



RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

FACULTY OF SCIENCE

DIRECTION NO. 30 OF 2012

**EXAMINATION LEADING TO ONE YEAR POST P.G.DIPLOMA IN NANOSCIENCE
AND NANOTECHNOLOGY**

WHEREAS, the Maharashtra Universities Act, 1994, hereafter referred to as Act, has come into force from 22nd July, 1994 and was amended from time to time.

AND

WHEREAS, the university under its power and duties is expedient to make provision for research and for the advancement and dissemination of knowledge in various branch of Studies. Faculties and Academic Council are to be approved by the Management Council for the institution of such Degrees, Diplomas Certificates and other academic distinctions by giving effect to it by virtue of promulgating academic session 2012-13 and onwards.

AND

WHEREAS, as per recommendation of Board of Studies in Physics under Faculty of Science has approved the syllabus of One Year **Post P.G. Diploma in Nanoscience and Nanotechnology** course along with scheme of Examination in its meeting held on 02-05-2012 and accepted by the faculty of science held on 18.9.2012. The faculty recommendation was accepted by the Hon'ble Vice Chancellor on behalf of academic and management council under section 14(7) of Maharashtra Universities act 1994, on 5.10.2012.

AND

WHEREAS, the same course should be implemented by way of issuing appropriate directions under section 14(8) of Maharashtra Universities act 1994, by the Hon'ble Vice Chancellor.

AND

WHEREAS, the University Grants Commission, New Delhi has approved and recommended its financial assistance to various colleges of excellence to promote this programme under the UGC scheme of Innovative Programme – Teaching and Research in Interdisciplinary and Emerging areas under time bound programme and the same is mandatory to implement by all the universities under the jurisdiction of University Grants Commission by granting necessary affiliation to run this course at respective colleges OR in broader terms if and colleges under the jurisdiction of the university desire to run the course by seeking any financial assistance from any apical body or at self sustainable level by following standard procedure of seeking new regular course to be started from the session 2012-2013 and onwards.

AND

Post P.G. Diploma in Nanotechnology courses from the session 2012-2013.

AND

WHEREAS, the Ordinance making is a time consuming process.

Now, therefore, I, Dr. V. S. Sapkal, Vice Chancellor, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur in exercise of the power vested under section 14(8) of the Maharashtra University Act o 1994 do hereby issue the following direction.

1. Title of the Direction:

This direction may be called "Examination leading to One Year Post P. G. Diploma in **Nanoscience and Nanotechnology**".

2. Nature of the Course:

This One Year Post P.G. Diploma in **Nanoscience and Nanotechnology** course shall be a full time regular course.

3. Eligibility Criteria:

The students seeking admission to this course should have obtained **Master of Science Degree** in Physics/ Applied Physics/ Chemistry/ Electronics/ Materials Science/ Biotechnology /Microbiology or any equivalent subjects from any UGC recognized university and other Deem University **OR Bachelor of Engineering Degree** in Chemical /Electronics /Electrical /Biotechnology or any related subjects from a recognized university with 45% marks. (Relaxation to reserved category student by 5% as per the norms of Central and State Government on reservation policy)

4. **Application of other Ordinance of University:**

The students admitted to this Diploma course shall be governed by the general Ordinances of the university which are applicable to all the regular or ex-students. These Ordinances includes complete as well as relevant provision of Ordinance No. 1, 2 ,6 ,7-A, 9, 10, 19, 109, Ordinance NO. 30 of 2006, (amended Ordinance No. 4 of 2006), Direction No. 9 of 2008, Direction 5 of 2004 wherever applicable accordingly.

5. **Fee structure for the course:**

As per the rules and guidelines of the UGC for such programmes or the fees decided at university level or any other competent authority.

6. **Syllabus:**

The syllabus or this course as prescribed by the Board of Studies in terms of annual pattern.

7. Medium of Instruction/Examination:

The medium of instruction and writing of examination shall be in English only.

8. Conduct of Examination:

The examination leading to the course of One Year Post PG Diploma in **Nanoscience and Nanotechnology** shall be held once in a year only (i.e. summer) at such place and on such dates as may be decided by the University.

9. Scheme of Examination:

The scheme of Examination shall be as per **Appendix-A** (Annual pattern). However, the scheme of Examination reflects the basic structure of theory and dissertation. The details/title of the theory paper can be suitably modified in future considering the need of the subject without disturbing the main structure.

10. Dissertation/Project:

The dissertation shall be assessed by the external examiner and project guide as internal examiner. However, final marks shall be awarded by external examiner. The dissertation examination shall be held separately.

11. Other Rules:

- (i) Successful examinee obtaining 60% or more marks in the aggregate at both of the examination shall be placed in the First division and those obtaining less than 60% in the second division and those obtaining less than 45% marks of aggregate but not less than 35% of marks shall be placed in Third Division.
- (ii) An examinee who is unsuccessful at the examination will be eligible for admission to the next written examination on payment of fresh fees prescribed for the examination together with an ex-student fee as applicable and on compliance of the conditions of the ordinance enforce from time to time.
- (iii) For being eligible for exception in a paper, dissertation work, the candidate must have obtained not less than 35% of marks.
- (iv) Provision of Ordinance No. 7-A relating to the condonation of deficiency of marks for passing the examination and of Ordinance No. 10 relating to the exemptions and compartments shall apply to the examination under this ordinance.

- (v) As soon as possible after the examination, but not later than 30th June, next following in case of examination held in April, the Management Council shall publish the list of successful examinees. The names of First Three examinees passing the examination with more than 60% marks in the minimum prescribed being arranged in order of merit.
- (vi) An examinee who is successful at an examination and obtain not less than 75% of the total marks prescribed in a subject shall be declared to pass the examination with Distinction in that subject.
- (vii) Notwithstanding anything to the contrary in this ordinance no person shall be admitted to this examination, if he/she has already passed this examination or an equivalent examination of any other statutory University.

12. Award of Diploma:

A successful examinee shall be awarded Post PG diploma in prescribed form signed by the Vice – Chancellor of the University.

Nagpur
Date: 11.10.2012

Sd/-
Dr. V. S. Sapkal
Vice-Chancellor

**POST P.G. DIPLOMA (ONE YEAR) IN NANOSCIENCE AND
NANOTECHNOLOGY**

Course of studies and scheme of examination

Eligibility: Master of Science in Physics /Chemistry/Electronics/Materials Science or any related subjects from a recognized university.

OR

Bachelor of Engineering in Chemical/ Electronics/ Electrical or any related subjects from a recognized university.

Medium: English only.

Duration: One Year

The examination for Diploma shall consist of two theory papers of 100 marks each and a Project Report with viva-voce of 200 marks.

The examination of theory papers and project report will be conducted by RTM Nagpur University, Nagpur.

Four Papers (2Theory + 1Project report) shall be as follows.

1. Basics of Nanoscience and nanotechnology. (120 Hrs)
2. Instrumentation and methodology. (120 Hrs)
3. Project Report with viva-voce (600 Hrs)

The scope of the Papers and Project Report work for the examination shall be as indicated in the syllabus.

In order to pass in the examination, student shall obtain not less than 35% of marks in each of the papers including Project Report as shown in Appendix- A.

An applicant for admission in the post P. G. Diploma in Nanoscience and Nanotechnology shall be required to conduct a field study in Nanoscience and Nanotechnology research and submit a project report thereon under the supervisor recognized for the purpose and get the clearance certificate thereof for the work from the Head of the Institution/ Coordinator of the course and submit it to the University before appearing to the examination.

The fees for the admission to the examination shall be as per University norms. Examinees successful in the examination shall receive a Diploma in the prescribed form signed by the Vice Chancellor of the University.

Appendix – A

Post P.G. Diploma (One Year) in Nanoscience and Nanotechnology

| Sr. | Papers | Maximum | Minimum | Aggregate |
|-----|--------|---------|---------|-----------|
|-----|--------|---------|---------|-----------|

| No. | | Marks | Marks | pass marks |
|-----|--|-------|-------|------------|
| 1 | Paper – I Basics of Nanoscience and Nanotechnology | 100 | 35 | 140 |
| 2 | Paper – II Instrumentation and methodology | 100 | 35 | |
| 3 | Paper - III Research project Project Report -- 150 viva-voce --- 50 | 200 | 70 | |

Paper –I

(Basics of Nano materials and nanotechnology)

Unit-I Basics of Nanoscience

Introduction to quantum physics, electron as waves, wave mechanics, Schrödinger equation and particle in a box, Heisenberg's uncertainty principle, exclusion principal, Free electron theory (qualitative idea) and its features, Idea of band structure, Density of states for zero, one, two and three dimensional materials, Quantum confinement, Quantum wells, wires, dots, Factors affecting to particle size
The p-n-junction and bipolar transistor, Metal semiconductor and metal insulator, semiconductor junction, field effect transistor.

Unit-II Properties of Nanomaterials

Mechanical, Thermal, Electrical, Optical, Magnetic and Structural.
Carbon nanostructures- Fabrication, structure, electrical properties and mechanical properties.

Unit-III Synthesis of Nonmaterial's

Physical methods: Bottom up-Ball Milling, Melt mixing, Physical vapour deposition, Ionised cluster beam deposition, Laser pyrolysis, Sputter deposition, Electric arc deposition, Gas evaporation.

Chemical methods: Hydrothermal combustion, bath deposition with capping techniques and top down, Chemical vapour deposition, Synthesis of metal & semiconductor nanoparticles by colloidal route, Microemulsions, Sol-gel method, Combustion method, Wet chemical method

Unit-IV Bionanotechnology

Biological building blocks, nanostructure, protein nanoparticles, DNA double nanowire.
Bionanostructures- Micelles, vesicles, multilayer films, biological interactions, bilayers, bioelectronics and biosensors.

Text and Reference Books:

1. Nanotechnology: Principles & Practicals. Sulbha K. Kulkarni, Capital Publishing Co.New Delhi.

2. Carbon nanotechnology.. recent developments in Chemistry, Physics, materials science and device applications, -Elsevier Science
3. Nanostructures & Nanomaterials Synthesis, Properties & Applications. Guozhong Cao, Imperials College Press London.
4. Physics, Chemistry and Application of Nanostructures, world scientific co.
5. Nanomaterials: Synthesis, Properties & Applications. Edited by A.S. Edelstein & R.C.Commorata. Institute of Physics Publishing, Bristol & Philadelphia.
6. Introduction to Nanotechnology. C.P. Poole Jr. and F. J.Owens, Wiley Student Edition.
7. Nano: The Essentials. T.Pradeep , McGraw Hill Education.
8. Handbook of Nanostructures: Materials and Nanotechnology. H. S. Nalwa Vol 1-5, Academic Press, Bostan.
9. Nanoscience and Technology: Novel Structure and Phenomena. Ping and Sheng
10. Hand Book of Nanotechnology, Bhushan

Paper –II

(Instrumentation and Methodology)

Unit-I Nanomaterials characterization

XRD, UV-VIS spectroscopy, X-ray fluorence, X-ray photon emission spectroscopy, Surface electon microscopy, Transmission electron microscopy, Scanning tunneling microscopy, Atomic force microscopy, Nuclear magnetic resonance spectroscopy, Electron spin resonance spectroscopy, Raman spectroscopy

Unit-II Characterization techniques

Electrochemical techniques-voltametric, ac-impedance analysis, compositional surface analysis, SIMS.

Vibrating sample magnetometer, spintronics, BH-curve, mass susceptibility.

Unit-III Nanomagnetics

Introduction to magnetism, Ferromagnetism, ferrimagnetism, antiferromagnetism, paramagnetism, effect of bulk nanostructuring of magnetic properties, dynamics of nanomagnets, giant and colossal magnetoresistance, applications in data storage, ferrofluids, Superparamagnetism, effect of grain size, magneto-transport, Magneto-electronics, magneto-optics, spintronics.

Unit-IV Nanocomposites and nanoelectronics

Classification of nanocomposites, Metallic, ceramic and polymer nanocomposites, Nano ceramic for ultra high temperature MEMS, Optimizing nanofiller performance in polymers, Preparation techniques, Graphene/Fullerene/Carbon nanotube (CNT) polymer nanocomposites,

Nanoscale MOSFETS, limits to scaling, system integration, interconnects, Nanowire Field Effect Transistors, Tunneling Devices, Single Electron Transistors, Carbon nanotube transistors, Memory Devices.

Text and reference books:

1. Edward L. Wolf (2nd Ed.), Nanophysics & Nanotechnology: An Introduction to Modern Concepts in Nanoscience, WILEY-VCH, 2006
2. H.S.Nalwa, Hand book of Nanostructure materials and nanotechnology; (Vol.1-5), Acad. Press, Boston, 2000
3. C.P.Poole Jr., F.J.Owens; Introduction to Nanotechnology, John Wiley and sons, 2003
4. C. Furetta, Hand book of thermoluminescence; World Scientific Publ.
5. T.J.Deming, Nanotechnology; Springer Verrlag, Berlin, 1999
6. C. Delerue, M.Lannoo; Nanostructures theory and Modelling
7. Fausto, Fiorillo, Measurement and Characterization of Magnetic materials
8. Janos H, Fendler; Nanoparticles and Nanostructured Films
9. Liu, Hand Book of Advanced Magnetic Materials (4 Vol.)
10. Banwong, Anurag Mittal; Nano CMOS Circuit and Physical Design
11. S. Sakka, Sol-gel science and technology processing, characterization and applications; Kluwer Acad. Publ.
12. Goser et al, "Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices"
13. A. A. Balandin and K. L. Wang, "Handbook of Semiconductor Nanostructures & Nanodevices"
14. Cao Guozhong, "Nanostructures & Nanomaterials - Synthesis, Properties & Applications"

Paper –III

Research project

Students are required to carry out a research project of three to six months duration related to Nanoscience/Nanotechnology. Each student is assigned with a supervisor from amongst the

panel of teachers. Student will be required to write a report on the basis of Nanotechnology research/training in an established research laboratory/ industry. Research project involved a structured investigation of research nature.

The length of the report is expected not to exceed 120 typed pages. Students shall have to appear for viva-voce test relating to his/her research work report.