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[OBE DESIGN- CHEMISTRY DEPARTMENT]

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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 Chemistry

1. Mission:

Mission Statement

- To develop the researcher and scientist in chemical science through post-graduate education and research programme.
- To develop the competent manpower with technology based experimentation methodologies and value based practices for business and industries.
- To undertake projects to solve field base problems.
- To provide student centric learning facilities for the development of overall personality of learner.

2. Vision:

Vision Statement

A respectable teaching – learning and research organization nationally and internationally in the area of chemical sciences. By providing competitive trained chemists which will assist the chemical world, industries and stake holders

The mission and vision of the organization help in preparation of strategic plan.

3. Title of the Program (s):

a. Master Science - Chemistry

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 of chemistry domain.

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. In-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.
b. Apply/implement interface between, on the one hand, the history of chemistry and natural science and, on the other hand, issues pertaining to the areas of modern technology, health, and environment.
c. Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.
d. Skill in examining specific phenomena theoretically and/or experimentally,
e. Generation of new scientific insights or to the innovation of new applications of chemical research.

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.

ANALYATICAL CHEMISTRY (50-60-70)

Course Code	Course Title	A(CO)	a	b	c	d	e
CH 101	Inorganic Chemistry	2.0	*	*	*		
CH 102	Organic chemistry	2.0	*	*	*		
CH 103	Physical Chemistry	2.0	*	*	*		
CH 104	Analytical chemistry	3	*	*	*		
CH 105	Pract. Course I	3	*	*	*		
CH 106	Prct. Course II	3	*	*	*		
CH 201	Inorganic Chemistry	2.2	*	*	*		
CH 202	Organic chemistry	2.0	*	*	*		
CH 203	Physical Chemistry	2.0	*	*	*		
CH 204	Spectroscopy	3	*	*	*		
CH 205	Pract. Course III	3	*	*	*		
CH 206	Prct. Course IV	3	*	*	*		
CH 301	Application of Spectroscopy	2		*	*	*	*
CH 302	Environmental Chemistry	3		*	*	*	*
CH 303	Organic Reactions & Rearrangements	2		*	*	*	*
CH 304	Analytical Methods in Chemical Analysis	3		*	*	*	*
CH 305	Pract.Course V	3		*	*	*	*
CH 306	Prct. Course VI	3		*	*	*	*
CH 401	Applied Analytical Chemistry–I	2		*	*	*	*
CH 402	Applied Analytical Chemistry–II	3		*	*	*	*
CH 403	Pharmaceutical & Clinical Analysis	3		*	*	*	*
CH 404	Applied Analytical Chemistry–III	3		*	*	*	*
CH 405	Practical Course–VII	3		*	*	*	*
CH 406	Practical Course–VIII (Project Work or Inplant Training)	3		*	*	*	*

DRUG CHEMISTRY

Course Code	Course Title	A(CO)	a	b	c	d	e
CH 101	Inorganic Chemistry	2.0	*	*	*		
CH 102	Organic chemistry	2.0	*	*	*		
CH 103	Physical Chemistry	2.0	*	*	*		
CH 104	Analytical chemistry	3	*	*	*		
CH 105	Pract.Course I	3	*	*	*		
CH 106	Prct. Course II	3	*	*	*		
CH 201	Inorganic Chemistry	2.2	*	*	*		
CH 202	Organic chemistry	2.0	*	*	*		
CH 203	Physical Chemistry	2.0	*	*	*		
CH 204	Spectroscopy	3	*	*	*		
CH 205	Pract.Course III	3	*	*	*		
CH 206	Prct. Course IV	3	*	*	*		
CH 301	Application of Spectroscopy	2		*	*	*	*
CH 302	Bioorganic & Green Chemistry	3		*	*	*	*
CH 303	Organic Reactions & Rearrangements	2		*	*	*	*
CH 304	Applied Organic Chemistry	3		*	*	*	*
CH 305	Pract.Course V	3		*	*	*	*
CH 306	Prct. Course VI	3		*	*	*	*
CH 401	Introduction to Medicinal Chemistry	2		*	*	*	*
CH 402	Drug Synthesis	3		*	*	*	*
CH 403	Drug Action & Development	3		*	*	*	*
CH 404	Pharmaceutical & Industrial practices	3		*	*	*	*
CH 405	Practical Course–VII	3		*	*	*	*
CH 406	Practical Course–VIII (Project Work or Inplant Training)	3		*	*	*	*

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-
d. Course Levels:
    i. Level-1: 40% students score greater than or equal to class average
    ii. Level-2: 50% students score greater than or equal to class average
    iii. Level-3: 60% students score greater than or equal to class average

Target Level: Level - 2

e. The target level is set (e.g. Level-2). It indicates that, the current target is level-2; 50% 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.
f. CO Attainment= 80% (Attainment level in end term examination) + 20% (Attainment level in internal examination).
g. <u>The example of calculating CO attainment is provided for one of the course from Analytical Chemistry in Point No. 12.</u>

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).
f. <u>The example of calculating PO attainment is provided for one of the PO from Analytical Chemistry in Point No. 13.</u>

12. The Results of CO Attainment:

PLEASE SEE THE ANNEXURE-B

<u>FOR EXAMPLE:</u>

<u>COURSE CODE/TITLE: CHE-102 ORGANIC CHEMISTRY</u>

e.g. For end term and internal examination;

i. Level-1: 50% students scored more than class average
ii. Level-2: 60% students score more than class average;
iii. Level-3: 70% students score more than class average

Average Marks in External examination: 65

% Students score more than 65 is 65 % i.e. Levl-2

Average Marks in Internal examination= 15

% Students score more than 15 is 65%, i.e. Level-2

A (CO) CHE-102= 80% (2) +20(2)

=1.6+0.4

= 2.0

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

ANALYATICAL CHEMISTRY (50-60-70)

Course Code	**Course Title**	**CO Attainment Value**	**Target Attainment Level**	**Fully Attained/ Not Attained**	**Remedial Measures**
CH 101	Inorganic Chemistry	2.0	2.0	**Fully Attained**	Not Applicable
CH 102	Organic chemistry	2.0	2.0	**Fully Attained**	
CH 103	Physical Chemistry	2.0	2.0	**Fully Attained**	
CH 104	Analytical chemistry	3	2.0	**Fully Attained**	
CH 105	Pract. Course I	3	2.0	**Fully Attained**	
CH 106	Prct. Course II	3	2.0	**Fully Attained**	
CH 201	Inorganic Chemistry	2.2	2.0	**Fully Attained**	
CH 202	Organic chemistry	2.0	2.0	**Fully Attained**	
CH 203	Physical Chemistry	2.0	2.0	**Fully Attained**	
CH 204	Spectroscopy	3	2.0	**Fully Attained**	
CH 205	Pract. Course III	3		**Fully**	

			2.0	**Attained**	
CH 206	Prct. Course IV	3	2.0	**Fully Attained**	
CH 301	Application of Spectroscopy	2	2.0	**Fully Attained**	
CH 302	Environmental Chemistry	3	2.0	**Fully Attained**	
CH 303	Organic Reactions & Rearrangements	2	2.0	**Fully Attained**	
CH 304	Analytical Methods in Chemical Analysis	3	2.0	**Fully Attained**	
CH 305	Pract.Course V	3	2.0	**Fully Attained**	
CH 306	Prct. Course VI	3	2.0	**Fully Attained**	
CH 401	Applied Analytical Chemistry–I	2	2.0	**Fully Attained**	
CH 402	Applied Analytical Chemistry–II	3	2.0	**Fully Attained**	
CH 403	Pharmaceutical & Clinical Analysis	3	2.0	**Fully Attained**	
CH 404	Applied Analytical Chemistry–III	3	2.0	**Fully Attained**	
CH 405	Practical Course–VII	3	2.0	**Fully Attained**	
CH 406	Practical Course–VIII (Project Work or Inplant Training)	3	2.0	**Fully Attained**	

DRUG CHEMISTRY

Course Code	Course Title	CO Attainment Value	Target Attainment Level	Fully Attained/ Not Attained	Remedial Measures
CH 101	Inorganic Chemistry	2.0	2.0	Fully Attained	Not Applicable
CH 102	Organic chemistry	2.0	2.0	Fully Attained	
CH 103	Physical Chemistry	2.0	2.0	Fully Attained	
CH 104	Analytical chemistry	3	2.0	Fully Attained	
CH 105	Pract.Course I	3	2.0	Fully Attained	
CH 106	Prct. Course II	3	2.0	Fully Attained	
CH 201	Inorganic Chemistry	2.2	2.0	Fully Attained	
CH 202	Organic chemistry	2.0	2.0	Fully Attained	
CH 203	Physical Chemistry	2.0	2.0	Fully Attained	
CH 204	Spectroscopy	3	2.0	Fully Attained	
CH 205	Pract.Course III	3	2.0	Fully Attained	
CH 206	Prct. Course IV	3	2.0	Fully Attained	
CH 301	Application of Spectroscopy	2	2.0	Fully Attained	
CH 302	Bioorganic & Green Chemistry	3	2.0	Fully Attained	
CH 303	Organic Reactions & Rearrangements	2	2.0	Fully Attained	
CH 304	Applied Organic Chemistry	3	2.0	Fully Attained	
CH 305	Pract.Course V	3	2.0	Fully Attained	
CH 306	Prct. Course VI	3	2.0	Fully Attained	
CH 401	Introduction to	2		Fully	

	Medicinal Chemistry		2.0	Attained	
CH 402	Drug Synthesis	3	2.0	Fully Attained	
CH 403	Drug Action & Development	3	2.0	Fully Attained	
CH 404	Pharmaceutical & Industrial practices	3	2.0	Fully Attained	
CH 405	Practical Course–VII	3	2.0	Fully Attained	
CH 406	Practical Course–VIII (Project Work or Inplant Training)	3	2.0	Fully Attained	

13.The Results of PO Attainment:

PLEASE SEE THE ANNEXURE-B

FOR EXAMPLE: ANALYTICAL CHEMISTRY

PO NO.: PO2

(Note: Refer point No. 11 above which describes the attainment level and set target attainment level)

PO Attainment= 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

A (PO) 2 = 80% (2+2+2+3+3+3+2.2+2+2+3+3+3)/11 +20% (2.51)

=80% (2.51) + 20% (2.51)

= 2.51 i.e. Level-5. The Target Level is Level-4.

Hence, PO is attained.

Table No. 2.0 PO Attainment Level

ANALYTICAL CHEMISTRY

PO/PSO number	Attainment	Target level	Fully attained/ Not Attained	Remedial Measures
a	3	4	Fully attained	Not Applicable
b	3	4	Fully attained	
c	3	4	Fully attained	
d	3	4	Fully attained	
e	3	4	Fully attained	

DRUG CHEMISTRY

PO/PSO number	Attainment level	Target level	Fully attained/ Not Attained	Remedial Measures
a	3	4	Fully attained	Not Applicable
b	3	4	Fully attained	
c	3	4	Fully attained	
d	3	4	Fully attained	
e	3	4	Fully attained	

14. Planned Actions for Course Attainment:

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

15. Planned Actions for Program Outcome Attainment:

Not Applicable

ANNEXURE-B

COURSE ATTAINMENT & PO ATATINEMENT LEVEL

Course Code	A(CO)	A	b	c	d	e
CH 101	2	2	2	2		
CH 102	2	2	2	2		
CH 103	2	2	2	2		
CH 104	3	3	3	3		
CH 105	3	3	3	3		
CH 106	3	3	3	3		
CH 201	2.2	2.2	2.2	2.2		
CH 202	2	2	2	2		
CH 203	2	2	2	2		
CH 204	3	3	3	3		
CH 205	3	3	3	3		
CH 206	3	3	3	3		
CH 301	2		2	2	2	2
CH 302	3		3	3	3	3
CH 303	2		2	2	2	2
CH 304	3		3	3	3	3
CH 305	3		3	3	3	3
CH 306	3		3	3	3	3
CH 401	2		2	2	2	2
CH 402	3		3	3	3	3
CH 403	3		3	3	3	3
CH 404	3		3	3	3	3
CH 405	3		3	3	3	3
CH 406	3		3	3	3	3
PO Attainment		3	3	3	3	3

DRUG CHEMISTRY

Course Code	Course Title	A(CO)	a	b	c	d	e
CH 101	Inorganic Chemistry	2	2	2	2		
CH 102	Organic chemistry	2	2	2	2		
CH 103	Physical Chemistry	2	2	2	2		
CH 104	Analytical chemistry	3	3	3	3		
CH 105	Pract.Course I	3	3	3	3		
CH 106	Prct. Course II	3	3	3	3		
CH 201	Inorganic Chemistry	2.2	2.2	2.2	2.2		
CH 202	Organic chemistry	2	2	2	2		
CH 203	Physical Chemistry	2	2	2	2		
CH 204	Spectroscopy	3	3	3	3		
CH 205	Pract.Course III	3	3	3	3		

CH 206	Prct. Course IV	3	3	3	3		
CH 301	Application of Spectroscopy	2		2	2	2	2
CH 302	Bioorganic & Green Chemistry	3		3	3	3	3
CH 303	Organic Reactions & Rearrangements	2		2	2	2	2
CH 304	Applied Organic Chemistry	3		3	3	3	3
CH 305	Pract.Course V	3		3	3	3	3
CH 306	Prct. Course VI	3		3	3	3	3
CH 401	Introduction to Medicinal Chemistry	2		3	3	3	3
CH 402	Drug Synthesis	3		3	3	3	3

CH 403	Drug Action & Development	3		3	3	3	3
CH 404	Pharmaceutical & Industrial practices	3		3	3	3	3
CH 405	Practical Course–VII	3		3	3	3	3
CH 406	Practical Course–VIII (Project Work or Inplant Training)	3		3	3	3	3
PO ATTAINMENT			3	3	3	3	3

ANNEXURE-C
COURSE OUTCOMES

Inorganic Chemistry

- Describe advanced material synthesis and material characterization.
- Analyze the connections between the structure and properties of solids, including theory and methods
- To conduct chemical analyses and characterization of the physical properties of solids.
- To analyze the structural decisions with x-rays/ neutron/electron; diffraction and spectroscopy for studying bonds and electronic state – in bulk or on surfaces;
- To measure physical properties such as magnetism or electronic conductivity, studies of optical properties, use of mass spectrometry and other analytical techniques.

Organic Chemistry

- Describe chemical and molecular processes that take place in organic chemical reactions.
- to use modern methods when planning strategies for synthesis of new substances and characterization of products.
- To use modern methods of synthesis and conduct extremely advanced experiments, the synthesis of complex molecular structures and handling sensitive chemicals.
- To use complicated analytical and spectroscopic methods and advanced program packages
- To design and production (synthesis) of complex molecules.

Physical Chemistry

- Describe simple chemical kinetics including zero, first, and second order rate laws.
- Explain the concept of activation energy and its effects on the rates of chemical reactions.
- Apply the tools to derive the rate law for simple reaction mechanisms
- Describe steady state, steady state approximation and its use in deriving the rate law for complex mechanisms such as that found in unimolecular reactions.
- Implement the interaction of radiation with matter, and a basic understanding of absorption, emission and scattering processes.
- Apply the basic principles of the major spectroscopies, including ultraviolet & visible spectroscopy, infrared and microwave spectroscopies

Spectroscopy

- To describe the quantum mechanical models of molecular rotation and vibration
- Demonstrate microwave and IR spectra arise from molecular rotation and vibration.
- To use of spectroscopy to give chemical structure information
- To explain the the atomic term symbols and electronic selection rules
- To explain the electronic spectra of transition metal ions.

Application of Spectroscopy

- To able to interpret UV-Visible spectroscopy
- To able to interpret IR spectroscopy,
- To able to interpret NMR spectroscopy,
- To able to interpret elemental analysis technique
- To able to interpret fluorescence spectroscopy,
- To able to interpret atomic absorption spectroscopy,

Organic Photochemistry

- Describe the occurrence of excitation by irradiation of organic molecues.
- Describe the photochemical reactions for organic compounds.
- Explain the mechanistic aspects for the photochemical transformations.
- Describe reactors and other equipment used to perform photochemical reactions.
- Use relevant concepts and terminology in a correct fashion.

Environmental Chemistry

- Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
- Recognize different types of toxic substances & responses and analyze toxicological information
- Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil)
- Describe watr purification and waste treatment processes and the practical chemistry involved
- Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.
- Explain energy crisis and different aspects of sustainability.

Bioorganic Chemistry

- Use rules for description of the structure and stereochemistry of bioorganic compounds
- Relate the chemical structure of biomolecules to properties such as solubility, binding ability (hydrogen bond ability, lipophilicity, hydrophilicity), chirality correlate the chemical structure of biomolecules to reactivity
- Compare between transformations of biomolecules in living systems (aquatic environment) and in vitro, e.g. industrial synthesis
- Describe the application of chemistry in the biomolecular - and pharmaceutical sciences
- Explain the chemical properties and reactivity that influence environmental and economical decisions
- Discuss appropriate chromatographic methods for determination of organic compounds

Biophysical Chemistry

- Describe the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.
- Explain the basic concepts within statistical thermodynamics and apply this to biological systems binding and cooperativity.
- Describe the structures and functions of biological membranes, as well as model systems and relevant, macromolecules in solution, conformational equilibria, membrane equilibria, ligand methods for the study of these structures and functions.
- Explain and apply methods for the determination of functional molecular mass of biological macromolecules in solution as well as determination of equilibrium - and rate constants for macromolecule-ligand interactions.
- Apply spectroscopic methods for the study of structures and functions in biological systems.

Drug Synthesis

- Describe the synthetic methods and strategies as well as retrosynthetic analysis of known drugs.
- Experiment the synthetic methods and strategies as well as retrosynthetic analysis of known drugs.
- Explain the biological and pharmacological properties of the drugs will also be included