UNIVERSITY OF KERALA

SYLLABUS FOR M. Phil. DEGREE COURSE

IN

NANOSCIENCE AND NANOTECHNOLOGY

Revised syllabus
w.e.f 2015 admission
M. Phil Course in Nanoscience and Nanotechnology

Regulations, scheme and syllabus for the M. Phil degree course in Nanoscience and Nanotechnology

1. Regulations:
   The M. Phil course may be conducted as per the existing M. Phil reformulated regulations No. Acad.L.3855/R/97 dated 18-11-1997.

2. Eligibility:
   The qualification for admission to the M. Phil Degree course in Nanoscience and Nanotechnology shall be a second class Masters Degree in Nanoscience/Nanotechnology/Nanoscience and Nanotechnology/Nanoscience and Technology, Physics, Chemistry, Materials Science or Photonics of this University or a Masters Degree in one of the above subjects from any other University recognized by this University, with not less than 55% marks subject to the rules of relaxation for SC/ST candidates.

3. Admission Procedure:
   Admissions to the M. Phil course will be made on the basis of the marks scored in the Entrance Examination and in the qualifying examination in the ratio 50:50.

4. Number of seats:
   A total of ten (10) candidates will be admitted to the M. Phil course.
UNIVERSITY OF KERALA
M. Phil Course in Nanoscience and Nanotechnology

SCHEME AND SYLLABUS

Scheme of Examination

<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Duration</th>
<th>Max. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper I</td>
<td>RESEARCH METHODOLOGY</td>
<td>3 hrs.</td>
<td>100</td>
</tr>
<tr>
<td>Paper II</td>
<td>NANOMATERIALS AND NANOSCIENCE</td>
<td>3 hrs</td>
<td>100</td>
</tr>
<tr>
<td>Paper III</td>
<td>ADVANCED NANOMATERIALS AND NANOTECHNOLOGY</td>
<td>3 hrs</td>
<td>100</td>
</tr>
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Dissertation 300
Viva-voce 100

TOTAL 700

Distribution of Marks

There will be two parts (Part A and Part B) for the question paper for each of the papers Paper I, Paper II and Paper III. Part A will contain twelve short answer type questions out of which eight questions will have to be answered. Part B will contain six long answer type questions out of which four questions will have to be answered. Mark distribution for each paper will be as follows:

- Part A 8 questions to be answered - 8 x 5 = 40 marks
- Part B 4 questions to be answered - 4 x 15 = 60 marks

Total 100 marks

Marks for Viva-voce based on Dissertation = 100
UNIT 1 OBJECTIVES AND TYPES OF RESEARCH

Meaning of research – Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. (ref: 1,2,3)

UNIT II RESEARCH FORMULATION

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Formulation of a working hypothesis - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – Reviews, treatise, monographs-patents – web as a source – Searching the web and information mining - Critical literature review – Identifying gap areas from literature review. (ref: 1,2,3)

UNIT III RESEARCH DESIGN, METHODS

Research design – Basic Principles- Need of research design – Features of good design – Important concepts relating to research design – Observation and facts, laws and theories. Prediction and explanation, induction, deduction - Development of models - Developing a research plan - Exploration, Description, Diagnosis - Experimentation - Determining experimental and sample design. (ref: 1,2,3,4)

UNIT IV DATA COLLECTION AND ANALYSIS

Execution of the research - Observation and Collection of experimental data. Methods of data collection - Sampling Methods - Sampling techniques, steps in sampling, sampling size, advantages and limitations of sampling - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation. (ref: 1,2,3)

UNIT V REPORTING AND THESIS WRITING


UNIT VI RESEARCH ETHICS

Environmental impacts - Ethical issues - Ethical Committees - Commercialisation – Copy right - royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights - Reproduction of published material-Plagiarism - Citation and acknowledgement - Reproducibility and accountability. (ref: 5)

UNIT VII ERRORS AND UNCERTAINTIES IN MEASUREMENTS

Introduction to Errors and uncertainties in the measurement - Performance parameters of instrument-Propagation of uncertainties in compound quantities-curve fitting, regression and correlation. (ref: 1,6,7)
REFERENCES


ADDITIONAL READINGS

5. Fink A, Conducting Research Literature Reviews: From the Internet to Paper. Sage 2009

PAPER II  NANOMATERIALS AND NANOSCIENCE

UNIT I  INTRODUCTION TO NANOMATERIALS

Zero-dimensional, one-dimensional and two-dimensional nanostructures, size dependent properties – quantum confinement – optical properties - specific heat and melting point- mechanical properties – super plasticity - plastic deformation of ceramics - nanoceramics - catalytic properties.

Synthesis of nanomaterials - bottom-up and top-down approaches - nanoparticles - colloidal technique - homogeneous and heterogeneous nucleation - synthesis of metallic and semiconductor nanoparticles - stabilization of nanoparticles - sonochemical method-synthesis and properties of core-shell nanoparticles.


UNIT II  EXPERIMENTAL TECHNIQUES

Principle, working and interpretation of results of – XRD – XPS - AES - EDS - SEM - STM – AFM – TEM - HRTEM - BET surface area and porosimetry - UV-Vis - FTIR and Raman spectroscopy - Thermal analysis – TGA, DTA and DSC. (ref. 7-10)
UNIT III  NANOBIOLOGY

Overview of cell structure and biomacromolecules - chemical building block of cells – DNA-based nanomaterials - self-assembled DNA nanotubes and their applications, nucleic acid nanoparticles - chemical and physical properties of therapeutic DNA - synthesis and characterization of nucleic acid nanoparticles - DNA functionalization for cell recognition and internalization - preparation of DNA nanoparticles enveloped with protective coat and cell internalization elements.


Engineered nanoparticles and biomedical applications - engineered nanoparticles in therapeutics – bioimaging - drug delivery.  

UNIT IV  QUANTUM CONFINED SYSTEMS


UNIT V  NANOELECTRONICS


Spintronics - Diffuse spin dependent transport – spin dependent scattering – giant magneto resistance (GMR) and colossal magneto resistance (CMR) materials – ballistic spin transport.

UNIT VI  CARBON NANOTUBES


UNIT VII  NANOPHOTONICS

REFERENCES

15. Challa Kumar(Ed) - Nanomaterials for Medical Diagnosis and Therapy, Wiley-VCH, 2006.
PAPER III ADVANCE NANOMATERIALS AND NANOTECHNOLOGY

UNIT I NANOSTRUCTURED FILMS

Synthesis - physical vapour deposition (PVD) – molecular beam epitaxy (MBE) - DC/RF magnetron sputtering - chemical vapour deposition (CVD) – progress and challenges of photovoltaic applications of silicon nanocrystalline materials - sol-gel technique – sol-gel films – properties and applications of sol-gel derived nanostructured thin films.

Electrodeposition of semiconductor quantum dot films – electrodeposition of thick films of semiconductors from DMSO – ultrathin films and isolated nanocrystal deposition – electronic characterization of electrodeposited semiconductor nanoparticle films. (ref. 1, 2, 3)

UNIT II NANOLITHOGRAPHY

Nanostructures fabricated by physical techniques – lithography – photo, electron beam, X-ray, ion beam, and AFM and STM based lithography – nanolithography – soft lithography – microcontact printing – dip-pen nanolithography – assembly of nanostructures. (ref. 1)

UNIT III PHOTOCHEMISTRY AND ELECTROCHEMISTRY OF NANO-ASSEMBLIES


UNIT IV DYE SENSITIZED SOLAR CELLS

Introduction to Photovoltaic (PV) systems - the PV cell - the PV module - the PV array - photoelectrochemical conversion of solar energy – photoredox reactions of colloidal semiconductors and particulates – dye sensitization of semiconductors – sequence of electron transfer steps of a dye-sensitized solar cell (DSSC) – key efficiency parameters of a DSSC – key components of DSSC – improvement in efficiency through nanostructuring of materials – dye solar cells based on nanorods/nanotubes and nanowires – sensitization using quantum dots - pervoskite solar cells. (ref. 5, 6, 7)

UNIT V PHOTOLUMINESCENCE OF NANOCRYSRTALS


UNIT VI MAGNETIC PROPERTIES OF NANOPOARTICLES

UNIT VII NANOCOMPOSITES


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