PHC 261: PHARMACEUTICAL ANALYTICAL CHEMISTRY-I (2 + 1)

Prereq. Chem. 108 or 105 + 106

Course Description

The course presents fundamental concepts and applications of volumetric analysis based on acid-base, precipitation, complexation and redox reaction. In addition on introduction to gravimetric analysis is given.

Theoretical	**No. of Lectures**
Acid-base titrations -Basic concepts and pH calculation. -Dissociation of weak acids and bases. -pH of salts. -Buffers and buffer capacity. -Titration curves. -Indicators. -Application to pharmaceutical analysis.	5 2
Non-aqueous titrations -Principles. -Solvents. -Solvents of organic acids - weak bases - weak base halogen salts - weak acids. -Application to pharmaceutical analysis.	2
Precipitation titrations -Solubility product, common ion - complex ions. -Mohr, Volhard, & Fajans methods. -Leibig's methods and its modifications, mercurimetry. -Application to pharmaceutical analysis.	4
Complexometric Titrations -Chelating agents and chelate compounds. -Complexometric titration curves. -PM - indicators. -Methods of EDTA-titration. -Masking and demasking.	4

Theoretical	**No. of Lectures**
Redox reactions -Oxidation reduction reactions. -Potential measurements. -$KMnO_4$ in acid, neutral, alkaline media. -$K_2Cr_2O_7$, Ce^{4+}, -I_2/I^- system. -KIO_3 - Andrew's method. -Hypoiodide. -Sodium nitrite titrations. -Br^-/BrO_3^- system. -Application to pharmaceutical analysis.	5 2
Gravimetry -Introduction, precipitation. -Co-precipitation and post-precipitation. -Application to pharmaceutical analysis.	2
Examination	2
Total	28

PHC 261: PRACTICAL

Lab. No.

Acid-base titrations

1 & 2 **Standardization of N/2 HCl (using primary standard Na_2CO_3).**
Standardization of NaOH.
Determination of boric acid.
Determination of borax.
Determination of mixture of boric acid and borax.
Determination of ammonium chloride (formol titration).
Determination of acetylsalicylic acid (Aspirin).
Assay of ammoniated mercury.
Assay of sodium benzoate.
Assay of oxyphenbutazone tablets.

3 & 4 **Non-aqueous and diazometric titrations**
Standardization of acetous perchloric acid.

Determination of Adrenaline.
Determination of glaphenine HCl.
Determination of benzoic acid.
Assay of paracetamol tab.
Assay of sulphaguanidine tab.
Assay of chloramphenicol caps.

5 & 6 **Precipitimetric and complexometric titrations**

Standardization of N/10 $AgNO_3$.
Standardization of N/10 amm. thiocyanate.
Determination of NH_4Cl by Volhard's method.
Determination of NH_4Cl by Fajans' method.
Mercurimetric determination of chloride.
Mercurimetric determination of I^-.
Standardization of M/20 EDTA.
Determination of hardness of water (Ca^{++} and Mg^{++}).
Determination of Ca. gluconate.
Precipitation (chloral hydrate draught).
(a) for chloral hydrate.
(b) for pot. bromide.
Determination of chlorobutol.
Determination of zinc oxide.

7 **Practical examination**

Lab. No.

8 & 9 **Redox titrations**

Standardization of N/10 $KMnO_4$ solution.
Standardization of N/10 iodine.
Assay of Vit. C tab.
Bromometric determination of Aspirin.
Assay of phenazone powder.
Assay of ferrous gluconate by amm. ceric SO_4.
Assay of ferrous gluconate by potassium dichromate.
Assay of ferrous gluconate by $KMnO_4$.
Determination of glycerol.

10 & 11 **Redox titrations**

Determination of hydrogen peroxide.
Determination of formic acid.
Determination of calcium lactate.
Assay of isoniazid tablets.
Determination of iodide (Andrew's method)
Determination of glucose by IO^- (hypoiodite).

Determination of phenol.
Prescription: Iodo-salicylic acid.
(a) for iodine.
(b) for salicylic acid.

12 & 13 **Gravimetry**

Determination of $Ca.^{++}$
Determination of piperazine.

14 **Practical exam**

PHC 262: PHARMACEUTICAL ANALYTICAL CHEMISTRY-II (2 + 1)

Prereq.: PHC 261

Course Description

The course furnishes a broad basis for instrumental analysis which comprises, colorimetry, UV-spectrophotometry, fluorometry, IR-spectrometry, flame photometry, atomic absorption, spectrophotometry, polarimetry, refractometry, conductiometry and potentiometry. Furthermore, nuclear magnetic resonance (NMR), mass-spectrometry and high-performance liquid chromatography (HPLC) will be briefly introduced.

Theoretical	**No. of Lectures**
Ultra-violet and visible spectrophotometry -Interaction of light with atoms and molecules: (Nature of light, various regions of electromagnetic spectrum, concept of quantization of energy, different types of energy of molecules). -U.V. - visible spectra of compounds: (Chromophores, auxochromes, factors affecting spectra). -Lambert - Beer's Law: (Application to single component and two component mixtures). -Instrumentation: (U.V. - visible spectrophotometers - components and function of each). -Colorimetric reactions: (Classes of reactions, conditions and chromogens).	5
Fluorometry -Theoretical background: (Exchange-energy processes induced, spectra, structural and environmental factors). -Fluorescence intensity and concentration. -Instrumentation: (Features of filter fluorimeters and fluorescence spectrophotometers). -Quantitative application.	2
Infra-red spectroscopy -Theoretical background: (Vibrational frequency, bond constant and reduced mass. Fundamental, combination and overtone bands. Degrees of freedom. Modes of vibaration).	4

-Sample handling and instrumentation:
(Different sample forms, components of IR-spectrophotometers, energy sources and detectors).

Theoretical	**No. of Lectures**
-Qualitative analysis: (Identification of compounds). -Quantitative application: (Base-line technique).	
Introduction to NMR spectroscopy -Theoretical. -Instrumentation. -Chemical shift. -Spin-spin coupling and decoupling. -Applications.	3
Introduction to MS spectroscopy -Theoretical. -Mass/charge ratio, mass spectrum. -Determination of molecular formula. -Applications.	2
Flame photometry and atomic absorption spectroscopy -Theoretical background: (Thermal excitation and emission, metal ions sensitive to flame emission and absorption methods - spectral and chemical interferences and their minimization). -Instrumentation: (Features of filter photometers and monochromator photometers). -Applications: Determination of alkali metal ions and divalent metal ions of pharmaceutical interest.	3
Polarimetry and refractometry -Theoretical. -Instrumental. -Measurement of angle of rotation. -Measurement of refractive index. -Application to pharmaceutical compounds.	2
Potentiometry and conductometry -Theoretical. -Instrumentation. -pH measurements.	4

-Potentiometric titrations curves.
-Conductance and conductivity.
-Titration curves.
-Application to pharmaceutical analysis.

Theoretical	**No. of Lectures**
-Application to pharmaceutical analysis. -Application of HPLC to pharmaceutical analysis.	1
Examination.	2
Total	28

PHC 262: PRACTICAL

Lab. No.

1 & 3 - Single component analysis ($KMnO_4$)
- Two component analysis
- Ultra violet spectrophotometry

4 & 5 IR spectrophotometry
Spectra of typical organic and pharmaceutical compounds to illustrate -OH, $-NH_2$, -NH, C = O, -COOH, C = C, etc.
Base-line technique
Polarimetry and refractive index

6 & 7 NMR & MS spectroscopy instrumentation
Spectra, interpretation

8 Fluorometric determination of quinine sulphate
λ_{ex}, λ_{em}, linearity, unknown concentrate.

9 Flame photometry and AAS

10 & 11 Potentiometry and conductometry

12 High performance liquid chromatography

13 & 14 Two Practical Exam.

14 Total

PHC 461: INSTRUMENTAL ANALYSIS (2 + 1)

Prereq.: PHC 262

Course Description

The course concerns with the study of the principles and theoretical bases of electrochemical analysis, spectrophotometric analysis as well as separation methods with regard to instrumentation, and application are also included.

Theoretical		No. of Lectures
I.	Ultraviolet and visible spectrophotometry	
	-Beer's Law, Lambert's Law, definitions, derivation, and presentation of spectra.	2
	-Effect and detection of impurities.	1
	-Correction of a constant and linear interferences. Morton & Stubb's method.	1
	-The compensation method & the ΔA method.	1
	-Job's method for complexation & photometric titrations.	1
	-Acid-dye technique and dissociation constant determination.	1
	-Derivative curves of absorption spectra.	1
II.	Optical rotatory dispersion & circular dichroism (ORD & CD).	2
III.	High performance liquid chromatography	
	-Instrumentation (choice of detector for different groups of drugs).	1
	-Choice of optimum systems for selected groups of drugs in various dosage forms.	2
	-Detection of degradation products and excipients	2
	-Separation and quantification of mixtures in various dosage forms.	2
	-Stability-indicating methods of assay.	1

VI. Electrochemical analysis

Potentiometric analysis 4

-Sign conventions for electrode processes, application of e.m.f. measurements for determination of Keq, Ksp, Ka and Kb.

-Non-aqueous potentiometric titrations, different solvents and electrodes used.

Theoretical	No. of Lectures
Polarography -Principles of polarography: features of polarograph-instrumentation-DME and its limitations. -Polarographic maxima - maxima suppressors - deaeration - diffusion current and Ilkovic equation. -Evaluation methods: calibration curve, standard addition and internal standard methods.	2
-Amperometric and biamperometric titrations.	2
Exams.	2
Total	28

PHC 461: Practical

Lab. No.

I. **Ultraviolet and visible spectrophotometry**

1 -Beer's Law - recording - stray light effect - calculation of constants-deviations - absorabance ratio - log A vs. plots - optimum conditions - applications.

2 -Typical benzenoid structures - isosbestic point - solvent effect - pH effect - dissociation constant - chromophores & auxochromes.

3 -Acid-dye technique - compensation method - correction of linear interference - the ΔA method.

-First and second derivative curves of absorption spectra - recording - linearity.

4 II. **Optical rotatory dispersion**

5 Practical examination.

III. **High pressure liquid chromatography**

i) Factors affecting the separation and analysis usng HPLC. 6

ii) Calculation of capacity factor, No. of theoretical plates and resolution using clobazam stanard and tablets.

Pharmaceutical Applications:

7 Sulphatriad.
Isoniazid tabs or paracetamol paed. drops.
Continuation:
Septrin tabs (Sulphamethoxazole + trimethoprim).

8 Chloramphenicol capsules.

9 **Practical exam.**

VI. **Electrochemical analysis**

Lab. No.

10 Non-aqueous potentiometric titrations:
-Use of semi-automatic potentiograph for the assay of basic medicinal agents in various dosage forms e.g. tablets, ointment suppori-tories, oily liquid preparation etc. using acetous 0.1 N - perchloric standard solution.

11 **Polarography**
-Recording of a polarogram of a typical electro-active substance e.g. Cd^{++}. Determination of $E_{1/2}$, residual current, diffusion and limiting currents.
-Demonstration of effect of oxygen during polarographing.
-Demonstration of effect of maximum suppressor and supporting electrolyte.
Evaluation methods
-Calibration curve method) Solution of Cd^{++}
) and Zn^{++} are used
-Standard addition method) for illustration.
-Internal standard method)
Amperometric titration
12 -Pb^{++} against $SO_4^{=}$.
-Pb^{++} against $Cr_2O_7^{=}$.
Bi-amperometric titration (dead-stop)

13 -Various medicinal agents (e.g. sulphonamides) are titrated against standard $NaNO_2$ in dil. HCl medium.
-Determination of moisture content in various pharmaceutical formulation by Karl Fisher method.

14 **Practical Examination**

14 Total

PHC 524: Spectroscopic Methods in Drug Analysis (2+1)

The course deals with application of advanced methods in single- and multi-component spectrophotometric and spectrofluorimetric analysis of pharmaceutical compounds. Chemical derivatization and functional group analysis using colorimetric methods are also discussed.

Course Description

		No. of Lectures
A.	Introduction	3
	a) Chemical and instrumental factors causing deviation from Lambert-Beer's Law b) Effects of stray light c) Relative photometric concentration error () C/C).	
B.	Advanced methods used in single- and multi-component spectrophotometric and spectro-fluorimetric analysis of pharmaceutical compounds: a) Compensation method b) Difference spectrophotometry () A) c) Absorbance ratio method d) Geometric polynomial methods e) Least squares method f) Orthogonal polynomial method g) Fourier function method.	5
C.	Derivative spectroscopy: first-, seonc- and higher derivative, i.e., $d_nA/d\lambda^n$, and their use in quantitation characterization of pharmaceutical compounds.	
D.	Derivative spectrofluorimetry	5
E.	Photolysis	3
F.	Chemical Derivatization : a) Acid-dye techniques b) Charge-transfer complexometry c) Functional group analysis	10

d) Metal-ligand complexation (Job's method)

Two Theoretical Exams.	2
	28

PHC 524: PRACTICAL

(A) A set of experiments will be conducted to investigate

- Deviations from Lambert-Beer's Law.
- Stray light effects.
- The relative photometric concentration error () C/C).

(B) Suitable UV-light absorbing systems will be utilized to demonstrate the mathematicl methods used in multi-component spectrophotometric analysis of pharmaceuticals.

(C) Experiments on first- and second-derivative absorption curves methods to illustrate the use of derivative UV-spectroscopy in quantitation of drug mixtures.

(D) Selected experiments will be performed to show the application of:

acid-dye techniques
charge-transfer complextion
functional group analysis
metal-ligand chelation

in colorimetric analysis of pharmaceutical compounds.

(E) Two practical Exams.

PHC 527: Chemical Kinetics in Drug Analysis (2+1)

The course is tailored to introduce chemical kinetics on experimental and theoretical basis. Kinetic parameters involving order of reaction, rate constant, activation energy and related parameters will be presented. In addition, the use of kinetic methods in quantitation will be elaborated and the link between mechanism and reaction kinetic is highlighted.

Course Description

No. of Lectures

A. Kinetic laws and types of reaction

a) Rate of reaction 9
b) Order of reaction (zero-, first-, second-orders ... etc)
c) Analysis of kinetic results (the method of integration and the differential method)
d) Molecularity of reactions
e) Opposing reactions
f) Consecutive reactions
g) Chain reactions
h) Effect of temperature on rate of reaction (Arrhenuis law)
i) Activation energy (E_a)
j) Determination of rate constant and E_a (Arrhenuis plot)
k) Transition-state theory

B. Factors affecting rate of reaction: 4

a) Polarity of the medium (solvent, ionic strength and type of buffer)
b) Catalysis (catalysed and uncatalysed reactions, acid and base catalysis)
c) pH

C. Acyl-transfer reactions: 4

a) Hydrolysis of carboxylic acid derivatives (RCOX)
b) Nucleophilic catalysis in hydrolytic reactions of RCOX
c) Structure of reactivity: Alkaline hydrolysis for esters (RCOR')

D. Kinetic methods of analysis (Medium rate reaction) 4

a) Initial rate method
b) Fixed time method
c) Variable time method

E. Stability-indicating analytical methods 3

	Selected methods adequately specific to distinguish between intact drug and its degradation products	
F.	Kinetic and mechanism:	2
	Some selected chemical reactions will be studied for illustration	
	Two Theoretical Exams	2
		28

PHC 527: PRACTICAL (CHEMICAL KINETICS IN DRUG ANALYSIS)

(A) Determination of

a) Order of reaction)
b) rate constant) using the differential method.
c) half-life)

First-order reactions.
Pseudo first-order reactions.

(B) Alkaline hydrolysis of an ester.

- Effect of [OH^-] on velocity of reaction.
- Effect of [ester] on velocity of reaction.
- Determination of order of reaction.

(C) Determination of the effect of temperature on the rate constant (Arrhrnius plot) using suitable systems.

- Estimation of activation energy (E_a).
- Estimation of frequency factor.

(D) Determination of the rate constants k_1, and k_{-1} and equilibrium constant (K_{eq}) for an opposing first-order reaction using a suitable reaction system.

(E) Selected kinetic methods of analysis.

(F) Selected experiments using stability-indicating methods.

(G) Two practical mid-term exams.

PHC 591: Pharmaceutical Literature (1+0)

A course designed to familiarize the student with the current pharmaceutical and medical literature and critically evaluate them. The course serves as a convenient guide for obtaining relevant information from the enormous literature in the field.

PHC 592: Seminar (1+0)

In this course the student is required to prepare and orally presents a short review lecture on a selected specialized topic of current interest in the field of pharmaceutical chemistry.