Attainment of Programme Outcomes (POs), Programme Specific Outcomes (PSOs) and Course Outcomes (COs)

In order to ensure that the teaching- learning process in the University is time adequately student responsive and academics has a target oriented outcome based approach, the Program Outcomes, Program Specific Outcomes and Course Outcomes are clearly defined using blooms taxonomy for all academic programmes and courses of the University. They are instrumental in achieving the vision, mission and strategic objectives of the University. Following aspects have been considered while defining Learning outcomes.

- The Learning outcomes are measurable and stated using active verbs (Bloom's taxonomy).
- They are expressed as complete declarative sentences that clearly describe the knowledge, skills, and competencies that students are expected to acquire as a result of completing their programme of study.
- The resources (faculty, library, labs, technology etc) and pedagogy to be implemented for effectivecourse delivery and student learning are determined in consonance with the learning outcomes to be achieved.
- The outcomes are assessed and measured to identify the extent to which goals are accomplished.
- The gaps identified after the analysis are addressed through the properly laid action plan
- The outcomes assessment plan also specifies the performance targets/criteria (measurable objectives) that are used by the domain to determine the extent to which the programme learning outcomes are being achieved
- The assessment of student learning outcomes is done by using direct and indirect measurement tools

- Assessment methodology/tools are decided keeping in mind the parameters/learning outcomes to be measured and the desired emphasis during the delivery of a programme as prescribed in the course curriculum

As an example, Deen Dayal Upadhyay KAUSHAL Kendra is an academic department in the University campus that imparts skill based education to students in the sectors of Industrial Automation and Automobile Technology. Presently, this departments is offering four distinct academic programme namely: Bachelor of Vocation (B. VOC) in Industrial Automation, Bachelor of Vocation (B. Voc) in Automobile, master of Vocation (M.VOC) in Industrial Automation, and Master of Vocation (M. VOC) in Automobile Technology. We will take up program entitled Bachelor of Vocation (B. VOC) in Industrial Automation as a typical reference for illustration. The Program Educational Objectives, Program Outcomes and Program Specific Outcomes of the said course are presented below –

Program Educational Objectives:

The objectives of B.Voc (Industrial automation) program are to produce graduates who -

1. Are equipped with time relevant knowledge of mechatronics and electronics to address multi disciplinary demand of automated manufacturing, and process in modern industries in capacity of productive System Developers and System Integrators.
2. Have a broad-based background to practice industrial automation in the areas of robotics, manufacturing, and process control in industry and Government settings meeting the growth expectations of stakeholders.
3. Have an ability to pursue higher studies and succed in academic and professional careers.
4. Have the ability to address professional demands individually and as a team member communicating effectively in technical environment using modern tools.
5. Recognize the need for and possess the ability to engage in lifelong learning.

6. Will be sensitive to consequences of their work both ethically and professionally for productive professional career.

Program Outcomes (PO):

Vocational Education is education that prepares the students for specific trades, crafts andcareer sat various levels and scopes. It trains the students from a trade/ craft, technician or professional position in R & D organizations.

The Program Outcomes are the skills and knowledge which the students have at each exit level/at the time of graduation. These Outcomes are generic and are common to all exit levels mentioned in the programme structure. Graduates of the B.Voc program are expected to -

PO1. **Domain knowledge:** Apply broad based fundamental knowledge of the specific skill based trade for the solution of target skill sector.

PO2. **Problem Analysis:** Identify industry domain related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of domain sectors and technical literature.

PO3. **Design Development of solutions :** Design / develop solutions for broad based problems in the target skill based trade to address changing challenges put forward by market demand/ stakeholder

PO4. **Conduct Investigation of complex problems:** Design and conduct technology enabled experiments, analyze the resulting data and interpret the same to provide valid conclusions

PO5. **Modern tools:** Use the techniques, skills and modern tools necessary skill based trade to practice with clear understanding of limitations.

PO6. **The citizenship and society:** Apply broad understanding of ethical and professional skill based trade practice in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.

PO7. **Environment and sustainability:** Apply broad understanding of impact of skill based trade in a global, economic, environmental and societal context.

PO8. **Ethics:** Apply ability to develop practical solutions for skill trade problems within positive professional and ethical boundaries.

PO9. **Individual and team work:** Function effectively as a leader and as well as team member in diverse/ multidisciplinary environments.

PO10. **Communication:** Communicate effectively in oral and written format addressing specific professional/ social demands.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the first principles of skill trade and apply these to one's own work as a member and leader in a team, to complete project in any environment.

PO12. **Life-long learning:** Recognize the need for and have the ability to address to the changing technological demands of the target skill trade.

Program Specific Outcomes (PSO):

Graduates of the B.Voc (Industrial Automation) program are expected to -

1. Apply broad based fundamental knowledge of electronics, electrical, mechatronics fundamentals and Industrial automation specialization for the solution of automated manufacturing and process related problems.

2. Identify complex industrial automation related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of electronics, electrical and mechatronics and technical literature.

3.Design and conduct technology enabled experiments, analyze the resulting data and interpret the same to provide valid conclusions.

4.Use the techniques, skills and modern tools necessary for industrial automation practice clear understanding of limitations.

Course Outcomes (for all courses):

The course outcomes are written by the respective faculty member using action verbs of learning levels as suggested by Bloom Taxonomy. Then, a correlation is established between COs and POs and COs and PSOs by preparing articulation matrix of COs-POs and COs-PSOs for respective courses in the program.

B. VOC Industrial Automation offers 78 courses spanning diversified aspects in the sectors of life skills, management skills, computational skills, and core areas of Industrial Automation. Course outcomes for all these courses have been framed as statements that describe the knowledge & abilities to be developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. Typically, there are4 to 7 course outcomes of any course. These have written in the specific terms and not in general. A concrete mechanism has been designed and adapted to ensure/monitor that the desired or defined outcomes are determined and according to the defined outcomes, programme curriculum, teaching learning methodology and supporting facilities are designed.

Before starting of the academics of every semester, a dedicated faculty meeting is conducted in each department where identified industry experts also remain present in some of the departments. This meeting is dedicated towards defining the modes of teaching/ learning in that semester in perspective of COs, POs and niches of industry/ society.

For the purpose of illustration, we will take up Course entitled 'Flexible manufacturing System' having Course Code VOC 611 (2 credits; 50 marks) . This is a skill based knowledge imparting course for the students of sixth semester of B.VOC (Industrial Automation) course. The Learning Objectives and Learning Outcomes are presented below –

Learning Objectives

1. To introduce students with manufacturing systems.
2. To make aware the students about the advance manufacturing practices/methods being implemented at leading industries across the globe, which ultimately leads to more customer satisfaction in terms of low cast and high quality.

Learning / Course Outcomes:

On completion of the course, students should be able to-

1	State the basic concepts of FMS, cell, JIT, KANBAN system and CMM
2	Classify and compare different types of FMS, machining centers, Kanban, CMM, AGVS, AS/RS; also differentiate between FMS and FMC
3	Illustrate area of applications of a FMS, CMM, JIT, various equipments and their functions required for an FMS
4	Analyze the reasons for adopting group technology, analyze the AGV Systems, AS/RS as well as distinguish between Axes and Format of Machining Centers, Horizontal and Vertical Machining Centers
5	Explain the visual inspection aspects

In order to assess the extent of correlation of the COs , POs and PSOs, and to ensure that POs and PSOs are maximally addressed by respective courses under the program, a CO-PO-PSO articulation matrix is prepared for every course. For purpose of illustration, the CO-PO-PSO articulation matrix for course entitled 'Flexible manufacturing System' having Course Code VOC 611 is presented below-

CO-PO-PSO Articulation Matrix for Course Code VOC 611:

L= Low Correspondence; M= Moderate Correspondence; H= High Correspondence

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	H	M						H						H	M		
CO2	H	M	H											H	M	H	
CO3		M	H		H										M	H	
CO4	H	H	M											H	H	M	
CO5	H		H		H									H		H	

A concrete mechanism for measuring attainment level of COs, POs, and PSOs has been generically implemented in academic departments. As most of the academic departments exercise academic autonomy and obey 80:20 assessment pattern (80- Semester end Examinationand 20 -Continuous Internal Assessment), the question papers are judicially / thoughtfully prepared for internal tests, semester end examination and practical examination so as to attain all target COs in respective course.

Mechanism to Measure Attainment of COs:

Three levels have been defined at Central level for attainment of COs to be implemented at departmental level and the same is as per below-

Level-1: 40% of students scored more than class average in the Semester End &Internal Examination.

Level-2: 50% of students scored more than class average in the Semester End & Internal Examination.

Level-3:60% or above students scored more than class average in the Semester End & Internal Examination.

Level-2 have been decided centrally as a target level for attainment of COs and following formula is used for calculating attainment of COs

Course attainment level = 80% of attainment level in the semester end examination + 20% of the attainment level in the internal assessment

Illustration:

Let us get back to'Flexible manufacturing System' having Course Code VOC 611 (2 credits; 50 marks) . This is a skill based knowledge imparting course for the students of sixth semester of B.VOC (Industrial Automation) course.

Continuous Internal Assessment (CIA; Out of 10)

1	Percentage of Students scoring more than Class Average	69.69
2	CO Attainment Level	03

Semester End Examination (SEE; Out of 40)

1	Percentage of Students scoring more than Class Average	51.51
2	CO Attainment Level	02

Overall Course Attainment Level

20% of attainment level in CIA + 80% of attainment level in SEE = 0.2(03) + 0.8*(02) = 0.6 + 1.6 = 2.2*

Therefore, Overall Attainment Level = (2); Fully Attained

CO-PO-PSO Attainment Articulation Matrix for the Course VOC 611:

L= Low Correspondence; M= Moderate Correspondence; H= High Correspondence

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	H(2)	M(2)						H(2)						H(2)	M(2)		
CO2	H(2)	M(2)	H(2)											H(2)	M(2)	H(2)	
CO3		M(2)	H(2)		H(2)										M(2)	H(2)	
CO4	H(2)	H(2)	M(2)											H(2)	H(2)	M(2)	
CO5	H(2)		H(2)		H(2)									H(2)		H(2)	

Mechanism to Measure Attainment of POs and PSOs:

Five levels decided by the University Department for attainment of POs and PSOs are as below;

Level-1: Greater than 0.5 and less than or equal to 1.0 (Poor)

Level-2: Greater than 1.0 and less than or equal to 1.5 (Average)

Level-3: Greater than 1.5 and less than or equal to 2.0 (Good)

Level-4: Greater than 2.0 and less than or equal to 2.5 (Very Good)

Level-5: Greater than 2.5 and less than or equal to 3.0 (Excellent)

Most of the university Departments have decided to have Level-4 as a target level for attainment of POs and PSOs and following formula is used for calculating attainment of POs and PSOs

Program attainment level= 80% (Average of attainment level from direct method) + 20% (Average of the attainment level from indirect method)

Illustration:

Suppose, PO3 is contributed by five course as shown in table below and the course attainment level of the respective courses (FOR DIRECT METHOD) is as shown in the table; (Reference table: Course-Program outcome mapping).

Course Code	Course Title	Attainment Level
VOC 611	Flexible manufacturing System	2.2 (as obtained above)
VOC 612		2.4 (to be supposed)
VOC 613		1.9 (to be supposed)
VOC 614		1.8 (to be supposed)
VOC 615		2.0 (to be supposed)

Similarly, the feedback was obtained from students, alumni and faculty members on three point scale of 1, 2 and 3. And the average of response to PO3 is 2.

Then,

PO attainment for PO3= 80% (2.2+2.4+1.9+1.8+2.0)/5 + 20% (2)

= 80% (10.30/5) +0.4

= 1.65 +0.4= 2.05

This indicates that, The PO attainment level for PO3 is (4); Fully attained.