هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T4 2020

Course Specifications

Course Title:	**ATOMIC AND MOLECULAR SPECTROSCOPY**
Course Code:	**2034105-3**
Program:	**Bachelor in Physics**
Department:	**Physics Department**
College:	**College of Science**
Institution:	**Taif University**

Table of Contents

A. Course Identification

1. Credit hours: 3 Hours
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☑ Elective ☐
3. Level/year at which this course is offered: 10th Level / 4th Year
4. Pre-requisites for this course (if any)**: Quantum Physics (1) 2033202-3** **Modern physics 2033105-4**
5. Co-requisites for this course (if any)**: None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	4	100%
2	**Blended**	0	0%
3	**E-learning**	0	0%
4	**Distance learning**	0	0%
5	**Other**	0	0%

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	40
2	**Laboratory/Studio**	0
3	**Tutorial**	0
4	**Others** (specify)	0
	Total	40

B. Course Objectives and Learning Outcomes

1. Course Description

The first half of this course deals principally with atomic structure and the interaction between atoms and electromagnetic waves. Comparing between atomic emission spectroscopy and atomic absorption spectroscopy; Optical spectroscopy, Atomic spectrum, Quantization of hydrogen atom, Atomic emission / absorption spectrophotometry atomic spectroscopy, Spectroscopy of inner electrons. Zeemen's effect, Sodium spectrum, Effect of magnetic field on the energy levels of atom. Theory of magnetic energy, Anomalous Zeeman's effect and Lande splitting factor.

The second half of the course deals with the binding of atoms into molecules, Molecular Spectra of diatomic molecules, Vibrational energy levels in both classical mechanics and quantum mechanics. Rotational spectra of diatomic molecule in gaseous state and rotational energy levels, Molecular spectra; harmonic Oscillator, Non Rigid Rotator, Infrared Vibration, Rotation spectra, spectrum, IR spectrum, RBS spectra, XRD spectrum, measurements of Absorbance, Transmitting and Reflecting using double beam Spectrophotometers in all ranges of wavelengths (UV-VIS-NIR-IR), Normal modes of vibrations; Natural of infrared absorption.

2. Course Main Objective

The aim of the course is that the student at the end of the course shall:

- Describe the atomic emission / absorption spectrophotometry and molecular spectroscopy
- Describe the atomic spectra of one and two valance electron atoms.
- Explain the change in behaviour of atoms in external applied electric and magnetic field.
- Explain rotational, vibrational, electronic and Raman spectra of molecules.
- Describe electron spin and nuclear magnetic resonance spectroscopy and their applications.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Define the nature of the interaction between the electromagnetic waves with matter and its associated spectra.	K2
1.2	Recognize theories explaining the structure of atoms and the origin of the observed spectra.	K3
2	**Skills :**	
2.1	Devise an instrumental procedure to account for molecular absorption and scatter from particulate matter in atomic absorption spectroscopy.	S1
2.2	Develop problem solving skills in spectroscopy physics	S2
3	**Values:**	
3.1	Show responsibility for working independently and for continuous improvement of personal capacities.	V1

C. Course Content

No	List of Topics	Contact Hours
1	Definition of the spectra, types (emission and absorption) and forms of the spectra (continuous, band and line) Electromagnetic waves, interaction of electromagnetic waves with matter, the main parts of the spectrophotometer (sources, dispersion units, samples compartment and detection unit)	4
2	The main atomic models (Tomson, Rutherford and Bohr) Hydrogen atom review	3
3	Calculation of the energies, wavelengths, frequencies and wave numbers of the Hydrogen atom series, the reasons for failure of Bohr model	3
4	Quantum numbers and atomic structure review, Pauli's Exclusion principles and Hund's rules, degeneracy, couples angular momentum	3
5	Spin – orbit (LS) coupling and fine structure, hyperfine interactions	3
6	Spectral consequences of the fine structure, selection rules, Helium energy levels	3
7	Atoms and field interactions, dipole interactions	3
8	Normal and anomalous Zeeman's effect, Lande – g – factor	3

9	Spectral consequences of the applied fields, Stark effect	3
10	Atom - atom Interactions, Bonding: Van der Waals, covalence	3
11	New degrees of freedom rotations and vibrations	3
12	Molecular electronic spectra	2
13	Experimental probes ultra violet (UV), visible (Vis)	2
14	Infrared (IR) and Raman spectroscopy, Selection rules	2
Total		40

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 the nature of the interaction between the electromagnetic waves with matter and its associated spectra.	Lecture	Written exam and Homework reports
1.2	Recognize theories explaining the structure of atoms and the origin of the observed spectra.	Lecture Discussion	Written exam
2.0	**Skills**		
2.1	Devise an instrumental procedure to account for molecular absorption and scatter from particulate matter in atomic absorption spectroscopy.	Groups discussion	Written exam
2.2	Develop problem solving skills in spectroscopy physics	Lecture and Group discussion	Homework reports
3.0	**Values**		
3.1	Show responsibility for working independently and for continuous improvement of personal capacities.	Group discussion	Project

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Activities	Periodically	10%
2	Midterm exam	6^{th}	30%
3	Short exam	9^{th}	10%
4	Final exam	12^{th}	50%

***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 :

- Each faculty member is assigned a group of students for continuous academic advice during six weekly office hours (6 hrs./week).
- Also teaching staff are available for individual student consultations during this period.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	1- Atomic and molecular spectroscopy; basic aspects and practical applications Svanberg S., springer, 2003. 2- Modern spectroscopy, Hollas, J. M., John Willy and Sons, Ltd. 2004.
Essential References Materials	1- Atomic spectra and atomic structure, Herzberg, G., Dover Pwblications, New York, 1944. 2- Introduction to atomic spectra, White, H. E. McGraw-Hill Book Company, Inc. New York and London, 1934.
Electronic Materials	Web Sites on the internet that are relevant to the topics of the course & general physics websites such as : 1- http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html 2- http://www.hazemsakeek.info/magazine/
Other Learning Materials	1- Multi media / CD associated with the text books (when available).

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	- Lecture room with max 50 seats.
Technology Resources (AV, data show, Smart Board, software, etc.)	- Computer room containing at least 10 stations - Software (MATLAB, Mathematica, Origin ……) data show, Smart Board, software
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	Not applicable for this course

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Student Feedback on Effectiveness of Teaching	Students	Indirect
Evaluation of Teaching	Pear reviewer Program coordinator Departmental council Faculty council	Indirect
Improvement of Teaching	Program coordinator Relevant committee	Direct
Quality of learning resources	Students Instructor Faculty	Indirect
Extent of achievement of course learning outcomes,	Program coordinator Instructor	Direct

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Course effectiveness and planning for improvement	Program coordinator Instructor	Indirect

Evaluation areas (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	October 2, 2022