|  |  |
| --- | --- |
| **Course Title:**  | **Physical Methods in Inorganic chemistry**  |
| **Course Code:** | **CHEM 523** |
| **Program:** | **Master of Science in Chemistry (M.Sc.)** |
| **Department:**  | **Chemistry** |
| **College:** | **Science** |
| **Institution:** | **King Saud University** |

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# Course Identification

|  |  |
| --- | --- |
| **1. Credit hours:** | 2 (2+0+0) |
| **2. Course type** |
|  | [x] Required | [ ] Elective |
| **3. Level/year at which this course is offered:** | 3rd Level / 1st 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** | 28 | 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** |  26 |
| **2** | **Laboratory/Studio** |  - |
| **3** | **Seminars** |  0 |
| **4** | **Others** (specify) |  2 |
| **Total** | 28 |

#

# B. Course Objectives and Learning Outcomes

|  |
| --- |
| 1. Course Description This course will build up on the student’s knowledge about the spectroscopy acquired in the inorganic chemistry course. The course will start with a review of the basic properties inorganic spectroscopy. and application of selection rules to different types of spectroscopy. Electronic spectroscopy of transition metal complexes, Vibrational spectroscopy, Rotational spectroscopy, ESR spectroscopy, NMR spectroscopy, and Mossbauer spectroscopy and x- ray single crystal analysis of inorganic compounds. |
| 2. Course Main Objective |
| After completing this course the student will be able to understand the key features of spectroscopy of inorganic compounds, including: * Electronic spectroscopy of transition metal complexes, selection rules, The Russell Saunders Coupling Scheme, Term symbols, Microstate and ground state, Spectroscopic Term Symbols
* Vibrational spectroscopy, selection rules, Interpretation of IR Spectra of ligands and metal complexes.
* Rotational spectroscopy, selection rules, Interpretation of IR Spectra of ligands and metal complexes.
* ESR spectroscopy: selection rules, Characteristics of g, Factors Affecting the Magnitudes of g-Values, Application of ESR.
* NMR spectroscopy: principal of NMR, chemical shift, splitting of signals, integration of signals, Coupling Constant, Application of NMR in Inorganic Compounds.
* Mossbauer spectroscopy
* X- ray single crystal analysis
 |

##

## 3. Course Learning Outcomes

| **Course Learning Outcomes (CLOs)** | **Aligned****PLOs\*** |
| --- | --- |
| 1 | **Knowledge and Understanding** |  |
| 1.1 | State the electronic spectroscopy of transition metal complexes, selection rules | **K1** |
| 1.2 | The Russell Saunders Coupling Scheme, Term symbols, Microstate and ground state, Spectroscopic Term Symbols. | **K2** |
| 1.3 | Describe the Vibrational spectroscopy, selection rules, Interpretation of IR Spectra of ligands and metal complexes.  | **K3** |
| 1.4 | Define the Rotational spectroscopy, selection rules, Interpretation of IR Spectra of ligands and metal complexes | **K3** |
| 1.5 | Describe the ESR spectroscopy, selection rules, Characteristics of g, Factors Affecting the Magnitudes of g-Values, Application of ESR | **K1** |
| 1.6 | Recognized the NMR spectroscopy, principal of NMR, chemical shift, splitting of signals, integration of signals, Coupling Constant, Application of NMR in Inorganic Compounds. | **K2** |
| 1.7 | Define Mossbauer spectroscopy. | **K1** |
| **2** | **Skills :** |  |
| 2.1 | Differentiate the microstates in transition metal complexes and selection rules | **S1** |
| 2.2 | Write the Term symbols, Microstate and ground state, Spectroscopic Term Symbols | **S2** |
| 2.3 | Explain the IR Spectra of ligands and metal complexes.  | **S3** |
| 2.4 | Interpret the Raman Spectra of ligands and metal complexes.  | **S4** |
| 2.5 | Estimate the geometry using ESR spectra  | **S5** |
| 2.6 | Calculate the chemical shift, splitting of signals | **S6** |
| 2.7 | Role of Mossbauer spectroscopy in metal complexes and X- ray analysis | **S6** |
| **3** | **Values:** |  |
| 3.1 | Demonstrate the lecture on any topics related to spectroscopy of inorganic compounds | **V1** |
| 3.2 | Judge the lecture and the quality of the course materials | **V2** |
| 3.3 | Evaluate the mistake and problems in the lectures | **V1** |
| 3.4 | Illustrate some new examples related spectroscopy | **V2** |
| 3.5 | Write the questions and their answers in groups | **V1** |

\* Program Learning Outcomes

# C. Course Content

|  |  |  |
| --- | --- | --- |
| **No** | **List of Topics** | **Contact Hours** |
| 1 | Electronic spectroscopy of transition metal complexes, selection rules, The Russell Saunders Coupling Scheme, Term symbols, Microstate and ground state, Spectroscopic Term Symbols. | 6 |
| 2 | Vibrational spectroscopy, selection rules, Interpretation of IR and Raman Spectra of ligands and metal complexes.  | 4 |
| 3 | Rotational spectroscopy, selection rules, Interpretation of IR Spectra of ligands and metal complexes.  | 4 |
| 4 | ESR spectroscopy: selection rules, Characteristics of g, Factors Affecting the Magnitudes of g-Values, Application of ESR. | 4 |
| 5 | NMR spectroscopy: principal of NMR, chemical shift, splitting of signals, integration of signals, Coupling Constant, Application of NMR in Inorganic Compounds. | 4 |
| 6 | Mossbauer spectroscopy and x- ray single crystal analysis | 4 |
| **Total** | 26 |

#

# 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 | State the electronic spectroscopy of transition metal complexes, selection rules | * Lectures and independent study assignments.
* A written work to be submitted prior to the tutorial.
* Extra classes for weak students
* Lecture Discussions Tutorials Problem Solving sessions
 | * Oral, Quiz, and written exams
* Samples of class and home assignments
* Assessment of processes followed by students to solve problems
* Individual discussion
 |
| 1.2 | The Russell Saunders Coupling Scheme, Term symbols, Microstate and ground state, Spectroscopic Term Symbols. | Do | Do |
| 1.3 | Describe the Vibrational spectroscopy, selection rules of IR and Raman spectroscopy, Interpretation of IR Spectra of ligands and metal complexes.  | Do | Do |
| 1.4 | Define the Rotational spectroscopy, selection rules, Interpretation of IR Spectra of ligands and metal complexes | Do | Do |
| 1.5 | Describe the ESR spectroscopy, selection rules, Characteristics of g, Factors Affecting the Magnitudes of g-Values, Application of ESR | Do | Do |
| 1.6 | Recognized the NMR spectroscopy, principal of NMR, chemical shift, splitting of signals, integration of signals, Coupling Constant, Application of NMR in Inorganic Compounds. | Do | Do |
| 1.7 | Define Mossbauer spectroscopy. | Do | Do |
| **2.0** | **Skills** |
| 2.1 | Differentiate the microstates in transition metal complexes and selection rules, | * Class and home assignments
* Case studies
* Cooperative learning
* Problem solving Comparative case studies Regular follow-up
 | * Oral and written exams
* Samples of class and home assignments
* Assessment of processes followed by students to solve problems
* Individual discussion
 |
| 2.2 | Write the Term symbols, Microstate and ground state, Spectroscopic Term Symbols | Do | Do |
| 2.3 | Explain the IR Spectra of ligands and metal complexes.  | Do | Do |
| 2.4 | Interpret the Raman Spectra of ligands and metal complexes.  | Do | Do |
| 2.5 | Estimate the geometry using ESR spectra  | Do | Do |
| 2.6 | Calculate the chemical shift, splitting of signals | Do | Do |
| 2.7 | Role of Mossbauer spectroscopy in metal complexes and X- ray analysis | Do | Do |
| **3.0** | **Values** |
| 3.1 | Demonstrate the lecture on any topics related to spectroscopy of inorganic compounds | * Meeting with the group of students during office hours to solve their problems related to their topic.
* Encourage them to enjoy the course in a group and support the weak students.
* In addition, writing group reports and support the week students
* Solving problems in groups also support to improve interpersonal skills of students.
* Designing an action plan
* Regular follow-up
* Immediate and delayed feedback from the students
 | * Samples of class and home assignments
* Observation of students’ behavior and interaction within working groups
* Individual and group discussion Oral and written exams
* Samples of class and home assignments
 |
| 3.2 | Judge the lecture and the quality of the course materials | Do | Do |
| 3.3 | Evaluate the mistake and problems in the lectures | Do | Do |
| 3.4 | Illustrate some new examples related spectroscopy | Do | Do |
| 3.5 | Write the questions and their answers in groups | Do | Do |

##

## 2. Assessment Tasks for Students

| **#** | **Assessment task\*** | **Week Due** | **Percentage of Total Assessment Score** |
| --- | --- | --- | --- |
| **1** | Class activates ( in class quizzes, and homework) | weekly | 15% |
| **2** | Midterm exams I | 6 | 20% |
| **3** | Midterm exam II | 12 | 20% |
| **4** | Final exam | 16 | 40% |
| **5** | Others | weekly | 5% |

**\*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:** |
| * Academic advices
* Office hours 3 h / week
* Help sessions 1hr/ week aided by two faculty members
 |

# F. Learning Resources and Facilities

## 1. Learning Resources

|  |  |
| --- | --- |
| **Required Textbooks** | * Spectral Methods in Transition Metal Complexes, K. Sridharan, Elsevier, 2016. ISBN: 978-0-12-809591-1.
* Physical Methods in Inorganic Chemistry by Russell S. Drago (ISBN: 9780278920668)
 |
| **Essential Reference Materials** | * Journal of coordination Chemistry.
* Spectrochimica Acta, Part A: Molecular and Biomolecular Spectroscopy.
 |
| **Electronic Materials** | * Websites on the internet those are relevant to the topics of this course.
* YouTube lectures
 |
| **Other Learning Materials** | * ChemDraw and Chemsketch
 |

## 2. Educational and research Facilities and Equipment Required

| **Item** | **Resources** |
| --- | --- |
| **Accommodation**(Classrooms, laboratories, demonstration rooms/labs, etc.) | Not Applicable |
| **Technology Resources** (AV, data show, Smart Board, software, etc.) | Software and Smart Board |
| **Other Resources** (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list) | Availability of new addition of books, Chemistry Models, relevant to the course material |

# G. Course Quality Evaluation

| **Evaluation****Areas/Issues**  | **Evaluators**  | **Evaluation Methods** |
| --- | --- | --- |
| Strategies for Obtaining Student Feedback on Effectiveness of Teaching |  | * Course evaluation by student
* Students- faculty meetings
* Knowledge exchange program
* Students tour of other institute/s
 |
| Other Strategies for Evaluation of Teaching by the Instructor or by the Department |  | * Peer consultation on teaching
* Departmental council discussions
* Discussions within the group of faculty teaching the course
* Department Monitoring and external evaluation
 |
| Processes for Improvement of Teaching |  | * Conducting workshops given by experts on the teaching and learning Methodologies
* Periodical departmental revisions of its methods of teaching
* Monitoring of teaching activates by senior faculty members
* Relate Work shops
* Attendance Feed Back
* Using the IT inside the Class room (Projector, Laptop, Internet Access)
* Using the U Shape for the Class Room.
* Open Discussion at the end of the lecture
* Seminar Inviting of national and International Speaker to the class room
 |
| Processes for Verifying Standards of Student Achievement |  | Not Applicable |
| Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. |  | * The course material and learning outcomes are periodically reviewed and the changes to be taken are approved in the departmental and higher councils.
* The head of department and faculty take the responsibility of implementing the proposed changes.
* Marks Analysis.
* Survey Make Course Portfolio open discussions and get suggestions

Periodical review of course content |

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

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

**Assessment Methods** (Direct, Indirect)

# H. Specification Approval Data

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