2018

[OBE DESIGN- MATHEMATICS DEPARTMENT]

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 Mathematics

1. Mission:

- To offer Mathematics education at post-graduate and research program for Science and Social Science disciplines.
- To develop the manpower to solve the industrial and business problems.
- To apply the mathematical tools in solving the problem and inclusive of research problem.
- To conduct research and analyse the data by applying and comparing the results from different mathematical tools.
- support Mathematics to the end users and to improve linkage with industries.
- To become a Centre of Excellence in teaching and quality oriented research.

2. Vision:

Vision Statement
- The vision of the department is to become a Centre of Excellence in using technology in mathematics, teaching and research.
- To develop creative and innovative platform for teaching of mathematics.
- To increase global linkages by attracting foreign students and by establishing collaborative research programs with reputed educational institutions.
- To contribute for the well-being of humankind through the study of mathematical sciences.

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

3. Title of the Program (s):
a. **Master of Science in Mathematics**
b. **Master of Science in Applied Mathematics**

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 mathematics and apply mathematical rules in designing/solving problems.

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. Solve problems in the advanced areas of (a) numerical analysis, (b) linear algebra, (c) real analysis, and (d) statistics.
b. Read, analyze, and write logical arguments to prove mathematical concepts.
c. Communicate mathematical ideas with clarity and coherence, both written and verbally.
d. Perform research in conjunction with others as well as individually.
e. Apply values based and ethical principles in providing leadership to profession and social life.

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.

M. Sc. Mathematics

Course Title	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
Advanced Abstract Algebra-I	*	*					
Real Analysis-I	*	*					
Topology-I	*	*					
Complex Analysis-I	*	*					
Differential Equation-I	*	*					
Advanced Abstract Algebra-II	*	*	*				
Real Analysis-II	*	*	*				
Topology-II	*	*	*				
Complex Analysis-II	*	*	*				
Differential Equation-II	*	*	*				
Indian Constitution				*	*		
Functional Analysis			*	*	*		
Partial Differential Equation			*	*	*		
MATLAB Programming	*		*	*	*		
Fluid Mechanics-I	*		*	*	*		
Numerical Analysis			*	*	*		
Lattice Theory			*	*	*		
Service Course			*	*	*		
Linear Integral equation			*	*	*		
Mechanics	*		*	*	*		
Differential Equations			*	*	*		
Fuzzy Mathematics			*	*	*		
Linear Algebra			*	*	*		

M. Sc. Applied Mathematics

Course Title	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
Advanced Abstract Algebra-I	*	*					
Real Analysis-I	*	*					
Topology-I	*	*					
Complex Analysis-I	*	*					
Differential Equation-I	*	*					
Advanced Abstract Algebra-II	*	*	*				
Real Analysis-II	*	*	*				
Topology-II	*	*	*				
Complex Analysis-II	*	*	*				
Differential Equation-II	*	*	*				
Functional Analysis			*	*	*		
Partial Differential Equation			*	*	*		
Wavelet Analysis & applications	*		*	*	*		
Fluid Mechanics-I	*		*	*	*		
Numerical Analysis			*	*	*		
Linear Integral equation			*	*	*		

Mechanics	*		*	*	*		
Wavelet Analysis & applications			*	*	*		
Fluid Mechanics-I			*	*	*		
Fuzzy Mathematics			*	*	*		

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: 30% students scored more than class average

    iii. Level-2: 40% students score more than class average;

    iv. Level-3: 50% 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; 40% 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).

f. **The example of calculation of CO attainment is demonstrated in Point No. 12. The example of one course from M. Sc. Mathematics is explained here.**

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-3). It implies that, the department is aiming at minimum level-3 (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. **The example of calculation of PO attainment is demonstrated in Point No. 13. The example of one PO from M. Sc. Mathematics is explained here.**

12. The Results of CO Attainment:

The Results of CO attainment is provided in Annexure-B

<u>**FOR EXAMPLE:**</u>

<u>**COURSE CODE/TITLE: 403/ Topology-1**</u>

e.g. For end term and internal examination;
i.   Level-1: 30% students scored more than class average
ii.   Level-2: 40% students score more than class average;
iii.   Level-3: 50% students score more than class average

Average Marks in External examination: 16.98 i.e. 17

% Students score more than 17 is 21/61 i. e. 34.42 % i.e. Levl-1

Average Marks in Internal examination= 2.98 i.e. 3.00

% Students score more than 3 is 23/61 i. e. 37.70% Level-1

A (CO) 403 = 80% (1) +20(1)

=1.00

=1.00

Hence, The attainment level is Level-1 and the set target level is Level-2 and therefore the CO is Not attained.

Table No. 1.0: CO Attainment Level

MASTER OF SCIENCE IN MATHEMATICS

Course Title	CO Attainment Value	Target Attainment Level	Fully attained/ Not Attained	Remedial Measures
Advanced Abstract Algebra-I	2	2	**Fully attained**	
Real Analysis-I	3	2	**Fully attained**	
Topology-I	1	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Complex Analysis-I	1.8	2	**Fully attained**	
Differential Equation-I	2.2	2	**Fully attained**	
Advanced Abstract Algebra-II	1.2	2	**Not Attained**	Assignments, exercises, coaching

Course Title				and tutorials
Real Analysis-II	3	2	**Fully attained**	
Topology-II	1.2	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Complex Analysis-II	1.2	2	**Not Attained**	
Differential Equation-II	2	2	**Fully attained**	
Functional Analysis	1.4	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Partial Differential Equation	2.8	2	**Fully attained**	2.8
MATLAB Programming	1	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Fluid Mechanics-I	0	2	**Not Attained**	
Numerical Analysis	0	2	**Not Attained**	
Lattice Theory	2.2	2	**Fully attained**	2.2
Service Course	1	2	**Not Attained**	Assignments, exercises, coaching and tutorials.
Linear Integral equation	1.6	2	**Not Attained**	
Mechanics	1.6	2	**Not Attained**	
Differential Equations	1.6	2	**Not Attained**	
Fuzzy Mathematics	0	2	**Not Attained**	
Linear Algebra	0	2	**Not Attained**	
MAT-535	1.2	2	**Not Attained**	
MAT-536	1	2	**Not Attained**	

MASTER OF SCIENCE IN APPLIED MATHEMATICS

Course Title	CO Attainment Value	Target Attainment Level	Fully Attained/ Not Attained	Remedial Measures
Advanced Abstract Algebra-I	1.2	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Real Analysis-I	2.8	2	**Fully Attained**	

Topology-I	0.4	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Complex Analysis-I	1.2	2	**Not Attained**	
Differential Equation-I	3	2	**Fully Attained**	
Advanced Abstract Algebra-II	0.2	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Real Analysis-II	1.6	2	**Not Attained**	
Topology-II	1	2	**Not Attained**	
Complex Analysis-II	0.4	2	**Not Attained**	
Differential Equation-II	1	2	**Not Attained**	
Functional Analysis	1.2	2	**Not Attained**	
Partial Differential Equation	2.8	2	**Fully Attained**	
Wavelet Analysis & applications	2.8	2	**Fully Attained**	
Fluid Mechanics-I	2.8	2	**Fully Attained**	
Numerical Analysis	1.4	2	**Not Attained**	Assignments, exercises, coaching and tutorials
Linear Integral equation	1.4	2	**Not Attained**	
Mechanics	2.2	2	**Fully Attained**	
Wavelet Analysis & applications	3	2	**Fully Attained**	
Fluid Mechanics-I	3	2	**Fully Attained**	
Fuzzy Mathematics	1.4	2	**Not Attained**	Assignments, exercises, coaching and tutorials

13. The Results of PO Attainment:

The Results of PO Attainment is shown in Annexure-B

FOR EXAMPLE:

PO NO.: PO-1

(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) 1 = 80% (2+3+1+1.8+2.2+1.2+3+1.2+1.2+2+1)/11 +20% (1.63)

$\quad$ =80% (1.63) + 20% (1.63)

$\quad$ = 1.63

$\quad$ = 1.63 i.e. Level-3. The target level is Level-3.

Hence, PO is attained.

Table No. 2.0 PO Attainment Level

M. Sc. Mathematics

PO/PSO number	PO Attainment Value	Target Attainment level	Fully attained / Not Attained	Remedial Measures
a	1.63	3	Fully attained	
b	1.86	3	Fully attained	
c	1.26	3	Not Attained	Assignments, exercises, coaching and tutorials shall be conducted for the corresponding courses.
d	1.1	3	Not Attained	
e	1.1	3	Not Attained	

M. Sc. Applied Mathematics

PO/PSO number	PO Attainment Value	Target Attainment level	Fully attained / Not Attained	Remedial Measures
a	1.58	3	Fully Attained	
b	1.28	3	Not Attained	Assignments, exercises, coaching and tutorials shall be conducted for the corresponding courses. .
c	1.75	3	Fully Attained	
d	2.2	3	Fully Attained	
e	2.2	3	Fully Attained	

14. Planned Actions for Course Attainment:

The CO having attainment level less than Level-2, shall be addressed through assignments, exercises, tutorial and remedial classes. The separate time table will be prepared for such courses.

15. Planned Actions for Program Outcome Attainment:

The PO having attainment level less than Level-3, shall be addressed through assignments, exercises, tutorial and remedial classes in the respective courses that contributes the PO. The separate time table will be prepared for such courses.

ANNEXURE-B
RESULTS OF CO-PO ATTAINMENT LEVELS

M. Sc. MATHEMATICS

Course Title	PO1	PO2	PO3	PO4	PO5
Advanced Abstract Algebra-I	2	2			
Real Analysis-I	3	3			
Topology-I	1	1			
Complex Analysis-I	1.8	1.8			
Differential Equation-I	2.2	2.2			
Advanced Abstract Algebra-II	1.2	1.2	1.2		
Real Analysis-II	3	3	3		
Topology-II	1.2	1.2	1.2		
Complex Analysis-II	1.2	1.2	1.2		
Differential Equation-II	2	2	2		
Functional Analysis			1.4	1.4	1.4
Partial Differential Equation			2.8	2.8	2.8

MATLAB Programming	1		1	1	1
Fluid Mechanics-I	0		0	0	0
Numerical Analysis			0	0	0
Lattice Theory			2.2	2.2	2.2
Service Course			1	1	1
Linear Integral equation			1.6	1.6	1.6
Mechanics	1.6		1.6	1.6	1.6
Differential Equations			1.6	1.6	1.6
Fuzzy Mathematics			0	0	0
Linear Algebra			0	0	0
MAT-535			1.2	1.2	1.2
MAT-536			1	1	1
	1.63	1.86	1.26	1.1	1.1

M. Sc. APPLIED MATHEMATICS

Course Title	PO1	PO2	PO3	PO4	PO5
Advanced Abstract Algebra-I	1.2	1.2			
Real Analysis-I	2.8	2.8			
Topology-I	0.4	0.4			
Complex Analysis-I	1.2	1.2			
Differential Equation-I	3	3			
Advanced Abstract Algebra-II	0.2	0.2	0.2		
Real Analysis-II	1.6	1.6	1.6		
Topology-II	1	1	1		
Complex Analysis-II	0.4	0.4	0.4		
Differential Equation-II	1	1	1		
Functional Analysis			1.2	1.2	1.2
Partial Differential Equation			2.8	2.8	2.8
Wavelet Analysis & applications	2.8		2.8	2.8	2.8
Fluid Mechanics-I	2.8		2.8	2.8	2.8
Numerical Analysis			1.4	1.4	1.4
Linear Integral equation			1.4	1.4	1.4
Mechanics	2.2		2.2	2.2	2.2
Wavelet Analysis & applications			3	3	3
Fluid Mechanics-I			3	3	3
Fuzzy Mathematics			1.4	1.4	1.4
	1.58	1.28	1.75	2.2	2.2

ANNEXURE-C
COURSE OUTCOMES