Attainment of Program Outcomes and Program Specific Outcomes

Calculation of attainment of POs & PSOs: The following procedure is employed for calculating the attainment of POs & PSOs in the direct assessment method.

1) Mapping CO to POs & PSOs with 'X'
2) Calculate the percentage of vital features for each PO & PSO
3) Defining Correlation Levels
4) Calculating Percentage of Attainment of POs & PSOs
5) Defining Attainment Levels of POs & PSOs

1) Mapping CO to POs & PSOs with 'X': CO to PO & PSO mapping with 'X' as shown inthe Table 3.2.

Table 3.2 Mapping of CO to POs & PSO with 'X'

Course Outcomes	Program Outcomes(POs)												Program Specific Outcomes(PSOs)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	X	X											X		
CO2	X	X											X		
CO3	X	X											X	X	
CO4	X												X		
CO5	X												X		
CO6	X	X											X		

2) Calculate the percentage of vital features for each PO & PSO

Table 3.3 Description of Vital features for each PO & PSO

Program Outcomes		Vital Features
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	Knowledge, understanding and application of 1. Scientific principles and methodology 2. Mathematical principles 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues; 2. Understand customer and user needs and the importance of considerations such as aesthetics; 3. Identify and manage cost drivers; 4. Use creativity to establish innovative solutions; 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal; 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes; 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context; 9. Understanding of the requirement for engineering activities to promote sustainable development; 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues;
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methodsincluding design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1. Knowledge of characteristics of particular materials, equipment, processes, or products; 2. Workshop and laboratory skills; 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.); 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues; 5. Understanding of appropriate codes of practice and industry standards; 6. Awareness of quality issues; 7. Ability to work with technical uncertainty. 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes; 9. Ability to identify, classify and describe theperformance of systems and components through the use of analytical methods and modeling techniques; 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, inorder to solve engineering problems; 11. Understanding of and ability to apply a systems approach to engineering problems.

PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1. Computer software / simulation packages / diagnostic equipment / technical library resources/ literature search tools.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1. Knowledge and understanding of commercial and economic context of engineering processes; 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context; 3. Understanding of the requirement for engineering activities to promote sustainable development; 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues; 5. Understanding of the need for a high level of professional and ethical conduct in engineering.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	Impact of the professional Engineering solutions (Not technical) 1. Socio economic, 2. Political and 3. Environmental
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in. 3. High degree of trust and integrity
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen - week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference. 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation. 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	"Students should demonstrate the ability to communicate effectively in writing / Orally." 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)

PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply theseto one's own work, as a member andleader in a team, to manage projects and in multidisciplinary environments.	1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year
Program Specific Outcomes		
PSO1	Design, implement, and test application software systems for desktop, web, and mobile platforms to meet the specified requirements.	Development of Application software systems 1. Design and implement application software for Desktop, Moblie and Web based applications. 2. Test application software for Desktop, Moblie and Web based applications.
PSO2	Use effectively and efficiently the functionality of systems software for building applications.	1. Design and translation of models for languages. 2. Working functionality of system software
PSO3	Understand the organization and architecture of Computer Systems, Embedded Systems, and Networked Systems.	Understanding the 1. Organization and architecture of Computer systems. 2. Communication and security of various machines over the network.

Calculation of percentage of Vital features: In the above example, PO2 is mapped to CO1,CO2, CO3 & CO6. The percentage of vital features of PO2 is calculated as:

$$\%\ of\ Vital\ Features\ for\ any\ PO/PSO = \frac{Total\ Vital\ Features taken\ into\ consideration\ for\ the\ CO\ Mapped\ to\ PO/PSO}{Total\ numbr\ of\ vital features taken\ for\ the\ PO/PSO}$$

Percentage of vital features for PO2 = (3/10)*100 = 30

The calculated Percentage of vital features of POs & PSOs is shown in the Table 3.5.
The Consideration of number of vital features for a CO with PO/PSO is shown in the table 3.4

Table 3.4 Consideration of number of vital features for a CO with PO/PSO

Course Outcomes (COs)	Program Outcomes(POs)												Program Specific Outcomes(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	No. of Vital Features														
	3	10	10	11	1	5	3	3	12	5	12	8	4	3	3
CO1	2	3											4		
CO2	1	6											3		
CO3	3	9											2	3	
CO4	3												2		
CO5	1												1		
CO6	2	4											3		

Table 3.5 Percentage of vital features of POs & PSOs

Course Outcomes (COs)	Program Outcomes(POs)												Program Specific Outcomes(PSOs)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
	No. of Vital Features														
	3	10	10	11	1	5	3	3	12	5	12	8	4	3	3
CO1	66.7	30											100		
CO2	33.3	60											75		
CO3	100	90											50	100	
CO4	100												50		
CO5	33.3												25		
CO6	66.7	40											75		

3) Defining Correlation Levels

The Correlation levels of POs and PSOs are as follows.

Correlation **Level 3:** Percentage of vital features of PO/PSO >=60%

Correlation **Level 2:** Percentage of vital features of PO/PSO >40% and < 60%.

Correlation **Level 1:** Percentage of vital features of PO/PSO >5% and <= 40%.

Table ***3.6 Correlation levels of POs & PSOs:***

Course Outcomes (COs)	Program Outcomes(POs)												Program Specific Outcomes(PSOs)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
	No. of Vital Features														
	3	10	10	11	1	5	3	3	12	5	12	8	4	3	3
CO1	3	1	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	1	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	3	3	0	0	0	0	0	0	0	0	0	0	2	3	0
CO4	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO5	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
CO6	3	1	0	0	0	0	0	0	0	0	0	0	3	0	0
Correlation levels	2.33	2											2.33	3	

After applying the correlation level to each CO-PO/PSO the correlation level of each PO can be calculated as

Correlation Level of PO2 = Average of all CO-PO/PSO mapping levels
= (1+3+3+1)/4 = 8/4 = 2

4) Calculating Percentage of Attainment of POs & PSOs

The mapping 'X' is replaced with the corresponding correlation level. The percentage of attainment of POs & PSOs is calculated in the following manner.

Percentage Attainment of PO/PSO=((Average of corresponding CO attainment(%)) * Correlation Level/3)

Percentage attainment of PO2 = ((83.56+84.14+82.42+86.37)/4 * 2/3)

= 84.12 * 2/3

= 56.08

The calculated percentage of attainment of POs & PSOs is shown in the Table 3.7.

Table 3.7 Percentage of attainment of POs & PSOs

Course Outcomes (COs)	Program Outcomes(POs)												Program Specific Outcomes(PSOs)			% CO attainment
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	
CO1	3	1											3			83.56
CO2	1	3											3			84.14
CO3	3	3											2	3		82.42
CO4	3												2			86.60
CO5	1												1			86.89
CO6	3	1											3			86.37
% of PO/PSO Attainment	**66**	**56.08**											**66**	**84.99**		

5) **Defining Attainment Levels of POs & PSOs:** The attainment levels of POs & PSOs aredefined as follows:

Attainment Level 3: Percentage of attainment of PO/PSO >=70%

Attainment Level 2: Percentage of attainment of PO/PSO >=50% and less than 70%.

Attainment Level 1: Percentage of attainment of PO/PSO >=10% and less than 50%. The attainment levels for POs & PSOs is shown in the Table 3.8

Table 3.8 Attainment Levels of POs & PSOs

Course Outcomes (COs)	Program Outcomes(POs)												Program Specific Outcomes(PSOs)			% CO attainment
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	
CO1	3	1											3			83.56
CO2	1	3											3			84.14
CO3	3	3											2	3		82.42
CO4	3												2			86.60
CO5	1												1			86.89
CO6	3	1											3			86.37
% of PO/PSO Attainment	**66**	**56.08**											**66**	**84.99**		
PO/PSO attainment levels	**2**	**2**											**2**	**3**		

In a similar way the POs & PSOs attainment levels are calculated for all courses. Direct attainment level of PO & PSO is determined by taking the average of all courses addressing the PO or PSO.

Example: PO1 is addressed for the courses C201, C302, C303 & C401 and their corresponding attainment levels are 3, 2, 1 & 3.
The direct attainment level of PO1 = (3+2+1+3)/4=2.25