INTERNATIONAL RESEARCH JOURNAL OF HUMANITIES AND INTERDISCIPLINARY STUDIES
(Peer-reviewed, Refereed, Indexed & Open Access Journal)
DOI : 03.2021-11278686 ISSN : 2582-8568 IMPACT FACTOR : 6.865 (SJIF 2023)

Design and Development of Framework for Computation of PO Attainment of Unstructured Excel Data

Dr. Girish R. Naik
Mechanical Department,
KIT's College of Engineering,
Kolhapur (Maharashtra, India)

Dr. Poornima G. Naik
Department of Computer Studies,
CSIBER, Kolhapur,
(Maharashtra, India)

DOI No. 03.2021-11278686 **DOI Link ::** https://doi-ds.org/doilink/03.2023-64284523/IRJHISIC2302047

Abstract:

The Outcome Based Education (OBE) associates each part of educational system around the pre-defined set of goals and imbibes the student with the requisite graduate attributes to achieve those goals at the end of his academic career. The performance of the student is measured with reference to the goals achieved by the student. OBE offers a student-centric teaching-learning process controlled with the content delivery, assessment methodology designed to achieve the stated outcomes. A course can be theoretical or practical-oriented. Skill attainment in each of these is measured along different scales. In the current research, the authors have designed and developed a model for computation of Programming Outcomes of different programmes launched by an institute. The framework previously designed for Course Objective attainment provides the requisite input for the model and PO attainments are computed on the scale of five. Also, the work is augmented for performing grade modelling separately for formative and summative assessments in a course 'Computer Organization and Architecture'. The bell shaped trend fittings ensure the true reflection of the performance range.

Keywords: *Bloom's Taxonomy, Course Objectives, CO-PO Mapping, Course Outcomes, Graduate Attributes, Outcome Based Education,*

1.0 Introduction:

In the traditional education system, the students merely focus on memorization through rote learning rather than conceptual understanding of the courses. Once the concepts are memorized there is very little scope for understanding. This results in lack of gaining of actual skills or practical knowledge. The Outcome Based Education (OBE) model focuses on clear objectives and through the continuous evaluation of progress the actual course outcomes which includes knowledge, skills and attitude are attained. OBE immensely contributes towards clarity of focus. The course design ensures

the conformance to clear attainment of course objectives by properly mapping them to course course outcomes. The core of OBE is continual improvement. OBE is student centric framework in which facilitators plan their course delivery and assessment with the course outcome as end point in mind. Programme Educational Objectives are nothing but the skill sets to be possessed by the students at the end of the programme and the Programme Specific Outcomes are the domain dependent strength or abilities of the student. It is related to the domain dependent POs which are numbered from 1 to 5. Higher POs from 6 to 8 focus on ethical, legal, social issues, life long learning, working effectively in a team and effective communication. In OBE emphasis is placed on what students are expected to know and be able to do i.e. it clearly tries to assess his knowledge and skill attributes.

The following table depicts different courses which are mapped to

Course Code	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CC-101	Computer Architecture and Operating system	2	1	1	2	3	0	2	2
CC-102	Software Engineering and Object Oriented Design	1	3	3	3	3	2	3	3
CC-103	Design and Analysis of Algorithms	3	3	3	3	3	1	2	2
CC-104	Programming with 'C'	2	2	3	2	3	1	2	2
CC-105	Web Design and Development	2	2	3	2	3	1	2	2
DSE-I	Programming with Python.	2	2	3	2	3	1	2	2
AEC-I	Stress Management	0	2	0	2	1	3	3	3

Bloom's taxonomy defines six knowledge levels pertaining to knowledge gain, comprehension, application, analysis, synthesis and evaluation as depicted in Figure 1.

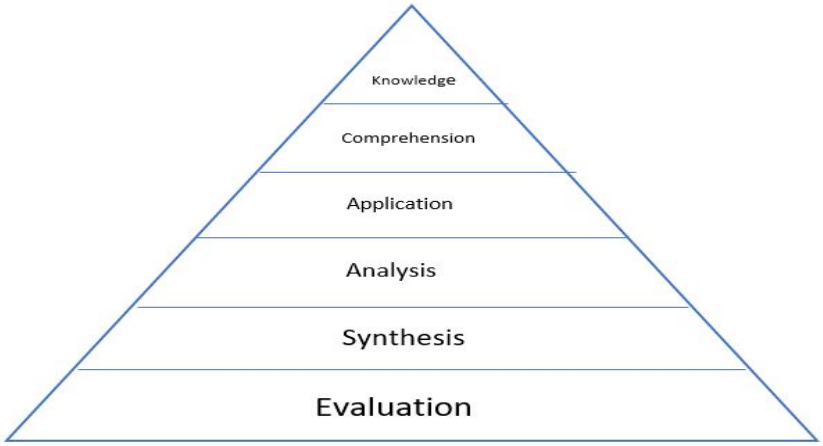


Figure 1. Bloom's Taxonomy Knowledge Levels

The twelve graduate attriburtes in OBE are listed below:

- Knowledge
- Problem Analysis
- Designing solutions
- Solutions to complex problems
- Usage of modern tools
- Relevance to societythought
- Environment and sustainability
- Ethics
- Working as individual and in a team
- Communication
- Project Management
- Life long learning

Over the years the teaching padegogy has been drastically changed to inculcate the requisite skills among the students to render them job ready. The padegogies such as flipped class room, think pair share enable the facilitators to render the sessions thought provoking. In the light of flipped class rooms, the teachers upload the resource materials comprising of pre-reading materials and any other digital content in a centralized digital repository and the students are instructed to read the materials and watch videos before they come to the class rooms. The teachers mainly act as facilitators in explaining difficult to learn concepts, if any and most of the focus is on problem solving sessions which may include case studies, system design, database design, coding exercises, problem solving tasks etc. This is where the teacher's presence is most required.

New Education Policy (NEP) 2020 advocates developing padegogy which ensures holistic development of students through flipped class rooms, integrated learning, experiential learning, discussion based peer learning.

2.0 Literature Review and Research Gaps:

There are plethora of research articles for the computation of PO attainment of a program but most of them are analytical in nature. During the survey conducted the authors did not find a paper which lays a sound mathematical foundation to the PO attainment procedure. NBA accreditation criteria focuses on Outcome Based Education (OBE) and Bloom's taxonomy. Washington Accord is an international accreditation agreement for professional colleges which ensures the equivalence of programmes accredited by the signatories. The challenges in OBE are writing good achievable course objectives and use of rubrics as effective assessment tools [1].KIET group of institutions OBE

manual with Bloom's taxonomy and manual of OBE of Jarkhand Rai University of Ranchi clearly specify the guidelines for stating Programme Educational Objectives (PEOs), Programme Specific Objectives (PSOs), Course Objectives and Programme Outcomes [2 - 4]. NBA insists on ten different criteria for achieving OBE in engineering stream with different perspectives. Kavitha et.al. have discussed in their research paper course delivery mechanisms for achieving OBE in an engineering programme focussing on assessment methods and attainments of Course Outcomes (CO) and Programme Outcomes (PO) [5, 6]. PO attainments computations rely on two mechanisms, direct method and indirect method based on course exit survey. Shaikh et. al. have employed both these techniques for calculation of PO attainment. The computations are performed in an Excel sheet [7].Reddy et.al have performed CO-PO attainment computation for the basic Electrical Engineering course offered for B.Tech – I year. The study has been extended further for computing the PSO attainment [8]. A simplified and robust approach for computation of CO attainment is presented [9, 10]. Rani et.al have replicated the computation for Tier-II institutions.

After the exhaustive literature survey the following research gaps were identified and addressed in the current paper:

- A generic framework for CO-PO attainment calculation with the separation of concerns employing scalable multi-tier application architecture is missing.
- Exporting the reports to MS-Word or PDF formats are not reported in the literature anywhere.
- Grade modelling for the determination of performance range which is an important component is not mentioned anywhere.

The research gaps spelt out above are addressed in the current research. A framework is designed for the computation of CO-PO attainment which can be extended further for computation of PEO and PSO attainment levels. The final reports can be exported to Word format. The trend fitting of grade modelling is carried out to investigate performance range in a sample subject of 'Computer Architecture and Organization'.

3.0 Research Methodology:

3.1 Mathematical Model:

In this section a mathematical model for the computation of CO attainment and PO attainment is devised.

Computation of CO Attainment;

Let $m1_{ij}$ denote the marks scored by i^{th} student in j^{th} course in a formative assessment and $m2_{ij}$ denote the corresponding marks scored by i^{th} student in j^{th} course in a summative assessment.

The sum of marks scored by various students in the j^{th} course is given by:

$S1j = \sum_{i=1}^{60} m1j =$ where 1 <= i <= 60 and

where j <= j <= 7

The average marks in j[th] course in formative assessment is given by,

$$Avg1j = \frac{S1j}{60}$$

The count of the students above average in jth course is given by,

$$Cij = \sum_{i=1}^{60} 1 \quad if\ mij > Avg1j$$

Hence the percentage of students above average in the j[th] course is given by

$$P1j = \frac{C1j}{Avg1j}\ x\ 100$$

The same procedure applies to summative assessment where $P2_j$ is the percentage of students above average in the j[th] course in summative assessment.

The CO attainment in jth course is given by,

$P_j = 0.2 \times P1_j + 0.8 \times P2_j$

Hence the CO attainment levels on the scale of 3 are computed as depicted in Table 1.

Table 1: CO Attainment Levels

Pj	Level (L_j)
>30 and<= 40	1
>40 and <= 50	2
> 50	3

Computation of PO Attainment by Indirect Method:

CO-PO mapping table is a matrix of order i x j where i is the no. of courses and j is the no. of POs. Let POij denote the j[th] PO of i[th] course in CO-PO mapping table with the weight between 1 and 3 with the meaning of each weight as furnished in Table 2.

Table 2: Weightages Assigned to POs

Weight	Meaning
Low	1
Medium	2
High	3

Compute another matrix employing the CO attainment computed earlier. It depicts the CO attainment for different POs specified by the programme. The corresponding modified matrix is given by,

$$PO'ij = \sum_{i=1}^{7}\sum_{j=1}^{8} Li\ x\ POij$$

Same computation applies to other semesters. Total courses offered in different semesters of MCA programme are depicted in Table 3.

Table 3: No. of Courses Offered in Different Semesters of MCA Programme

Semester	No. of Courses
I	7
II	9
III	10
IV	9
Total :	**35**

Finally, PO attainment of i^{th} subject is given by,

$$POAtti = \frac{\sum_{j=1}^{35} PO'ij}{35}$$

Finally, based on the score the CO attainment level is determined as depicted in Table 4.

Table 4: PO Mapping Table

Level	Score	Score
Level-1	> 0.5 and <1.0	Poor
Level-2	> 1.0 and <1.5	Average
Level-3	> 1.5 and <2.0	Good
Level-4	> 2.0 and <2.5	VeryGood
Level-5	> 2.5 and <3.0	Excellent

POs of MCA Academic Curriculum:

There are total eight Programme Outcomes defined in MCA academic curriculum. Some sample POs are furnished herewith:

- PO 1: Apply the knowledge of computing and mathematics to understand problems in different domains.
- PO 2: Analyze problems to identify and understand the requirements appropriate to its solution.

- PO 3: Design and develop a computer-based solution to meet desired requirements with understanding of social concerns.
- PO 4: Design and conduct experiments to identify alternative solutions and interpret results.

CO-PO Mapping Table:

The structure of sample CO-PO mapping table is depicted in Figure 2.

H19

	A	B	C	D	E	F	G	H	I
1		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
2	CC 101	1	2	0	3	3	1	1	1
3	CC 102	3	2	3	3	0	1	1	1
4	CC 103	2	2	1	2	1	1	1	1
5	CC 104	2	2	1	2	1	1	1	1
6	DSE I	2	2	2	1	2	0	1	1
7	GE I	3	2	2	2	2	1	1	1
8	AEC I	0	0	0	0	0	2	2	2
9									

Figure 2. CO-PO Mapping Table for Semester-I of MCA Programme

3.2 Application Framework:

Figure 3. depicts the application framework for the computation of PO attainment levels for the MCA programme. The input to the framework if CO attainment framework designed by one of the authors.

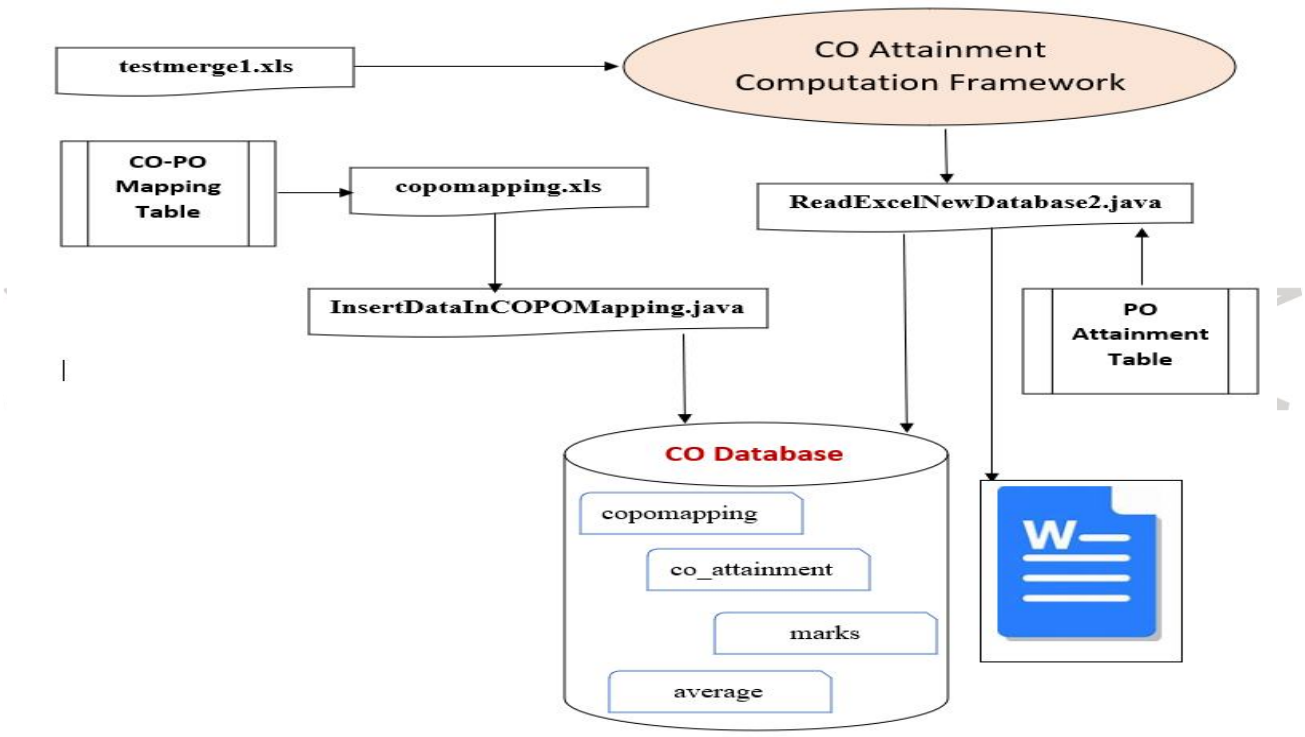


Figure 3. Application Framework for PO Attainment Computation

In the above architecture, testmerge1.xls file contains the cleaned Excel worksheet which is employed by CO attainment framework for computation of CO attainments levels for different courses of MCA programme. The results are employed by the PO mapping framework. The CO-PO mapping for different courses are stored in different Excel sheets. 'InsertDataInCOPOMapping.java' program employs standard JAR file for retrieving the data and persisting the same in MySQL backedn database. The 'ReadNewExcelDatabase2.java' program in the business logic tier employs the database and PO attainment table for computation of PO attainment levels for MCA programme. Currentl, the results can be exported to Word document.

3.3 Structure of Excel Worksheet:

The structure of Excel worksheet after data cleaning is depicted in Figure 4.

	A	B	C	D	E	F	G	H
1	Course :							
2	Seat No.	CC 101	CC 102	CC 103	CC 104	DSE I	GE I	AEC I
3		COMP.ORG. ARCH. Cr.Pt.4.00	SOFT. ENG. Cr.Pt.4.00	PROG. WITH C Cr.Pt.4.00	WEB DESI. DEVT. Cr.Pt.4.00	ETHICAL HACKING Cr.Pt.4.00	FUND. MGT. Cr.Pt.4.00	COMM. AT WORK Cr.Pt.3.00
4		Int.	Int.	Int.	Int.	Int.	Int.	Int.
5		Theory	Theory	Theory	Theory	Theory	Theory	Theory
6		Grace	Grace	Grace	Grace	Grace	Grace	Grace
7		20/40	20/40	20/40	20/40	20/40	20/40	20/40
8		24/60	24/60	24/60	24/60	24/60	24/60	24/60
9	1101	35	36	34	35	34	34	33
10	*BAWALE	48	41	48	42	42	39	44
11	1102	35	35	34	34	33	31	28
12	*DHARANI	42	35	34	30	35	31	42
13	1103	34	33	34	33	32	31	32
14	*BHOSALE	40	41	38	37	44	35	46
15	1104	29	28	30	29	25	21	30
16	CHAVAN	34	29	20	198	06	33	32
17	1105	34	34	34	33	31	31	32
18	*CHAVAN	45	39	37	27	40	36	44
19	1106	29	30	31	31	28	26	29
20	*CHOUGULE	46	33	45	46	37	35	34
21	1107	35	31	32	29	32	29	34
22	*DESAI APURVA	34	31	29	32	40	33	40
23	1108	36	31	31	36	32	26	33
24	*KADAM SWAPNALI	40	33	32	26	36	27	24
25	1109	35	33	34	33	29	22	28
26	*KULKARNI	41	30	38	25	36	28	26

Figure 4. Cleaned Excel Worksheet Containing Formative and Summative Assessments

Start Cell Address – B9 Column Range for Marks – B to H First Course Code – CC 101

3.4 Database Structure:

The structure of the database and structure of different tables in the database along with their contents is depicted in Figure 5(a) – 5(i).

Name of the Database:co

	Table	Action	Rows	Type	Collation	Size
☐	average	Browse Structure Search Insert Empty Drop	7	InnoDB	utf8mb4_general_ci	16.0 KiB
☐	copomapping	Browse Structure Search Insert Empty Drop	296	InnoDB	utf8mb4_general_ci	64.0 KiB
☐	co_attainment	Browse Structure Search Insert Empty Drop	37	InnoDB	utf8mb4_general_ci	16.0 KiB
☐	marks	Browse Structure Search Insert Empty Drop	266	InnoDB	utf8mb4_general_ci	64.0 KiB
	4 tables	Sum	606	InnoDB	utf8mb4_general_ci	160.0 KiB

Commands for Table Creation:

Create table copomapping (subcode char (50), po char(5), levle int);

create table co_attainment (Course char(50), Internal int, External int, CO_Score float, Attainment char(20));

Table Structure and Contents:

Table Names:

- copomapping
- marks
- average
- co_attainment

copomapping Table Structure:

	#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
☐	1	subcode	char(50)	utf8mb4_general_ci		Yes	*NULL*			Change Drop More
☐	2	po	char(5)	utf8mb4_general_ci		Yes	*NULL*			Change Drop More
☐	3	levle	int(11)			Yes	*NULL*			Change Drop More

Content of copomapping Table:

subcode	po	levle
CC 101	PO1	1
CC 101	PO2	2
CC 101	PO3	3
CC 101	PO4	3
CC 101	PO5	3
CC 101	PO6	1
CC 101	PO7	1
CC 101	PO8	1
CC 102	PO1	3
CC 102	PO2	2
CC 102	PO3	3
CC 102	PO4	3
CC 102	PO5	0
CC 102	PO6	0
CC 102	PO7	1

Co_attainment Table Structure:

	#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
☐	1	Course	char(50)	utf8mb4_general_ci		No	None			Change Drop More
☐	2	Internal	int(11)			Yes	NULL			Change Drop More
☐	3	External	int(11)			Yes	NULL			Change Drop More
☐	4	CO_Score	float			Yes	NULL			Change Drop More
☐	5	Attainment	char(20)	utf8mb4_general_ci		Yes	NULL			Change Drop More

Content of co_attainment Table:

Course	Internal	External	CO_Score	Attainment
AEC I	3	3	3	Fully Attained
AEC II	2	2	2	Fully Attained
AEC III	3	3	3	Fully Attained
AEC IV	3	3	3	Fully Attained
CC 101	3	3	3	Fully Attained
CC 102	3	3	3	Fully Attained
CC 103	3	3	3	Fully Attained
CC 104	2	3	2.8	Fully Attained
CC 201	3	3	3	Fully Attained
CC 202	3	3	3	Fully Attained
CC 203	3	2	2.2	Fully Attained
CC 204	3	2	2.2	Fully Attained
CC 205	3	3	3	Fully Attained

Structure of marks table:

	#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
☐	1	sub_name	char(100)	utf8mb4_general_ci		Yes	NULL			Change Drop More
☐	2	seatno	int(11)			Yes	NULL			Change Drop More
☐	3	internal	int(11)			Yes	NULL			Change Drop More
☐	4	external	int(11)			Yes	NULL			Change Drop More

Content of marks Table

sub_name	seatno	internal	external
CC 501	2361	29	60
CC 501	2362	34	52
CC 501	2363	32	60
CC 501	2364	34	60
CC 501	2365	32	56
CC 501	2366	30	48
CC 501	2367	33	54
CC 501	2368	33	60
CC 501	2369	34	60

Structure of average table:

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	sub_name	char(50)	utf8mb4_general_ci		Yes	NULL			Change Drop More
2	average_internal	float			Yes	NULL			Change Drop More
3	average_external	float			Yes	NULL			Change Drop More

Content of average table:

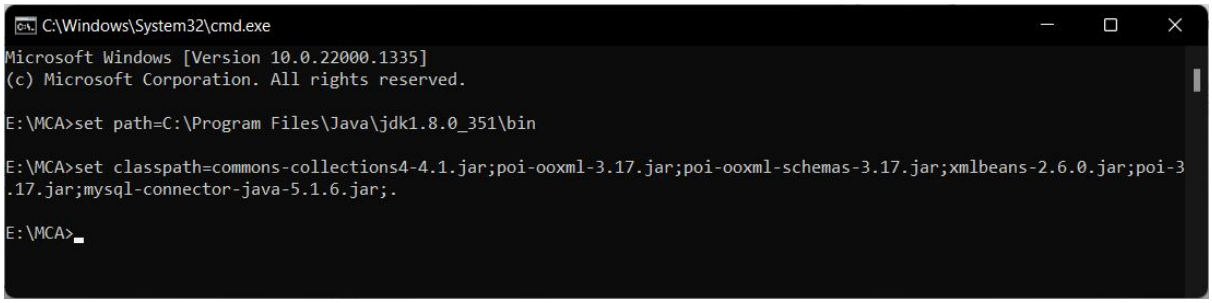
sub_name	average_internal	average_external
CC 501	32.0526	57.9474
CC 502	30.8421	33.1053
CC 503	30.8158	53.6842
CC 504	30.5263	40.6316
CC 505	29.9474	42.8158
DSE IV	30.8684	41.9474
DSE V	33.3158	59.0526

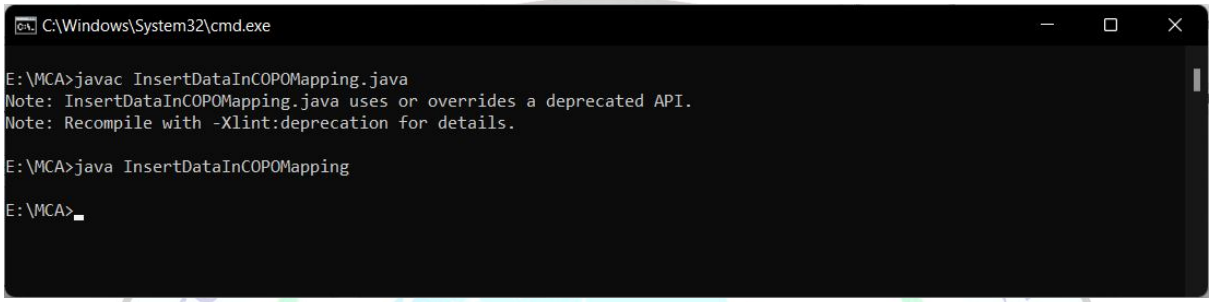
Figure 5 (a)-5(i). Structure of Database

Path and Classpath Setting

```
set path=C:\Program Files\Java\jdk1.8.0_351\bin
set classpath=commons-collections4-4.1.jar;poi-ooxml-3.17.jar;poi-ooxml-schemas-3.17.jar;xmlbeans-2.6.0.jar;poi-3.17.jar;mysql-connector-java-5.1.6.jar;.
```

The application's execution in business logic tier is shown in Figure 6(a) – 6(c) along with the data extracted from unstructured Excel sheet which is persisted in the backend database.





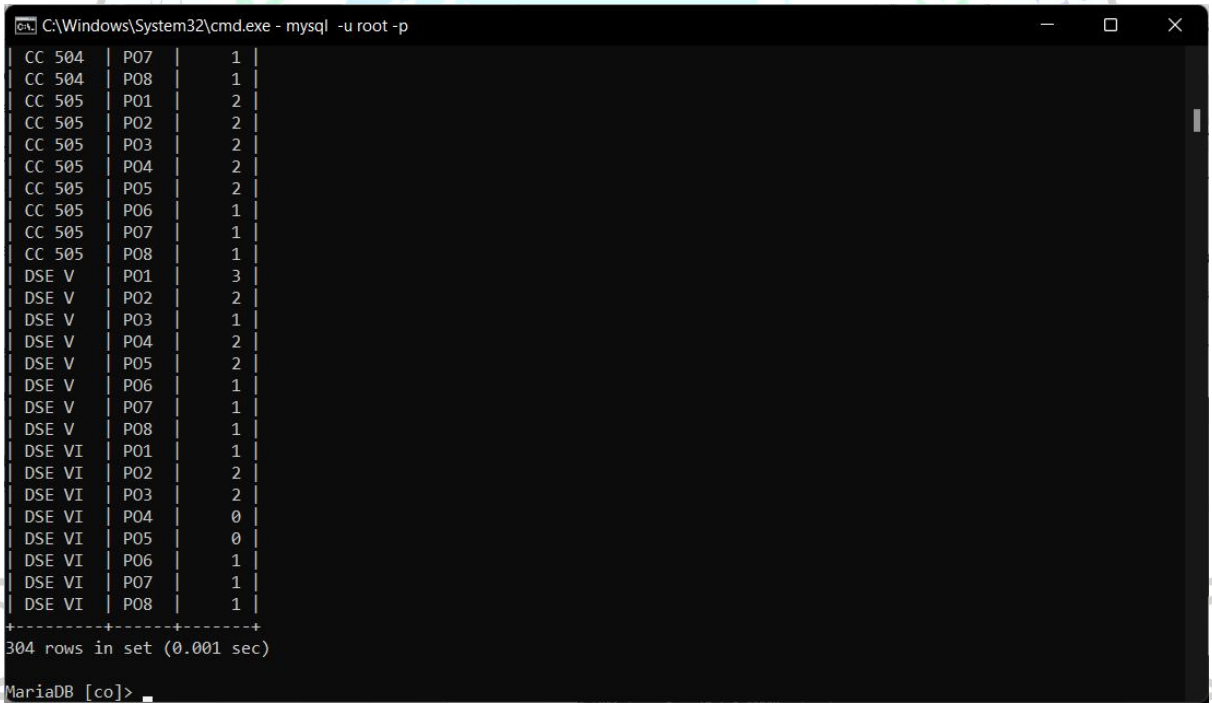
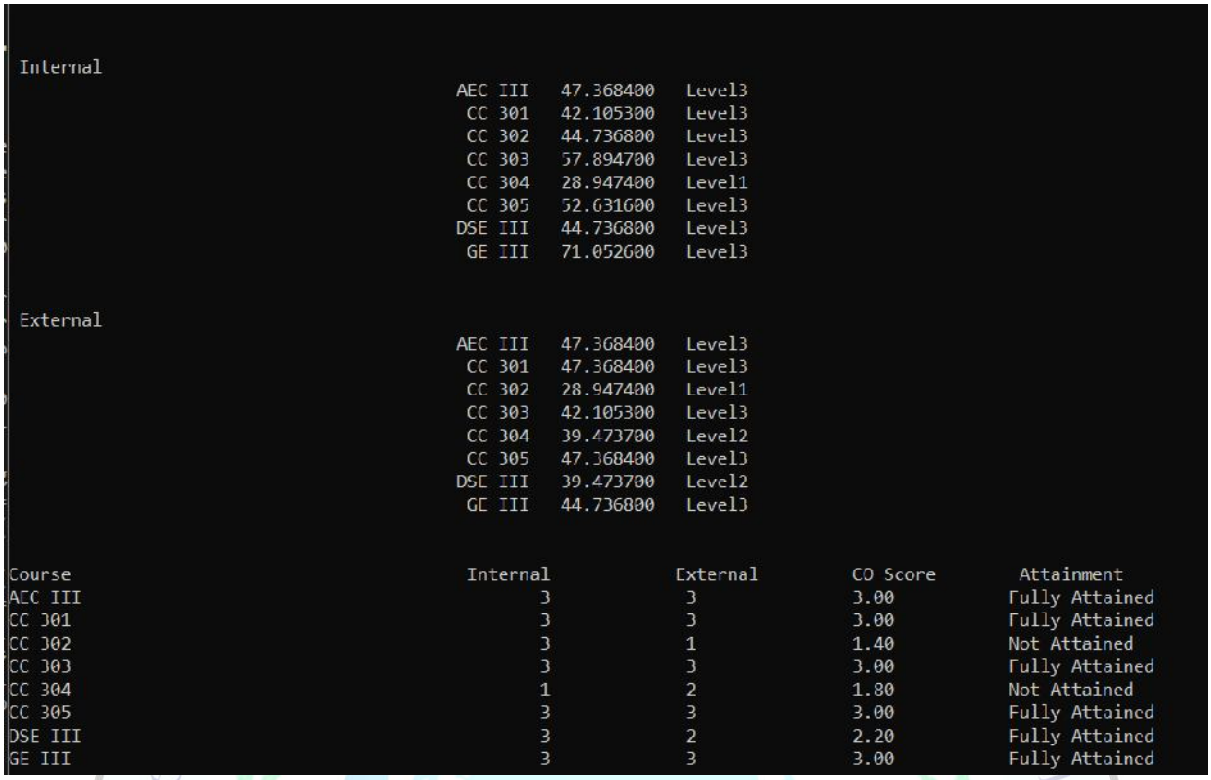


Figure 6(a) – 6(c). Application Execution in Business Tier and Data Persistence in Data Tier

The final results of CO computation is shown in Figure 7.



Internal

AEC III	47.368400	Level3
CC 301	42.105300	Level3
CC 302	44.736800	Level3
CC 303	57.894700	Level3
CC 304	28.947400	Level1
CC 305	52.631600	Level3
DSE III	44.736800	Level3
GE III	71.052600	Level3

External

AEC III	47.368400	Level3
CC 301	47.368400	Level3
CC 302	28.947400	Level1
CC 303	42.105300	Level3
CC 304	39.473700	Level2
CC 305	47.368400	Level3
DSE III	39.473700	Level2
GE III	44.736800	Level3

Course	Internal	External	CO Score	Attainment
AEC III	3	3	3.00	Fully Attained
CC 301	3	3	3.00	Fully Attained
CC 302	3	1	1.40	Not Attained
CC 303	3	3	3.00	Fully Attained
CC 304	1	2	1.80	Not Attained
CC 305	3	3	3.00	Fully Attained
DSE III	3	2	2.20	Fully Attained
GE III	3	3	3.00	Fully Attained

Figure 7. Computation of CO Attainment Levels

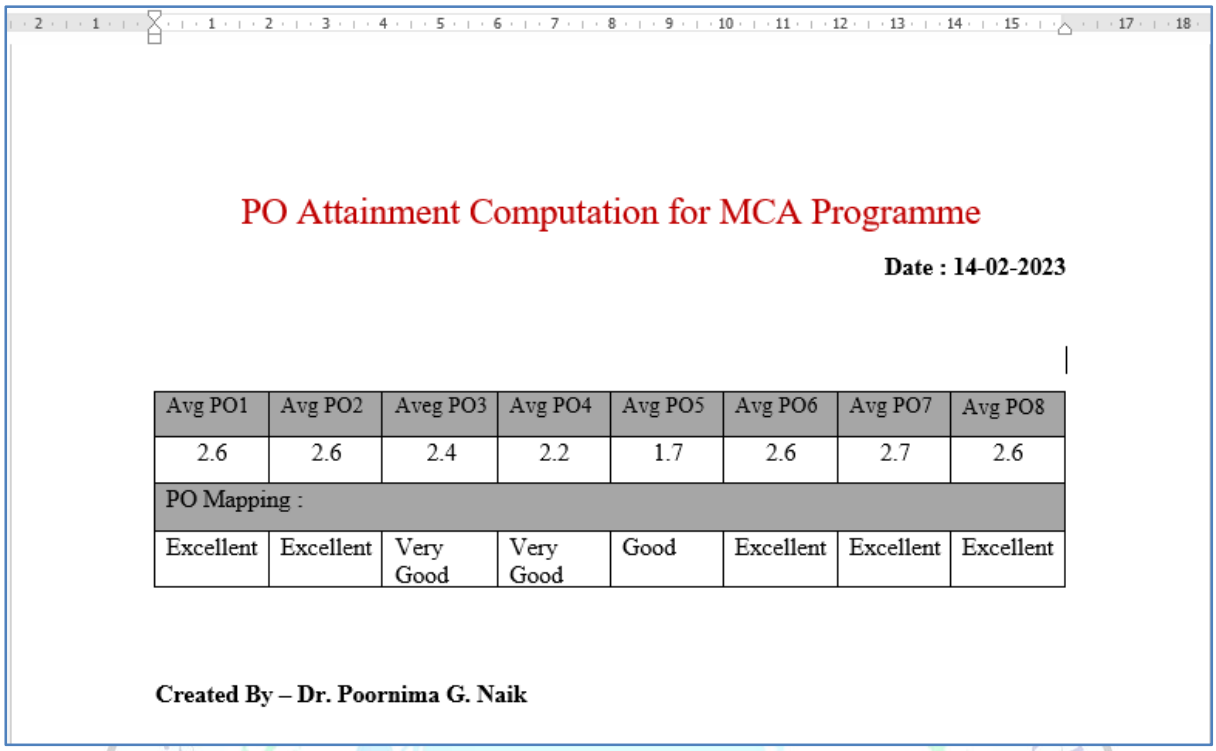
4.0 Results and Discussions:

The mathematic model developed in section 3.1 and application architecture devised in section 3.2 are implemented in java 8. The data validations are performed in presentation tier and the results of PO attainment are depicted in Table

Table 5: PO Attainment for MCA Programme

Avg PO1	Avg PO2	Avg PO3	Avg PO4	Avg PO5	Avg PO6	Avg PO7	Avg PO8
2.6	2.6	2.4	2.2	1.7	2.6	2.7	2.6
PO Mapping :							
Excellent	Excellent	Very Good	Very Good	Good	Excellent	Excellent	Excellent

Figure 8. depicts exporting of PO attainment reports to MS-Word document.



PO Attainment Computation for MCA Programme

Date : 14-02-2023

Avg PO1	Avg PO2	Aveg PO3	Avg PO4	Avg PO5	Avg PO6	Avg PO7	Avg PO8
2.6	2.6	2.4	2.2	1.7	2.6	2.7	2.6
PO Mapping :							
Excellent	Excellent	Very Good	Very Good	Good	Excellent	Excellent	Excellent

Created By – Dr. Poornima G. Naik

Figure 8. Exporting PO Attainment Reports to MS-Word Document

Further, the work is augmented for performing grade modelling separately for formative and summative assessments in a course 'Computer Organization and Architecture' and is shown in Figure 8(a) – 8(b). The bell shaped trend fittings ensures the true reflection of the performance range.

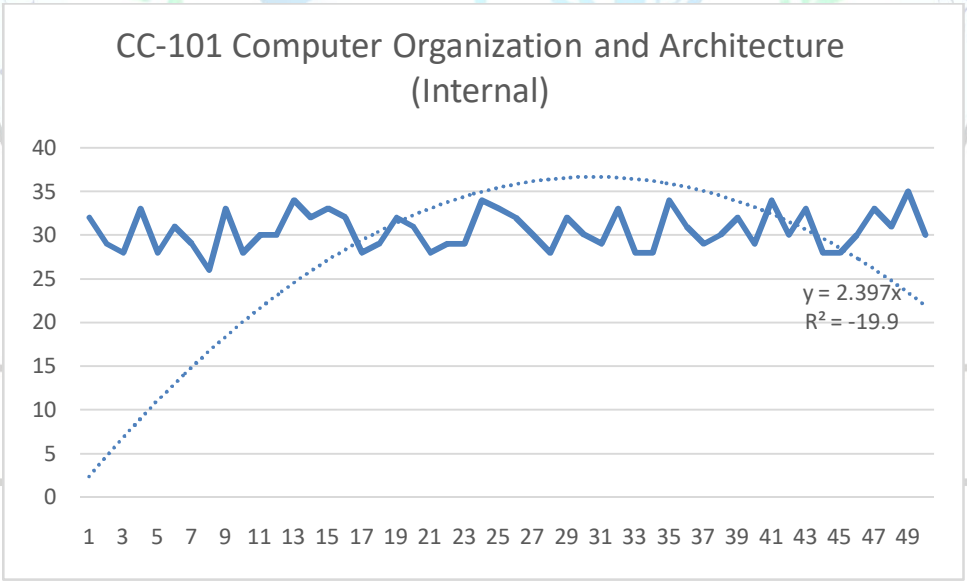


Figure 8(a) Grading Model for Computer Organization and Architecture in Formative Assessment

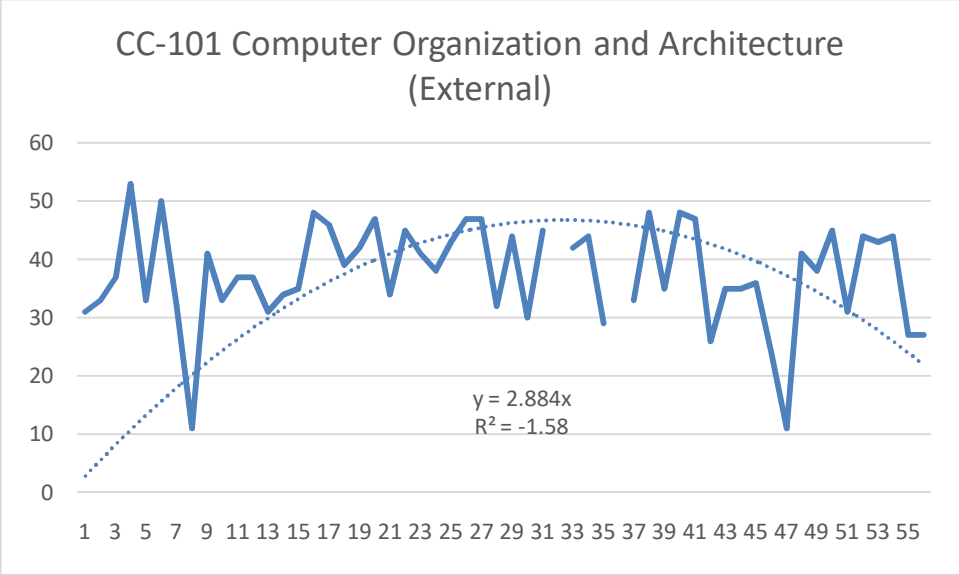


Figure 8(b) Grading Model for Computer Organization and Architecture in Summative Assessment

5.0 Scope for Future Work:

As a prototype model of CO and PO attainment computation, the Discipline Specific Electives (DSE) and Generic Electives (GE) are merged together. However, for getting the real feedback about each of these, they need to be separated and CO and PO attainments need to be computed separately for each of them as CO-PO mapping may differ in each case. Currently the presentation tier is CLI based which can be converted in to a GUI based user friendly interface. Currently, the PO attainment reports can be exported only to Word file. The work can be extended to export the reports to PDF and Excel documents as well.

References:

1. https://www.bits-pilani.ac.in/tlc/Pilani/Resources/Talks/Talk_Dr_A_Roy.pdf
2. https://www.kiet.edu/uploads/naac/2.3.1%20(d)%20Outcome%20Based%20Education%20Manual.pdf
3. https://www.jru.edu.in/wp-content/uploads/downloads/University%20OBE%20Manual.pdf
4. https://www.kpritech.ac.in/obe-nba
5. Bhimasen Soragaon, K S Mahesh , Measuring Attainment of Course Outcomes and Program Outcomes – A Simplified Approach as per Self-Assessment Report -June 2015, , International Journal of Research & Method in Education 6(4):2320-7388 DOI:10.9790/7388-0604041318
6. Dr.A. Kavitha, K.Immanuvel Arokia James, K.A. Harish and Dr.V. Rajamani, A Empirical Study on Co-Po Assessment & Attainment for NBa Tier-Ii Engineering Accreditation Towards Empowering The Students Through Outcome Based Education, International

Journal of Pure and Applied Mathematics, Vol. 118 No. 20 2018, pp. 2615-2624, ISSN: 1314-3395

7. Hasib Masud Shaikh, Arun Kumar, Implementing an automated application for attainment calculations of program outcomes in outcome based education, Journal of Positive School Psychology, 2022, Vol. 6, No. 2, 6006– 6016
8. B. Rajagopal Reddy, Natarajan Karuppiah , Md. Asif , S. Ravivarman, A Case Study on the Assessment of Program Quality through CO-PO Mapping and its Attainment, Journal of Engineering Education Transformations, Volume: 34, Issue: Special Issue, 2020, Pages: 104-111, DOI: 10.16920/jeet/2021/v34i0/157114
9. Bhimasen Soragaon, K S Mahesh, Measuring Attainment of Course Outcomes and Program Outcomes – A Simplified Approach as per Self-Assessment Report, IOSR Journal of Research &Method in Education (IOSR-JRME), e-ISSN: 2320–7388,p-ISSN: 2320–737X Vol. 6, No. 4 Ver. IV (Jul. - Aug. 2016), PP 13-1
10. Dandin Sandesh S, Jinde Rohan, Kamble Naresh, An Attainment Tool for measuring Course Outcomes and Program Outcomes International Journal of Advance Research and Developmen, Vol. 3, No. 3, pp. 24-28
11. Ch. Santhi Rani, Dr. K. Raja Sekhara Rao, K. Eliah, A Simple Approach to Calculate CO & PO Attainment Levels by Direct And Indirect Methods, Journal of Emerging Technologies and Innovative Research, Vol. 10, No. 2February 2023