|  |  |
| --- | --- |
| **Course Title:** | Electrochemical Methods of Analysis |
| **Course Code:** | **CHEM 552** |
| **Program:** | **MSc. Program** |
| **Department:** | **Chemistry** |
| **College:** | **Science** |
| **Institution:** | **King Saud University** |

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# Course Identification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1. Credit hours:** | | 2 (2+0) | | |
| **2. Course type** | | | | |
|  | **☐✓**Required | | **☐**Elective | |
| **3. Level/year at which this course is offered:** | | | | **3rd level/ Second year** |
| **4. Pre-requisites for this course** (if any)**: NA** | | | | |
| **5. Co-requisites for this course** (if any)**: NA** | | | | |
|  | | | | |

**6. Mode of Instruction** (mark all that apply)

| **No** | **Mode of Instruction** | **Contact Hours** | **Percentage** |
| --- | --- | --- | --- |
| **1** | **Traditional classroom** | 2 | 100% |
| **2** | **Blended** |  |  |
| **3** | **E-learning** |  |  |
| **4** | **Distance learning** |  |  |
| **5** | **Other** |  |  |

**7. Actual Learning Hours** (based on academic semester)

|  |  |  |
| --- | --- | --- |
| **No** | **Activity** | **Learning Hours** |
| **1** | **Lecture** | 24 |
| **2** | **Laboratory/Studio** | - |
| **3** | **Seminars** | - |
| **4** | **Others** (specify) |  |
| **Total** | |  |

# 

# B. Course Objectives and Learning Outcomes

|  |
| --- |
| 1. Course Description This one-semester course introduces the fundamentals of electrochemistry and commonly used electroanalytical methods. Frontiers research in various fields using these electrochemical techniques will be discussed |
|  |
| 2. Course MainObjective |
| 1. Understanding of the basic theory and the practical aspects of the operation of electrochemical cells. 2. Knowing and understanding the types of electrochemical methods of Analysis (types of interfacial methods and bulk methods). 3. The implementation of these techniques in the electrochemical Quantitative Analysis |

## 3. Course Learning Outcomes

| **Course Learning Outcomes (CLOs)** | | **Aligned PLOs\*** |
| --- | --- | --- |
| 1 | **Knowledge and Understanding** |  |
| 1.1 | Define and describe the basic concepts and theories of electrochemical techniques. | K1 |
| 1.2 | Recall the analytical applications related to the electroanalysis methods. | K2 |
| **2** | **Skills :** |  |
| 2.1 | Recognize the theory of the main categories of electroanalytical methods; Bulk electrolysis: (electrogravimetry and coulometry), potentiometry, polarography, voltammetryand stripping methods. | S1 |
| 2.2 | Explain the basic components of electroanalytical technique. | S1 |
| 2.3 | Recognize the theory of the main categories of electroanalytical methods; Bulk electrolysis: (electrogravimetry and coulometry), potentiometry, polarography, voltammetry and stripping methods. | S2 |
| **3** | **Values:** |  |
| 3.1 | Discuss and solve the problems individually and with group. | V1 |
| 3.2 | Giving presentation on some topics in electrochemical analysis. | V2 |

\* Program Learning Outcomes

# C. Course Content

|  |  |  |
| --- | --- | --- |
| **No** | **List of Topics** | **Contact Hours** |
| 1 | Electrochemical cells – Conduction in a cell – Solution structure, the double layer – Faradaic and nonfaradaic currents – Mass transfer in cells with the passage of current – Galvanic and electrolytic cells – Liquid junction potential – Schematic representation of cells. | 2 |
| 2 | Electrode potentials – Formal potentials – Ohmic potential (IR drop) -Effect of other equilibria on standard potentials – Determination of solubility product, dissociation and formation constants by potential measurements (examples and problems). | 2 |
| 3 | Types of electroanalytical methods – Potentiometric methods – Reference electrodes - Types of indicator electrodes – Ion selective electrodes – Glass electrode for pH measurements (composition, structure and electrical conduction). | 4 |
| 4 | The potential of glass electrode – errors affecting the measurements of pH with glass electrodes – Crystalline membrane electrodes – The Fluoride electrode – Electrodes based on Silver salts – Liquid membrane electrodes – Molecular selective electrode systems – Gas sensing probes – Biocatalytic membrane electrodes. | 2 |
| 5 | Instruments for measuring cell potentials – Potentiometer – Direct potentiometric methods – Equations for direct potentiometry – Calibration curves for concentration measurements – Standard addition method – The operational definition of pH – Potentiometric titrations ( zero, first and second derivative curves) –Null point potentiometry – Applications on potentiometry. | 2 |
| 6 | Units for quantity of electricity (examples and problems) – Types of Coulometric methods (potentiostaticcoulometry, amperostaticcoulometry and instrumentation) – Applications – Types of coulometric titrations ( applications and instrumentation) – Comparison of coulometric and volumetric titrations – Advantages of coulometric titrations – Sources of errors in coulometric titrations. | 2 |
| 7 | Voltammetry – Advantages of voltammetry – Excitation signals in voltammetry –Linear scan voltammetry – Voltammetric systems – Microelectrodes – Types of Mercury microelectrodes (Mercury film electrode, hanging mercury dropping electrode (HMDE) and dropping mercury electrode (DME)) - Voltammograms –Half wave potential. | 2 |
| 8 | Hydrodynamic voltammetry – Concentration profiles at microelectrode surfaces during electrolysis –Voltammetric currents – Current/voltage relationships for reversible reactions - Current/voltage relationships for irreversible reactions - Voltammograms for mixtures of reactants – Anodic and mixed anodic/cathodicvoltammograms – Oxygen waves. | 2 |
| 9 | Applications of hydrodynamic voltammetry – Voltammetric detectors in chromatography and FIA – Voltammetric sensors – Clark oxygen sensor – Amperometric titrations – Types of amperometric electrodes –Cyclic voltammetry – Cyclic voltametric excitation signals and cyclic voltammograms – Advantages and applications. | 2 |
| 10 | Polarography – Polarographic currents – Polarograms – Diffusion current at dropping mercury electrodes – Ilkovic equation – Residual currents – Comparison of currents from DME and stationary planar electrode – Advantages and disadvantages of the DME – Pulse polarographic and voltametric methods – Differential pulse polarography – Square wave polarography and voltammetry – Applications of polarography – Stripping methods – Adsorptive stripping methods. | 4 |
| **Total** | | 24 |

# D. Teaching and Assessment

## 1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

| **Code** | **Course Learning Outcomes** | **Teaching Strategies** | **Assessment Methods** |
| --- | --- | --- | --- |
| **1.0** | **Knowledge and Understanding** | | |
| 1.1 | Define and describe the basic concepts and theories of electrochemical techniques. | -Lectures  - Quizzes  - Presentations | -Homework assignments  -Midterm and final exams  -Final exam |
| 1.2 | Recall the analytical applications related to the electroanalysis methods. |  | -Homework assignments  -Midterm and final exams  -Final exam |
| **2.0** | **Skills** | | |
| 2.1 | Recognize the theory of the main categories of electroanalytical methods; Bulk electrolysis: (electrogravimetry and coulometry), potentiometry, polarography, voltammetryand stripping methods. | -Homework’s  -Using available electronic technology in teaching | -Direct questions  -Midterm and final exams  -Homework assignments |
| 2.2 | Explain the basic components of electroanalytical technique | - Homework’s  - Using available electronic technology in teaching | -Direct questions  -Midterm and final exams  -Homework assignments |
| 2.3 | Recognize the theory of the main categories of electroanalytical methods; Bulk electrolysis: (electrogravimetry and coulometry), potentiometry, polarography, voltammetryand stripping methods. | - Homework’s  - Using available electronic technology in teaching | -Direct questions  -Midterm and final exams  -Homework assignments |
| **3.0** | **Values** | | |
| 3.1 | Discuss and solve the problems individually and with group | Demonstration | Evaluating the proficiency in communicating the results |
| 3.2 | Giving presentation on some topics in electrochemical analysis | -Encourage students to collect information through university provided Wi-Fi  -Demonstration | Evaluating individual presentations |

## 2. Assessment Tasks for Students

| **#** | **Assessment task\*** | **Week Due** | **Percentage of Total Assessment Score** |
| --- | --- | --- | --- |
| **1** | Quizzes and homework | Week 1, 2 and 3 | 10% |
| **2** | Midterm exam - 1 | Week 5 | 20% |
| **3** | Midterm exam - 2 | Week 9 | 20% |
| **4** | oral presentation | Week 10 | 10% |
| **5** | Final exam | Week 13 | 40% |
| **6** |  |  |  |
| **7** |  |  |  |
| **8** |  |  |  |

**\*Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

# E. Student Academic Counseling and Support

|  |
| --- |
| **Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:** |
| Office hours: 4 h/week  Previous exams and their answers |

# F. Learning Resources and Facilities

## 1.Learning Resources

|  |  |
| --- | --- |
| **Required Textbooks** | "Fundamentals of Analytical Chemistry", Skoog, West, Holler and Crouch, 8th edition. |
| **Essential Reference Materials** | "Principles of Instrumental Analysis", Skoog, Holler and Crouch, 6th edition. |
| **Electronic Materials** | http://en.wikipedia.org/wiki/Electroanalytical\_method, Science Direct (Web Site.) |
| **Other Learning Materials** | Handouts and Power Point Presentations |

## 2. Educational and research Facilities and Equipment Required

| **Item** | **Resources** |
| --- | --- |
| **Accommodation**  (Classrooms, laboratories, demonstration rooms/labs, etc.) | Classroom with 25 seats. |
| **Technology Resources**  (AV, data show, Smart Board, software, etc.) | Data show, Smart board and internet in classrooms |
| **Other Resources**  (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list) | The presence of related equipments |

# G. Course Quality Evaluation

| **Evaluation**  **Areas/Issues** | **Evaluators** | **Evaluation Methods** |
| --- | --- | --- |
| Effectiveness of teaching and assessment | postgraduate students | Student questionnaires |
| Extent of achievement of course learning outcomes | Peer Reviewer  Program Leaders | Peer consultation on teaching  Departmental council meetings |
|  |  |  |
|  |  |  |
|  |  |  |

**Evaluation Areas/Issues** (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)

**Evaluators** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

**Assessment Methods** (Direct, Indirect)

# H. Specification Approval Data

|  |  |
| --- | --- |
| **Council / Committee** |  |
| **Reference No.** |  |
| **Date** |  |