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[OBE DESIGN- NANO-TECHNOLOGY DEPARTMENT]

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY AURANGABAD-431 001

PREFACE

Outcome Based Education (OBE) is the educational approach which focuses on student centric education in the context of development of personal, social, professional and knowledge (KSA) requirements in one's career and life. It is the decade ago curriculum development methodology. The educational triangle of *LEARNING-ASSESSMENT-TEACHING* is the unique nature of the OBE approach. The curriculum practices such as Competency Based Curriculum, Taylor's Model of Curriculum Development, Spadys' Curriculum principles, Blooms taxonomy and further use of assessment methodologies like, Norm-reference testing and Criterion reference testing, etc is being practiced since decades. It is also interesting to know that, globally, different countries and universities adopts the curriculum development models/approaches such as, CDIO (Conceive-Design-Implement-Operate), Evidenced Based Education, Systems' Approach, etc as the scientific and systematic approaches in curriculum design.

The authorities of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S.) in-lieu of accreditation standards of National Assessment and Accreditation Council, decided to opt for Outcomes Based Education (OBE). As the part of the decision, different meetings, workshops and presentations were held at the campus of university.

This document is the outcome of different meetings and workshops held at university level and department level. The detailed document is designed and the existing curriculum of the department is transformed in to the framework of OBE. This is the first step towards the implementation of OBE in the department. The document will serve all stakeholders in the effective implementation of the curriculum. The OBE is continuous process for quality enhancement and it will go a long way in order to enhance the competencies and employability of the graduates/Post-graduates of the university department.

Head of Department

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OUTCOME BASED EDUCATION

Faculty of Science & Technology

Department of Nano-Technology

1. Mission:

Mission Statement

The mission of this department to teach and learn Nanotechnology in collaborative performance based path way, we look to encourage the students towards observation and analysis of the natural world and to provide the tools and skills to the students to be torch bearer of Nanotechnology by contributing effectively to the existing lows of the methods.

2. Vision:

Vision Statement

- To be the center of excellence to provide opportunity to the youths of this region and to cope up with the growing interest in Nanotechnology from the entire sector.
- To offer National and International recognition to the Department, teachers, students and ultimately to the university.
- To train young generation and also achieve research grants from various funding agencies through quality research projects of significance to the society.
- To transform technology to the industries around the region.
- Further, we intend to go for evaluation of our progress through accreditation and re-accreditation of the Department

3. Title of the Program (s):

a. Master of Science (Nano-Technology)

4. Program Educational Objectives:

The program educational objectives (PEO) are the statement that describes the career and professional achievement after the program of studies (graduation/ post-graduation). The PEO s are driven form question no. (ii) Of the Mission statement (What is the purpose of organization). The PEOs can be minimum three and maximum five.

PEO1: To have advance knowledge and application of nanotechnology in the field of research, industry and developmental domains.

PEO2: To provide the professional services to industry, research organization, institutes.

PEO3: To provide the professional consultancy and research support for the relevant organization in the domain of super specialization.

PEO4: To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.

PEO5: To provide, value based and ethical leadership in the professional and social life.

5. Program Outcomes:

The program outcomes (PO) are the statement of competencies/ abilities. POs are the statement that describes the knowledge and the abilities the graduate/ post-graduate will have by the end of program studies.

a. Ability to apply knowledge of physics, chemistry, biology, medical science, pharmacy and engineering.
b. An ability to design and conduct experiments, as well as to analyse and interpret data of Nano-materials.
c. An ability to identify nano-scale processing and characterization methodology for advance nano-devices towards its use and limitations.
d. An ability to participate and contribute in multidisciplinary work.
e. An ability to identify, formulate and solve, energy, environmental, health and society related problems.
f. An ability of understanding of professional and ethical responsibility and ability to communicate effectively.
g. Recognition of the need for, and an ability to engage in life-long learning.
h. An ability to use the techniques, skills and modern technological tools necessary for nanotechnology practice.
i. An ability to analyse the problems and provide solutions by the use of nanotechnology knowledge; and
j. An ability to apply software engineering principles in product development using emerging technology.

6. Course- Program outcome Matrix:

The Program Outcomes are developed through the curriculum (curricular/co-curricular-extra-curricular activities). The program outcomes are attained through the course implementation. As an educator, one must know, ***"to which POs his/her course in contributing?"***. So that one can design the learning experiences, select teaching method

and design the tool for assessment. Hence, establishing the Corse-PO matrix is essential step in the OBE. The course-program outcomes matrix indicates the co-relation between the courses and program outcomes. The CO-PO matrix is the map of list of courses contributing to the development of respective POs.

The CO-PO **MATRIX** is provided in the below table.

COURSE-PO MATRIX

COURSE TITLE [Ist & IInd Year)	**a**	**B**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**PSO1**	**PSO2**
NANO 111 (Quantum Physics- I)	√	√	√				√	√				
NANO 112 (Solid State- I)	√	√		√					√	√		
NANO 113 (Chemistry- I)	√	√	√	√	√			√		√		
NANO 114 (Bioscience- I)	√			√	√	√				√		
NANO 222 (Quantum Physics- II)	√	√	√				√	√				
NANO 223 (Solid State- II)	√	√		√					√	√		
NANO 224 (Chemistry- II)	√	√	√	√	√			√		√		
NANO 225 (Biosciences- II)	√			√	√	√				√		
NANO333 (Quantum Confinement I)			√	√	√					√		
NANO 334 (Advances in Nanotechnology-I)		√	√		√			√	√		√	√
NANO 335 (Applications of Nanotechnology-I)	√	√		√		√	√	√		√	√	√
NANO 444 (Quantum Confinement II)			√	√	√					√	√	√
NANO 445 (Advances in Nanotechnology-II)		√	√		√			√	√		√	√
NANO 446 (Applications of Nanotechnology-II)	√	√		√		√	√	√		√	√	√

7. Course Outcomes (for all courses):

The course outcomes are the statement that describes the knowledge & abilities developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. There can be 5 to 7 course outcomes of any course. These are to be written in the specific terms and not in general. The list of Course Outcomes is the part of ***Annexure-C*** attached herewith.

8. Set Target levels for Attainment of Course Outcomes:

The course outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment are measured/calculated. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

9. Set Target level for Attainment of Program Outcomes:

The program outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment and program outcome attainment is measured/calculated. The program outcome attainment is governed by curricular, co-curricular and extra-curricular activities including the stakeholders' participation. The direct method and indirect method is adopted to calculate the PO attainment. The direct method implies the attainment by course outcomes contributing to respective program outcomes. And indirect method is the satisfaction/feed-back survey of stakeholders. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

The set target level is the set benchmark to ensure the continuous improvements in the learners/ graduates' performance.

10. Course Attainment Levels:

a. CO attainment is defined/set at three levels;
b. The CO attainment is based on end term examination assessment and internal assessment;
c. The Co attainment is defined at three levels in ascending order-
    i. e.g. For end term and internal examination;
    ii. Level-1: 60% students scored more than class average
    iii. Level-2: 70% students score more than class average;
    iv. Level-3: 80% students score more than class average.

d. The target level is set (e.g. Level-2). It indicates that, the current target is level-2; 70% students score more than class average. The CO attainment is measured and the results are obtained. Based on the results of attainment, the corrective measures/remedial action are taken.
e. CO Attainment= 80% (Attainment level in end term examination) + 20% (Attainment level in internal examination).

11.Program attainment Level:

a. PO attainment is defined at five levels in ascending order;
b. The PO attainment is based on the average attainment level of corresponding courses (Direct Method) and feed-back survey (Indirect method);
c. The PO attainment levels are defined / set as stated below;
    i. Level-1: Greater than 0.5 and less than 1.0 (0.5>1)- Poor
    ii. Level-2: 1.0>1.5-Average
    iii. Level-3: 1.5>2.0-Good
    iv. Level-4: 2.0>2.5-Very Good
    v. Level-5: 2.5>3.0 -Excellent
d. The PO attainment target level is set/defined (say, Level-4). It implies that, the department is aiming at minimum level-4 (very good) in the performance of abilities by the graduates. Based upon the results of attainment, the remedial measures are taken;
e. PO Attainment= 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

12. The Results of CO Attainment:

The Results of CO Attainment shall also be provided in Annexure-B.

FOR EXAMPLE:

COURSE CODE/TITLE: NANO-222

e.g. For end term and internal examination;

i. Level-1: 60% students scored more than class average
ii. Level-2: 70% students score more than class average;
iii. Level-3: 80% students score more than class average

Average Marks in External examination: 62

% Students score more than 62 is 58/107 i.e. 70% i.e. Levl-2

Average Marks in Internal examination= 8.25

% Students score more than 8 is 80%, i.e. Level-3

A (CO) NANO-222 = 80% (2) +20(3)

=1.6+0.6

= 2.2

Hence, the attainment level is Level-2 and the set target level is Level-2 and therefore the CO is fully attained.

Table No. 1.0: CO Attainment Level

COURSE TITLE [Ist & IInd Year)	CO Attainment Value	Target Attainment Level	Fully Attained/ Not Attained	Remedial Measures
NANO 111 (Quantum Physics- I)	3	2	**Fully Attained**	
NANO 112 (Solid State- I)	3	2	**Fully Attained**	
NANO 113 (Chemistry- I)	1.4	2	Not Attained	Assignments, Tutorials, Exercise and Remedial coaching
NANO 114 (Bioscience- I)	1.4	2	Not Attained	
NANO 115 (Bioscience- I)	1.4	2	Not Attained	
NANO 116 (Bioscience- I)	3	2	**Fully Attained**	
NANO 117 (Bioscience- I)	1.4	2	Not Attained	Assignments, Tutorials, Exercise and Remedial coaching
IC 001	1.4	2	Not Attained	
NANO 222 (Quantum Physics- II)	2.2	2	**Fully Attained**	
NANO 223 (Solid State- II)	3	2	**Fully Attained**	
NANO 224 (Chemistry- II)	1.4	2	Not Attained	Assignments, Tutorials, Exercise and Remedial coaching
NANO 225 (Biosciences- II)	3	2	**Fully Attained**	
NANO 226	2.2	2	**Fully Attained**	
NANO 227	2.2	2	**Fully Attained**	

13.The Results of PO Attainment:

The PO attainment will be calculated after the program batch is graduated. It will graduate in April 2019.

Table No. 2.0 PO Attainment Level

PO/PSO number	PO Attainment Value	Target Attainment level	Fully attained/ Not Attained	Remedial Measures

14. Planned Actions for Course Attainment:

The courses having CO attainment level less than Level-2 shall be addressed by taking the remedial measures such as assignments, tutorials, exercises and remedial coaching.

15.Planned Actions for Program Outcome Attainment:

Not Applicable as the batch is graduated in April 2019.

ANNEXURE-B

RESULTS OF CO-PO ATTAINMENT LEVEL

ANNEXURE-C
COURSE OUTCOMES

NANO-TECHNOLOGY

Quantum Physics

- Describe the aspects of the historical development of quantum mechanics.
- Describe and interpret experiments that reveal the wave properties of matter and advantage over classical mechanics.
- Describe the concepts and principles in quantum mechanics, (such as the Schrödinger equation, the wave function and its statistical interpretation, the uncertainty principle, stationary and non-stationary states, time evolution of solutions, as well as the relation between quantum mechanics and linear algebra)
- Solve the Schrödinger equation on your own for simple systems in one to three dimensions, both analytically and by using robust numerical methods.
- Apply the concepts of angular momentum and spin, as well as the rules for quantization and addition of these.
- Explain the physical properties of elementary particles, nucleons, atoms, molecules and solids based on quantum mechanics.
- Describe the importance of analytic and numerical solutions are important in quantum mechanics, and have acquired experience in using both types of methods on quantum mechanical problems.

Solid State

- Explain the concept of crystal systems and spatial symmetries
- Analyze crystalline materials using diffraction, including concepts like form factor, structure factor, and scattering amplitude.
- Explain the principles of structure determination by diffraction.
- Describe the concept of reciprocal space and be able to use it as a tool
- Calculate thermal and electrical properties in the free-electron model
- Describe Bloch's theorem
- Describe the Fermi surface and explain its measurement.

Bioscience

- Describe the concept of animal biosciences.
- Perform practical experience in a range of animal science techniques.

- Apply/implement the concepts of One Biology, One Health, One Medicine and equip students to carry out research in this area.
- Describe the application of scientific principles to the study of animal biosciences.
- Apply scientific knowledge and technical skills in research.
- Critically analyse and evaluate obtained data and to identify and solve methodological problems.
- Establish the ability to utilise effective and modern methods for interpreting, analysing and describing scientific data.
- Enhance the ability to communicate, in writing and verbally, scientific results and information in research.
- Ensure an understanding of animal biosciences, to enable the undertaking of independent research.
- Use laboratory equipment to generate data

Quantum Confinement

- Explain the basic concepts of quantum mechanics and be able to solve the quantum confinement equations which lead to reduced dimensionality.
- Describe the various modern technologies used in nanotechnology to grow bulk crystals, thin films, and nanoscale quantum structures, including the epitaxy of semiconductors.
- Use the optical and electronic properties of semiconductor nanostructures such as quantum wells and quantum dots.
- Manipulate and calculate physical parameters related to nanotechnology, such as mean free paths and phase coherence lengths.
- Explain the effect of the reduced dimensionality on the electronic charge transport.
- Explain the operating principle of various nanofabrication techniques, such as lithography patterning, self-assembling, single atom manipulation, etc.
- Explain the main properties of Nano objects such as nanotubes, nanowires, and nanoparticles.
- Explain the basic optical and electronic properties of organic/molecular-based materials, as well as main applications.

Advances in Nano-technology

- Applying engineering and physics concepts to the non-continuum domain.
- Understand the fundamental forces controlling the dynamic and static response of materials at the nano-scale.
- Demonstrate a comprehensive understanding of state-of-the-art nano-fabrication methods.
- Determine and evaluate processing conditions to engineer functional nanomaterials.
- Design and analyse scalable system for the continuous production of nanomaterials.

- Practice and explain the state-of-the-art characterization methods for nanomaterials, understanding and critiquing nanomaterial safety and handling methods.

Nanotechnology Applications

- Analyse problems regarding definitions and terminology in the field of nanotechnology in different areas of life sciences as well as relate them to regulatory aspects,
- Apply and describe the most common bottom-up and top-down processes for the synthesis of nanomaterial
- Select the appropriate characterization method and independently use relevant characterization tools for a given application,
- Demonstrate/explain for complex health and environmental risk factors associated with nanoparticles and how various risks can be estimated,
- Describe examples of international and national industrial applications and development projects in which nanotechnology is used in the life sciences area, as well as scientifically explain why nanotechnology is an essential prerequisite for their implementation.