



Ref: 01 /.../CSF/ 2026

**EXTRAIT DU PV
DE LA REUNION ORDINAIRE DU CONSEIL SCIENTIFIQUE
Du 02/02/2026**

Objet : : Expertise de polycopié pédagogique

En l'an deux mille vingt-six (2026), le lundi 02 février à 13 h 30, une réunion ordinaire du Conseil Scientifique de la Faculté des Sciences de la Matière et de l'Informatique s'est tenue dans la salle de réunion de la faculté (Bloc B).

Suite aux rapports favorables reçus de la part des experts cités ci-après concernant l'expertise du polycopié pédagogique, le CSF a prononcé favorablement pour la conformité du polycopié pédagogique en vue de préparer son professorat.

- **Auteur du polycopié** : Dr. FIZIR Meriem (MCA)
- **Intitulé du polycopié** : Drug Analysis and Control « Course Material and Evaluation Exercises »
- **Destiné aux étudiants de** : 2ème année Master Chimie Pharmaceutique.
- **Experts du polycopié** :

- | | | |
|-----------------------|-----|--------------------|
| • REZALA Houria | MCA | UDB-Khemis Miliana |
| • DJAFER Abderrahmane | Pr | UHB- Chlef. |

Président du
Conseil Scientifique de la Faculté SMI
Dr. BOUDERBALA Mihoub
المجلس العلمي
كلية علوم المادة والإعلام الآلي
رئيس المجلس العلمي
مضاء: بودربالة ميهوب

People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research



Djilali Bounaama University Khemis Miliana
Faculty of Matter Sciences and Computer Science
Department of Chemistry

Handout

Drug Analysis and Control

"Course Material and Evaluation Exercises"

Prepared by:

Dr. Meriem FIZIR

Academic Year: 2025-2026

People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research



Djilali Bounaama University Khemis Miliana
Faculty of Matter Sciences and Computer Science
Department of Chemistry

Handout

Drug Analysis and Control

"Course Material and Evaluation Exercises"

Prepared by:

Dr. Meriem FIZIR

Academic Year: 2025-2026

Preface



This course handout for *Drug Analysis and Control* is designed for second-year Master's students in Pharmaceutical Chemistry, and is also suitable for those in Pharmaceutical Engineering and Pharmacy programs.

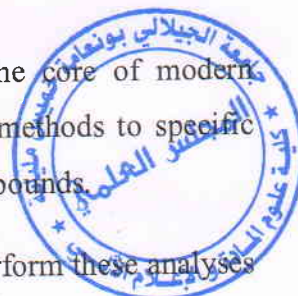
The content integrates fundamental chemical principles with their specialized applications to ensure the safety, efficacy, and quality of medicinal products. The knowledge presented in these chapters forms the essential foundation supporting the pharmaceutical industry's commitment to public health. Drawing on several years of teaching experience in this field, this handout aims to provide students with comprehensive support to master the essential concepts of pharmaceutical quality control.

This handout has been developed in accordance with the official program curriculum. It guides students from broad regulatory frameworks to the detailed application of analytical techniques for specific drug classes.

The essential context is first established in Chapters I and II, which examine the State System Structure in Quality Control and the rigorous preparation of technical documentation for standards. The core principles of pharmaceutical analysis are systematically presented in Chapter III, detailing specific characteristics, essential criteria, method validation parameters, and the general principles for establishing the authenticity of medicinal substances. Chapter IV discusses the types of technical analysis within a pharmaceutical complex. This theoretical foundation is complemented by the practical aspects covered in Chapter V: Sample Selection, emphasizing that the validity of any sophisticated analysis depends entirely on obtaining representative samples.

A comprehensive examination of modern pharmaceutical quality control methods is provided in Chapters VI through X. Chapter VI discusses sterilization methods for microbiological safety; Chapter VII presents ash analysis for purity assessment; Chapter VIII details physical characterization methods, including melting point and optical rotation determination; Chapter IX covers chemical analysis techniques through titrimetric methods and functional group identification; and Chapter X explores advanced physicochemical instrumentation, including

spectral, chromatographic, and electrochemical techniques that form the core of modern quality control laboratories. Subsequent chapters (XI-XIV) apply these methods to specific drug classes, including aliphatic, aromatic, heterocyclic, and alkaloid compounds.



Upon completion of this course, students will be equipped not only to perform these analyses but also to critically evaluate analytical data, develop robust quality control protocols, and contribute to advancements in pharmaceutical sciences.

The final assessment consists of two components, each worth 50% of the final grade: a practical work assessment (comprising mini-projects, attendance, and participation) and a final written exam covering all course material from the semester. A minimum overall grade of 10 out of 20 is required to pass the module.

This manuscript is written in a clear style, rich with examples, to ensure its accessibility. I warmly invite all readers, students, and fellow educators to share their feedback, comments, and suggestions concerning the content and format of this work at my email address: meriem.fizir@univ-dbk.m.dz. Your input would be highly valued.

Table of Content

CHAPTER I: CONCEPT OF STATE SYSTEM STRUCTURE IN DRUG QUALITY CONTROL ..	10
1. Objectives	10
2. Introduction	10
3. Concept of state system structure in drug quality control	10
4. Quality management systems	11
4.1. Good Manufacturing Practice (GMP).....	11
4.2. International Organization for Standardization ISO 9001	11
4.3. Pharmacopeial standards.....	11
4.4. The International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) guidelines	11
5. Common approaches for quality control of drugs: Pharmacopoeia	12
5.1. The State Pharmacopoeia.....	13
5.1.1. Pharmacopoeia of Europe	13
5.1.2. United States pharmacopoeia	14
5.1.3. Japanese Pharmacopoeia (JP).....	14
5.1.4. British Pharmacopoeia (BP)	14
5.2. Harmonization of pharmacopoeias	14
6. Order of development of technical documentation of standards in pharmacy.....	15
CHAPTER II: QUALITY CONTROL OF DRUGS IN PHARMACIES	17
1. Objectives	17
2. Introduction	17
3. Definition of quality	17
4. Definition of quality assurance	17
5. Quality in the pharmaceutical industry.....	18
6. Good laboratory practices (GLP).....	18
6.1. GLP principles	18
7. The European pharmacopoeia	21
7.1. Definition of the European pharmacopoeia	21
7.2. The role of the European pharmacopoeia	21
8. Definition of quality control	22
8.1. Quality management in the drug industry	22
8.1.1. Quality assurance.....	23



TABLE OF CONTENT

8.1.2. Quality control responsibilities.....	23
8.1.3. Quality assurance responsibilities.....	23
CHAPTER III : PARTICULARITIES OF PHARMACEUTICAL ANALYSIS AND THE ESSENTIAL CRITERIA.....	25
1. Objective	25
2. Introduction	25
3. Essential criteria of pharmaceutical analysis	26
3.1. Accuracy.....	26
3.2. Precision	27
3.3. Detection Limit (Limit of Detection, LOD)	28
3.4. Quantitation Limit (Limit of Quantitation, LOQ)	28
3.5. Selectivity and Specificity	29
3.6. Robustness	30
3.7. Linearity	31
CHAPTER IV: TECHNICAL LABORATORY OPERATIONS IN A PHARMACEUTICAL COMPLEX.....	32
1. Objectives	32
2. Introduction	32
3. Types of technical analysis in a pharmaceutical complex.....	33
3.1. Analysis of raw materials and components	33
3.2. In-process controls (IPC).....	33
3.3. Finished product testing (release testing).....	34
3.4. Stability testing	34
4. Analytical techniques	34
5. Good practices applicable to pharmaceutical quality control laboratories	35
5.1. Organization and management of a pharmaceutical quality control laboratory.....	35
5.2. Quality management system.....	37
5.3. Presentation of documentation in complex laboratories	40
5.4. Working methods in pharmaceutical laboratories.....	41
5.4.1. Sample reception and management	41
5.4.2. Traceability and documentation	42
5.4.3. Validation and execution of analyses	42
5.4.4. Management of results and archiving.....	42
5.5. Laboratory safety rules	43
CHAPTER V : SAMPLING OPERATIONS.....	45



TABLE OF CONTENT

1. Objectives	45
2. Introduction	45
• Sample selection in drug analysis	45
• Terms and types of samples	46
5. General rules	48
5.1. Sampling facilities	48
5.2. Health and safety	49
5.3. Sampling operation and precautions	50
• Packaging, labeling and storage of samples	51
CHAPITRE VI : STERILIZATION	52
1. Objectives	52
2. Introduction	52
3. Sterilization methods	52
3.1. Destruction based methods	53
3.1.1. Heat (Dry and moist)	53
3.1.2. Radiation	54
3.1.3. Gas Sterilization	55
3.2. Elimination based methods	56
3.2.1. Filtration	56
CHAPTER VII: ASH ANALYSIS	57
1. Objectives	57
2. Introduction	57
3. Ash values	57
3.1. Determination of total ash	58
3.1.1. Principle	58
3.1.2. Apparatus	58
3.1.3. Procedure	58
3.2. Determination of acid insoluble ash	59
3.3. Sulphated ash analysis	59
3.3.1. Procedure	59
CHAPTER-VIII: PHYSICAL ANALYSIS METHODS FOR CHEMICAL PREPARATIONS IN PHARMACY	61
1. Objectives	61
2. Introduction	61



TABLE OF CONTENT

3. Colour of liquids	62
3.1. Definition.....	62
3.2. Recommended procedure	62
4. Determination of mass density and relative density.....	62
4.1. Definition.....	62
4.2. Recommended procedure	63
4.2.1. Use of a pycnometer	63
5. Determination of melting temperature, congealing point, and boiling point.....	64
5.1. Determination of melting points	64
5.1.1. Definition	64
5.1.2. Principles and methods of melting point determination	65
5.2. Determination of boiling points	67
5.2.1. Apparatus and experimental procedures	68
5.3. Determination of congealing point.....	69
5.3.1. Apparatus and experimental procedures	69
• Determination of water content in pharmaceutical substances	70
6.1. Drying methods (Thermogravimetric Methods)	70
6.1.1. Direct determination	70
6.1.2. Indirect determination: Loss on Drying (LOD).....	71
6.2. Selective (Chemical) methods	71
6.2.1. Karl Fischer (KF) titration	71
This is the most widely used and precise method for direct water quantification in pharmaceuticals.....	71
• Determination of optical rotation and specific rotation.....	72
7.1. Generality	72
7.2. Polarimetry	73
7.3. Measuring optical rotation	73
7.4. Calibration	75
• Determination of refractive index	75
8.1. Definition.....	75
3.4. Apparatus.....	76
CHAPTER IX: CHEMICAL ANALYSIS METHODS FOR CHEMICAL PREPARATIONS IN PHARMACY	77
1. Objectives	77
2. Introduction	77



TABLE OF CONTENT

3. Colour of liquids	62
3.1. Definition.....	62
3.2. Recommended procedure	62
4. Determination of mass density and relative density.....	62
4.1. Definition.....	62
4.2. Recommended procedure	63
4.2.1. Use of a pycnometer	63
5. Determination of melting temperature, congealing point, and boiling point.....	64
5.1. Determination of melting points	64
5.1.1. Definition	64
5.1.2. Principles and methods of melting point determination	65
5.2. Determination of boiling points	67
5.2.1. Apparatus and experimental procedures	68
5.3. Determination of congealing point.....	69
5.3.1. Apparatus and experimental procedures	69
• Determination of water content in pharmaceutical substances	70
6.1. Drying methods (Thermogravimetric Methods)	70
6.1.1. Direct determination	70
6.1.2. Indirect determination: Loss on Drying (LOD).....	71
6.2. Selective (Chemical) methods	71
6.2.1. Karl Fischer (KF) titration	71
This is the most widely used and precise method for direct water quantification in pharmaceuticals.....	71
• Determination of optical rotation and specific rotation.....	72
7.1. Generality	72
7.2. Polarimetry	73
7.3. Measuring optical rotation.....	73
7.4. Calibration	75
• Determination of refractive index	75
8.1. Definition.....	75
3.4. Apparatus.....	76
CHAPTER IX: CHEMICAL ANALYSIS METHODS FOR CHEMICAL PREPARATIONS IN PHARMACY	77
1. Objectives	77
2. Introduction	77



TABLE OF CONTENT

4. Titrimetric Methods	77
3.1. Generality	77
3.2. Definition.....	78
3.2.1. Definition of some terms	78
3.3. End points in volumetric analysis.....	79
3.4. Classification of reaction in titrimetric analysis	80
3.4.1. Acid-base titration.....	80
3.4.2. Redox titration	81
3.4.3. Precipitation titration	81
3.4.4. Complexometric titration	82
4. Analysis of oils and fats in the pharmaceutical industry	85
4.1. Acid Value	86
4.2. Saponification Value	86
3. Iodine Value (Iodine Number).....	86
4. Acetyl Value	86
5. Ester Value	87
5. The oxygen flask method	87
5.1. Definition.....	87
5.2. Apparatus and reagents.....	87
5.3. Procedure.....	88
5.4. Applications in pharmaceuticals	88
5.2. Determination of bromine and chlorine via oxygen flask combustion.....	89
5.2.1. Principle.....	89
5.2.2. Procedure	89
5. Chemical identification tests.....	90
5.1. Definition.....	90
5.2. Examples of common tests	90
5.2.1. Ferric chloride test for phenols.....	90
5.2.2. Silver nitrate test for halides.....	90
CHAPTER X: PHYSICO-CHEMICAL ANALYSIS METHODS FOR DRUG QUALITY CONTROL	91
2. Objective	91
3. Introduction	91
4. Spectral methods for drug quality control	91



TABLE OF CONTENT

3.1. Ultraviolet and visible spectrophotometry.....	91
3.1.1. Generality.....	91
3.1.2. The electromagnetic spectrum.....	92
3.1.3. Specific absorption.....	93
3.1.4. Absorption and concentration.....	94
3.1.3. Instrumentation.....	95
3.2. Infrared (IR) spectroscopy.....	100
3.2.1. Energy of a molecule.....	101
3.2.2. Interaction of light and molecules.....	101
3.2.3. Older Technology.....	102
3.2.4. Fourier Transform Infrared (FT-IR) spectrometry.....	103
3.2.5. The Sample analysis process.....	103
3.2.6. An example of IR spectrum analysis.....	105
3.3. Atomic absorption spectroscopy (AAS).....	107
3.3.1 Theory of absorption by atoms.....	107
3.3.2. Instrumentation and components.....	108
3.3.3. Sample preparation techniques.....	109
3.3.4. Calibration and standardization methods.....	110
3.3.5. Applications in pharmaceutical analysis:.....	111
5. Chromatographic methods for drug quality control.....	111
4.1. Chromatography principle.....	112
4.2. Stationary phase in chromatography.....	112
4.3. Mobile phase in chromatography.....	113
4.4. High performance liquid chromatography (HPLC).....	113
4.4.1. Principle of HPLC.....	113
4.4.2. Instrumentation of HPLC System.....	114
4.4.3. Types of High-Performance Liquid Chromatography.....	115
4.4.4. Parameters affecting HPLC separation.....	116
4.4.5. Applications of HPLC in pharmaceutical analysis.....	116
4.5. Gas chromatography (GC).....	117
4.5.1. Principle of GC.....	117
4.5.2. Instrumentation of GC System.....	118
4.5.3. Stationary phase in gas chromatography.....	119
4.5.4. Parameters affecting GC separation.....	120

TABLE OF CONTENT

4.5.5. Applications of GC in pharmaceutical analysis	120
4.6. Thin layer chromatography (TLC).....	120
4.6.1. Principle of TLC.....	120
4.6.2. Solvent used in thin layer chromatography.....	121
4.6.3. Instrumentation of TLC.....	122
4.6.4. Applications of TLC in pharmaceutical analysis	123
4.7. Paper Chromatography.....	123
4.7.1. Paper chromatography principle.....	124
4.7.2. Material required in paper chromatography.....	124
4.7.3. Paper chromatography procedure.....	124
4.7.4. Uses of paper chromatography.....	125
4.8.1. Size exclusion chromatography.....	126
4.8.2. Ion exchange chromatography	126
4.8.3. Super critical fluid chromatography	127
4.8.4. Chiral chromatography	128
4.9. Method validation for chromatographic techniques.....	128
6. Electrochemical methods.....	129
5.1. Principles of electrochemical methods.....	129
5.2. Electrochemical techniques	130
5.2.1. Voltammetry	130
5.2.2. Potentiometry	130
5.2.3. Conductometry	131
5.3. Practical Applications.....	131
5.3.1. Drug discovery and development.....	131
5.3.2. Quality control and assurance	131
5.3.3. Pharmacokinetics and metabolism studies.....	132
5.3.4. Therapeutic drug monitoring.....	132
5.3.5. Environmental monitoring	132
5.3.6. Counterfeit drug detection	132
CHAPTER XI: ANALYSIS AND CONTROL OF ALIPHATIC PHARMACEUTICAL PREPARATIONS.....	133
1. Objectives.....	133
2. Introduction	133
3. Analysis of halogenated derivatives.....	133

TABLE OF CONTENT

3.1. Roles in pharmaceutical formulations	134
3.2. Analysis methods	134
3.2.1. Gas Chromatography	134
3.2.2. High-Performance Liquid Chromatography	135
3.2.3. Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	135
3.2.4. Nuclear Magnetic Resonance (NMR) Spectroscopy	135
4. Analysis of alcohols and ethers	136
4.1. Roles in pharmaceutical formulations	136
4.1.1. Alcohols	136
4.1.2. Ethers	137
4.2. Analysis methods	138
4.2.1. Gas Chromatography	138
4.2.2. High-performance liquid chromatography	138
4.2.3. Fourier-transform infrared spectroscopy	139
4.2.4. Mass Spectrometry	139
5. Analysis of urea derivatives	139
5.1. Major classes of urea-based pharmaceuticals	140
5.2. Analysis methods	140
5.2.1. High-performance liquid chromatography	140
5.2.2. Gas chromatography	141
5.2.3. Fourier-transform infrared spectroscopy	141
CHAPTER XII: ANALYSIS AND CONTROL OF AROMATIC PHARMACEUTICAL PREPARATIONS	142
1. Objectives	142
2. Introduction	142
3. Analysis of phenol and aniline derivatives	142
2.1. Analysis techniques	143
2.1.1. High-performance liquid chromatography	143
2.1.2. Gas chromatography-mass spectrometry	144
2.1.3. Titrimetry	144
2.1.4. Fourier-transform infrared spectroscopy	144
2.1.5. Nuclear magnetic resonance spectroscopy	145
4. Analysis of benzoic acid and its derivatives	145
4.1. Analytical techniques	146

TABLE OF CONTENT

4.1.1. High-performance liquid chromatography with uv or photodiode array detection	146
4.1.2. Titrimetry	146
4.1.3. Spectroscopic techniques	146
5. Analysis of salicylic acid and its derivatives	147
5.1. Analytical techniques	147
5.1.1. Titrimetric method	147
5.1.2. Spectrophotometric method	148
5.1.3. High-performance liquid chromatography - the reference method	148
5.2. Practical application: HPLC analysis of salicylic acid in aspirin tablets	149
Chapter XIII: Analysis and Control of Heterocyclic Pharmaceutical Preparations	150
1. Objective	150
2. Introduction	150
3. Common structural types of heterocycles	151
4. Analysis and control of heterocyclic pharmaceutical preparations with a single heteroatom	151
5. Analysis of pyridine derivatives	152
5.1. Analytical techniques	152
CHAPTER XIV: ANALYSIS OF ALKALOIDS	154
1. Objectives	154
2. Introduction	154
3. Identification test	155
EVALUATION EXERCISES	157
References	Error! Bookmark not defined.





CHAPTER I: CONCEPT OF STATE SYSTEM STRUCTURE IN DRUG QUALITY CONTROL

1. Objectives

By the end of this chapter, the student will be able to:

- ❖ Explore the state system structure in drug quality control
- ❖ Examine quality management systems in the pharmaceutical industry
- ❖ Understand the role of pharmacopoeias
- ❖ Develop knowledge of quality documentation and standards

2. Introduction

Every medicine is characterized by special requirements of efficiency and safety, which determine its quality. High-grade medicines and their active substances always comply with all regulatory requirements. Medicine quality control is carried out during the whole manufacturing process (at every stage), also when releasing the drug on the market and during its circulation there.

3. Concept of state system structure in drug quality control

The concept of state system structure in drug quality control refers to the organization and management of quality control processes for drugs. This includes the establishment of protocols and procedures for testing, analysis, and evaluation of drug products to ensure that they meet the required standards for safety, efficacy, and quality. The state system structure may involve the use of various analytical techniques and technologies, such as chromatography, spectroscopy, and microbiological methods, as well as the implementation of quality management systems and regulatory frameworks to monitor and control drug quality throughout the entire supply chain. The ultimate goal of the state system structure in drug quality control is to safeguard public health by ensuring that drugs are safe, effective, and of high quality.

4. Quality management systems

The process of standardization and quality control is implemented in three main areas: identification of medicines, purity assessment (absence of impurities) and assay. Drugs quality indicators together with the methods of their analysis are stated in special regulatory documents (RD). The main one is Pharmacopoeia. There are other several quality management systems used in drug quality control. Here are a few examples:

4.1. Good Manufacturing Practice (GMP)

GMP is a set of guidelines that ensure that pharmaceutical products are consistently manufactured and controlled according to quality standards. GMP covers all aspects of the manufacturing process, including the facilities, equipment, personnel, documentation, and procedures.

4.2. International Organization for Standardization ISO 9001

ISO 9001 is a quality management system standard that can be applied to any industry, including the pharmaceutical industry. ISO 9001 provides a framework for implementing a quality management system that focuses on customer satisfaction, continuous improvement, and the prevention of defects.

4.3. Pharmacopeial standards

Pharmacopeial standards are a set of standards for the identity, strength, quality, and purity of drugs and drug ingredients. These standards are developed by organizations such as the United States Pharmacopeia (USP) and the European Pharmacopoeia (Ph. Eur.) and are used by regulatory authorities and pharmaceutical companies to ensure the quality of drugs.

4.4. The International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) guidelines

The ICH is a global organization that brings together regulatory authorities and the pharmaceutical industry to develop and harmonize guidelines for the development, registration, and post-approval of pharmaceutical products. The ICH guidelines provide a framework for ensuring the quality, safety, and efficacy of drugs by establishing standards for the design, conduct, and reporting of clinical trials, as well as for the manufacturing and quality control of drug products. The guidelines cover various aspects of drug development and quality control, including stability testing, impurity testing, analytical methods validation, and risk management. By implementing the ICH guidelines, pharmaceutical companies can