**MS/M.Phil /Ph.D**

**Advanced Spectroscopic Techniques**

**Inorganic Chemistry**

**Contact Hours:** **Credit Hours:**

Theory =48 Theory = **3.0**

Practical = 00 Practical = 0.0

Total = 48 Total = **3.0**

**Code =**

 **--------------------------------------------------------------------------------------**

**Course Objectives**

The objectives of the course are:-

1. To develop an understanding modern spectroscopic that governs spectroscopic measurements and allow scientists of all disciplines to characterize chemical structure and chemical reactions.
2. To develop knowledge in interpretation of results of FTIR, mass spectrometer NMR spectroscopy.

**COURSE LEARNING OUTCOMES:**

Upon successful completion of the course, the student will be able to:

1. Understand the use spectroscopic terminology and concepts explain how various regions of the electromagnetic spectrum can be used to measure different aspects of molecules structure.
2. Analyze real experimental data to retrieve information about chemical and biological systems
3. Interpret the data results of NMR, Mass spectrometry, Raman and FTIR techniques used to measure structure and photochemical reactions

**Course outline:**

1. Electronic spectroscopy (UV-Visible-NIR), Laser spectroscopy
2. Absorption and Fluorescence spectroscopy including use in biology
3. Vibrational spectroscopy and introduction to FTIR, Michelson Interferometer, Fourier transform of a time domain signal
4. Advanced Raman techniques: Surface-enhancement, plasmonics and some bioanalytical applications
5. Photochemistry - chemical reactivity from spectroscopic measurements. Time-resolved spectroscopy -Wave packets and transition state spectroscopy
6. NMR, Physical principles of NMR, Bulk magnetization vector, e Induction decay and relaxation, Multiple NMR spectroscopy, Mass spectroscopy, GC-MS and LC-MS.
7. Advanced types of spectroscopy: [Circular Dichroism](https://en.wikipedia.org/wiki/Circular_Dichroism) (CD) spectroscopy; [Coherent anti-Stokes Raman spectroscopy](https://en.wikipedia.org/wiki/Coherent_anti-Stokes_Raman_spectroscopy): applications, [Inelastic electron tunneling spectroscopy](https://en.wikipedia.org/wiki/Inelastic_electron_tunneling_spectroscopy).
8. [Laser-induced breakdown spectroscopy](https://en.wikipedia.org/wiki/Laser-induced_breakdown_spectroscopy), [Mossbauer spectroscopy](https://en.wikipedia.org/wiki/M%C3%B6ssbauer_spectroscopy), [Spin noise spectroscopy](https://en.wikipedia.org/w/index.php?title=Spin_noise_spectroscopy&action=edit&redlink=1),  [Time-resolved spectroscopy](https://en.wikipedia.org/wiki/Time-resolved_spectroscopy) measures, [Time-stretch](https://en.wikipedia.org/wiki/Time_stretch_analog-to-digital_converter) spectroscopy
9. [Thermal infrared spectroscopy](https://en.wikipedia.org/wiki/Thermal_infrared_spectroscopy), [Transient grating spectroscopy](https://en.wikipedia.org/wiki/Transient_grating_spectroscopy)

**Teaching Methodology**

* Lecturing
* Written Assignments/Presentations

**Assessment**

**Mid Term (40%)**

* Written (Long Questions, Short Questions, MCQs) 50%
* Presentation 20%
* Assignments 20%
* Quiz 10%

**Final Term (60%)**

* Written (Long Questions, Short Questions, MCQs) 50%
* Presentation 20%
* Assignments 20%
* Quiz 10%

**Text and Reference books:**

1. Modern Spectroscopy (2004).
2. Fundamentals of Molecular Spectroscopy (1994).
3. Laser Chemistry. Spectroscopy, dynamics and applications (2007).
4. Silverstein, R.M; Webster, F.X. Spectroscopic Identification of Organic Compounds, 6th ed. John Wiley & Sons.Inc.New York, 1998.
5. Demtröder Wolfgang, **Laser spectroscopy. Vol. 1 Basic principles**
4th ed. Berlin: Springer: cop. 2008.
6. Demtröder Wolfgang Laser spectroscopy, Vol. 2 Experimental techniques
4. ed. Berlin: Springer: cop. 2008.
7. Crouch, Stanley; Skoog, Douglas A. (2007). Principles of instrumental analysis, Australia: Thomson Brooks.
8. [W. Demtröder](https://en.wikipedia.org/wiki/W._Demtr%C3%B6der), Laser Spectroscopy, 3rd ed. (Springer, 2003).
9. [Brian Orr](https://en.wikipedia.org/wiki/Brian_Orr); J. G. Haub; Y. He; R. T. White (2016). "Spectroscopic Applications of Pulsed Tunable Optical Parametric Oscillators". In [F. J. Duarte](https://en.wikipedia.org/wiki/F._J._Duarte). Tunable Laser Applications (3rded.), Boca Raton: [CRC Press](https://en.wikipedia.org/wiki/CRC_Press). p. 17-142.
10. Wang, Xiping; Wacker, James P. (2006). ["Using NIR Spectroscopy to Predict Weathered Wood Exposure Times"](http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_wang002.pdf) (PDF). WTCE 2006 - 9th World Conference on Timber Engineering.
11. John M. Chalmers; Peter Griffiths, eds. (2006). Handbook of Vibrational Spectroscopy, 5th Vol. New York: Wiley.
12. Jerry Workman; Art Springsteen, eds. (1998). [Applied Spectroscopy](https://books.google.com/?id=OzAnX25h4soC&pg=PR4). Boston: Academic Press.
13. Peter M. Skrabal (2012). [Spectroscopy- An interdisciplinary integral description of spectroscopy from UV to NMR](https://vdf.ch/index.php?route=product/search&search=skrabal) (e-book).