



MAHATMA GANDHI UNIVERSITY, KERALA

Abstract

Academic - Ph.D. Programme in Nanoscience and Nanotechnology - IIUCNN - Course II of Course Work (2025 Admission December Session) - Revised Syllabus - Approved - Orders Issued.

ACADEMIC A 11 SECTION

No. 9247/AC A 11/2026/MGU

Priyadarsini Hills, Dated: 23.10.2026

- Read:-* 1. Letter No. 14/REG/IIUCNN/2026-27 dated 29.06.2026 received from the Hon. Director, IIUCNN
2. U.O. No. 7876/AC A 11/2026/MGU dated 24.08.2026
3. Report received from Dr. Beena Mathew, Professor of Eminence, School of Chemical sciences dated 30.09.2026

ORDER

The Hon'ble Director, International and Inter University Centre for Nanoscience and Nanotechnology (IIUCNN), vide paper cited (1) above, had requested to approve the revised syllabus of Course II for the Course Work of Ph.D Programme in Nanoscience and Nanotechnology (2025 Admission December Session), prepared by Dr. Raji V, Assistant Professor, School of Biosciences, Mahatma Gandhi University.

An expert committee was constituted with Dr. Beena Mathew, Professor of Eminence, School of Chemical sciences, as Convenor, to examine the said syllabus, vide order cited (2) above. The expert committee examined the syllabus and unanimously recommended the same, vide paper read (3) above.

Sanction has therefore been accorded by the Vice-Chancellor to approve the revised syllabus of Course II for the PhD Course Work Examination of the research scholars registered at International and Inter University Centre (IIUCNN), in the discipline Nanoscience and Nanotechnology, 2025 Admission (December Session).

The approved copy of the syllabus and model question paper for the discipline 'Nanoscience and Nanotechnology' is appended.

Orders are issued accordingly.

SIJI ANNA KURIEN

ASSISTANT REGISTRAR IV

(ACADEMIC)
For REGISTRAR

Copy To

1. Hon. Director, IIUCNN
2. Dr. Beena Mathew, Professor of Eminence, School of Chemical Sciences
(Convenor, Expert Committee)
3. Dr. Raji V, Assistant Professor, School of Biosciences
4. PS to Vice-Chancellor / Pro - Vice Chancellor
5. PA to Registrar / Director of Research
6. Ac A6/ PRO / Records Sections
8. IT Cell / University Website

Forwarded / By Order

Section Officer

MAHATMA GANDHI UNIVERSITY

International and Inter University Centre for Nanoscience and Nanotechnology (IIUCNN)

Syllabus for Ph.D. Course Work (2025 December Admission)

Course -II CNN DC102: Physico-chemical Methods of analysis and Biological Techniques

Credits : 4

Duration : 72 Hrs

Module 1: Spectroscopic methods

15 Hrs

Principles, instrumentation and applications of the following spectroscopic techniques: infrared(IR) spectroscopy, Raman spectroscopy, nuclear magnetic resonance(NMR) spectroscopy, electron spin resonance(ESR) spectroscopy, mossbauer spectroscopy, nuclear quadrupole resonance (NQR) spectroscopy, fluorescence spectroscopy, atomic absorption spectroscopy (AAS), atomic emission spectroscopy (AES), inductively coupled plasma atomic emission spectroscopy, UV/Visible spectroscopy and mass spectroscopy. Principles, instrumentation and applications of auger electron spectroscopy, secondary ion mass spectroscopy (SIMS), X-ray photoelectron spectroscopy (XPS).

Module II: Microscopic Techniques and Thermal analysis

15 Hrs

Principle, instrumentation and applications of atomic force microscopy(AFM), optical microscopy, scanning probe microscopy(SPM), scanning tunneling microscopy(STM), scanning electron microscopy(SEM), transmission electron microscopy(TEM). Applications of microscopy in biological studies – Brightfield microscopy, phase contrast and Differential Interference Disc microscopy, Fluorescence microscopy, confocal Raman microscopy.

Principle, instrumentation and applications of differential scanning calorimetry (DSC), thermo mechanical analysis(TMA), thermo gravimetric analysis(TGA), dynamic mechanical spectroscopy(DMS), differential thermal analysis(DTA), dielectric thermal analysis(DETA).

Module III: Fundamental methods in biology

15 Hrs

pH, Buffers, methods of expressing concentration of solution. Methods to quantify proteins and nucleic acids. Microbial staining techniques – simple staining and differential staining – bacterial culture media and methods. Sterilization techniques in microbiology – antibiotic sensitivity tests – diffusion and dilution techniques. Immunological techniques: Testing for the evaluation of immunomodulatory effects; Agglutination, precipitation, Western Blotting, Radio Immuno Assay, Immunofluorescence, Electrophoresis, PAGE, PCR.

Module IV: Animal cell culture

12 Hrs

Cell culture basics, Culture conditions, Primary vs immortalized cells, Adherent and suspension cultures, Mammalian vs non-mammalian culture, Cell growth and confluency. Cell line, Cell culture media, preparation of media, Aseptic techniques, Primary cell isolation, Subculturing/passaging cells, Cryopreservation and thawing, Testing cells for mycoplasma infection, Cell counting, Cell transfection. Flow cytometry, Determining Cell Viability.

Module V: Concepts of animal experiments

15 Hrs

Experimental animal models, ethical guidelines, acute and chronic toxicity studies – systemic, local, ANS, CVS, anti diuretic anti cancer, analgesic, anti inflammatory, anti asthmatic, immune stimulant, immune suppressor activities. Haematological analyses - respiratory testing, histological techniques, Techniques in Cancer Research.

Anti oxidant assays, free radical scavenging, superoxide scavenging, nitric oxide scavenging, peroxide scavenging; Plant derived medicines – general methods of isolation, purification, identification and estimation of phyto-constituents. CPCSEA guidelines, transgenic animals.

Seminars/Assignments related to Course –II

Seminar: Each student must present a seminar on a biological technique which he/she will be using in his/her research

Assignment: Each student must submit an assignment on a biological technique as per the directions of the course coordinator

REFERENCE:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. *Principles of Instrumental Analysis*, 7th Edition, Cengage Learning, 2018.
2. Christian, G. D., Dasgupta, P. K., & Schug, K. A. *Analytical Chemistry*, 7th Edition, John Wiley & Sons, 2014.
3. Rouessac, F., & Rouessac, A. *Chemical Analysis: Modern Instrumentation Methods and Techniques*, 2nd Edition, John Wiley & Sons, 2013.
4. Murphy, D. B., & Davidson, M. W. *Fundamentals of Light Microscopy and Electronic Imaging*, 2nd Edition, Wiley-Blackwell, 2013.

5. Goldstein, J., Newbury, D. E., Michael, J. R., Ritchie, N. W. M., Scott, J. H. J., & Joy, D. C. *Scanning Electron Microscopy and X-ray Microanalysis*, 4th Edition, Springer, 2018.
6. Brown, M. E. *Introduction to Thermal Analysis: Techniques and Applications*, 2nd Edition, Springer, 2001.
7. Nelson, D. L., & Cox, M. M. *Lehninger Principles of Biochemistry*, 8th Edition, W. H. Freeman, 2021.
8. Wilson, K., & Walker, J. (Eds.). *Principles and Techniques of Biochemistry and Molecular Biology*, 8th Edition, Cambridge University Press, 2018.
9. Abbas, A. K., Lichtman, A. H., & Pillai, S. *Cellular and Molecular Immunology*, 10th Edition, Elsevier, 2021.
10. Freshney, R. I. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*, 8th Edition, Wiley-Blackwell, 2021.
11. Current Protocols Series (Wiley): *Current Protocols in Molecular Biology*, *Current Protocols in Cell Biology*, and *Current Protocols in Immunology*.
12. CPCSEA. *Guidelines for Laboratory Animal Facility and Guidelines for Laboratory Animal Experimentation*, Committee for the Purpose of Control and Supervision of Experiments on Animals, Government of India
13. Sarker, S. D., & Nahar, L. *Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry*, Wiley, 2019.
14. Bancroft, J. D., & Gamble, M. *Theory and Practice of Histological Techniques*, 8th Edition, Elsevier, 2019.

MAHATMA GANDHI UNIVERSITY
International and Inter University Centre for Nanoscience and Nanotechnology
(IIUCNN)

Ph.D. Course Work Examination (2025 December Admission)
COURSE -II CNN DC102: PHYSICO-CHEMICAL METHODS OF ANALYSIS
AND BIOLOGICAL TECHNIQUES

MODEL QUESTION PAPER

PART A

Answer any TEN questions. Each question carries 4 marks. (10 × 4 = 40)

1. Explain the basic principle of FTIR spectroscopy. Mention two applications in biomaterials research.
2. Differentiate between Raman spectroscopy and Infrared spectroscopy.
3. Describe the principle and working of UV-Visible spectroscopy.
4. Explain the principle of Nuclear Magnetic Resonance (NMR) spectroscopy and mention its applications.
5. Compare SEM and TEM with respect to working principle and applications.
6. Explain the principle of Atomic Force Microscopy (AFM). State its advantages over optical microscopy.
7. Discuss the principle of Thermogravimetric Analysis (TGA) and its significance in polymer characterization.
8. Explain the role of buffers in biological experiments. How is buffer capacity influenced?
9. Briefly describe Western blotting and its applications.
10. Explain the principle of Polymerase Chain Reaction (PCR) and list its major applications.
11. Distinguish between primary cell culture and immortalized cell culture.
12. Briefly discuss the importance of CPCSEA guidelines in animal experimentation.

PART B

Answer any 1 out of 2 Each question carries 10 marks. (1 × 10 = 10)

13. You have developed a polymeric scaffold for wound healing. Explain how FTIR, Raman spectroscopy, SEM, AFM, DSC, and TGA can be used to characterize the scaffold. Discuss the information obtained from each technique.
14. Discuss the principles and applications of animal cell culture. Explain culture media preparation, aseptic techniques, cell passaging, cryopreservation, and methods for determining cell viability.