Overview)

9.4 Glycolysis

9.4.1. Fates of Pyruvate

9.4.2. Energy yield of Glycolysis

9.5 Citric Acid Cycle

9.6 Electron Transport Chain and Oxidative Phosphorylation

9.7 Hexose Monophosphate Pathway (Pentose Phosphate pathway)

9.7.1 Overview

9.7.2 NADPH/Pentose

9.8. Gluconeogenesis

9.8.1. Overview

9.8.2. Reactions Unique to Gluconeogenesis

9.8.3. Substrates for Gluconeogenesis

9.8.4. Regulations of Gluconeogenesis

**10. Lipid Metabolism**

10.1 Introduction

10.2 Metabolism of Dietary Lipids

10.2.1 Overview

10.2.2 Digestion, Absorption, Secretion, and Use of Dietary Lipids

10.3 Fatty Acid and Triacylglycerol Metabolism

10.4 Mobilization of Stored Fats and Oxidation of Fatty Acids

10.5 Phospholipid Metabolism

**11. Amino Acids/Nitrogen Metabolism**

11.1 Nitrogen Fixation and Synthesis of Amino Acids

11.1.1. Digestion of Dietary Proteins

11.1.2. Removal of Nitrogen from Amino Acids

11.1.3. Urea Cycle: The Major Pathway of Disposal of Nitrogen

11.2 Amino Acids: Metabolism of Carbon Atoms

11.2.1 Catabolism of the Carbon Skeletons of Amino Acids

11.2.2 Biosynthesis of Nonessential Amino Acids

11.3 Conversion of Amino Acids to Specialized Products: An overview

**Instructional Methods and Strategies:** Generally, the instructional methods and strategies throughout the course should be student-centered approach Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

P.C. Champe; R.A. Harvey, Biochemistry, 4th Ed., Lippincott,s Illustrated Reviews, 2007.

**References:**


1. J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry, 5th Ed., 2005: and Student's Companion to Stryer's Book.
2. Voet and Voet, Biochemistry, 2nd Ed., 1990.
3. Zubay, Parson and Vance, Principles of Biochemistry, 1995.


### 9.2.5.4. Research Methodology and Scientific Writing

| | |
|---|---|
| **Course Title:** | Research Methodology and Scientific Writing |
| **Course Number:** | Chem 3126 |
| **Credit Hours/ECTS:** | 2/3 |
| **Contact Hours:** | 2 Lecture Hours per Week |
| **Year:** | III |
| **Semester:** | II |
| **Pre-Requisite:** | No Pre-requisite |

**Course Description:**

The course "Research Methodology and Scientific Writing" is designed to give student's competency in understanding the basic research methods and scientific writing. The course incorporates reviewing scientific literatures, proposal development and presentation. The students will able to use chemical literature: handbooks, chemical encyclopedia, spectral collections, journals, abstracts and indexes, monographs; research methods; scientific writing.

**Course Objectives:**

At the end of the course the students will be able to:

- Explain about the importance of research,
- Discuss the need to conduct and present research,
- Review scientific literatures,
- Develop scientifically sound proposal, present and defend.

**Course Outline:**

**1. What is Scientific Method?**

1.1. Introduction to the process of conducting research

1.2. Meaning, objectives, motivation, utility of research

**2. Steps in the Process of Research**

2.1. Identifying a hypothesis and/or research problem,

2.2. Specifying a purpose,

2.3. Creating research questions,

2.4. Research topic selection

2.5. Reviewing literature

2.5.1. Use of chemical literature: handbooks, chemical encyclopedia and spectral collection

2.5.2. Accessing journals, abstracts and indexes

2.5.3. Using monographs

2.5.4. Ethics of research and informed consent

2.6. Research proposal development

2.7. Sampling and data collection

2.8. Data processing and interpretation

**3. Research Design**

3.1. Concept and importance in research

3.2. Features of a good research design

3.3. Exploratory research design: concept, types and uses

3.4. Descriptive research designs: concept, types and uses

3.5. Experimental design: concept of independent & dependent variables.

**4. Scientific Writing and Presentation**

4.1. Research problem formulation
4.2. Research proposal development
4.3. Research methods
4.4. Data presentation
4.5. Preparing scientific paper and presentation
4.6. Evaluating scientific papers

**Instructional Methods and Strategies:** Generally the instructional methods and strategies throughout the course should be student-centered approach and re-laid-back to Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 70% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 30% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book**:

To be designated at the commencement of the course.

**References:**

1. Catherine Dawson (2007). A practical guide to research methods 3rd edition. Published by Books Ltd Spring Hill House, United Kingdom.

2. Mimi Zeiger (1999). Essentials of Writing Biomedical Research Papers [2 ed.] McGraw-Hill Professional
3. A Guide to Scientific Writing (2009). From Research to Manuscript - Michael Jay Katz. Publisher: springer

### 9.2.5.5. Environmental Chemistry and Toxicology

| | |
|---|---|
| **Course Title:** | Environmental Chemistry and Toxicology |
| **Course Number:** | Chem4122 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Analytical Chemistry (Chem2021) |

**Course Description:**

This course "Environmental Chemistry and Toxicology" will familiarize students with the concept Environmental chemistry and Green chemistry. The students will also learn about the common causes of environmental pollution and pollution mitigation methods. The course will cover the major chemical cycles and effects of environmental pollution in these systems; basics of atmospheric chemistry; aquatic chemistry; soil chemistry; pollution of air, water and soil; chemical toxicology: toxicants and their metabolism; energy production and its impact on the environment; analytical methods in environmental studies; Introduction to green chemistry.

**Course Objectives:**

Upon completion of this course the students would be able to:

- Familiarize with the concept of Environmental Chemistry;
- Identify the common causes of environmental pollution;
- Describe about Aquatic Chemistry and water pollution;
- Explain about Atmospheric Chemistry and Air pollution;
- Familiarize with the concept of Green Chemistry;

- Study some toxic organic chemicals and their effects
- Device methods to decrease pollution.

**Course Outline:**

**1. Introduction to Environmental Chemistry**

1.1. Basic concepts in Environmental chemistry

1.2. Properties of chemicals in the environment

1.3. Environmental transformation and degradation

1.3.1. Abiotic transformation and degradation

1.3.2. Biotransformation and degradation

1.4. Matter and cycles of matter

**2. Aquatic Chemistry and Water Pollution**

2.1. Introduction to the Fundamentals of aquatic chemistry

2.2. The Properties of water, a unique substance

2.3. Water Quality

2.4. Water quality requirements

2.5. Nature and types of Water pollutants

**3. Atmospheric Chemistry and Air pollution**

3.1. Importance and physical characteristics of the atmosphere

3.2. Atmospheric chemical reactions

3.3. Air quality

3.4. Nature and classification of air pollutants

3.4.1. Gaseous inorganic air pollutants

3.4.2. Organic air pollutants

3.4.3. Photochemical smog

3.4.4. Chlorofluoro compounds and ozone layer depletion

3.4.5. Green House Gases and Global warming

**4. Soil Chemistry**

4.1. Soil and agriculture

4.2. Nature and composition of soil

4.3. Nutrients in soil

4.4. Reactions in soil

4.5. Wastes and pollutants in soil

**5. Environmental Toxicity and Toxicology**

5.1. Introduction

5.2. Organic and inorganic pollutants

5.3. Agricultural and pharmaceutical contaminants

5.4. Pesticides

5.5. PCB's (polychlorinated biphenyls)

5.6. Nitrogen and phosphorous compounds

5.7. Toxic heavy metals (Hg, Pb, As, Cr and Cd) and organometallic compounds

5.8 Environmental risk analysis

5.8.1 Analysis of risk

5.8.2 Dose-response evaluation

5.8.3 Exposure and latency

**6. Green Chemistry**

6.1. Introduction

6.2. The concept of Atom Economy

6.3. Design and application of surfactants for carbon dioxide

6.4. Designing an environmentally safe marine synthetic antifoulant

**Instructional Methods and Strategies:** Generally the instructional methods and strategies throughout the course should be student-centered approach including Gapped lecture, Role playing, field trip, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:**

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, writing field trip report, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 50% continuous assessments (Quizzes, Tests, Assignments, Field trip report, Project Work and/or Mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

S. E. Manahan, Environmental Chemistry, 7th ed., ©2000 by CRC Press, Lewis Publishers

**References:**


1. M-H. Yu, Environmental Toxicology, 2nd ed., CRC Press, 2005.
2. R.N. Reeve, Environmental Analysis, 1994.
3. S.C. BHATIA, Environmental Chemistry ©2007, Satish Kumar Jain for CBS Publishers and Distributors
4. P.S.SINDHU, Environmental Chemistry ©2002, New Age International Publishers
5. Ming-Ho Yu (2005), Environmental Toxicology, Second ed., CRC Press
6. A.K.DE, Environmental Chemistry, 6th ed., ©2002, New Age International Publishers
7. Reeve, Environmental Analysis, ©1994, Wiley and Sons Publishers
8. Renep. Schwarzenbach, Philip M. Gschwend & Dieter M. Imboden, Environmental Organic Chemistry 2nd edition, ©2003, Wiley and Sons, Inc., Hoboken, New Jersey Publishers
9. Clark J, Macquarrie D, Handbook of Green Chemistry and Technology. Blackwell Science Ltd, 2002.


### 9.2.5.6. Introduction to Material Chemistry

| | |
|---|---|
| **Course Title:** | Introduction to Material Chemistry |
| **Course Number:** | Chem 4124 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | IV |

**Semester:** II

**Prerequisite:** Does not Require Pre-Requisite

**Course Description**

The course presents about materials, properties of materials, and their applications with particular emphasis on the correlation between materials structure and their properties. This course will cover the following topics: introduction about the subject, solid materials, solid matter synthesis, thermoelectrics, energy materials, magnetic properties, insulators, basic crystallography, band theory, porous materials, nano-structured materials, special materials like superconductors, surface phenomena, metal-organic frameworks and some material characterization techniques including powder X-ray diffraction and physical adsorption.

**Course Objectives**

Students will be introduced to the field of material science in general and particularly from the point of view of the research and development of new materials. In particular, at the end of the course students will be able to:

- Define Material Chemistry and its role
- Mention some solid material classes
- Describe the most common and important materials synthesis methods.
- Describe the principles for the atomic-level build-up of solid materials, involving amorphous as well as crystalline materials.
- Explain some advantages of conductors
- Discuss the properties of conducting and insulating properties
- Describe solid material preparation /growth and characterization methods
- Discuss solid ,material characterization methods
- Mention some thermoelectric/Energy materials devices and their applications
- Explain the difference between magnetic and non-magnetic properties
- Discuss the application of nanoporous materials

**Course Outline:**

**1. Introduction to Material Chemistry**

1.1. An introduction to basic concepts of materials science

1.2. Approaches to produce new materials and new properties

1.3. Classification of materials and their characteristics

1.4. Selection of materials in view of service and fabrication requirements and economics

1.5. Chemical, physical and mechanical properties of materials

1.6. Factors influencing properties, scope and application of materials science and engineering

1.7. The role of chemistry in material science

**2. Solid Materials**

2.1. Conductors

2.1.1. Semiconductors

2.1.1.1. Applications of semiconducting materials

2.1.2. Carbon based materials; graphene

2.1.3. Phase change materials in memory technology

2.1.4. Conducting polymers

2.2. Optical materials (LEDS and lasers)

2.3. Magnetic materials

**3. Synthesis of Materials**

3.1. Nucleation and growth of Crystal

3.1.1. Homogeneous and heterogeneous nucleation

3.1.2. Atomic level growth of solid material (crystalline and short-range ordered), as well as surfaces.

3.2. Types of Solid solution: ordered and disordered solid solution

3.3. Grain and grain boundaries

3.4. Effect of cooling rate on grain size and mechanical properties

3.5. Microstructures and phase transformation.

3.6. Material preparation and characterization methods

3.6.1. Preparation methods

3.6.1.1. Sol-gel, hydrothermal, high pressure, zone refining, Czochralski and Bridgman and Stockbarger methods

3.6.2.Characterization

3.7. Thermogravimetric and differential thermal analysis, X-ray diffraction (XRD) and electron microscopy (SEM and TEM)

**4. Thermoelectrics/Energy Materials**

4. 1. Thermal materials

4.2. Energy materials

4.2.1. Batteries

4.2.2. Solar cells

4.2.3 Fuel cells

4.2.4. Water splitting

**5. Special materials**

5.1. Superconductivity

5.1.1. Introduction

5.1.2. Meissner effect – mention of Bardeen

5.1.3. Cooper and Schrieffer theory and Cooper pairs

5.1.4. Examples of superconducting oxides

5.1.5. Chevrel phases

5.1.6. Applications of superconducting materials

5.2. Ionic conductors

5.2.1. Sodium-β alumina, sodium-sulphur battery

5.2.2. Intercalation – layered compounds – graphitic compounds

5.2.3. Special applications of solid state materials

5.2.3. High energy battery, lithium cells

5.3. Liquid crystals: nematic, cholesteric and smectic types and applications

**6. Insulating Materials**

6.1. Dielectric materials

6.2. Pyroelectrics, ferroelectrics

6.3. Heat resistance materials

6.3. Common plastics: synthesis methods

6.4. Properties and uses of common plastics

6.5. Future challenges of plastics

6.6. Thermosetting resins: synthesis methods

**7. Materials in Nanoscience and Nanotechnology**

7.1. Introduction

7.2. Synthesis and fabrication of nanostructures

7.3. Examples of nanostructures

7.4. Major challenges in nanoscience and technology

**8. Introduction to Nanoporous Materials**

8.1. Definition,terminology and classification of pore structures

8.2. Examples of nanoporous materials:composition, structure,

8.2.1. Activated carbon

8.2.2. Zeolites

8.2.3. Metal-Organic frameworks (MOFs)

8.3 Characterization of nanoporous materials

8.3.1. Gas adsorption

8.3.2. Thermogravametric analysis (TGA), and Infrared spectroscopy (IR)

8.3.3. X-ray diffraction (XRD), scanning electron microscopy (SEM) and Transmission electron microscopy (TEM)

8.4 Selected applications of nanoporous materials

**Instructional Methods and Strategies:** Generally the instructional methods and strategies throughout the course should be student-centered along with Gapped lecture, Role playing, Case study, Individual assignment and presentation, Questing and answering, Demonstration of experimental facts by reviewing literatures, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 50% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 50% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

To be designated at the commencement of the course.

**References:**


1. Solid State Chemistry-An Introduction by Lesley Smart and Elaine Moore, Chapman Hall, London, 1992.
2. Solid State Chemistry by M. G. Arora, Anmol Publications, New Delhi, 2001.
3. Materials Science by P. K. Palanisamy, Scitech Publications, Chennai, 2003.
4. Modern Inorganic Chemistry by W. L. Jolly, Mc Graw Hill Book Company, NY, 1989.
5. Inorganic Chemistry by D. F. Shriver and P. W. Atkins, Longford, Oxford University press, 1990.
6. Introductory Solid State Physics by H. P. Meyers, Viva Books Private Limited, 1998.
7. Solid State Chemistry and its applications by A. R. West, John-Wiley and sons, 1987.
8. Modern aspects of Inorganic Chemistry by H. J. Emelius and A. G. Sharpe, Universal Book Stall, 1989.
9. Ionic crystals, Lattice defects and nonstoichiometry, N. N. Greenwood, Butterworths, London, 1968.
10. Solid State Physics by Charles Kittel, John-Wiley and sons, NY, 1966.
11. “Solid State Chemistry - An Introduction”, Lesley E. Smart and Elaine A. Moore, Third Edition, CRC Press, 2005.
12. “Inorganic Chemistry”, Gary L. Miessler and Donald A. Tarr, Third Edition, Pearson Prentice Hall, 2004

13. Hiroaki Yanagida, Chemistry of Ceramics (2nd Edition), Maruzen (in Japanese) Jiro Shiokawa,
14. Introduction to Inorganic Materials, Kagaku-Dojin Publishing (in Japanese) Sandra E. Dann, Reaction and Characterization of Solids, RSC Publishing, 2000
15. Fred W. Billmeyer, Jr., Textbook of Polymer Science (3rd Edition), Wiley, 1984
16. Wei-Fang Su, Principles of Polymer Design and Synthesis, Springer, 2013
17. T. Ogawa, Introduction to Polymer Materials for Engineers, Kyoritsu Shuppan, 1998 (in Japanese)

### 9.2.5.7. Student Senior Project

| | |
|---|---|
| **Course Title:** | Student Senior Project |
| **Course Number:** | Chem 4126 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | A Semester Work |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Research Methodology and Scientific Writing (Chem4121) |

**NB**

- A senior project is used as a partial fulfillment of the Bachelor of Degree in Chemistry.
- The project could be Original Research work or Review of Scientific Literatures
- It could be conducted in group (2-3 students) and/or individually
- It should be submitted in written and presented to the public.

### 9.2.6. Elective Chemistry Courses

#### 9.2.6.1. Chemistry of Consumer Products

| | |
|---|---|
| **Course Title:** | Chemistry of Consumer Products |
| **Course Number:** | Chem4112 |
| **Credit Hours/ECTS:** | 3 (2+1)/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Does not Require Pre-Requisite |

**Course Description**:

The course "Chemistry of Consumers Products" will discuss the preparation and uses of: soaps and detergents, hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone will be covered. The course will have both theory and practical sessions.

**Course Objectives:**

After completion of this course, students will be able to:

- Use the basic knowledge obtained from consumer product chemistry to practical applications,
- Discuss the preparation methods commonly used consumer products,
- Explain modern trends in the industry of consumer products,
- Demonstrate the necessary practical trainings in consumer product analysis,
- Describe the importance of essential oils in cosmetic industries.

**Course Outline**

**1. Soaps**

1.1. Saponification of oils and fats

1.2. Manufacture of soaps: formulation of laundry and toilet soaps

1.3. Mechanism of action of soap

1.4. Different ingredients used and their functions

1.5. Medicated soaps and herbal soaps

1.6. Soft soaps: shaving soaps and creams

1.7. ISO specifications and quality testing procedures

**2. Detergents**

2.1. Anionic detergents

2.1.1. Manufacture of linear alkyl benzene (LAB)

2.2.2. Sulphonation of LAB – preparation of acid slurry

2.2.3. Different ingredients in the formulation of detergent powders and soaps

2.2.4. Liquid detergents: foam boosters, alpha olefin sulphonates (AOS)

2.2. Cationic detergents: examples, manufacture and applications

2.3. Non-ionic detergents: examples, manufacture of ethylene oxide condensater

2.4. Mechanism of action of detergents

2.5. Comparison of soaps and detergents

2.6. Biodegradation – environmental effects

2.7. ISO specifications/limits

**3. Shampoos**

3.1. Manufacture of sodium lauryl sulfate (SLS) and sodium lauryl ether sulfate (SLES)

3.2. Ingredients and functions

3.3. Different kinds of shampoos –anti-dandruff, anti-lice, herbal and baby shampoos

3.4. Manufacture of conditioners

3.5. ISO specifications and testing procedures

**4. Hair Colourants**

4.1. Introduction

4.2. Temporary colourants

4.3. Gradual colourants

4.4. Dyeing systems: semi-permanent, oxidative, permanent dying

4.5 natural dyes

**5. Skin and Manicure Preparations**

5.1. Face and skin powders

5.2. Ingredients and functions

5.3. Different types of face creams

5.4. Chemical ingredients used

5.5. Sun screen preparations: UV absorbers and Skin bleaching agents

5.6. Depilatories, turmeric and neem preparations

5.7. Vitamin oil

5.8. Nail polishes: nail polish preparation, nail polish removers

5.9. Lipsticks, roughes, eyebrow pencils. Ingredients and functions – hazards

5.10. ISO specifications

**6. Essential oils and Cosmetic Industries**

6.1. Introduction

6.2. Eugenol and geraniol

6.3. Sandalwood oil, eucalyptus, and rose oil

6.4. 2-phenyl ethyl alcohol

6.5. Jasmone, civetone, and muscone

**Instructional Methods and Strategies:**

To motivate students to take part in the teaching-learning process of the course. Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be gapped lecture, Role playing, Case study, questioning and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, listening to lectures, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 70% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 30% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

To be designated at the commencement of the course.

**References:**


1. Gobala Rao. S , Outlines of chemical technology, Affiliated East West press,1998
2. Kafaro, Wasteless chemical processing, Mir publishers, 1995.
3. Sawyer. W, Experimental cosmetics, Dover publishers, New york, 2000.
4. Bruno Burlando, Luisella Verotta, Laura Cornara, and Elisa Bottini-Massa, Herbal Principles in Cosmetics: Properties and Mechanisms of Action, CRC Press, Taylor and Francis Group, LLC, 2010


**Suggested Practical Activities**

Experiment 1. Estimation of iodine value and saponification value of an oil.

Experiment 2. Determination of active content (SLS, SLES, LABS) in a detergent.

Experiment 3. Preparation of talcum powder

Experiment 4. Preparation of shampoo

Experiment 5. Preparation of hair remover

Experiment 6. Preparation of face cream

Experiment 7. Preparation of nail polish and nail polish remover

**Reference**


1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.


**9.2.6.2. Food Safety and Analysis**

**Course Title:** **Food Safety and Analysis**

| | |
|---|---|
| **Course Number:** | Chem4112 |
| **Credit Hours/ECTS:** | 3 (2+1)/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Does not Require Pre-Requisite |

**Course Description**:

The course discusses on the principles of food safety and sanitation, potential biological, chemical and physical hazards that may cause unacceptable consumer health risks, principles of Good Manufacturing Practices (GMP) , Sanitation Standard Operating Procedures (SSOP) and principles of Hazard Analysis Critical Control Points (HACCP) () *It also covers* principles of chemical, physical and microbiological analyses of foodsThis course will give general overview of the laws, regulations, history and policies that govern food regulations in Ethiopia from the perspective of food science. It also, familiarizes students with the concepts of quality; national and international standards concerning food quality assurance and total quality management system in the food industry.

**Course Objectives:**

Up on the successful completion of the course, students will be able to:

- Identify sanitation practices in food processing facilities
- Discuss food safety hazards, assessment of risk, and evaluation.
- Explain the principles, actions, and limitations of food sanitation procedures.
- Describe the international food safety management system such as Hazard Analysis and Critical Control Point system (HACCP)
- Explain the importance of food analysis in food quality and food safety assurance system
- Describe the principles behind chemical and physical analytical techniques associated with foods
- Apply the principles of sampling, sample handling and preparation in food analyses

- Compare various methods of proximate analyses (moisture, ash, carbohydrates, protein and fats), and select suitable analytical methods considering the characterstics of food materials
- Discuss the government laws and regulations that contribute to a safe, nutritious, and wholesome food supply in Ethiopia.
- Acquaint students with the current issues of food laws and regulations, especially those in connection with nutrition labeling, food additives (e.g. colorings) as well as toxic and harmful (e.g. heavy metals) substances in foods and to have a good grasp of the knowledge of quality criteria
- Apply the basic knowledge in achieving quality control of food products , food production processes , quality management, quality assurance systems with repect to national and international standards

**Course Outline:**

1. **Introduction to Food Safety**
   1.1. Factors Contributing to Food Safety Concerns
   1.2. Food Borne Pathogens
   1.3. Chemicals Affecting Food Safety
   1.4. Food Safety strategies and control programs
2. **Introduction to Food Analysis**
   2.1. Reason for analyzing foods
   2.2. properties of foods
   2.3. analytical techniques
3. **Sampling Methods**
   3.1. Sampling Plan
   3.2. Statistical consideration in sampling
   3.3. preparation of samples
4. **Analytical Methods**
   4.1. Total acidity
   4.2. Equivalence point and acid Ratio
   4.3. Organic acids in food

4.4. Physicochemical properties

**5. Proximate Analysis**

5.1. Analysis of moisture

5.2. Analysis of ash

5.3. Analysis of fat

5.4. Analysis of protein

5.5. Analysis of crude fibers

5.6. Analysis of carbohydrate

**6. Instrumentation**

6.1. Theory, principles and application of UV-Spec, AAS, HPLC, GC, MS, NMR in food analysis

**7. Food Legislation and Quality Control in Food Systems**

7.1. Introduction to food legislations

7.2. Food Standards Regulating bodies (Ethiopian Standards, Codex Alimentarius, FAO, WHO, ISO standards, USA and EU StandardsTopic)

7.3. Principles of Food Quality Control

7.4. Evaluation of Food Quality

7.5. Quality control laboratory layout

**Instructional Methods and Strategies**: Competency based education which is a student-centred methodology emphasizing theory; skills, attitudinal; change and professional development will be exercised. In this interaction, there shall be class room lectures, laboratory activities, and practical exercises in the private sector. Students will also engage in presentations, group projects, which reflect actual situations in business or industry

**Teacher's activities:** An instructor of this course is expected to be honest to the content, policies and guidelines of this course. He/she is also expected to be well prepared on the course as well as prepare course outlines & teaching materials, follow up and assess students as per the guidelines.

**Students' activities:** Students are expected to attend regularly. Doing all the academic activities in time and according to given instructions. Active participation in the class room or outside the

class learning sessions and engaging in new concepts, skills and attitudes will be expected from them.

**Assessment Strategies and Techniques**: Based on the progressive understandings of the course, students will be evaluated continuously through both non-graded assignments / activities, like (reading assignments) and graded assignments/activities and assessments including class discussion & participation, Test, Term Paper & presentation, Home Taken Exam/case studies and Final Exam. At least 50% continuous assessments (quizzes, tests, assignments, and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Marriott, N, Robert, B. (2006). Principles of Food Sanitation, 5th Ed.
2. Garner, W.Y., Marge, M.S., an Ussary, J.P. (1992). Good Laboratory Practice Standards. ACS Professional Reference Book, American Chemical Society, Washington, DC.
3. Pomeranz, Y and Meloan, C.E. (2000). Food Analysis: Theory and Practice. AVI Publishing Co., Inc. Wesport, Connecticut.
4. Daubert, C.R., and Foegeding, E.A. (2003). Rheological Principles for Food Analysis. Ch. 30 in Food Analysis, 3rd Ed., S.S. Nielsen (Ed.), Kluwer Academic, New York.
5. Nielsen, S. S. (2003). Food Analysis, 3rd Ed., Technology and Engineering.
6. Leo, M.L. (2004). Handbook of Food Analysis, Second Edition -3 Volume Set (Food Science and Technology)
7. Macleod AJ (1973).Instrumental Methods of Food Analysis Elek Sci. Marcel Dekker.
8. Otles, S. (2008). *Handbook of food analysis instruments,* 1st Ed., CRC.
9. Early, R. (Ralph) (1995). Guide to quality management systems for the food industry , Blackie Academic & Professional, London
10. Vasconcellos, J. Andres. (2004). Quality Assurance for the Food Industry. A Practical Approach. CRC Press

Curtis, P.A. (2005). A Guide to Food Laws and Regulations, ed. Wiley-Blackwell Publishers

### 9.2.6.3.Chemistry of Natural Products

| | |
|---|---|
| **Course Title:** | Chemistry of Natural Products |
| **Course Number:** | Chem4112 |
| **Credit Hours/ECTS:** | 3 (2+1)/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Does not Require Pre-Requisite |

**Course Description:**

This course is primarily designed to offer basic understanding of secondary metabolites and the biosynthetic pathways of amino acids, terpens, alkaloids, quinones, and introduction to natural dyes.

**Course Objectives:**

Individuals who successfully complete this course will be able to:

- Differentiate secondary metabolites from primary metabolites,
- Discuss various classes of natural products,
- Explain the biosynthetic path ways of the secondary metabolites,
- Identify the major types of natural dyes,

**Course Outline:**

1. **Introduction to Natural Products**
   - 1.1 Primary and secondary metabolites
   - 1.2 Properties and purpose of secondary metabolites
2. **Key Biological Intermediate: Acetyl Coenzyme A**
   - 2.1 What is acetyl coenzyme A?
   - 2.2 Comparison of organic and acetyl coenzyme a reactions
   - 2.3 Malonyl coenzyme a - a partnership with acetyl coenzyme a
   - 2.4 How is acetyl coenzyme a used in biosynthesis?

**3. Biosynthesis of Fatty Acids**

3.1 What are fatty acids?

3.2 Occurrence and function of fatty acids

3.3 Biosynthesis of saturated straight-chain fatty acids

3.4 Biosynthesis of saturated branched fatty acids

3.5 Mono-unsaturated fatty acids

3.6 Poly-unsaturated fatty acid

3.7 Oxygenated fatty acids

**4. Terpenes**

4.1 What are terpenes?

4.2 Carbocations as intermediates in terpene biosynthesis

4.2.1 Hydride shifts

4.2.2 Alkyl shifts

4.2.3 Cyclizations

4.3 Termination of carbocations

4.3.1 Loss of a proton

4.3.2 Addition of water

4.4. Biosynthesis initiated by heterolysis of pyrophosphates

4.5. Biosynthesis initiated by protonation or epoxidation of an alkene

**5. Biosynthesis of Polyketides**

5.1 What are polyketides?

5.2 The chemistry of 1,3-dicarbonyls: keto-enol tautomerism

5.3 The chemistry of 1,3-dicarbonyls: condensation reactions

5.4 Polyketide cyclizations: formation of unsaturated products

5.5 Secondary structural modifications during polyketide cyclizations

5.5.1 Alkylation

5.5.2 Reduction

5.5.3 Oxidation

5.5.4 Decarboxylation

5.5.5 Modifications to the carbon skeleton

6. **The Shikimic Acid Pathway**
    6.1 Introduction
    6.2 Transamination
    6.3 Biosynthesis of natural products derived from cinnamic acid
    6.4 Lignans
    6.5 Biosynthesis of alkaloids
7. **Products Derived from Amino Acids**
    7.1 Alkaloids
    7.2 Penicillins and related compounds
    7.3 Macrocyclic peptides
    7.4 Porphyrins
8. **Natural Dyes**
    8.1 Occurrence, colour and constitution
    8.2 Structural determination and synthesis of indigoitin and alizarin

**Instructional Methods and Strategies**: To motivate students to take part in the teaching-learning process of the course Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities**: Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (Oral questions, quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Text Book:**

Stanforth, Stephen P. Natural product chemistry at a glance: 1st edition 2006.

**References:**


1. James R. Hanson .Natural Products: The Secondary Metabolites. 2009.
2. Paul M. Dewick. Medicinal Natural Products: A Biosynthetic Approach, 3rd Edition 2009.
3. Richard Firn. Nature's Chemicals: The Natural Products that shaped our world. 2010.


### 9.2.6.4. Synthetic Organic Chemistry

| | |
|---|---|
| **Course Title:** | Synthetic Organic Chemistry |
| **Course Number:** | Chem4112 |
| **Credit Hours/ECTS:** | 3 (2+1)/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Physical Organic Chemistry (Chem 4041) |

**Course Description:**

Functionalization and Interco version of functional groups; Formation of Carbon -carbon bonds and ring closure and ring opening reactions; Analysis of synthetic pathways; Principles of asymmetric synthesis and the use of protective groups in synthesis; Illustrative examples of multistep synthesis.

**Course Objectives:**

At the end of the course the students will be able to:

- Discuss the difference between various functional groups and their inter conversions using appropriate reagents
- Propose the mechanisms and the reagents involving the c-c bond formation,
- Discuss methods of ring opening and the ring closure reactions
- Elaborate reactions in the asymmetric synthesis of some compounds

- Conduct the multistep synthesis

**Course outline:**

1. **Functionalization and Interconversion of Functional Groups**
   - 1.1 Functionalization
     - 1.1.1 Functionalization of alkanes,
     - 1.1.2 Functionalization of alkenes,
     - 1.1.3 Functionalization of alkynes,
     - 1.1.4 Functionalization of aromatic hydrocarbon,
     - 1.1.5 Functionalization of simple hetrocyclic compounds
   - 1.2 Interconversion of functional groups
     - 1.2.1 Transformation of the hydroxyl group,
     - 1.2.2 Transformation of the amino group,
     - 1.2.3 Transformation of the alkyl halides,
     - 1.2.4 Transformation of the nitro compounds,
     - 1.2.5 Transformation of the aldehydes, ketones, acid and acid derivatives
2. **Formation of Carbon-Carbon Bonds; Ring Closure and Ring Opening Reactions**
   - 2.1 Formation of carbon-carbon bonds
   - 2.2 Electrophilic carbon bonds
   - 2.3 Nucleophilic carbon bonds,
   - 2.4 Reaction of organometallic species
   - 2.5 Ring closure, Intramolecular cyclization electrophile-nucleophile interaction, cycloaddition, electrocyclic ring closure, ring opening reaction 2
   - 2.6 Hydrolysis, Solvolysis, and other electrophile-nucleophile interaction, oxidative and reductive ring opening, electrocyclic ring opening
3. **Analysis of Synthetic Pathways**
   - 3.1 Synthetic strategies
   - 3.2 target selection,
   - 3.3 retrosynthetic analysis
4. **Principles of Asymmetric Synthesis**
   - 4.1 What is asymmetric synthesis?

4.2 Asymmetric induction

5. **Protective Groups in Synthesis**

   5.1 Alcohol protective groups,

   5.2 Protective groups of aldehyde and ketones,

   5.3 Protective groups of amino groups

   5.4 Carboxylic acids protective groups

6. **Illustrative Examples of Multi-Step Synthesis**

**Instructional Methods and Strategies**: To motivate students to take part in the teaching-learning process of the course Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities**: Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time, reading reference materials, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (Oral questions, quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Text Book:**

M. B. Smith. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6$^{th}$ edition 2007.

**References:**

1. S. G. Warren, Organic Synthesis: the Disconnection Approach, Wiley, 1982.

2. F.A. Carey and R. J. Sundberg, Advanced Organic Chemistry - Parts A and B (5th ed.), Springer, 2007
3. M. B. Smith, Organic Synthesis, 2nd Ed., McGraw Hill, 2002.
4. E. J. Corey, X.-M. Cheng, The Logic of Chemical Synthesis, Wiley, 1995.
5. K. C. Nicolaou, E. J. Sorensen, Classics in Total Synthesis, VCH, 1996
6. K. C. Nicolaou, S. A. Snyder, Classics in Total Synthesis II, Wiley-VCH, 2003
7. Eliel, E. L.; Wilen, S. H.; Mander, L. N. Stereochemistry of Organic Compounds, Wiley: New York, 1994

**9.2.6.5. Forensic Chemistry**

| | |
|---|---|
| **Course Title:** | Forensic Chemistry |
| **Course Number:** | Chem4112 |
| **Credit Hours/ECTS:** | 3 (2+1)/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Does not Require Pre-Requisite |

**Course Description**:

The course forensic chemistry is designed to introduce the students the importance of forensic chemistry to detect a crime. The course incorporates introduction to forensic chemistry, different types of chemical testes, food adulterations, food poisons and antidotes, trace evidences in solving forensic cases, controlled substances, classes of drugs and chemical analysis, fire, arson, and explosives derbies, environmental forensics, detection of latent fingermarks, forgery and counterfeiting.

**Course Objectives:**

After completion of this course, students will be able to:

- Rxplain the role of the forensic chemist in the laboratory, in the forensic community, and in court

- Describe chemical color tests and microcrystalline tests
- Demonstrate the major chemical color tests for drugs
- Explain how drugs function biochemically in the human body
- Differentiat and identify drugs by their chemical and spectroscopic properties
- Differentiate between physical and chemical characteristics of trace evidence
- Detect trace evidence using microscopy and instrumental methods
- Define arson and list some potential evidence of arson in a case
- Use ion mobility spectrometer in investigations of explosions
- Describe methods used to detect and identify forgery and counterfeiting
- Describe the use of pesticides and herbicides in warfare
- Explain how to detect and identify herbicides and pesticides

**Course Outline:**

**1. Introduction to Forensic Chemistry**

1.1. Forensic investigation

1.2. Tools of forensic chemistry

**2. Chemical Tests**

2.1. Colorimetric tests for drugs

2.2. Chemical tests for poisons

2.3. Colorimetric tests for explosives

2.4. Microcrystalline tests for drugs

2.5. Microcrystalline tests for explosives

2.6. The future of chemical tests

**3. Food Adulteration**

3.1. Contamination of wheat, rice, milk, butter, red pepper (Berbere), etc. with clay, sand, stone, water and toxic chemicals

3.2. Food poisons: natural poisons (alkaloids, nephrotoxins), pesticides (DDT, BHC, Follidol), Chemical poisons (KCN)

3.3. First aid and Antidotes for poisoned persons.

3.4. Heavy metal (Hg, Pb, Cd) contamination of sea food and detecting of poisoning (e.g., As in human hair)

**4. Chemical Analysis of Trace Evidence**

4.1. Glass and Soil

4.2. Inks and Paint

4.3. Polymers: hair, fibers, plastics, paper, and adhesives, etc

4.4 Glass examinations and comparison, standard laboratory practices

4.5 Interpretation of glass evidence examinations and comparisons

4.6 Forensic examination of inks and paint

4.7 Paint evidence evaluation

4.8. Collecting soil samples, analysis and comparison

**5. Forensic Fire Debris Analysis**

5.1 Introduction

5.2 Process overview

5.3 Sample collection

5.4 Ignitable liquid classification

5.5 Petroleum-based ignitable liquids

5.6 Non-petroleum-based ignitable liquids

5.7 Sample preparation

5.8 Sample analysis and data interpretation

**6. Explosives**

6.1 The nature of an explosion

6.2 Physical and chemical properties of explosives

6.3 Protocols for the forensic examination of explosives and explosive devices

6.4 Chemical analysis of explosives

**7. Drugs of Abuse**

7.1. Introduction

7.2. Law and legislation

7.3. Classes of drugs

7.3.1. Stimulants

7.3.2. Depressants and antianxiety drugs

7.3.3. Hallucinogens

7.3.4. Opiates/opioids

7.3.5. Anabolic steroids

7.3.6. Other drugs abused in sports

7.3.7. New psychoactive substances

7.4. Sampling and Chemical analysis: Identification and quantitation

**8. Environmental Forensics**

8.1. Pesticides

8.2. Herbicides

8.3. Fungicides

8.4. Antimicrobials

8.5. Examples of detection, identification, and quantification of herbicides and pesticides

**9. Chemical Methods for the Detection of Latent Fingermarks**

9.1 Introduction

9.2 Sources of latent fingermark residue

9.3 Chemical processing of latent fingermarks

9.4 Experimental considerations for latent fingermark chemistry research

**10. Forgery and Counterfeiting**

10.1. Detecting forgery in bank cheques/drafts and educational records (mark lists, certificates), using UV-light. Alloy analysis using AAS to detect counterfeit coins. Checking silverline water mark in currency notes.

10.2. Jewelry: detection of gold purity in 22 carat ornaments, detecting gold plated jewels, authenticity of diamonds (natural, synthetic, glassy).

**Instructional Methods and Strategies:** To motivate students and take part in the teaching-learning process of the course Student-centered approach instructional methods are suggested. Some of the instructional methods and strategies in the course could be (but not limited to): Gapped lecture, Role playing, Case study, Individual assignment and presentation, Questing and answering, Demonstration, Discussion and Collaborative learning.

**Students' Activities:** Active participation in discussion, participate in team work, active listening in lecturing, taking notes on the lessons, asking questions and giving response to questions, presentations, working and submitting assignments in group or individually on time,

reading reference materials according to the course outline or tasks given by the instructor, attending classes regularly and arriving classes on time.

**Assessment Strategies and Techniques:** About 60% continuous assessments (Quizzes, Tests, Assignments, Project Work and/or Mid-examination) and 40% final examination at the end of the semester.

**Instructional Resources (Materials and Equipments):** LCD, Over-head projector, Computer (Desktop or Laptop), Course outlines, Markers, Flip Charts, Atomic models, Periodic tables, White board, Chalk board, Duster.

**Text Book:**

To be designated at the commencement of the course.

**References:**


1. Kelly M. Elkins, Introduction to Forensic Chemistry, CRC Press, Taylor & Francis Group, LLC, 2019
2. JaVed I. Khan; Thomas J. Kennedy; Donnell R. Christian, Jr., Basic Principles of Forensic Chemistry, Humana Press, Springer Science +Business Media, LLC, 2012
3. Jay A. Siegel, Forensic Chemistry Fundamentals and Applications, John Wiley & Sons, Ltd, 2016
4. Matthew E. Johll, Investigating Chemistry a Forensic Science Perspective, 2nd ed, W. H. Freeman and Company Publishers, New York, 2009.
5. King L. A., Forensic Chemistry of Substance Misuse A Guide to Drug Control, RSC publishing, Cambridge CB4 0WF, UK, 2009
6. David E. Newton, Forensic Chemistry, Facts on File, Inc. An imprint of InfoBase Publishing, New York, 2007


### 9.2.6.6. Agricultural Chemistry

**Course Title:** Agricultural Chemistry

**Course Number:** Chem4112

| | |
|---|---|
| **Credit Hours/ECTS:** | 3 (2+1)/5 |
| **Contact Hours:** | 2 Lecture Plus 3 Laboratory Hours per Week |
| **Year:** | IV |
| **Semester:** | II |
| **Prerequisite:** | Does not Require Pre-Requisite |

**Course Description:**

The course "Agricultural Chemistry" introduces concepts related to soil composition, formation and reaction, colloidal chemistry of soil constituents and solutions. Pesticides and their mode of action, and and fertilizers.

Food Chemistry: Alcoholic fermentation, stimulant, flavors, spices, additive food coloring and contaminates, chemistry of vitamins, fruits and vegetables, quality control in food services and agricultural biotechnology will be covered.

**Course Objectives:**

In successful completion of the course students should be able to:

- Discuss the chemistry of soil formation, reaction and composition that supports the plant growth
- Explain when and how diseases controlling chemicals used
- Explain the importance of fertilizers in agriculture
- Examine agrochemicals like pesticides and insecticides for better plant growth
- Discuss the role and challenge of biotechnology in agricultural products
- Explain some biomolecules and their process in plants

**Course Outline**

1. **Soil Formation**
    1.1. Physical weathering
    1.2. Chemical weathering
    1.3. Biological weathering
    1.4. Humus formation

1.5. Soil horizon or layer

1.6. Composition of soil

1.7. Microbes in the soil

1.8. Properties of soil

2. **Reactions in Soils**

2.1. Redox reactions

2.2. Acid–Base reactions

2.3. Ion-Exchange reaction

2.4. Precipitation reactions

2.5. Colloidal chemistry of soil constituents

3. **Agricultural Water**

3.1. Agricultural water sources

3.2. Agricultural water quality

3.3. Use of water in agriculture

4. **Overview of Biomolecules of Living Things and Processes**

4.1. Amino acids and protein

4.2. Sugars: monosaccharides, polysaccharides, starch and cellulose

4.3. Fatty acids, lipids, waxes

4.4. Vitamins

4.5. Terpenes and terpenoids

4.6. Enzymatic reactions and cellular metabolism

4.7. Energy aspects of chemical and biochemical reactions

4.8. Enzymes: structure, properties and classification

4.9. Photosynthesis

4.9.1. Chlorophyll and other pigments

4.9.2. Reactions of the light and the dark phases

4.9.3. Photosynthesis in C3, C4 and CAM plants

4.9.4. Photorespiration

4.9.5. Pentose phosphates cycle

4.10. Respiration

4.10.1. Glycolysis: Alcoholic fermentation and lactic acidosis

4.10.2. Krebs cycle

4.10.3. Oxidative cytochrome system and oxidative phosphorylation

4.10.4. Glyoxylic acid cycle

4.10.5. Beta-oxidation of fatty acids

4.10.6. Pentose phosphate pathway

4.10.7. Energy aspects of respiration

4.10.8. Basic metabolism of nitrogen and sulfur

4.11. Reduction of nitrates and sulfates and biosynthesis of amino acids.

5. **Agrochemicals**

5.1. Pesticides

5.2. Insecticides

5.3. Fungicides

5.4. Herbicides

5.5. Novel methods of insect control

5.6. Environmental challenges of agrochemicals

6. **Fertilizers**

6.1. Fertilizers

6.2. Physical and chemical properties of biogenic elements

6.3. Plant nutrients

6.4. Functions of nutrients

6.5. Need for fertilizers

6.6. Nitrogenous fertilizers

6.7. Phosphate fertilizers

6.8. Potassium fertilisers

6.9. Mixed fertilizers

6.10. Cycle of the elements in soil

6.11. Fertilizers and the environment

7. **Biotechnology and the Quest for Better Crop Yield**

7.1. Agricultural biotechnology

7.2. Genetically Engineered (GE) Crops

7.3. The controversy over GMOS

**Instructional Methods and Strategies**: Instructional methods and strategies including gapped lecture, inquiry, homework, assignment, group discussion and so on will be employed. In general, student-centered approach will be implemented in the course.

**Students' Activities**: Active participation in taking notes, discussion and team works; active listening during lecturing; asking questions and answering to questions; submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: Formative and summative assessments should be employed in students' assessments. At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Materials**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Ricardo Meléndez-Ortiz, Christophe Bellmann, Jonathan Hepburn. Agricultural Subsidies in the WTO Green Box: Ensuring Coherence with Sustainable Development Goals [1st ed.], 2010
2. P. Meenakshi, Elements of Environmental science and engineering, 2005
3. A.K. De, Environmental Chemistry, 5th Ed., 2005.

## 9.3. Core Supportive Courses

### 9.3.1. Introductory Statistics

| | |
|---|---|
| **Course Title:** | Introductory Statistics |
| **Course Code**: | Stat 2011 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Prerequisite:** | No Prerequisite. |

**Course Description**:

Meaning of statistics; methods of data collection; methods of data presentation; measures of central tendency; measures of variation; counting techniques; concepts of probability ; probability distributions: Binomial, Poisson, Normal; sampling and sampling distribution of the mean; elementary description of the tools of statistical inference: basic concepts, estimation(point and interval) for the population mean, hypothesis testing on the population mean, chi-square test of association; simple linear regression and correlation.

**Course objectives:**

Upon completion of this course students should be able to:

- Demonstrate statistical techniques through principles of data collection, descriptive statistics, probability and sampling distributions; statistical inference and linear regression;
- Show different schemes of presenting the collected data and interpretation of the result.
- State and compute sample space, event, relative frequency, probability, conditional probability, independence, random variable, probability distribution, expected value and variance;
- Familiar with some standard discrete and continuous probability distributions;
- Use standard statistical tables for the normal, t, chi-square distributions;
- Discuss some desirable properties of point estimators;

- Demonstrate the framework of estimation and hypothesis testing to carry out statistical inference;
- Construct and interpret interval estimates and tests hypotheses correctly in some simple cases;
- Interpret the results of statistical analyses correctly and in non-technical language;
- Have basic skills in exploratory data analysis;

**Course outline**:

**1. Introduction**

1.1. Definitions and classification of statistics

1.2. Stages in statistical investigation

1.3. Definition of some terms

1.4. Applications, uses and limitations of statistics

1.5. Scales of measurement

**2. Methods of Data Collection and Presentation**

2.1. Methods of data collection

2.1.1. source of data

2.1.2. Types of data

2.2. Methods of data presentation

2.2.1. Introduction

2.2.2. Frequency distributions: Qualitative, quantitative (absolute, relative, percentage, cumulative)

2.2.3. Diagrammatic presentation of data: Bar charts, pie-chart, pictogram, Steam and leaf plot

2.2.4. Graphical presentation of data: Histogram, Frequency polygon, Ogive

**3. Measures of Central Tendency**

3.1. Introduction

3.2. Objectives of measuring central tendency

3.3. The summation notation

3.4. Important characteristics of measures of central tendency

3.5. Types of measures of central tendency

3.5.1. The mean (Arithmetic, weighted, Geometric and Harmonic)

3.5.2. The mode

3.5.3. The Median

3.5.4. The quantiles (quartiles, deciles, percentiles)

**4. Measures of Variation**

4.1. Introduction

4.2. Objectives of measuring variation

4.3. Absolute and relative measures

4.4. Types of measures of variation

4.4.1. The range and relative range

4.4.2. The variance, the standard deviation and the coefficient of variation

4.5. The standard scores

**5. Elementary Probability**

5.1. Introduction

5.2. Definition and some concepts(Random experiment, sample space, event, equally likely outcomes and mutually exclusive event)

5.3. Counting rules: addition, multiplication , permutation and combination rule

5.4. Approaches in probability definition (Classical and Axiomatic)

5.5. Some probability rules

5.6. Conditional probability and independence

**6. Probability Distributions**

6.1. Definition of random variables and probability distributions

6.2. Introduction to expectation: mean and variance of a random variable

6.3. Common discrete probability distributions: Binomial and Poisson

6.4. Common continuous probability distributions: normal

**7. Sampling and Sampling Distribution of the Sample Mean**

7.1. Basic concepts: population, sample, parameter, statistic, sampling frame, sampling units

7.2. Reasons for sampling

7.3. Types of sampling techniques

7.3.1. Non-probability sampling: Basic concepts and definitions

7.3.2. Probability sampling: Basic concepts and definitions

7.4. Sampling distribution of the sample mean

7.5. The central limit theorem

**8. One Sample Inference**

8.1. Introduction

8.2. Estimation

8.2.1. point estimation of population mean

8.2.2. Interval estimation of population mean

8.3. Hypothesis testing

8.3.1. Important concepts in testing statistical hypothesis

8.3.2. Hypothesis testing about population mean

8.3.3. Tests of association

9. **Simple Linear Regressions and Correlation**

9.1. Introduction

9.2. Fitting simple linear regression

9.3. The covariance and the correlation coefficient

9.4. The rank correlation coefficient

**Instructional Methods and Strategies**: Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice and defend their own opinions and enhancing the students' commitment to individual study and acquiring knowledge are among the activities.

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Textbook:**

Bluman, A.G. (1995). Elementary Statistics: A Step by Step Approach (2nd edition).Wm. C. Brown Communications, Inc.

**References:**


1. Coolidge, F.L.(2006). Statistics: A Gentle Introduction (2nd edition).
2. David, S.M., McCabe, P. and Craig, B. (2008). Introduction to the Practice of Statistics (6th edition). W.H. Freeman
3. EshetuWencheko (2000). Introduction to Statistics. Addis Ababa University Press.
4. Freund, J.E and Simon, G.A. (1998). Modern Elementary Statistics (9th Edition).
5. Gupta, C.B. and Gupta, V. (2004). An Introduction to Statistical Methods. Vikas Publishing House, Pvt. Ltd, India.
6. Snedecor, G.W and Cochran, W.G. (1980). Statistical Methods (7th edition).
7. Spiegel, M.R. and Stephens, L.J. (2007). Schaum's Outline of Statistics, Schaum's Outline Series (4th edition). McGraw-Hill.


### 9.3.2. Calculus I for Chemists

| | |
|---|---|
| **Course Title** | Calculus I for Chemists |
| **Course Code**: | Math 2021 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Prerequisite:** | No Prerequisite. |

**Course Description**:

The course “Calculus I for Chemists” is designed for applied science students. It equips students with basic concepts of vectors, matrices, determinants, solving systems of linear equations, concepts and applications of differential calculus of one variables that are useful for solving

chemical problems.

**Course Objectives**

Upon completion of this course the students will be able to:

- Understand the concept of vectors
- Understand matrices and determinants
- Understand the concepts of limit and continuity;
- Evaluating derivatives of functions;
- Apply derivatives;
- Understand the concepts of integration;
- Techniques of Integrations;
- Applications of integrations;

**Course Outline:**

1. **Vectors**
   - 1.1. Definition of points in n-space
   - 1.2. Vectors in n-space; geometric interpretation in 2 and 3-spaces
   - 1.3. Scalar product, and norm of a vector, orthogonal projection, and direction cosines
   - 1.4. The vector product
   - 1.5. Applications on area and volume
   - 1.6. Lines and planes
2. **Matrices**
   - 2.1. Definitions of a matrix
   - 2.2.Algebra of matrices
   - 2.3. Types of matrices: square, identity, scalar, diagonal, triangular, symmetric, and skew symmetric matrices
   - 2.4. Elementary row and column operations
   - 2.5. Row reduced echelon form of a matrix
   - 2.6. Rank of a matrix using elementary row/column operations
   - 2.7. System of linear equations
3. **Determinants**

3.1. Definition of a determinant

3.2. Properties of determents

3.3. Adjoint and inverse of a matrix

3.4. Cramer's rule for solving system of linear equations (homogenous and non-homogenous)

3.5. The rank of a matrix by sub-determinants

3.6. Determinant and volume

3.7. Eigenvalues and eigenvectors of a matrix

3.8. Diagonalization of a symmetric matrix

**4. Limit and Continuity**

4.1. Limit and Continuity

4.2. Revision of functions and their graphs

4.3. Formal definition of limit

4.4. Basic limit theorems

4.5. One-sided limits

4.6. Infinite limits and Limit at infinity

4.7. Formal definition of continuity

4.8. One-sided continuity

4.9. The intermediate value theorem

**5. Derivatives**

5.1. Definition of derivatives

5.2. Geometric interpretation of derivative as a slope

5.3. Differentiable functions

5.4. Derivatives of combinations of functions

5.5. The chain rules

5.6. Higher order derivatives

5.7. Implicit differentiation

5.8. Application of chain rule to Related Rates and Implicit Differentiation

**6. Application of Derivatives**

6.1. Extreme values of functions

6.2. The mean value theorem and its application

6.3. Monotonic functions

6.4. First and second derivative tests

6.5. Concavity and inflection points

6.6. Curve sketching

6.7. Tangent line approximation

6.8. Indeterminate forms and L' Hospital's rule

**Instructional Methods and Strategies**: In general the instructional methods and strategies to be used should be student-centered approach so as to make students participatory throughout the course and to get the necessary knowledge and skills in fostering the ideas stated in the course in particular and in mastery of the concepts in Calculus I. Some of the instructional methods and strategies could be used include gapped lecture, role playing, case study, questing and answering, demonstration, individual or group assignments, discussion, collaborative learning and so on.

**Studets' Activities**: Active participation in discussion and team works; active listening during lecturing; taking notes on the lessons; asking questions and answering to questions; presentations; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Robert Ellis and Denny Gulick, Calculus with analytic geometry, 6$^{th}$ed, Harcourt Brace Jovanovich, Publishers, 5$^{th}$ ed, 1993.
2. Leithold, The calculus with analytic geometry, 3$^{rd}$ Edition, Herper & Row, publishers.
3. R. T. Smith and R. B. Minton, Calculus concepts and connections, McGram-Hill book company, 2006

4. E. J. Purcell and D. Varberg, Calculus with analytic geometry, Prentice-Hall INC., 1987
5. Adams, Calculus: A complete course, 5th ed, Addison Wesley, 2003

### 9.3.3. Calculus II for Chemists

| | |
|---|---|
| **Course Title** | Calculus II for Chemists |
| **Course Code:** | Math 2022 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | II |
| **Prerequisite:** | Calculus I for Chemists (Math 1021) |

**Course Description**:

The course "Calculus II for Chemists" is designed on building the knowledge and skills gained in the first course with an extension to multidimensional problem solving. This course covers integral calculus of one variable and its application; sequence and series; Limit and Continuity of functions of several variables; differential and integrals calculus of functions of several variables and their applications.

**Course Objectives**

Upon completion of this course the students will be able to:

- Understand integration and its application
- Find domain and range of a function of several variables;
- Limits of functions of several variables;
- Find partial derivatives;
- Apply partial derivatives;
- Find directional derivatives and gradients;
- Use tangent plane approximation;
- Evaluate double and triple integrals;
- Change rectangular coordinate systems to polar, cylindrical and spherical coordinate

systems,

- Apply different coordinate systems to evaluate multiple integrals.

**Course Outline:**

1. **Integrations and Its Applications**
   - 1.1. Ant derivatives
   - 1.2. Partitions, lower sum, upper sum, Riemann sum
   - 1.3. Definite integrals
   - 1.4. Basic properties of definite integral
   - 1.5. Techniques of integration (Substitution, by part, partial fraction, by Trigonometric Substitution)
   - 1.6. Fundamental theorem of calculus first and second
   - 1.7. Indefinite integral and their properties
   - 1.8. Improper Integrals
   - 1.9. Application of Integration
     - 1.9.1. Area and Volume
     - 1.9.2. Arc Length and Work
2. **Limits and Continuity of Functions of Several Variables**
   - 2.1. Definitions and examples of real valued functions of several variables
   - 2.2. Domain and range of functions of several variables
   - 2.3. Graphs and level curves
   - 2.4. Limit and continuity
3. **Partial Derivatives and its Applications**
   - 3.1. Partial Derivatives; tangent lines, higher order derivatives
   - 3.2. Directional Derivatives and Gradient
   - 3.3. Total Differential, tangent plane approximation and error estimation
   - 3.4. Chain Rule and Implicit Differentiation
   - 3.5. Relative Extreme of functions of two variables
   - 3.6. Largest and smallest values of function on a given set
   - 3.7. Extreme values under constraint conditions, Lagrange's Multiplier
4. **Multiple Integrals**
   - 4.1. Double integrals and their calculation by iterated integrals

4.2. Double integrals by reversing order of integration

4.3. Double integrals in polar coordinates

4.4. Applications of double integrals: Area, Surface area and volume

4.5. Triple integrals and their calculation by iterated integrals

4.6. Triple integrals in cylindrical and spherical coordinates and their applications

**Instructional Methods and Strategies**: In general the instructional methods and strategies to be used should be student-centered approach so as to make students participatory throughout the course and to get the necessary knowledge and skills in fostering the ideas stated in the course in particular and in mastery of the concepts in Calculus II. Some of the instructional methods and strategies could be used include gapped lecture, role playing, case study, questing and answering, demonstration, individual or group assignments, discussion, collaborative learning and so on.

**Students' Activities**: Active participation in discussion and team works; active listening during lecturing; taking notes on the lessons; asking questions and answering to questions; presentations; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


6. Robert Ellis and Denny Gulick, Calculus with analytic geometry, 6$^{th}$ed, Harcourt Brace Jovanovich, Publishers, 5$^{th}$ ed, 1993.

2. Leithold, The calculus with analytic geometry, 3$^{rd}$ Edition, Herper & Row, publishers.

3. Edwards and Penny: Calculus with Analytic Geometry.

4. Johnson and Kiokemes: Calculus with Analytic Geometry.

5. Thomas, Calculus and Analytic Geometry, 9$^{th}$ edition.

### 9.3.4. Applied Mathematics for Chemists

| | |
|---|---|
| **Course Title:** | Applied Mathematics for Chemists |
| **Course Code:** | Math 3022 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | III |
| **Semester:** | II |
| **Prerequisite:** | Calculus II for Chemists (Math 2022) |

**Course Description**:

The course "Applied Mathematics for Chemists" is designed for chemistry students to apply mathematics to solve subject related problems. It equips students with sophisticated techniques of problem solving related to subject area. This course covers sequence and series, power series and Fourier series, introduction to first and second order Ordinary Differential Equations. Furthermore, introduction to partial differential equation of first order and second order is also included.

**Course Objectives**

Upon completion of this course the students will be able to:

- Understand sequence and types of sequence
- Decide convergence and divergence of sequence;
- Understand series;
- Decide on convergence or divergence of a wide class of series by appropriate tests;
- Represent a wide class of functions by a Taylor's series;
- Understand the concepts power series and Fourier series;
- Deal with first order ordinary differential Equations;
- Deal with Linear Second Order ordinary differential Equations;
- Understand introduction to partial differential equation of first order and second order with their respective solution.

**Course outline:**

1. **Sequence and Series**
   1.1. Definition and types of sequence
   1.2. Convergence properties of sequences
   1.3. Bounded and monotonic sequences
   1.4. Definition of infinite series
   1.5. Convergence and divergence, properties of convergent series
   1.6. Tests of convergence for nonnegative series (integral, comparison, ratio and root tests)
   1.7. Alternating series and alternating series test
   1.8. Absolute and conditional convergence
   1.9. Generalized convergence tests
2. **Power Series and Fourier Series**
   2.1. Definition of power series
   2.2. Convergence and divergence, radius and interval of convergence
   2.3. Differentiation and integration of a power series
   2.4. Taylor & Maclaurin series
   2.5. Binomial Theorem
   2.6. Fourier series of functions with period $2\pi$
   2.7. Fourier series of functions with arbitrary period
   2.8. Fourier series of odd and even functions
3. **Introduction to first and second order Ordinary Differential Equations**
   3.1. Basic Concepts and Ideas
   3.2. Separable Equations
   3.3. Homogeneous first order ordinary differential Equations
   3.4. Exact Differential Equations
   3.5. Linear First Order Differential Equations.
   3.6. Homogeneous Linear Equations of the Second Order
   3.7. Solving Homogeneous Second order Equations with Constant Coefficients
   3.8. A Method for Solving Non homogeneous Linear Equations with Constant Coefficients (Method of Undetermined Coefficients and Method of variation of parameter).
4. **Introduction to First and second Order Partial Differential Equation**
   4.1. Definitions and basic concepts

4.2. Classification of PDEs( Order, degree, linearity)

4.3. Definition of initial/boundary value problems

4.4. Solution of first order PDEs with constant coefficients

4.5. Solution of a first order PDEs with variable coefficients

4.6. Definition and classification of second order PDEs

4.7. Method of separation of variables for solving some second order partial differential equation (Parabolic, Elliptic and Hyperbolic).

**Instructional Methods and Strategies**: In general the instructional methods and strategies to be used should be student-centered approach so as to make students participatory throughout the course and to get the necessary knowledge and skills in fostering the ideas stated in the course in particular and in mastery of the concepts in Applied Mathematics for Chemists. Some of the instructional methods and strategies could be used include gapped lecture, role playing, case study, questing and answering, demonstration, individual or group assignments, discussion, collaborative learning and so on.

**Students' Activities**: Active participation in discussion and team works; active listening during lecturing; taking notes on the lessons; asking questions and answering to questions; presentations; working and submitting group or individual assignments on time; reading reference materials according to the course outline or tasks given by the instructor; attending classes regularly; and arriving classes on time.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**References**


1. Robert Ellis and Denny Gulick, Calculus with analytic geometry, 6$^{th}$ed, Harcourt Brace Jovanovich, Publishers, 5$^{th}$ ed, 1993.
2. Erwin Kreyszing, Advanced Engineering Mathematics

3. R. C. Mcowen, Partial differential equations, methods and applications, Pearson education, INC, 2003
4. I. N. Sneddon, Elements of partial differential Eequations

### 9.3.5. Mechanics and Heat for Chemists

| | |
|---|---|
| **Course Title:** | Mechanics and Heat for Chemists |
| **Course Code**: | Phys 2241 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Plus 2 Tutorial Hours per Week |
| **Year:** | II |
| **Semester:** | I |
| **Prerequisite:** | No Prerequisite |

**Course Description**:

This course is designed to introduce the basic concepts in mechanics, identify the connection between them and explain the common phenomena. They will also develop skills of solving problems. The topics to be included are vector algebra, Particle Kinematics and Dynamics, Work and Energy, Conservative forces and Potential Energy Dynamics of Systems of Particles, Collision, Rotational Kinematics, Dynamics and Static of a Rigid Body, Oscillations, Gravitation and Planetary Motion, Fluid Mechanics, Heat.

**Course objectives:**

Upon completion of this course students should be able to:

- Compute average and instantaneous values of velocity, speed and acceleration
- Derive the kinematic equations for uniformly accelerated one-dimensional motion
- Solve problems involving bodies moving in one-dimensional and two-dimensional motion using the concepts in calculus and trigonometry
- Explain some implications of newton's laws of motion
- Derive the work-energy theorem
- Solve mechanics problem using impulse, momentum and the conservation of linear momentum

- Apply the law of conservation of linear momentum to collisions
- Repeat the procedures followed in rectilinear motion for rotational motion explain basic laws of heat and thermodynamics

**Course Outline:**

1. **Vectors**
   - 1.1. Vector algebra
   - 1.2. Geometrical & algebraic representation of vectors
   - 1.3. Vector calculus
2. **One & Two Dimensional Motions**
   - 2.1. Average and instantaneous Velocity
   - 2.2. Average and instantaneous Acceleration
   - 2.3. Motion with Constant Acceleration
   - 2.4. Projectile Motion
   - 2.5. Uniform Circular Motion
3. **Particle Dynamics**
   - 3.1. Newton's Laws of Motion
   - 3.2. Friction Force
   - 3.3. Application of Newton's Laws
   - 3.4. velocity dependent forces
4. **Work & Energy**
   - 4.1. Work done by constant and variable forces
   - 4.2. the work energy theorem
   - 4.3. Conservative and non-conservative forces, conservative force and potential energy,
   - 4.4. Conservation of mechanical energy
   - 4.5. Power
5. **Dynamics of System of Particles**
   - 5.1. Linear Momentum and Impulse
   - 5.2. Conservation of Momentum
   - 5.3. system of particles
   - 5.4. Center of mass

5.5. Center of mass of a rigid body

5.6. Motion of system of particles

5.7. Elastic and Inelastic Collision (1 & 2-D)

5.8. Elastic collisions in one-dimension

5.9. Two-dimensional elastic collisions

5.10. Inelastic collisions

5.11. Systems of variable mass

**6. Rotation of Rigid Bodies**

6.1. Rotational motion with constant and variable angular accelerations

6.2. Rotational kinetic energy

6.3. Moment of inertia

6.4. Rotational dynamics

6.5. Torque and angular momentum

6.6. Work and Power in Rotational Motion

6.7. Conservation of Angular Momentum

6.8. Relation between linear and angular motions

**7. Simple Harmonic Motion**

7.1. Energy in Simple Harmonic Motion

7.2. Equations of Simple Harmonic Motion

7.3. Pendulum

7.4. Damped and forced oscillations

7.5. Resonance

**8. Heat and Thermodynamics**

8.1. Temperature, Zeroth law of thermodynamics,

8.2. Heat, work, and Internal energy of a thermodynamic system,

8.3. the first law of thermodynamics, and its consequences

8.4. The second law of thermodynamics, Carnot's engine

8.5. Entropy, the third law of thermodynamics, Kinetic theory of gases

**Instructional Methods and Strategies**: Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice

and defend their own opinions and enhancing the students' commitment to individual study and acquiring knowledge are among the activities.

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Course Textbook**

Raymond A. Serway, Physics: For Scientists & Engineers, 6th ed., Thomson Bruke, 2004.

**References**


1. Hugh D. Young and Roger A. Freedmann, University Physics with Modern Physics 12th ed., 2008.
2. Douglas C. Giancoli, Physics for scientists and engineers, Printice Hall, 4th, 2005.
3. Robert Resnick and David Halliday, Fundamentals of Physics Extended, HRW 8th ed., 2008.
4. Paul M. Fishbane, Stephene Gasiorowicz, Stephen T. Thoronton, Physics for Scientists and Engineers, 3rd ed., 2005.


### 9.3.6. Electricity and Magnetism

| | |
|---|---|
| **Course Title:** | Electricity and Magnetism |
| **Course Code**: | Phys 3241 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Plus 2 Tutorial Hours per Week |
| **Year:** | III |
| **Semester:** | I |

**Prerequisite:** No Prerequisite

**Course Description**:

This course is designed to introduce concepts of classical electrodynamics with the aid of calculus. It also emphasizes on establishing a strong foundation of the relation between electric and magnetic phenomena; a concept that turns out to be a fundamental basis for many technological advances. The topics to be included are Coulomb's Law, Electric Field, Gauss' Law, Electric Potential, Electric Potential Energy, Capacitors and Dielectric, Electric Circuits, Magnetic Field, Bio-Savart's Law, Ampere's Law, Electromagnetic Induction, Inductance, Circuits with Time Dependent Currents, Maxwell's Equations, Electromagnetic Wave.

**Course objectives:**

Upon completion of this course students should be able to:

- Explain the basic concepts of electric charge, electric field and electric potential
- Apply vector algebra and calculus in solving different problems in electricity and magnetism
- Analyze direct and alternating current circuits containing different electric elements and solve circuit problems
- Describe properties of capacitors and dielectrics
- Describe the magnetic field and solve problems related to the magnetic field and magnetic forces.
- Discuss about electromagnetic induction
- State maxwell's equation in free space
- Describe some applications of maxwell's equations
- Describe electromagnetic radiation in medium and free space.

**Course Outline:**

1. **Electric Field**
   1.1. Properties of electric charges
   1.2. Coulomb's law
   1.3. Electric field due to point charge

1.4. Electric dipole

1.5. Electric field due to continuous charge distribution

1.6. Motion of charged particles in electric field

1.7. Gauss' Law

**2. Electric Potential**

2.1. Electric potential energy

2.2. Electric potential due to point charges

2.3. Electric potential due to continuous charge distribution

2.4. Relations between potential and electric field

2.5. Equi-potential surfaces

**3. Capacitance and Dielectrics**

3.1. Capacitance

3.2. Combination of capacitors

3.3. Capacitors with dielectrics

3.4. Electric dipole in an external field

3.5. Electric field energy

**4. Direct Current Circuits**

4.1. Electric current and current density

4.2. Resistance and Ohm's law

4.3. Resistivity of conductors

4.4. Electrical energy, work and power

4.5. Electromotive force

4.6. Combinations of Resistors

4.7. Kirchhoff's Rules

4.8. RC Circuits

**5. Magnetic Force**

5.1. Properties of magnetic field

5.2. Magnetic force on a current carrying conductor

5.3. Torque on a current loop in uniform magnetic field

5.4. Motion of charged particles in magnetic field

5.5. Hall Effect

**6. Calculation of Magnetic Field**

6.1. Source of electric field

6.2. Biot-Savart's law

6.3. The force between two parallel conductors

6.4. Ampere's Law and its application

**7. Electromagnetic Induction**

7.1. Magnetic flux

7.2. Gauss's Law in Magnetism

7.3. Faraday's Law of Induction

7.4. Lenz'z law

7.5. Induced Emf (including motional Emf)

7.6. Induced electric field

7.7. Displacement current

**8. Inductance**

8.1. Self-inductance and mutual inductance

8.2. RL circuits

8.3. Energy in Magnetic field

8.4. Oscillations in an LC circuits

**9. AC Circuits**

9.1. AC sources and phasors

9.2. Resistors in an AC circuits

9.3. Inductors in an AC circuits

9.4. Capacitors in an AC circuits

9.5. The RLC series circuits

9.6. Power in an AC circuits

**10. Maxwell's Equations**

10.1. Maxwell's equations

10.2. Electromagnetic waves

**11. Nature of Light**

11.1. Electromagnetic spectrum

11.2. Propagation and speed of light

11.3. Reflection and refraction
11.4. Refractive index and optical path
11.5. Reversibility principle
11.6. Fermat's principle
11.7. Propagation of light in material medium

**Instructional Methods and Strategies**: Interactive lecture methods followed by discussion, demonstration, etc. and guide students in project work. And also permitting the students to voice and defend their own opinions and enhancing the students' commitment to individual study and acquiring knowledge are among the activities.

**Students' activities:** Active involvement of learners is required at each phase. This is done through questioning and answering, reflection, reporting, solving problems associated with the respective topics. The students individually and in peer practice and learn through project and practical work. Each practical will result in a report for assessment.

**Assessment Strategies and Techniques**: At least 50% continuous assessments (quizzes, tests, assignments, project work and/or mid-examination) and 50% final examination

**Instructional Resources (Materials and Equipments)**: LCD, computer (desktop or laptop), course outlines, markers, flip charts, white board, chalk board, duster.

**Course Textbook**

Raymond A. Serway, PHYSICS For Scientists & Engineers

**References**

1. Douglas C. Giancoli, Physics for scientists and engineers.
2. Robert Resnick and David Halliday, Fundamentals of Physics.

### 9.3.7. Introduction to Geochemistry

| | |
|---|---|
| **Course Title:** | Introduction to Geochemistry |
| **Course Code**: | Geol 2012 |
| **Credit Hours/ECTS:** | 3/5 |
| **Contact Hours:** | 3 Lecture Hours per Week |
| **Year:** | II |
| **Semester:** | II |
| **Prerequisite:** | General Chemistry (Chem 1012) |

**Course description**

This course examines the chemical processes characteristic of specific geological settings, with an emphasis placed on the processes governing elemental differentiation, migration, and distribution. The topics covered include basic concepts and principles of geochemistry, high and low temperature fluid-rock interaction, aqueous geochemistry, stable and radiogenic isotopes, thermodynamics and kinetics, biogeochemistry, solid-Earth geochemistry and common analytical techniques for determining whole rock, mineral, soil, and water compositions.

## 10. Course Policy

Courses shall be managed by at least a MSc holder according to his specialty area. Laboratory classes can be managed by GA or BSc holder. Academic adviser from instructors should be assigned to each batch level.

## 11. Quality Assurance

The program included several methods to guarantee quality. Some of the elements quality assurance expected from the candidate are presented earlier under the graduation requirements. Grade report of courses at each semester; feedback from stakeholders, participation and/or presentation of his/her field and outreach findings to the department could be used as quality assurance. Finally, the curriculum is expected to be revised in five years from the commencement of the program whenever there is a need to do so.

## 12. Staff Profile and Available Physical Facilities

### 12.1. Staff Profile

The department of Chemistry is one of the several academic departments of ----------------------- university. Currently, the department has ---------- and ---------- academic and laboratory technician staff members, respectively. The following Table indicate the overall staff profile of the department (active staffs in ----------).

**Table 2:** Staff Profile of the department

| S. N | Full Name | Sex | Acad. Rank | Field of Specialization |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

## 12.2 Available Physical Facilities

Currently, the department has ---------- undergraduate teaching laboratories. There are ------ research laboratories dedicated to the staffs and postgraduate research undertakings. The department has also ----- ICT room/s which is equipped with desktop computers and fast internet connection. The department has the following instruments, which are used for research and teaching purposes.

- ----------
- ----------
- ----------