Attainment of POs and PSOs

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1 Vision of the Institute

The Siksha 'O' Anusandhan will be a leading institution of higher learning in its chosen areas of concentration, preparing future generations through quality teaching and innovative research and will emerge as a comprehensive and socially inclusive University in the country for professional advancements in related disciplines.

2 Mission of the Institute

1. Educate students to become responsible, enlightened, and productive citizens.
2. Conduct scholarship and promote entrepreneurship that improve the human condition.
3. Serve business, education, government, health care systems, and community.
4. Enhance the cultural environment of the region.

3 Program Educational Objectives (PEO)

- Our Graduates will have successful professional careers in industry, government, academia or non-profit organizations.
- Our Graduates will effectively lead, work and communicate in multidisciplinary teams and apply sound engineering principles and design methodology to solve societal problems.
- Our Graduates will maintain currency in their chosen field through higher study, through organizational participation and through participation in professional developmental activities.

4 Outcome-based Education

At the end of a program, outcome-based education seeks to produce desired outcomes (in terms of awareness, abilities, attitudes, and behavior). Outcome-based education is described as teaching with this knowledge and putting forth the necessary effort. This

necessitates a consistent approach for determining the achievement of results and bench marking them against program outcomes that are in line with the goals.

5 Program Outcomes

5.1 B.Tech Program

There are twelve program outcomes (1-12) for the B. Tech program

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **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.
6. **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.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **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.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **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.

5.2 B.Pharm and M. Pharm Program

There are nine program outcomes (1-9) for the B.Pharm and M.Pharm program

1. **Pharmacy Knowledge:** Possess knowledge and comprehension of the core and basic knowledge associated with the profession of pharmacy, including biomedical sciences; pharmaceutical sciences; behavioral, social, and administrative pharmacy sciences; and manufacturing practices.

2. **Problem analysis:** Utilize the principles of scientific inquiry, thinking analytically, clearly and critically, while solving problems and making decisions during daily practice. Find, analyze, evaluate and apply information systematically and shall make defensible decisions.

3. **Technical Skills:** Develop an ability to use various instrument and equipment with an in depth knowledge on standard operating procedures for the same.

4. **Modern Tool Usage:** Develop/apply appropriate techniques, resources, and IT tools including prediction and modeling to complex health issues and medicine effect with an understanding of the limitations.

5. **Research and Development:** To demonstrate knowledge of identifying a problem, critical thinking, analysis and provide rational solutions in different disciplines of Pharmaceutical Sciences and Technology.

6. **Communication:** Communicate effectively on health care activities with the medical community and with society at large, provide drug information, give and receive clear instructions.

7. **The Pharmacist and Society:** Apply reasoning informed by the contextual knowledge to comprehend medical prescription, perform patient counseling and assess issue on drug safety and the consequent responsibilities relevant to the professional pharmacy practice.

8. **Ethics:** Follow the code of ethics and commit to professional values and responsibilities and norms of the pharmacy practice. Apply ethical principles while making decisions and take responsibility for the outcomes associated with the decisions.

9. **Environment and sustainability:** Understand the impact of the professional pharmacy solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

5.3 Nursing Program

There are ten program outcomes (1-13) for the Nursing (BSc. Nursing) program

1. Apply knowledge from physical, biological and behavioural sciences, medicine, including alternative systems and nursing in providing nursing care to individuals, families and communities.

2. Demonstrate understanding of life style and other factors, which affect health of individuals and groups.

3. Provide nursing care based on steps of nursing process in collaboration with the individuals and groups

4. Demonstrate critical thinking skill in making decisions in all situations in order to provide quality care.

5. Utilize the latest trends and technology in providing health care.

6. Provide promotive, preventive and restorative health services in line with the national health policies and programs.

7. Practice within the framework of code of ethics and professional conduct and acceptable standards of practice within the legal boundaries.

8. Communicate effectively with individuals and groups and members of the health team in order to promote effective interpersonal relationships and teamwork.

9. Demonstrate skills in teaching to individuals and groups in clinical/ community health settings.

10. Participate effectively as members of the health team in health care delivery system.

11. Demonstrate leadership and managerial skills in clinical / community health settings.

12. Conduct need based research studies in various settings and utilize the research findings to improve the quality of care.

13. Demonstrate awareness, interest and contribute towards advancement of self and of the profession

There are ten program outcomes (1-10) for the Nursing (Post BSc. Nursing) program

1. Assess health status, identify nursing needs, plan, implement and evaluate nursing care for patients/clients that contribute to health of individuals, families and communities.
2. Demonstrate competency in techniques of nursing based on concepts and principles from selected areas of nursing physical, biological and behavioral sciences.
3. Participate as members of health team in the promotive preventive, curative and restorative health care delivery system of the country.
4. Demonstrate skills in communication and interpersonal relationship.
5. Demonstrate leadership qualities and decision-making abilities in various situations.
6. Demonstrate skills in teaching to individuals and groups in community health settings.
7. Demonstrate managerial skills in community health settings.
8. Practice ethical values in their personal and professional life.
9. Participate in research activities and utilize research findings in improving nursing practice.
10. Recognize the need for continued learning for their personal and professional development.

5.4 Hotel Management Program

There are twelve program outcomes (1-12) for the Hotel Management (BHMCT and MBA in Hospitality Management) program

1. **Basic Knowledge:** Acquire, understand, and utilize the basic, intermediate, and advanced concepts in the core areas of Professional Cookery, F&B Service, Front office, and Housekeeping services.
2. **Problem Analysis:** Ability to understand, analyse, and solve the existing & emerging issues pertaining in the hotel Industry by establishing a close link between theoretical knowledge and practical operations.
3. **Analytical Skill:** Become well versed with the strategic management issues involved in the operations of hotels and should be able to apply the concepts, tools, & techniques to generate practical solutions for the industry.

4. **Environment and Sustainability:** Understand and utilize the current and emerging concepts in the ever changing business environment in order to sharpen their leadership and entrepreneurial skills.

5. **Business Knowledge:** Appreciate and demonstrate the knowledge and skills desired at the local, national, and international business management activities and to produce creative business solutions to attract, maintain and grow the customer base.

6. **Communication Skills:** Accumulate, synthesize, and disseminate the key information through the effective use of various professional communication channels and technologies in written, verbal, and visual modes.

7. **Quantitative Skills:** Collect, analyze, understand, and effectively use the data and information regarding the market through various statistical, forecasting, and estimation techniques in order to arrive upon various business decisions.

8. **Critical Thinking Skills:** Appreciate, evaluate, and demonstrate proficiency in critical thinking and apply the same in solving the cultural, social, professional, and legal issues and to make effective business decisions in both structured and unstructured situations.

9. **Technology:** Realize and utilize the current and emerging technologies in order to operate varieties of machines, equipment, and applications towards enhancing their productivity and efficiencies.

10. **Ethics:** To be able to interpret, demonstrate, and utilize professionalism and ethical practices in order to manage both domestic and international business issues.

11. **Multicultural and Diversity:** To develop awareness, understandings, respect, and responsiveness towards the multi-cultural work environment comprising of people belonging to contrasting regions, age, genders, caste, colors, religions, & political affinities that impact business operations at a global level.

12. **Demonstrate Learning:** Acquire and demonstrate the traits of curiosity, self-motivation, reflectiveness, perseverance, positiveness, tireless attitude, devotion, honesty, integrity, hard work, and flexibility and become self-regulated lifelong learners.

5.5 Medical Program

There are five program outcomes (1-5) for the MBBS program

1. Recognize 'health for all' as a national goal and health right of all citizens and should fulfill their social obligations towards realization of this goal.

2. Learn every aspect of national policies on health and devote them to its practical implementation.

3. Competent in practice of holistic medicine, including promotive, preventive, curative and rehabilitative aspects of common diseases.

4. Develop scientific temper, acquire educational experience for expertise in profession and promote healthy living.

5. Become an exceptional citizen by observation of medical ethics and fulfilling social and professional obligations, according to the national aspirations.

There are 12 program outcomes (1-12) for the MD/MS program

1. To acquire adequate understanding of the basic sciences relevant to the concerned specialty.

2. To identify and consider social, economic, and emotional determinants of health in a given case, during the planning of therapeutic, rehabilitative, preventive and primitive strategies.

3. After completion of course to be able to diagnose and manage majority of the conditions in the specialty concerned on the basis of clinical assessment, and appropriately selected and conducted investigations.

4. To be able to plan and advise measures for the prevention and rehabilitation of patients suffering from disease and disability related to the specialty.

5. To learn the skills in the documentation of individual case details as well as morbidity and mortality rate relevant to the assigned situation.

6. To acquire skills to organize and supervise the assigned health care services demonstrating adequate managerial skills in the clinic/hospital/field situation.

7. To practice the specialty concerned ethically and in step with the principles of primary health care.

8. To demonstrate empathy and human approach towards patients and their families and exhibit interpersonal behavior in accordance with the societal norms and expectations.

9. To develop skills as a self-directed learner, recognize continuing education needs; he/ she should select and use appropriate learning resources.

10. To be competent in basic concepts of research methodology and epidemiology and should be able to critically analyze relevant published research literature.

11. To acquire skills in using educational methods and techniques as applicable to the teaching of medical/nursing students, general physicians, and paramedical health workers.

12. To be aware of implementation of national health programs effectively and responsibly.

5.6 Dental Program

There are fifteen program outcomes (1-15) for the BDS program

1. Describe normal and abnormal human structure, development, function and behavior that is relevant to the practice of Dentistry.
2. Apply basic knowledge of biomedical, technical and clinical sciences for the effective practice of Dentistry.
3. Elicit detailed Dental and relevant Medical history, perform an oral and general physical examination and choose relevant laboratory diagnostic tests for identification of oral disorders, prevention of oral disease and promotion of oral health.
4. Demonstrate the ability to interpret available clinical and laboratory data and effective clinical problem solving, in order to generate differential diagnoses and to manage oral health disorders.
5. Perform and interpret a basic oral radiological examination safely.
6. Plan and administer, safely, appropriate treatments, including surgical procedures, for common oral disorders in adults as well as children.
7. Identify and manage common medical emergencies encountered in general dental practice.
8. Identify and refer patients who may require specialist care.
9. Demonstrate knowledge of global and national needs, policies and regulatory frameworks relevant to oral health.
10. Function effectively as an oral health care team member in health care settings.
11. Communicate effectively and sensitively with patients, care-givers, colleagues and the public in a manner that will improve health care outcomes and patient / client satisfaction.
12. Demonstrate the ability to continue refining existing knowledge / skills and acquire new knowledge/skills.
13. Select and pursue an appropriate career pathway that is professionally rewarding and personally fulfilling.
14. Recognize and manage medico-legal, ethical and professional issues in dental practice.
15. Demonstrate and practice integrity, responsibility, respect and selflessness.

5.7 MBA and BBA Program

There are fifteen program outcomes (1-8) for the MBA and BBA program

1. Identify the different functional aspects of business world and recognize different opportunities of business.
2. Acquire the different skills necessary for the professional attitudes.
3. Demonstrate a global outlook with the ability to identify aspects of the global business and cross cultural understanding.
4. Identify the problems and challenges and inculcate the capability to cope with the spontaneous changes.
5. Analyze the importance of innovation and research, tackle the contemporary needs and accordingly grab the opportunities.
6. Develop effective and oral communication especially in business applications, with the use of appropriate technology.
7. Collaborate and lead teams across organizational boundaries and demonstrate leadership qualities, maximize the uses of diverse skills of team members in the related context.
8. Develop effective communication especially in business applications, with the use of appropriate technology

5.8 MBA in Hospital Administration Program

There are fifteen program outcomes (1-11) for the MBA program

1. **Management Knowledge:** Acquire knowledge and skills in management and ability to apply its principles and practices to arrive at optimal solution health care related problems.
2. **Problem Thinking and analysis:** Demonstrate critical thinking skills in understanding managerial issues and problems by collecting and analyzing data in hospitals
3. **Design and Development of solutions:** Design solutions for patient management problems by applying the contemporary methods in health care to enhance hospital efficiency and to find innovative patient care solutions for better patient care improvement .
4. **Behavioral skills:** Improve the verbal and non-verbal communication skills and acquire leadership skill and team work capabilities through participation. Demonstrate hands-on experience in administration and research.

5. **Ethics:** Apply ethical principles and understand the impact of the professional management solutions in societal and environmental contexts related to hospitals.
6. **Entrepreneurial Perspective:** To identify business opportunities and acquire entrepreneurial traits to evaluate and manage their own business successfully.
7. **Global Perspective:** Students should be able to demonstrate their ability to analyze and evaluate the political, economical, social, legal and technological global health care environment.
8. **Life-long learning:** Ability to engage in independent and life-long learning in the context of managing unpredictable societal and global issues related to healthcare.
9. **Communication:** Communicate effectively on hospital related activities with the health care 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.
10. **Functional business knowledge of Different areas:** Evaluate the threats, vulnerabilities, and importance of physical and information security in the healthcare industry.
11. **Social, legal and ethical responsibilities of organizations and society:** Demonstrate Evaluate ethical and legal issues relevant to the policies, practices, and management of healthcare delivery in a competitive environment

6 Program Specific Outcomes (PSO)

In addition to the POs each institution/department has defined Program Specific Outcomes (PSO) for relevant programs to assess the students attainment level, based on their respective area of expertise/specialization. In this section we have shown an example of formation of PSOs by department of Mechanical Engineering for their graduates.

There are three program specific outcomes for the Mechanical Engineering B. Tech program.

PSO-1. Graduates of Mechanical Engineering will achieve excellence in product design, thermal engineering and manufacturing system, innovation and entrepreneurship by acquiring knowledge in mathematics, science and designing principles.

PSO-2. Graduates will be able to design an experiment as well as to analyse, interpret and provide solutions to the real-life mechanical engineering problems.

PSO-3. Graduates will be able to understand the impact of engineering solutions in a global, economic, environmental, and societal context and to use the though in the multidisciplinary problem.

7 Attainment of Course Outcomes

Assessment is defined as one or more processes that identify, collect, and prepare the data necessary for evaluation. Evaluation is defined as one or more processes for interpreting the data acquired though the assessment processes in order to determine how well the program outcomes/program specific outcomes are being attained. Each program regularly assesses the satisfaction of program outcomes through both direct as well as indirect measures. The Departmental Board coordinates the process of evaluation of program outcomes. Additionally, all assessment tools such as grading rubrics for direct assessment and questionnaires for surveys for indirect assessment use a 4-point scale (1-4) for consistency, with quality of response directly proportional to the value on the scale.

In the process of assessment we have also tried to assess the students learning level through the Blooms taxonomy. The different levels of Blooms taxonomy is presented in Figure 1.

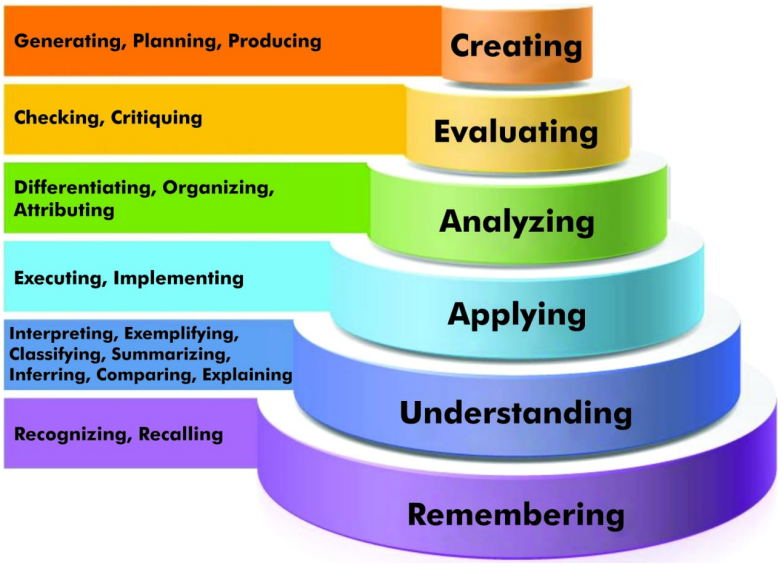

Figure 1: Blooms Taxonomy

7.1 Objective of Blooms taxonomy

The objective of Blooms taxonomy is as follows:

- Establish the intent of a pedagogical exchange so that both teachers and students are aware of it.
- Bloom's taxonomy is used by educators to promote higher-order thinking in their students by building up from lower-level cognitive skills.
- Bloom's taxonomy is a hierarchical structure that categorizes students' cognitive skills, ranging from the most basic ability of remembering information to assessment, which includes assessing and voicing an opinion about information. Bloom's taxonomy is a useful method for teachers and educators to use when creating lesson plans and assessments to promote critical thinking.

Higher levels of Bloom's Taxonomy are best satisfied by Design Projects which require students to solve real-world problems using the Engineering Design Process. The design process followed for the student is depicted in the Figure 2.

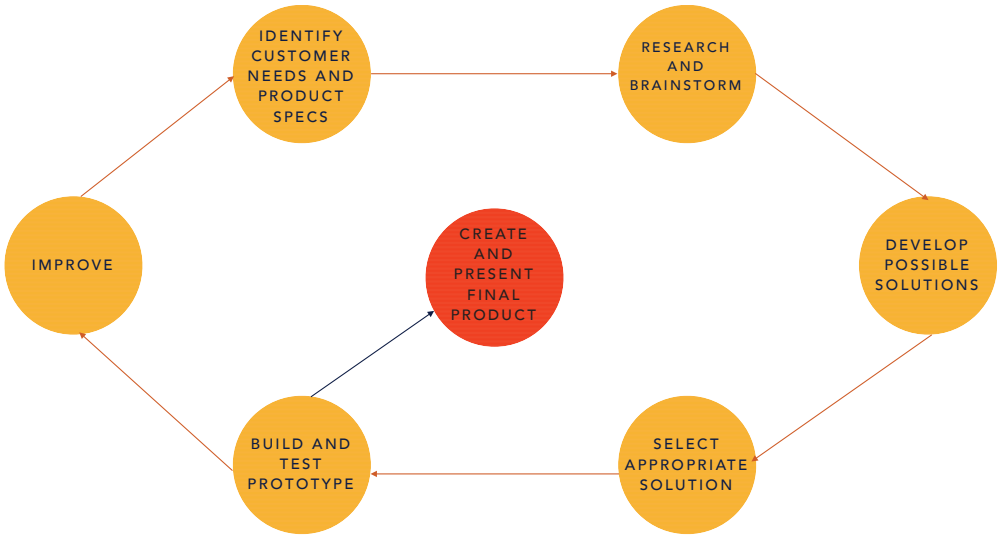

Figure 2: Design Process

7.2 Direct Assessment

- Program Outcomes and Program Specific Outcomes are assessed directly through required departmental subjects using Direct assessment measures such as Questions on the Final Exam, mid semester exam, quizzes and assignments.

- The Department also uses presentations and design reports as direct assessment measures for several program outcomes.
- Each outcome is directly assessed by the Subject Development Committee (SDC) of the subjects assigned for its assessment using grading rubrics to measure the degree of satisfaction of performance indicators in measures chosen for assessment.
- The Department aims to directly assess the satisfaction of each and every program outcome/program specific outcome at least once in an academic year.

7.2.1 Steps of Direct Assessment

- **Step 1: Data Collection Process:** Subject development committee submit the departmental assessment booklet to departmental board. Assessment data is collected from subject development committee. In addition to the data the booklet comprising of the observations and actions for recommendation looking at its previous cycle and current cycle. Then Departmental Board (Board of studies) analyzes the data in the assessment and provides the necessary suggestions.
- **Step 2: Role of Advisory Board** Departmental Board submits the assessment booklet to the Advisory Board. Suggestions given by the Departmental Board are discussed in the Advisory Board meeting at length.
- **Step 3: Role of Board of Studies** The assessment booklet with recommendations from advisory board is duly incorporated and then the Board of Studies discusses it at length and duly puts the stamp of approval.
- **Step 4: Role of Academic Council** The submitted proposals from Departmental Board are verified and approved by Academic Council of the University.

Figure 3: Continuous Improvement Assessment Cycle

Figure 3 shows the continuous improvement cycle.

7.2.2 Rubrics of Assessment

A rubric for evaluation is a method for interpreting and grading students' work against criteria and expectations, typically in the form of a matrix or grid. Criteria sheets, rating systems, and scoring guides are all terms used to describe rubrics. Rubrics can be created for any form of material.

- A rubric defines a set of measurement parameters as well as planned performance expectations. Rather than awarding a single subjective grade, assessors test a student's success against all of these.
- A rubric provided to students during an assessment task briefing, it informs them of all assessment task requirements and assists them in evaluating their own work as it progresses. It also helps teachers apply common criteria when assessing qualitative tasks and encourages consistency in group marking.
- Rubrics may be used to help students coordinate conversations about various levels of success on an evaluation assignment. They will use the rubric to produce and explain judgments during peer and self-assessment. Once you've introduced students to the concept of rubrics, you should make them participate in the rubric design process, giving them a greater sense of ownership over their own learning.
- Assessment rubrics can be used to evaluate learning at all levels, from discrete tasks within a course to capstone projects at the program level, as well as broader study or design projects and learning portfolios.

7.2.3 Benefits of Rubrics

- Provide a structure that clarifies the evaluation criteria and performance expectations for various grades They endorse evaluation as learning in this way so students can see what is relevant and where they should concentrate their learning efforts.
- Ensure that students are knowledgeable about evaluation criteria and how different levels of achievement receive different grades in a transparent and consistent manner. They allow assessors to provide students with very detailed feedback on their results.
- Encourage students to take ownership of their work while they are involved in its construction.
- systematically reveal inconsistencies and shortcomings in students' comprehension based on specific requirements, allowing teachers to focus on areas that need to be addressed.

We have present here one example of rubrics used for assessing the B. Tech graduates. It has been designed for different program outcomes. In similar to this other programs are also assessed through different rubrics designed by other constituent institutions of SOA.

7.2.4 Rubric for Evaluating Program Outcome 1

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. Table 1 shows the rubrics of Program Outcome 1.

Table 1: Rubric for Evaluating Program Outcome 1

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Problem is translated in to mathematical form	Properly translated in to mathematical forms	Translated in to mathematical forms but with minor errors	Translated in to mathematical forms but with major errors
2. Execution of knowledge of mathematics to get results	Appropriately solved and got correct results	Sufficiently solved, but got few incorrect results	Problem solved, but got results with major errors
3. Use of scientific/ engineering principles	Relevant scientific principles correctly used	Scientific principles contain minor error	Scientific principles contain major error
4. Execution of scientific/ engineering principles to get results	Appropriately solved resulting expression and got correct results	Sufficiently solved resulting expression, but got few incorrect results	Problem solved, but got results with major errors

7.2.5 Rubric for Evaluating Program Outcome 2

PO-2: 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. Table 2 shows the rubrics of Program Outcome 2.

Table 2: Rubric for Evaluating Program Outcome 2

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1.Identify engineering problem	Highly proficient at recognizing problems and linking them to their source	Sufficiently recognizes problems and links them to their source	Has difficulty in recognizing problems and linking them to their source
2. Formulate engineering problem	Readily applies principles and theories to define a clear problem statement and links theory to practice	Sufficiently formulates problem statements and links theory to practice	Has difficulty in formulating problem statements and linking theory to practice
3. Solve engineering problem	Adept at generating multiple potential solutions, selecting most appropriate solution based on well developed criteria, and implementing solution using appropriate tools and techniques	Sufficiently generates potential solutions, develops evaluation criteria, and implements most appropriate solution	Has difficulty generating and implementing most appropriate solution

7.2.6 Rubric for Evaluating Program Outcome 3

PO-3: 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. Table 3 shows the rubrics of Program Outcome 3.

Table 3: Rubric for Evaluating Program Outcome 3

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Need recognition and problem definition	Collects customer needs data; Identifies needs as requirements and constraints; Prioritizes customer needs; Defines design problem completely	Collects customer needs data sufficiently; Identifies needs as requirements and constraints; Prioritizes customer needs with minor error; Defines design problem accordingly	Customer needs data collection lacking from some sources; Identifies needs as requirements and constraints; Prioritizes customer needs but better tools exist; Design problem definition not proper
2. Function decomposition and function tree	Identifies primary product function; Decomposes to sub-functions hierarchically; Creates functions tree; Establishes function structure	Identifies primary product function; Does decomposition of product function; Minor difficulty in creating functions tree; Function structure incomplete	Identifies primary product function but better function exists; Does decomposition of product function; Major difficulty in creating functions tree; Function structure incomplete
3. Product tear down and engineering specifications	Lists design issues, Benchmarks by function, Sets up product specifications (house of quality method)	Lists design issues, Benchmarks by function, Product specifications incomplete	Lists design issues, Difficulty in Bench marking, Product specifications incomplete
4. Product architecture	Groups similar functions into modules using basic method	Groups similar functions into modules using basic method with minor error in few modules	Modularization has major errors
5. Concept generation	Generates two or more ideas; Generates two or more concepts for each idea; Sketches each concept that adequately address the problem	Generates two or more ideas; Generates two or more concepts for each idea; Sketches each concept but with few procedural error	Generates two or more ideas; Generates two or more concepts for each idea; Sketches are imprecise for some concepts; Sketches convey meaningfully different objectives

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
6. Concept selection	Two or more alternatives considered; All evaluated correctly based on clearly defined criteria that adequately address the problem; Justifies the choice adequately;	Two or more alternatives considered; Each is evaluated correctly based somewhat on imprecisely defined criteria that partially addresses the problem; Justifies the choice imprecisely	Two or more alternatives considered; Evaluation criteria contains minor errors; Evaluation criteria do not address the problem well; Alternatives are not meaningfully differentiated; Justifies the choice but better justification exists
7. Product embodiment	Applies general process of product embodiment; Creates embodiment checklist; Performs systems modeling	Applies general process of product embodiment; Creates embodiment checklist; Performs systems modeling with minor error	Applies general process of product embodiment but it can be made better; Embodiment checklist insufficient; Systems modeling insufficient
8. Product metric model	Selects model by performance specifications; Constructs basic mathematical model; Constructs refined model that considers customer needs up to check model and display	Selects model by performance specifications; Constructs basic mathematical model with one or two minor errors; Refined model contains minor error	Performance specifications insufficiently included in the model; Basic mathematical model contains few conceptual/procedural errors; Refined model insufficiently addresses design problem
9. Design for manufacture, assembly and environment	Uses design guidelines, does manufacturing cost analysis, identifies environmental objectives (global, regional and local issues), designs for less environmental impact	Uses design guidelines, does manufacturing cost analysis, identifies most of environmental objectives	Uses design guidelines, incomplete manufacturing cost analysis, very few environmental objectives identified

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
10. Analysis	Analysis is complete, correct and consistent with assumptions; Assumptions are clearly stated and methods selected for analysis are appropriate	Analysis is sufficiently complete and correct but contains 1 or 2 minor errors; Some minor assumptions are omitted or violated	Analysis is satisfactory but other more appropriate analytical tools exist for this problem; Analysis contains procedural errors; One or more major assumptions are omitted or violated
11. Preliminary physical prototype	Explores all range of materials; Explores prototyping processes; Creates modules and does final assembly	Explores most range of materials; Explores most prototyping processes; Creates modules and does final assembly	Explores materials but many are left out; Many prototyping processes missing; Better tools exist for modules creation
12. Testing and improvement	Conducts specified tests, notes results, compares with theoretical value, does reanalysis, gets criteria for improvement, does redesign, develops final prototype	Conducts specified tests, notes results, compares with theoretical value, does reanalysis, gets criteria for improvement, redesigns with minor error, develops final prototype	Conducts specified tests, notes results, compares with theoretical value, reanalysis done erroneously, gets incorrect criteria for improvement, redesigns with significant error, develops final prototype accordingly

7.2.7 Rubric for Evaluating Program Outcome 4

PO-4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. Table 4 shows the rubrics of Program Outcome 4.

Table 4: Rubric for Evaluating Program Outcome 4

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1.Designing of experiment	Clear understanding of theory, breaks into logical steps, finds an idea for experiment. Properly fabricates the components and creates assembly of experimental setup	Sufficient understanding of theory, logical breakdown and idea for experiment. Fabrication and assembly contain one or two errors	Insufficient understanding of theory, logical breakdown and idea for experiment. Fabrication and assembly contain major errors
2.Conducting experiments	Nicely puts measuring and recording tools in places. All measurements proper. Repeats experiment. Correct tabulation of data	One or two tools not in place. Few error in measurements. Repeats experiment. Few errors in tabulation	Many tools not in place. Major errors in measurement. Erroneous table.
3.Analyzing data	Correct sample calculation. Draws relevant graphs using statistical procedures (Point-wise curve, straight line curve, smooth curve, best fit curve)	Correct sample calculation. Minor error in graphs.	Sample calculation contains few errors. Procedural error in graphs
4.Interpreting data	Nicely validates experimental results with theory. Explains deviation of from theory; assesses accuracy of the results	Validation contains one or two procedural errors. Sufficiently explains deviation. Accuracy assessment could be better	Validation contains major procedural errors. Insufficient explanation of deviation. Accuracy assessment is poor.

7.2.8 Rubric for Evaluating Program Outcome 5

PO-5: 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. Table 5 shows the rubrics of Program Outcome 5.

Table 5: Rubric for Evaluating Program Outcome 5

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Engineering drawing (Manually or SolidWroks)	Properly employs techniques of orthographic projection and obtains views (front, top and side) at proper places	Sufficiently employs techniques of orthographic projection and obtains views (front, top and side) at proper places	Has difficulty in employing techniques of orthographic projection and obtaining views (front, top and side) properly
2. Use of SolidWorks	Able to create complete solid model of required complexity, make assembly of parts, generate 2D drawing and parts list	Sufficiently creates the solid model of required complexity, makes assembly of parts, generates 2D drawing and parts list	Has difficulty in creating the solid model of required complexity, assembly of parts, generating 2D drawing and parts list
3. Use of MATLAB	Completely understands expressions and control structures, creates script file, creates function file, runs the program, generates data file, plots figures, analyzes and interprets the results	Sufficiently understands expressions and control structures, creates script file, creates function file, runs the program, generates data file, plots figures, analyzes and interprets the results	Has difficulty in understanding expressions and control structures, script file and function file are not clear, data and figures not clear, poor analysis and interpretation of results
4. Use of SIMULINK	Does complete modeling and simulation, interprets results	Sufficiently does modeling and simulation, interprets results	Modeling and simulation has two or more errors, faulty interpretation
5. Use of FEM	Discretizes into elements, Uses shape functions, creates local and global stiffness matrices, obtains solution using boundary conditions, employs post-processing	Sufficient discretization, local and global stiffness matrices contain one or two errors, obtains solution using boundary conditions, employs post-processing	Does discretization but it can be made better, local and global stiffness matrices contain many errors, Many errors in solution

7.2.9 Rubric for Evaluating Program Outcome 6

PO-6: 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. Table 6 shows the

rubrics of Program Outcome 6.

Table 6: Rubric for Evaluating Program Outcome 6

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
Capable enough to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice	Fully capable to handle the issues	Good understanding of the issues	Marginally understands the issues

7.2.10 Rubric for Evaluating Program Outcome 7

PO-7: 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. Table 7 shows the rubrics of Program Outcome 7.

Table 7: Rubric for Evaluating Program Outcome 7

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Impact of engineering solution in global context	Great ability in discussing impact in global context	Reasonable ability in discussing impact in global context	Did not gain much (average) the ability in discussing impact in global context
2. Impact of engineering solution in economic context	Great ability in discussing impact in economic context	Reasonable ability in discussing impact in economic context	Did not gain much (average) the ability in discussing impact in economic context
3. Impact of engineering solution in environmental context	Great ability in discussing impact in environmental context	Reasonable ability in discussing impact in environmental context	Did not gain much (average) the ability in discussing impact in environmental context
4. Impact of engineering solution in societal context	Great ability in discussing impact in societal context	Reasonable ability in discussing impact in societal context	Did not gain much (average) the ability in discussing impact in societal context

7.2.11 Rubric for Evaluating Program Outcome 8

PO-8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. Table 8 shows the rubrics of Program Outcome 8.

Table 8: Rubric for Evaluating Program Outcome 8

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1.Demonstrates knowledge of professional code of ethics	An application of total knowledge of ethics in solution of engineering problems	A moderate knowledge of ethics is applied for engineering solution	A little knowledge of engineering ethics is applied for arriving at an engineering solution
2. Ability to evaluate the ethical dimensions of a problem in the discipline	Understands the problem significantly and evaluates systematically on the context of ethical dimensions	Demonstrates fair amount of knowledge in evaluating the ethical dimension of any engineering problems	No knowledge to analyze the ethical dimensions for the solutions of the problem
3. Demonstrate ethical practices	Demonstrate an ethical practice for a total solution of the engineering problem	Demonstrates an ethical practice for a solution of the engineering problem	Applies an ethical practice for arriving at a solution of an engineering problem
4. Consequence of unethical actions/ behavior	Understands fully the consequence of unethical actions/ behaviors because of engineering failures and prevents its occurrence	Understands the consequence of unethical actions /behaviors and tries to prevent the failure	Understands the consequence of unethical actions/behaviors but not concern for its recurrence

7.2.12 Rubric for Evaluating Program Outcome 9 & 11

PO-9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO-11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Table 9 shows the rubrics of Program Outcome 9 and 11.

Table 9: Rubric for Evaluating Program Outcome 9 & 11

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Participation and Contributions as a team member	Design review Documentation shows fair and even distribution of work between all team members	Design Review Documentation includes largely satisfactory contributions from some/ all team members	Design review documentation includes non- ideal task assignment
2. Shares equally	Always does the assigned work without having to be reminded	Usually does the assigned work–rarely needs reminding	Rarely does the assigned work –often needs reminding
3. Personal conduct (Knows when to assume a leadership role and when to let others to assume that role)	Acts as an active leader in major activities of the project, and allows others to lead when required	Acts as a leader in a few activities of the project and acts as an active participant in all other activities	Never takes initiative or leadership but is a good follower in all activities
4. Team decision making through Consensus	Reaching conclusions based upon clear analysis of facts and ideas, and alters solutions so that all can support it.	Reaches conclusion by analyzing only some of the facts and agrees to others point of view	Some places takes decision based on gut-feel rather than facts and not interested to analyze and listen to others point of view

7.2.13 Rubric for Evaluating Program Outcome 10

PO-10: 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. Table 10 shows the rubrics of Program Outcome 10.

Table 10: Rubric for Evaluating Program Outcome 10

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Ability to communicate information, ideas, and concepts in written form	Writing reports with correct grammar and vocabulary which expresses exact meaning, clarity of test, table and figure	Very little grammatical error in writing report in addition to clarity of test, table and figure	Improper sentence structure and lack of proper meaning of sentence for writing report, clarity of test, table and figure
2. Ability to communicate information, ideas, and concepts in the form of oral presentation (through ppt)	High fluency with effective use of grammar and vocabulary during presentation though PPT	High fluency of presentation with little grammatical error	Moderate fluency of presentation with many grammatical errors
3. Ability to communicate information, ideas, and concepts in the form of graphical presentation	Data presentation in appropriate graphs like line, bar, area, etc., correct selection of axis range for data with clarity in graph, proper selection of pattern, style and weight for better clarity and visibility	Understanding of data presentation with correct selection of axis range but improper selection of pattern, style and weight	Understanding of data presentation but improper selection of axis range pattern, style and weight

7.2.14 Rubric for Evaluating Program Outcome 12

PO-12: 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. Table 11 shows the rubrics of Program Outcome 12.

Table 11: Rubric for Evaluating Program Outcome 12

Performance Indicator	Exemplary (3)	Satisfactory (2)	Developing (1)
1. Able to independently find and use technical and scientific information	Has inquiring mind, self-directed, identified relevant sources of information. Used correct data and giving its reference at appropriate place	Has inquiring mind, self-directed; Most of the sources of information identified and used. Reference given at appropriate place	Has inquiring mind, Many of the sources of information lacking. Reference given for few information
2.Able to plan own policy	Knows what to seek and how to seek; Has logical and independent thought	Reasonable knowledge of what to seek and how to seek; Has mostly logical and independent thought	Did not have much knowledge of what to seek and how to seek; Less ability of logical and independent thought
3. Able to assess and monitor own policy	Analyzes the learning plan, assesses resulting outcomes, keeps himself updated by periodically consulting information sources	Sufficiently analyzes the learning plan, assesses resulting outcomes, keeps himself updated by periodically consulting information sources	Has difficulty in analyzing learning plan, assessing resulting outcomes, self updation to information not regular.

7.3 Indirect Assessment

Indirect Assessment of program outcomes is done through the Senior Exit Survey and through the Alumni Survey.

- **Senior Exit Survey:** The Senior Exit survey is conducted online every academic year for students in their final year of study to allow them to give feedback regarding satisfaction of program outcomes.
- **Alumni PO Survey:** The Alumni Program Outcomes survey is conducted once every two years to gather feedback regarding the satisfaction of program outcomes from Alumni who have been graduates for a period of more than Two years.
- The survey is conducted online with the web link to the survey distributed to graduates through email, over social media and during alumni meets. Data is gathered over a period of one year.

8 Evaluation of a Course

As an example, in this section we have explained, how a course is evaluated and assessed using direct and indirect assessment. This course is evaluated and assessed in 2018-19.

8.1 Course Details

Course Code	:	MEL 1003
Course Name	:	Engineering Statics
Offered in	:	3rd Semester
Credits	:	4
Contact Hours	:	6 Contact Hours (2 classes/week, 1 hr class, One 2 hr problem solving session/week, One 2 hr Analysis session/week)

8.2 Grading Pattern

This course comes under Grading Pattern 1 and follows a Relative Grading System. The following is the split up of marks from a numeric score of 100.

Attendance	:	5 Marks
Major Lab / Problem Solving Assignments / Quizzes	:	10 Marks
Minor Assignments/ Class Assignment	:	10 Marks
Mid-term Examination	:	15 Marks
Total Internal	**:**	**40 Marks**
Problem Solving Examination	:	15 Marks
Theory Examination	:	45 Marks
Total External	**:**	**60 Marks**

8.3 Whether a required course for promotion (Yes/No)

Yes, it is a required course for promotion from 2nd year to 3rd year in Mechanical Engineering.

8.4 Pre-requisites/ Co-requisites

PHY 1002: Introduction to Mechanics using MATLAB

8.5 Course Offered for

This course is offered for ME B.Tech Program.

8.6 Text Book(s)

1. Engineering Mechanics: Statics & Dynamics, R. C. Hibbeler, Eleventh Edition, Publisher: Pearson India
2. Mechanics, J. P. Den Hartog, 1961, Publisher: Dover Publications, New York

8.7 Course Description

This course introduces the concept of rigid body static equilibrium problems subjected to internal and external forces. The course covers the topic of force vector, equilibrium of particle and rigid body, structural analysis, internal forces, friction, centre of gravity, centroid, moment of inertia and virtual work. After the completion of this course the student should able to solve and analyze the various engineering problems through the principle of static equilibrium.

8.8 Course Objectives

1. To build foundation to work with basic engineering problems related to static structures.

2. Construct a free body diagram.
3. Identify and model various types of structures under different loading and support conditions.
4. Apply the basic knowledge of mathematical, physical and engineering principles to analyze and solve equilibrium problems.
5. Understand the significance of centroid, centre of gravity, centre of mass and moment of inertia with an aptitude for their determination and application.
6. Understand the principle of virtual work and build a foundation for its applications.

8.9 Course Outcomes

CO 1. Add forces and resolve them into components, understand principles of vector algebra and apply to force vectors.

CO 2.
i. Sketch and analyze the free body diagram of a particle as well as rigid body and to use equilibrium equations to solve particle equilibrium equations and rigid body equilibrium equations.
ii. Scalar and Vector formulation of moment of a force and couple, compute results of non-concurrent force system.

CO 3.
i. Determine forces in the members of a truss using method of joints and sections and to describe the difference between two methods.
ii. Analyze internal forces in the members of frames and machines under given loading conditions.

CO 4. Analyze rigid body equilibrium problems subjected to dry friction and its application to wedges and belts.

CO 5.
i. Determine the location of the centre of gravity and centroid for a system of discrete particles and a body of arbitrary shape.
ii. Compute Moment of Inertia for an area.

CO 6. Apply Principle of Virtual Work and equilibrium equations to determine the equilibrium configuration of the system.

8.10 Mapping of Course Outcomes with Program Outcomes along with Taxonomy Levels

The matching of course-level results with curriculum outcomes is made simpler with outcome mapping (program mapping). It enables teachers to build a program's visual

map. It's also used to see how students are doing in terms of achieving program-level targets at the course level. The emphasis of outcome mapping is on student learning. The mapping is shown in Table 12.

Table 12: Mapping of Course Outcomes with Program Outcomes along with Taxonomy Levels

Course Outcomes	Program Outcome Satisfied	Outcome Element Satisfied	Taxonomy Level
CO 1	PO-1	Engineering knowledge	Application
	PO-10	Communication	Evaluation
CO 2	PO-2	Problem analysis	Application
	PO-10	Communication	Analysis
CO 3	PO-1	Engineering knowledge	Application
	PO-2	Problem analysis	Application
	PO-10	Communication	Evaluation
CO 4	PO-2	Problem analysis	Application
	PO-10	Communication	Evaluation
	PO-12	Life-long learning:	Application
CO 5	PO-1	Engineering knowledge	Analysis
	PO-5	Modern tool usage	Application
	PO-10	Communication	Evaluation
CO 6	PO-2	Problem analysis	Analysis
	PO-10	Communication	Evaluation

8.11 Justification of how the outcome elements are satisfied by the course

Many studies have shown that when students are exposed to teaching and learning objectives that facilitate deep learning over surface learning, they learn more effectively. In this section we have explained for a particular subject in which each outcome is deeply explained and the justification is shown corresponding to each outcome element.

Table 13: Mapping of Course Outcomes with Program Outcomes along with Taxonomy Levels

Outcome Element	Justification of satisfaction
Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	Apply knowledge of Vector Algebra to add forces and resolve a force into components.
	Apply Knowledge of Vector Algebra to Compute Moment of a force and a couple. Additionally calculate the Resultant.
	Apply concept of integral calculus to determine centroid and centre of gravity.
	Apply concept of Integral calculus to determine area moment of inertia.
Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	Use theoretical concepts of free body diagrams of rigid body, support reactions equilibrium equations to solve practical engineering problems.
	Use theoretical concepts of Method of Joints and Method of Sections to compute axial forces in the members of truss based systems.
	Use Theoretical Concepts of free body diagrams, method of members and equilibrium conditions to compute internal forces in the members of frames and machines.
	Use Theoretical Concepts of Free body diagrams, shear and binding equations to sketch the shear and binding moment diagrams.
	Use theoretical concepts of Free body diagrams and equilibrium equations to solve practical engineering problems involving cables.
	Analyze free body diagrams and identify equilibrium equations that can be used to solve particle equilibrium problems.

Outcome Element	Justification of satisfaction
	Analyze and Identify ideas that can be used to solve for possible equilibrium configurations involving dry friction as applicable to wedges, belts, etc.
	Analyze and identify ideas that can be used to solve for possible equilibrium and stable configurations of a system of bodies.
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	Listens carefully and responds to questions appropriately and interpret results. (for all course outcomes)
	Analyze the results of internal forces and reaction forces, illustrate concept of equilibrium equations by drawing free body diagrams.
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	Use MATLAB to solve mathematical equations to determine the centroid and moment of inertia of the given figure.

8.12 Program Outcomes addressed by the course

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. 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.

8.13 List of Topics

Force Vectors, Equilibrium of a Particle (Two and Three Dimensions), Force System Resultants

Equilibrium of Rigid Bodies (Equilibrium in Two and Three Dimensions, Equations of Equilibrium)
Structural Analysis (Simple Trusses, Method of Joints, Zero – Force members, Method of Sections, Space Trusses, Frames and Machines)
Internal Forces (Shear and Moment Equations and Diagrams, Cables)
Friction (Dry Friction, Wedges, Belt Friction)
Centre of Gravity and Centroid, Moments of Inertia
Virtual Work

8.14 Lesson Plan

A lesson plan is a teacher's regular guide to what students should learn, how it should be taught, and how learning should be assessed. Lesson plans include a comprehensive guide for teachers to follow during each class period, enabling them to be more effective in the classroom. The lesson plan of the subject mentioned above is shown in Figure 14.

Table 14: Lesson Plan

Week 1	**General Principles and Force Vector**
Lecture 1	Fundamental Concepts, Units of Measurement, General Procedure for Analysis
Lecture 2	Scalars and Vectors, Vector Operations, Vector Addition of Forces, Addition of a System of Coplanar forces, Cartesian Vectors
Problem Solving Session 1	Problems on Force Vectors
Analysis Session 1	Analysis of Force Vectors
Week 2	**Force Vector**
Lecture 3	Addition and Subtraction of Cartesian Vectors, Position Vectors
Lecture 4	Force Vector Directed along a line, Dot Product

Problem Solving Session 2	Problems on Position Vector, Application of Dot Product
Analysis Session 2	Analysis of Problems on Application of Dot Product, Cartesian Vector
Week 3	**Equilibrium of a Particle**
Lecture 5	Condition for the equilibrium of the particle, The free body diagram
Lecture 6	Co-planar Force System
Problem Solving Session 3	Problems on equilibrium of Particle
Analysis Session 3	Analysis on Equilibrium of Particle
Week 4	**Equilibrium of a Particle and Force System Resultants**
Lecture 7	Three Dimensional Force System
Lecture 8	Moment of a Force-Scalar Formulation, Cross Product, Moment of a Force-Vector Formulation
Problem Solving Session 4	Problems on Three dimensional force system
Analysis Session 4	Analysis on Force System Resultants
Week 5	**Force System Resultants**
Lecture 9	Principle of Moments
Lecture 10	Moment of a force about a Specified Axis
Problem Solving Session 5	Problems on Principle of Moments
Analysis Session 5	Analysis on Moments of a force about a specified axis
Week 6	**Force System Resultants**
Lecture 11	Moment of a Couple, Equivalent System, Resultants of a Force and couple system
Lecture 12	Further Reduction of a Force and Couple System, Reduction of a Simple Distributed Loading
Problem Solving Session 6	Problems on Moment of a Couple, Equivalent System
Analysis Session 6	Analysis on Force and Couple System, Analysis of Beam subjected to Simple Distributed loading

Week 7	**Equilibrium of a Rigid Body**
Lecture 13	Conditions for Rigid-body equilibrium, Equilibrium in two dimensions, Free-Body Diagrams
Lecture 14	Equations of Equilibrium, Two and three force members
Problem Solving Session 7	Problems on Rigid body equilibrium
Analysis Session 7	Analysis on Rigid body equilibrium
Week 8	**Equilibrium of Rigid Body**
Lecture 15	Equilibrium in Three dimensions, Free body Diagram
Lecture 16	Equations of Equilibrium, Constraints for a rigid body
Problem Solving Session 8	Problems on Equilibrium in three dimensions
Analysis Session 8	Analysis on Rigid body equilibrium (three dimensions)
Week 9	**Structural Analysis**
Lecture 17	Simple Trusses, The Method of Joints
Lecture 18	Zero Force Members, The method of Section
Problem Solving Session 9	Problems on Truss using method of section and joint
Analysis Session 9	Analysis of Truss
Week 10	**Internal Forces**
Lecture 19	Internal forces developed in Structural members
Lecture 20	Shear and Moment Equations and Diagrams, Relation between Distributed load, shear and moment, Cables
Problem Solving Session 10	Problems on Shear force and Bending Moment Diagram
Analysis Session 10	Analysis of Beams through Shear force and Bending Moment Diagram
Week 11	**Friction**
Lecture 21	Characteristics of Dry Friction, Problem Solving Dry Friction, Wedges
Lecture 22	Frictional Forces on Flat Belts

Problem Solving Session 11	Problems on Dray Friction
Analysis Session 11	Analysis of Belt Friction and Wedges
Week 12	**Center of Gravity and Centroid**
Lecture 23	Center of Gravity and Center of mass for a system of particle, Center of gravity, center of mass and centroid for body
Lecture 24	Composite Bodies, Theorems of Pappus and Guldinus
Problem Solving Session 12	Problems on Center of gravity, center of mass and centroid for body
Analysis Session 12	Analysis of Center of gravity, center of mass and centroid for body
Week 13	**Moments of Inertia and Virtual Work**
Lecture 25	Definition of Moments of Inertia for areas, Parallel axis theorem for an area, radius of gyration of an area, Moments of inertia for an area by integration, moments of inertia for composite areas
Lecture 26	Definition of work and virtual work, Principle of virtual work for a particle and a rigid body, Principle of virtual work for a system of connected rigid bodies
Problem Solving Session 13	Problems on Moment of Inertia of bodies
Analysis Session 13	Analysis of Rigid bodies through the principle of virtual work

8.15 Assignment, Problem Solving and Analysis Questions List

The primary goal of assignments is to help students develop their learning abilities. That if students use their minds, they have a better chance of learning more. As a result, the primary purpose of assigning homework is to provide practice exposure and knowledge enhancement in a topic. Assignment of the subject mentioned above is shown in Figure 15. The problems are given from the book “Engineering Mechanics:

Statics & Dynamics, R. C. Hibbeler, Eleventh Edition, Publisher: Pearson India".

Table 15: Assignment

Chapter 2: Exercise Problems: 2.1, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.11, 2.13, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.25, 2.29, 2.30, 2.31, 2.38, 2.40, 2.42, 2.43, 2.45, 2.46, 2.49, 2.50, 2.52, 2.57, 2.58, 2.59, 2.63, 2.64, 2.66
Chapter 3: Exercise Problem: 3.1, 3.2, 3.3, 3.4, 3.7, 3.8, 3.10, 3.11, 3.13, 3.16, 3.17, 3.18, 3.22, 3.23, 3.25, 3.26, 3.27, 3.28, 3.31
Chapter 4: Exercise Problem: 4.4, 4.5, 4.7, 4.9, 4.15, 4.17, 4.20, 4.214.22, 4.23, 4.24, 4.26, 4.28, 4.30, 4.32, 4.34, 4.43, 4.49, 4.58, 4.61, 4.62, 4.64, 4.65
Chapter 5: Exercise Problem:5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.13, 5.20, 5.21, 5.23, 5.25, 5.26, 5.27, 5.28, 5.30, 5.33
Chapter 6: Exercise Problem: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.8, 6.15, 6.17, 6.18, 6.19, 6.21, 6.22, 6.23
Chapter 7: Exercise Problem: 7.4, 7.6, 7.18, 7.19, 7.22, 7.26, 7.28, 7.32, 7.35, 7.39, 7.43, 7.44
Chapter 8: Exercise Problem: 8.1, 8.3, 8.5, 8.6, 8.8, 8.17, 8.23, 8.26, 8.31, 8.36, 8.39, 8.41, 8.42, 8.43
Chapter 9: Exercise Problem: 9.1, 9.2, 9.5, 9.6, 9.8, 9.16, 9.22, 9.23, 9.27, 9.29, 9.36
Chapter 10: Exercise Problem: 10.4, 10.5, 10.7, 10.12, 10.13, 10.14, 10.15, 10.18, 10.19
Chapter 11: Exercise Problem: 11.1, 11.2, 11.10, 11.11, 11.12, 11.13, 11.15

8.16 Correlation between the course outcome and the Program Outcomes (POs) & Program Specific Outcomes

Every Course Leads to Some Outcomes. All the courses must cover the stated list of outcomes. One way of verifying this to prepare a match matrix to represent the same.

8.16.1 Course Articulation Matrix

All the courses together must cover all the POs (and PSOs). For a course we map the COs to POs and PSOs through the CO-PO-PSO matrix as shown in Table 16 for the subject MEL1003.

Table 16: Mapping with COs, POs and PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MEL1003.1	3	-	-	-	-	-	-	-	-	3	-	-	2	1	-
MEL1003.2	3	3	-	-	-	-	-	-	-	3	-	-	2	-	-
MEL1003.3	3	3	-	-	-	-	-	-	-	3	-	-	2	2	-
MEL1003.4	3	3	-	-	-	-	-	-	-	3	-	2	2	1	-
MEL1003.5	3	-	-	-	2	-	-	-	-	3	-	-	2	-	-
MEL1003.6	3	3	-	-	-	-	-	-	-	3	-	-	2	-	-
Average	3	3	-	-	2	-	-	-	-	3	-	2	2	1.33	0

8.16.2 Program Articulation Matrix

Each Program has to set an attainment levels for all POs and PSOs. The attainment levels are set according to the understanding level of course outcomes. The mapping of course MEL1003 with POs and PSOs is ahown in Table 17.

Table 17: Mapping with Course, POs and PSOs

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MEL1003	3	3	-	-	2	-	-	-	-	3	-	2	2	1.33	0

8.17 Course Outcome attainment of the course

The following are the characteristics of the Course Outcome attainment:

- The assessments is aligned with the COs
- Question paper is set to assess all COs
- The average marks obtained in assessments against items for each CO is indicating the CO attainment
- The target is set for each CO

8.17.1 Grading Scale

The grading scale of the attainment is presented in Table 18.

Table 18: Grading Scale

SCORE <40%	1 (Low)
40% < SCORE <70%	2 (Moderate)
SCORE ≥ 70%	3 (Strongly related)

8.17.2 Assessment Details (End Sem Questions)

Table 19: Assessment Details

Course Outcomes	Program Outcome Assessed	End Sem Questions
CO 1	PO-1	1.a, 1.b,1.c
CO 2	PO-1	2.a, 2.b, 2.c, 3.a, 3.b, 3.c, 4.a,4.b,4.c
CO 3	PO-2	5.a, 5.b, 5.c
CO 4	PO-2	6.a, 6.b, 6.c, 7.a, 7.b, 7.c
CO 5	PO-1	8.a, 8.b, 8.c, 9.a, 9.b, 9.c
CO 6	PO-2	10.a, 10.b, 10.c

In this section the assessment details of the end sem question is presented. Table 19 shows the question number picked for the assessment. The target level is set as: **75% of students should score > 70% of marks for attainment**.

8.17.3 CO Assessment Report

The CO assessment report of the course MEL1003 is presented in Table 20.

Table 20: Assessment Details

Course Outcomes	Grading Average in Scale of 3	Distribution %		
		3	2	1
CO1	2.802	80%	20%	0%
CO2	2.808	81%	18%	0%
CO3	2.833	83%	17%	0%
CO4	2.567	59%	38%	2%
CO5	2.72	75%	22%	2%
CO6	2.29	34%	61%	5%

8.17.4 Number of Students Scoring ≥ 75%

As per the target set by the SDC, the below table represents, weather the course outcome is attained or not. Table 21 shows the result of attainment of each CO.

Table 21: Student scoring Details

Course Outcome	% of Student Achieved CO	CO Result
CO1	80%	YES
CO2	81%	YES
CO3	83%	YES
CO4	59%	NO
CO5	75%	YES
CO6	34%	NO

8.17.5 Direct Assessment Graph

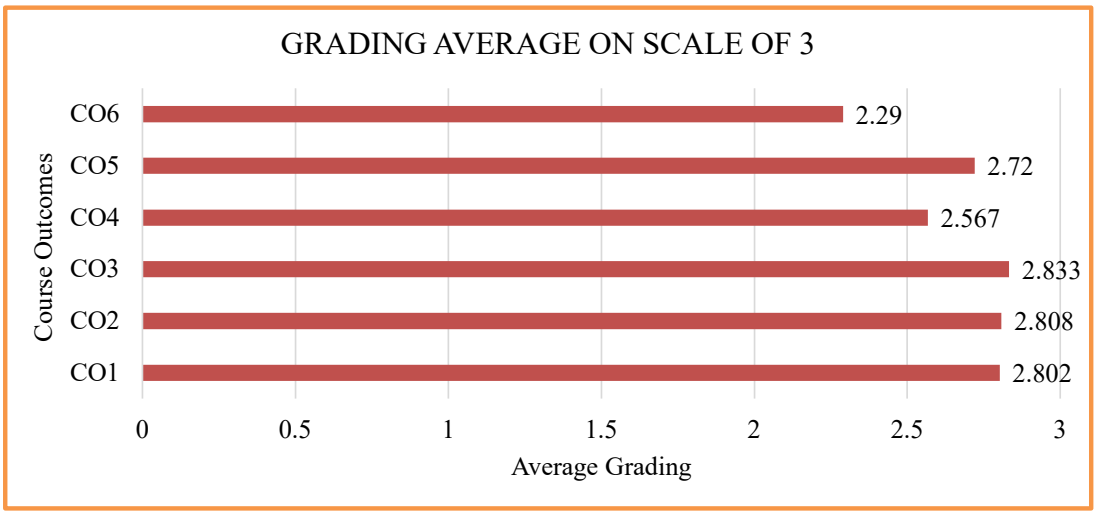

Figure 4: Direct Assessment Result

The results obtained from the assessment has been plotted to made a comparative statement between the COs. The graph is shown in the Figure 4.

8.17.6 Indirect Assessment Graph

Indirect assessment for the Senior exit survey 2017, 2018, 2019 and the Alumni PO survey of 2018-19 has been done and presented in the Figure 5-15.

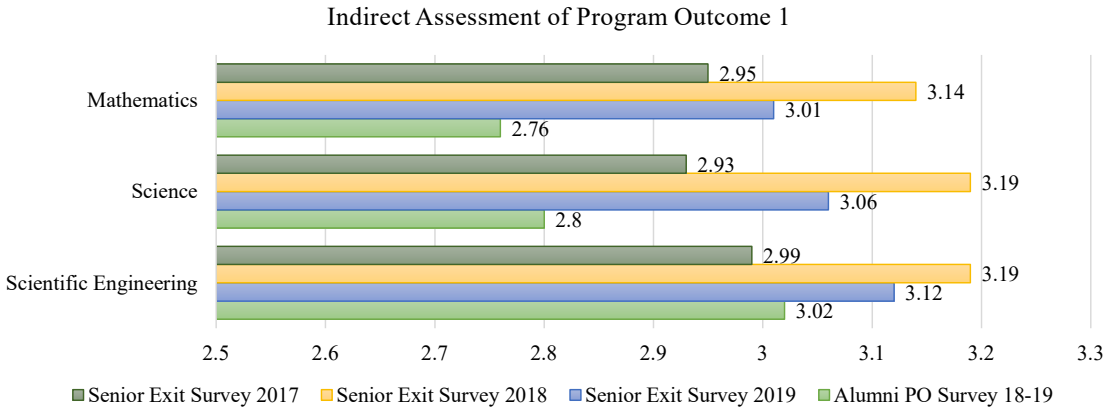

Figure 5: Indirect Assessment Result of PO1

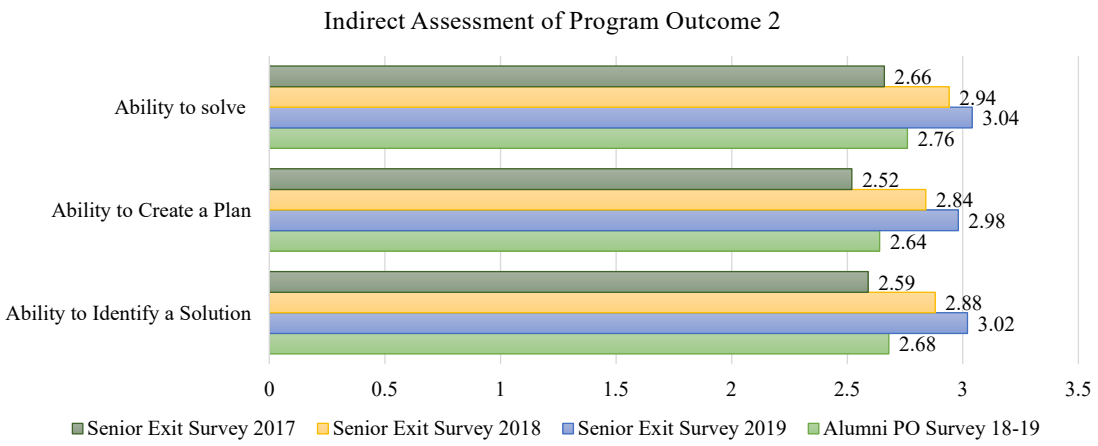

Figure 6: Indirect Assessment Result of PO2

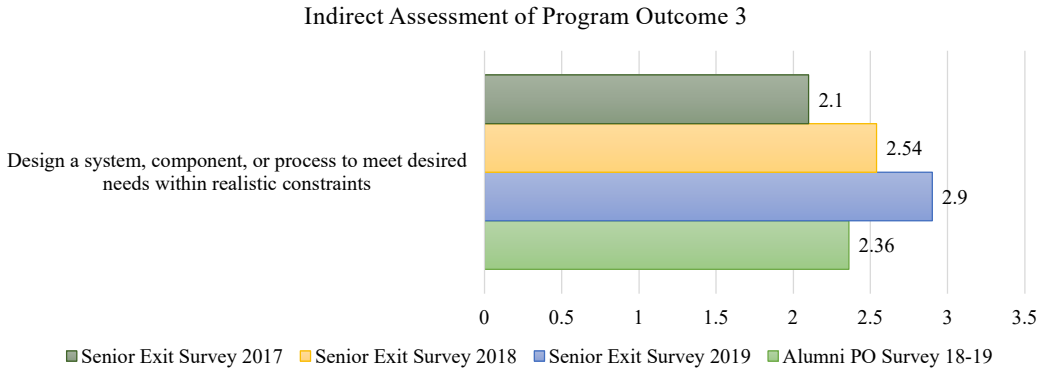

Figure 7: Indirect Assessment Result of PO3

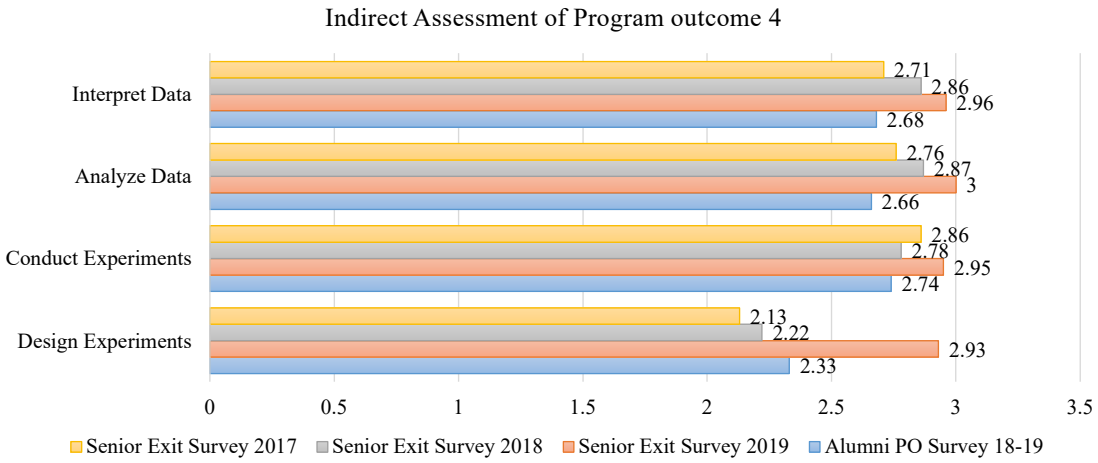

Figure 8: Indirect Assessment Result of PO4

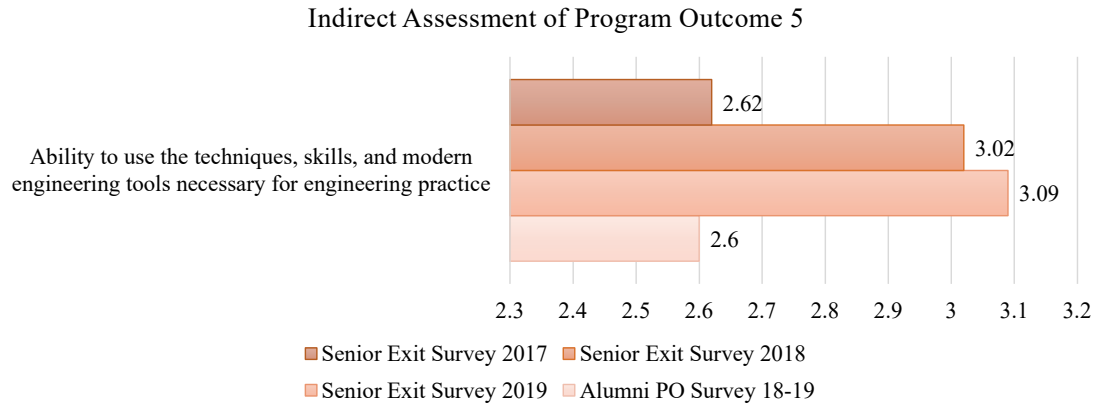

Figure 9: Indirect Assessment Result of PO5

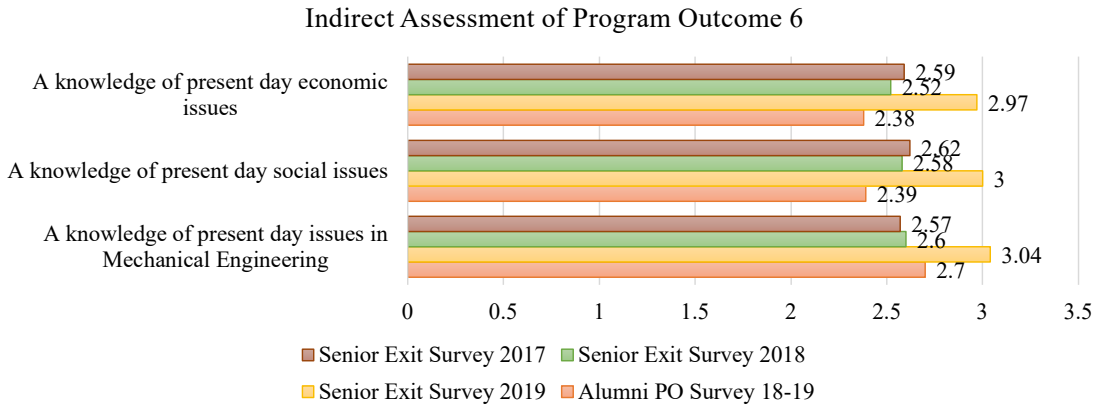

Figure 10: Indirect Assessment Result of PO6

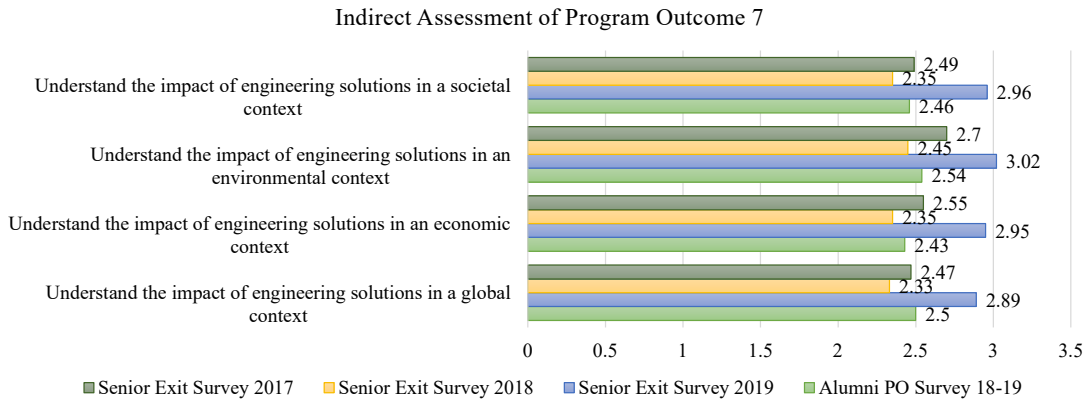

Figure 11: Indirect Assessment Result of PO7

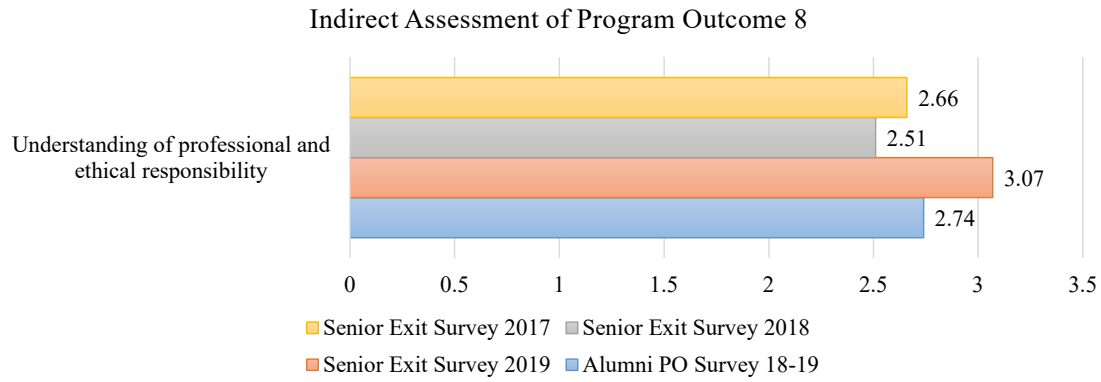

Figure 12: Indirect Assessment Result of PO8

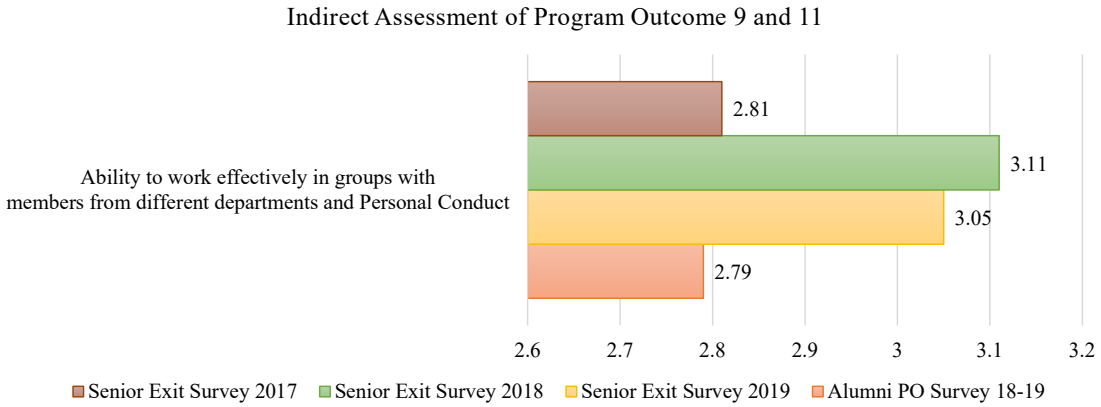

Figure 13: Indirect Assessment Result of PO9 and 11

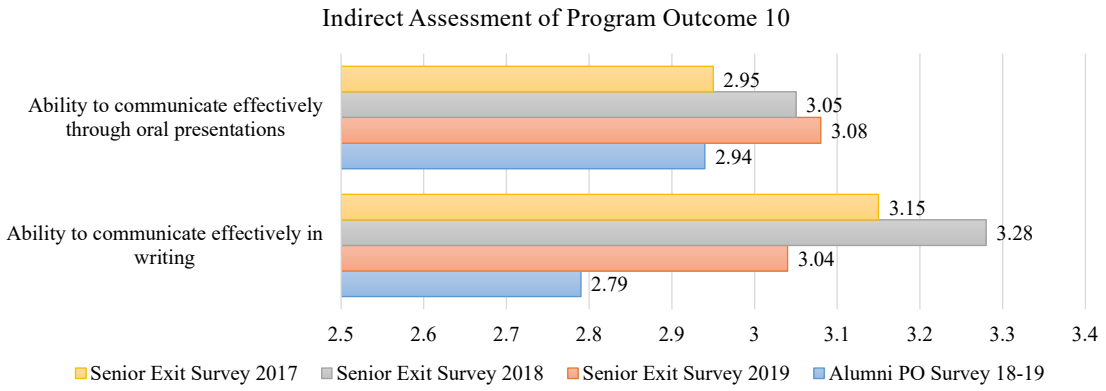

Figure 14: Indirect Assessment Result of PO10

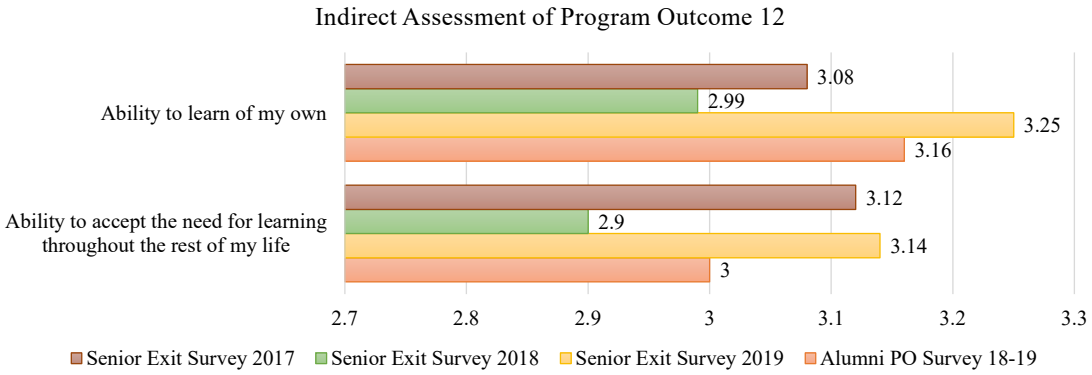

Figure 15: Indirect Assessment Result of PO12

8.17.7 Assessment of End Sem Questions

To know the understanding level of the students we have also assessed the end sem question. The question is set keeping in the view of Bloom's taxonomy level. It is observed that 13.3% of questions asked from remembering, 20% of questions asked from understanding level, 30% of questions asked from applying level and remaining 36.7% of questions asked from analyzing level. As this is a fundamental level question, so there is no questions asked from evaluating and creating level. Out of the questions asked 95% of students attempted the remembering level questions, i.e around 12.7% of total questions, similarly 94% student attempted the understanding level questions, 92% of the students attempted the questions of application level and 92% of students attempted the analysis level question. Overall 92.8% of students attempted the questions and 7.2% of students not attempted the questions. Figure 16 shows the assessment of question.

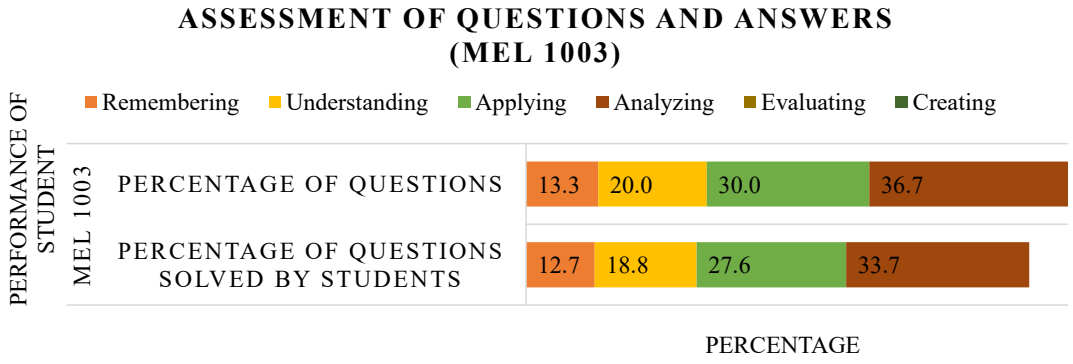

Figure 16: Assessment of End Sem Question

8.17.8 POs Attainment Levels and Actions for Improvement

Based on the result of attainment, certain observation made and the future course of action for the improvement has been presented in Table 22.

Table 22: POs Attainment Levels and Actions for Improvement

POs	Target Level	Attainment Level	Observations
PO1: Engineering Knowledge	2.75	2.776	1. The students are able to solve the mathematical equations. 2. More emphasis has been given to solve the integral and differential equations.
Action Taken: i. Mathematical questions related to integration, differentiation, has to solved in initial classes. ii. Problem solving and problem analysis classes to be fully utilized through various tests.			
PO2: Problem Analysis	2.75	2.563	1. More problem-solving session to be introduced 2. Fundamentals to be clear in the prerequisites.
Action Taken: i. More prerequisite classes to be introduced. ii. Problem solving and problem analysis classes to be fully utilized through various tests. iii. Some hands-on problems must be discussed.			

9 Summary

- Assessment helps the institution to create a benchmark to achieve its mission and broad based goals.
- It helps to maintain quality in the teaching and motivate to engage the students in life long learning.
- Through assessment we are able to develop ethical responsibility, environmental responsibility as well as social responsibility for the student and faculty.
- Outcome assessment helps formulate judgments about the quality of the reading program. It helps to classify students in terms of whether they improved or achieved grade-level performance. Outcome assessment also provides a bottom-line evaluation of the effectiveness of a reading program.