OBE IMPLEMENTATION HAND BOOK

(VERSION1.1)

E.G.S. PILLAY ENGINEERING COLLEGE,

NAGAPATTINAM-611002.

APPROVED IN 39TH GOVERNING BODY MEETING
WITH EFFECT FROM 12.08.2017

GLOSSARY

DEFINITIONS

Programme Educational Objectives (PEOs) describe the career and professional developments of graduates, which are to be assessed in a minimum of five years.

Programme Outcomes (POs) explain the knowledge, skills, and values that the students are expected to attain upon graduation.

Course Outcomes (COs) outline the course specifications to be acquired by students.

Course Plan is a lecturer teaching-learning plan throughout a semester.

Course Syllabus provides a comprehensive description of a curriculum offered by the respective programme of study.

Course File is a lecturer teaching-learning portfolio.

Course End Report is an in-house developed tool to measure the achievement of COs and POs.

National Board of Accreditation (NBA) is a kind of recognition which indicates that a programme or Institution fulfils certain standards in India

Self Assessment Report (SAR) is an account of the universities plan, implementation, assessment and evaluation of the programme conducted.

Washington Accord(WA) is an international agreement among bodies responsible for accrediting engineering degree programmes.

ENGINEERING PROGRAMS AND NBA ACCREDITATION

Engineering Programs in India

- Are offered as per the regulations of All India Council for Technical Education (AICTE)
- Are offered by Tier 1 (Academically Autonomous) and Tier 2 (Academically Non-autonomous) Institutions
- At present 95% of engineering colleges are academically non-autonomous, i.e., Tier 2 institutions.

National Board of Accreditation (NBA)

- Established in the year 1994 under Section 10 (u) of AICTE Act.
- NBA became Autonomous in January 2010 and in April 2013 the Memorandum of Association and Rules of NBA were amended to make it completely independent of AICTE, administratively as well as financially.
- NBA became a permanent member of the Washington Accord (an international accord) in 2014.

Washington Accord

- It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering

Accreditation

- Accreditation is a process of quality assurance and improvement, whereby a program in an approved Institution is critically appraised to verify that the Institution or the program continues to meet and/or exceed the Norms and Standards prescribed by regulator from time to time.
- It is a kind of recognition which indicates that a programme or Institution fulfils certain standards.
- Programs, and not Educational Institutions, are considered for accreditation.

Purpose of accreditation is NOT TO

- Find faults with the institution but to assess the status-ante of the performance
- Denigrate the working style of the institution and its programs but to provide a feed back on their strengths and weaknesses
- Demarcate the boundaries of quality but to offer a sensitizing process for continuous improvement in quality provisions
- Select only institutions of national excellence but to provide benchmarks of excellence and identification of good practices

Benefits of Accreditation

- Facilitates continuous Quality Improvement
- Demonstrates accountability to the public
- Improves staff morale

- Recognizes the achievements/innovations
- Facilitates information sharing

- Priority in getting financial assistance helps the Institution to know its strengths, weaknesses and opportunities
- Initiates Institutions into innovative and modern methods of pedagogy
- Promotes intra and inter-Institutional interactions

OUTCOME BASED EDUCATION

What are Outcomes?

- An outcome of an education is what the student should be able to do at the end of a program/ course/ instructional unit.
- Outcome-based education is an approach to education in which decisions about the curriculum are driven by the exit learning outcomes that the students should display at the end of the program/ course.

Why is OBE important?

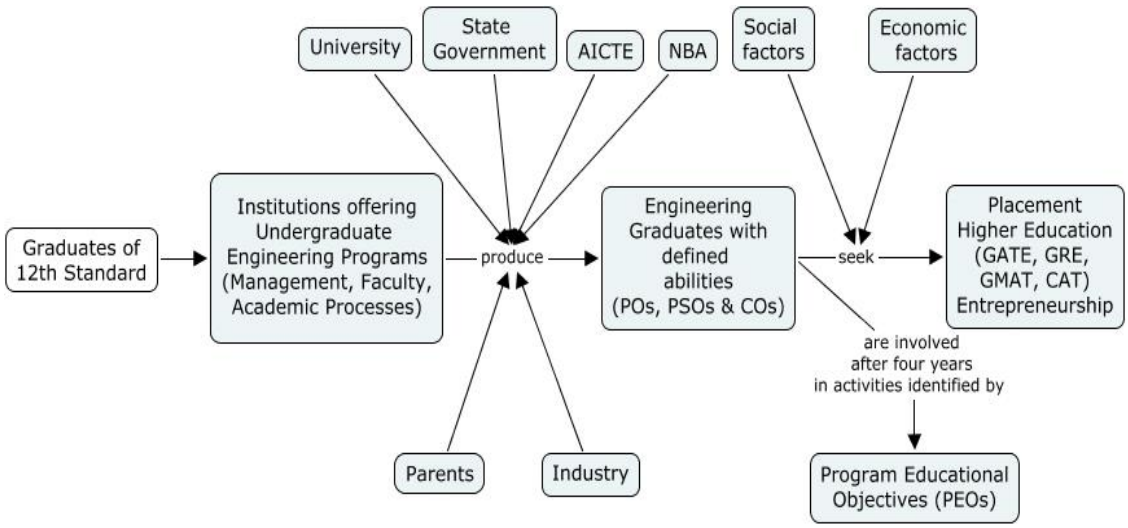


Figure 1: Structure of OBE

Outcomes

✓ Outcomes are the abilities the students acquire at the end of the program
✓ Outcomes provide the basis for an effective interaction among stakeholders
✓ In outcome-based education, "product defines process".
✓ It is the results-oriented thinking and is the opposite of input-based education where the emphasis is on the educational process and where we are happy to accept whatever is the result"
✓ Outcome-based education is not simply producing outcomes for an existing curriculum.

Perceived Disadvantages of OBE

Imposition of Constraints

- ✓ The concern was that education should be open ended, taking the student where he or she was able to develop.
- ✓ "The proposed outcomes watered down academics in favour of ill-defined values and process skills"
- ✓ "Traditional academic content is omitted or buried in a morass of pedagogic clap-trap in the outcome-based education plans that have emerged to date"
- ✓ Inclusion and Emphasis on Attitudes and Values was Inappropriate

Inhibition of Learning by Discovery

- ✓ Education should be valued for its own sake and not because it led to a pre-identified outcome
- ✓ To define education as a set of outcomes decided in advance of teaching and learning, conflicts with the wonderful, unpredictable voyages of exploration that characterize learning through discovery and enquiry

Levels of Outcomes

- **Program Educational Objectives:** PEOs are broad statements that describe the career and professional accomplishments in five years after graduation that the program is preparing graduates to achieve.
- **Program Outcomes**: POs are statements that describe what the students graduating from engineering programs should be able to do
- **Program Specific Outcomes**: PSOs are statements that describe what the graduates of a specific engineering program should be able to do
- **Course Outcomes:** COs are statements that describe what students should be able to do at the end of a course

VISION AND MISSION

Vision: Where you "see" your college/department down the road; typically one sentence!

Mission: What you "do" to get there? Typically, 2-3 sentences.

- ➢ Must follow from Vision and Mission of the Institute
- ➢ Must be shared with all stake holders!
- ➢ Better to avoid "flowery" phrases (generally):
  - ✓ World-Class
  - ✓ Global excellence
  - ✓ All round excellence …

Must result from a well-defined and recorded process!

Vision and Mission - PROCESS

- ➢ Stakeholders: Top Management (...), Faculty and Staff, Current Students, Alumni, Employers, Industry reps, ...

- ➢ Process:
  - ✓ Initial brainstorming at multiple levels;
  - ✓ Review, refine, and validate (Experts, Advisory Group,...)
  - ✓ Wide publicity (Institute web site, campus, ...)

- ✓ Review “to close the loop” (5 years?)
- ✓ (Regular interactions with new faculty and staff; students?)

- Process documentation
- Records of process implementation

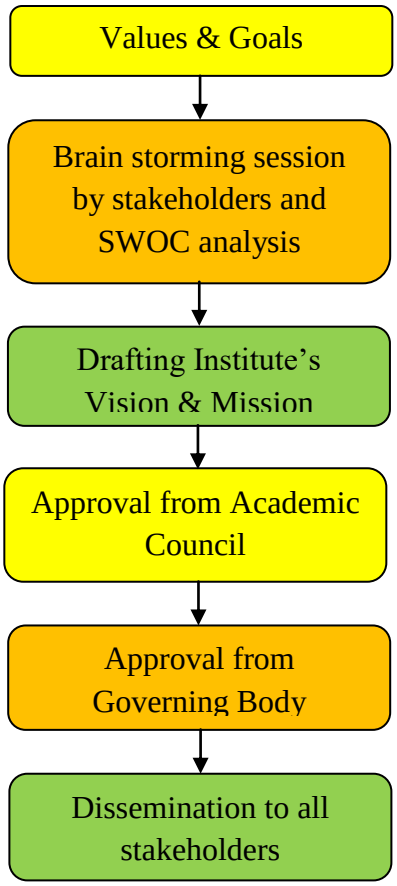


Figure 2.1. Process of drafting Institute’s Vision & Mission

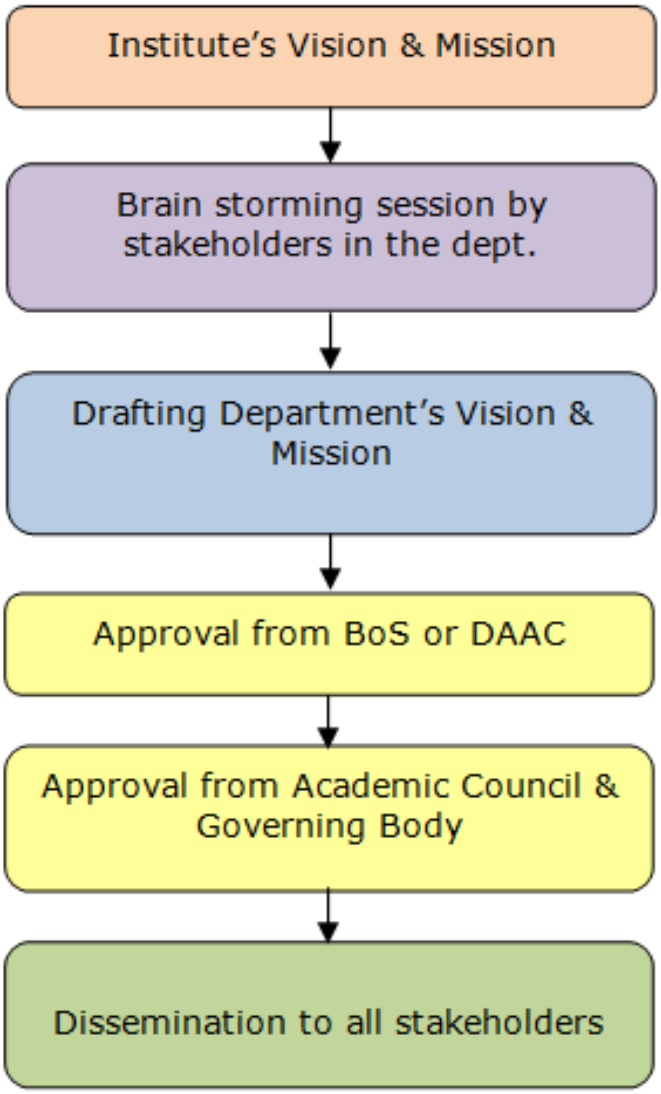


Figure 2.2: Process of Defining Vision and Mission of the Department

Vision and Mission of the Institute (EGSPEC):

Vision:

Envisioned to transform our institution into a Global Center of Academic Excellence

Mission:

1.To provide world class education to the students and to bring out their inherent talents
2.To establish state-of-the-art facilities and resources required to achieve excellence in teaching-learning and supplementary processes
3.To recruit competent faculty and staff and to provide opportunity to upgrade their knowledge and skills
4.To have regular interaction with the industries in the areas of R&D and offer consultancy training and testing services
5.To establish centers of excellence in the emerging areas of research
6.To offer continuing education, and non-formal vocational education programmes that are beneficial to the society.

Vision and Mission of the Department: (Sample for Mechanical Engineering)

Vision

To foster academic excellence in Mechanical Engineering Education and Research and turn out students into competent professionals to serve the society

Mission

M1: To produce successful mechanical engineers through innovative teaching and learning processes and by enhancing the knowledge and skills of faculty members and supporting staff through various training programmes.

M2: To establish state-of-art laboratories and centers of excellence to promote good quality education, research and consultancy for industrial and societal needs.

M3: To prepare the students for higher education and successful engineering careers by inculcating leadership and entrepreneurial qualities, team work capability, interpersonal skills, lifelong learning, moral and ethical values.

Programme Educational Objectives (PEOs):

- What the Graduates of the program are expected to achieve within 3 to 4 years of completing the program.
- Can be abstract to some extent; but must be smaller in number and must be achievable.
- Must follow from Vision and Mission
- Must follow an established process
- Typically, the process is similar to the one for Vision and Mission
  - Process Documentation
  - Records of Process Implementation
  - Must be shared with all stake holders!
  - Key elements (generally):
  - Professional success
  - Life-long learning, Higher Education, Research
  - Ethical professional practice
  - Communication skills
  - Team player
  - ……
- 3 to 5 PEOs may be arrived at following a well-defined and recorded process
- Measurement and closing the loop

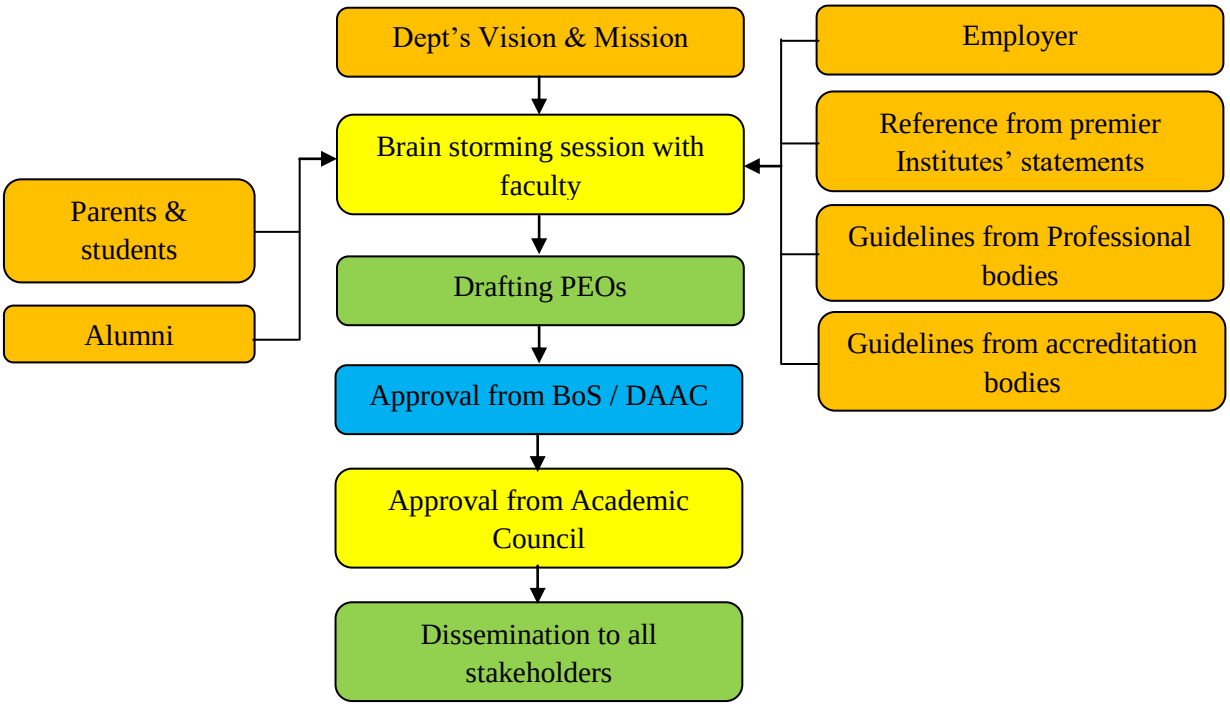


Figure 3.1. Process of drafting PEOs

Example:(Sample for Mechanical Engineering)

After successful completion of the programme, graduates are able to

PEO 1: Have successful career in mechanical and associated industries or become an entrepreneur or pursue higher education and research.

PEO 2: Apply fundamental technical knowledge and skills to find practical solutions to technological challenges and problems in core and allied areas of mechanical engineering.

PEO 3: Adapt to evolving technological challenges, learn continuously, communicate effectively,work effectively as individuals and as team members and adhering to professional ethics.

Mission – PEO Mapping

- PEOs must be consistent with the Mission
- **Example:** A PEO states that the Graduates will be successful in Research BUT Mission has no mention of Research!
  - Develop the PEO-Mission Matrix
  - The strength of mapping between a PEO and an element of Mission may be marked as Substantial, Moderate, Slight
  - Such mapping strengths must be justified
  - From this perspective also, it is better to limit the number of PEOs to a reasonably small number and have fairly crisp Mission statements.

	M_1	M_2	...	M_k
PEO_1	-	3		3
...				
...				
PEO_n	-	1	1	1

- M_1, M_2, and so on are elements of the Mission
- Correlation levels: 1, 2, or 3 interpreted as follows: 1- Slight; 2- Moderate; 3 – Substantial. If there is no correlation, indicate by a "–"
- Each mapping needs to be justified

Example:

A PEO states that the Graduates will engage in life-long learning; this is mapped to an element of the Mission statement, "environment conducive for self-directed learning"; PEO_3–M_4: The mapping strength is "substantial"

Justification: The learning environment provided in the college is designed to promote self-directed learning by the students; this coupled with the Program Curriculum will lead Graduates to engage in continuous learning in their professional careers.

- **Example: (Sample for Mechanical Engineering)**

PEO 1: Have successful career in mechanical and associated industries or become an entrepreneur or pursue higher education and research.
PEO 2: Apply fundamental technical knowledge and skills to find practical solutions to technological challenges and problems in core and allied areas of mechanical engineering.

PEO 3: Complement the class room teaching with live projects, fieldworks, seminars to build self-learning, and lifelong learning capability, and to develop out of box thinking. Also, adapt to evolving technological challenges, communicate effectively,work effectively as individuals and as team members and adhering to professional ethics.

Mission Vs PEOs Mapping

M / PEO	1	2	3
1	3	3	3
2	3	3	1
3	3	1	3

POs and PSOs

- What the students become capable of, at the end of the program (PEOs look at the graduates 3 to 4 years after the completion of the program!)
- POs (12 in number) are defined by NBA; are applicable to all UG programs; cover not just technology competence but also skills and attitudes!
- PSOs are program specific; 2 to 4; need to be defined following a documented process

WHAT ARE PO?

Programme Outcomes (PO) are the knowledge, skills, and abilities students should possess upon graduation.

WHAT ARE PSO?

Programme Specific Outcomes (PSO) are the knowledge, skills, and abilities students should possess upon graduation in the programme.

Example:(Sample for Mechanical Engineering)

PSO1: Design, develop, test and maintain advanced thermal engineering systems for industrial and other applications.
PSO2: Apply the concepts of modern manufacturing and industrial engineering techniques in industries.
PSO3: Modeling, design and analysis of mechanical components using Computer Aided Design and Analysis software tools.

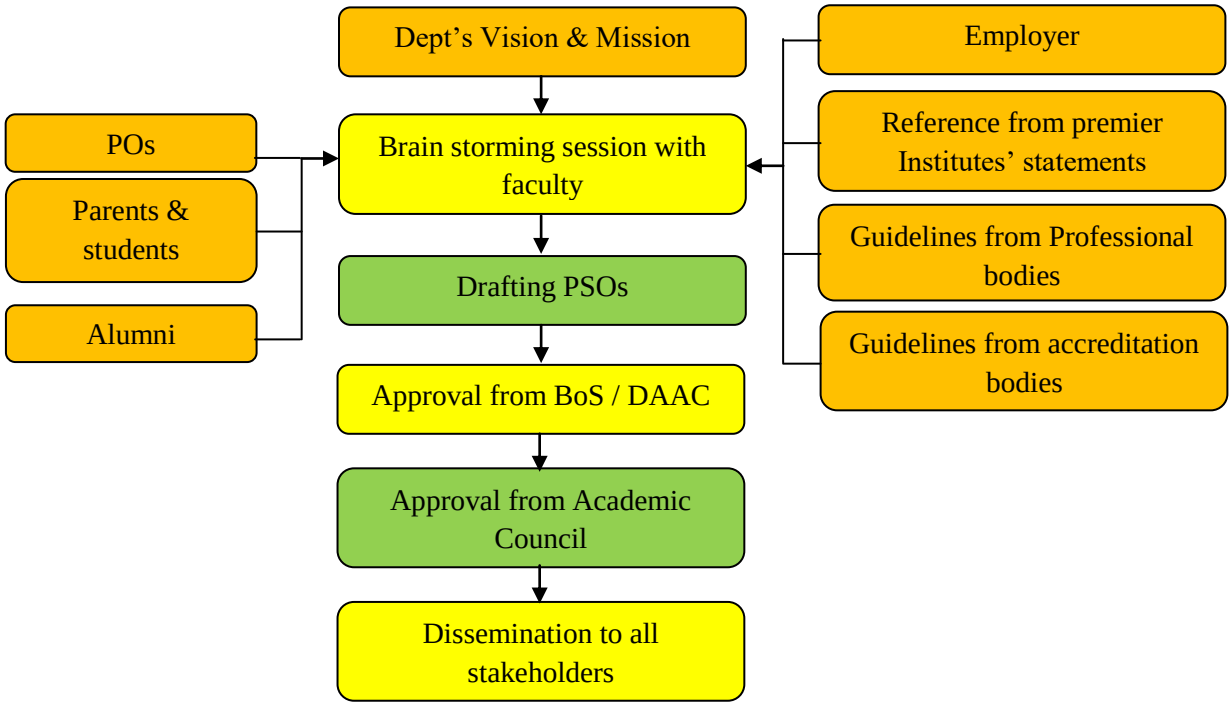


Figure 3.2. Process of drafting PSOs

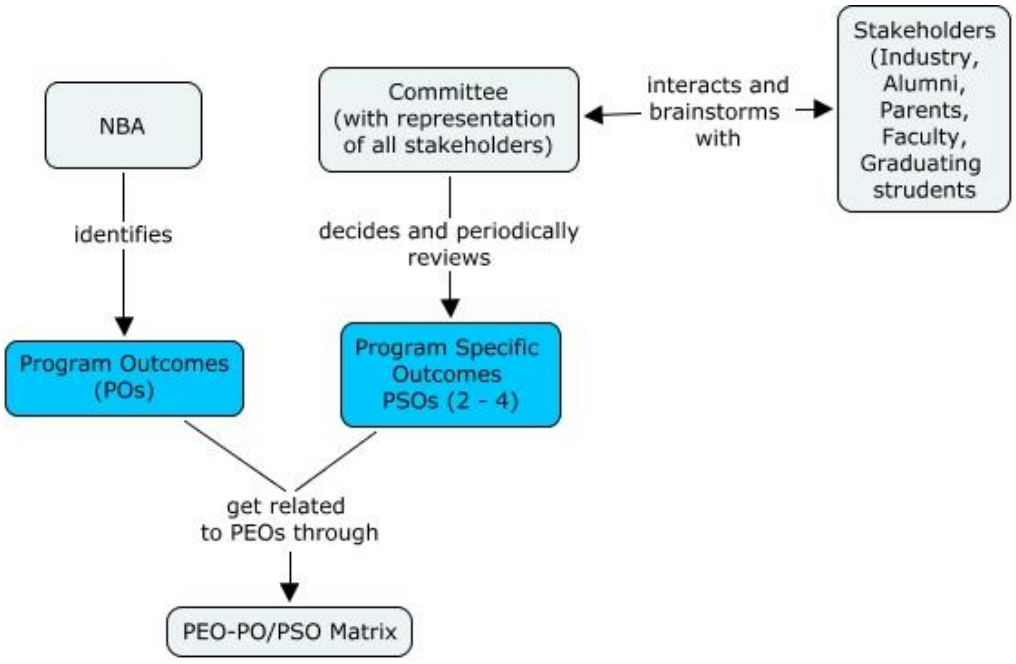


Figure 4: Matrix of PEOs, POs, PSOs

PROGRAM OUTCOMES(POs)

Engineering Graduates will be able to:

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.

COURSE OUTCOME (COS)

WHAT ARE CO?

CO are the statements of knowledge/ skills/ abilities that students are expected to know, understand and perform as a result from their learning experiences.

WHAT IS THE RELATION BETWEEN PO AND CO?

The CO are linked to the PO using the PO vs CO matrix as stated in Course Syllabus blueprint. When designing the CO, lecturers of each course map their CO to the appropriate PO in order to ensure that all PO are delivered throughout the four year study.

WHY IS IT IMPORTANT TO HAVE A WELL WRITTEN CO?

Well written CO facilitate lecturers in measuring the achievement of the CO at the end of the semester. It also helps the lecturers in designing suitable delivery and assessment methods to achieve the designed CO.

WHEN TO DEVELOP OR REVISE CO?

New CO are developed when a new course is offered.

Existing CO are revised upon feedback from stakeholders or during the 5 years cycle of Curriculum Review. If the changes are not affecting the course content, endorsement from the department is required. If the changes of CO change more than 30% of the course content, endorsement from higher authority; Senate is required.

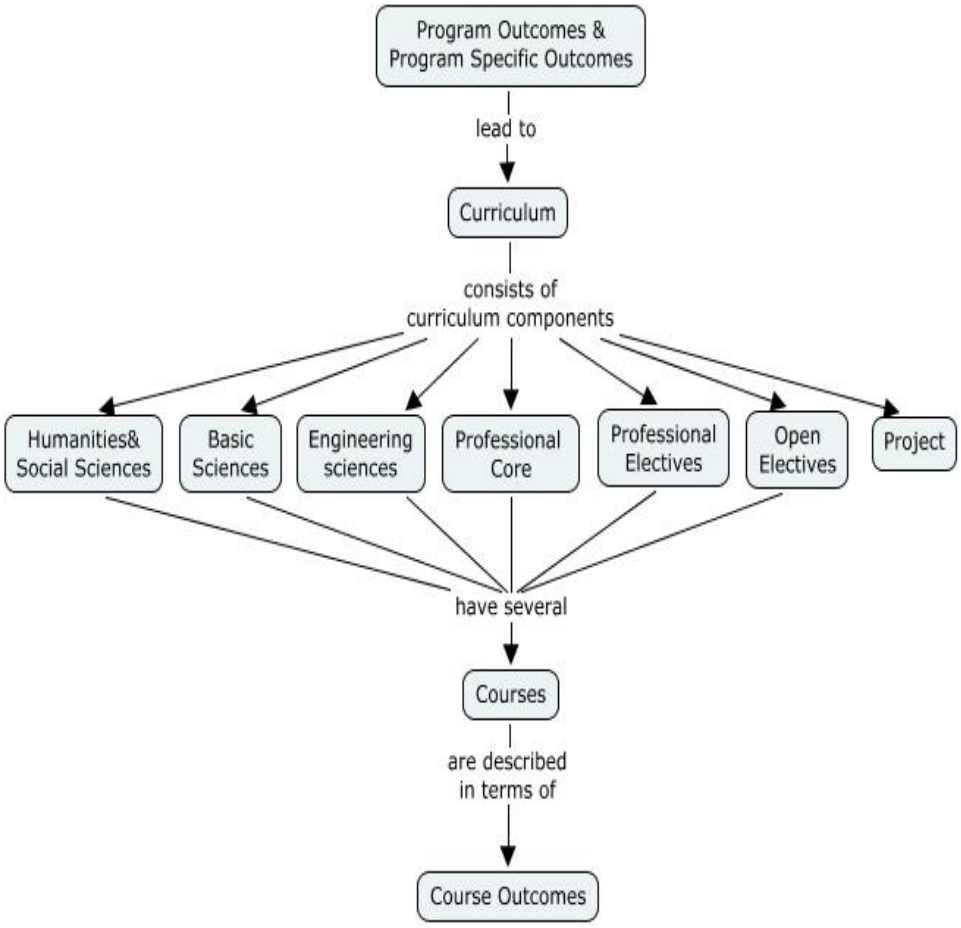


Figure 5: Course Outcome Structure

WHAT ARE THE RULES OF THUMB TO DEVELOP CO?

The rules of thumb to develop CO are **SMART**.

S = SPECIFIC
student can tell **what** they should be able to achieve from reading the outcomes.
M = MEASURABLE
student is able to recognize **when** they have achieved the outcomes.
A = ACHIEVABLE
it is genuinely **possible to complete** the outcomes in the time, and with the resources available.
R = REALISTIC
outcomes are **appropriate** for the student and the situation.
T = TIME BOUNDED
outcomes have a **time limit** for completion.

To follow the SMART rules, CO are constructed by four elements of ABCD, where;

A = Audience B = Behavior C = Condition D = Degree/ Standard

Selection of behavior elements is important. There are three types of behavior elements or also known as educational activities; **cognitive (knowledge), psychomotor (skills) and affective (attitude)**. Appropriate behavior elements are selected from the Teaching and Learning Taxonomy. The domains are classified into several levels and numbered from 1 to 7 depending on the ability expected from the students.

Taxonomy of Teaching, Learning and Assessment

- Dimensions of Learning
  - Cognitive
  - Cognitive Processes
- Knowledge Categories
- Affective (Emotion)
- Psychomotor

Cognitive Processes

Anderson/Bloom's Taxonomy

Cognitive level / K-level	Meaning
K1 (Remember)	Remember or recognize a term or a concept.
K2 (Understand)	Select an explanation for a statement related to the question topic.
K3 (Apply)	Select the correct application of a concept or technique and apply it to a given context.
K4 (Analyze)	Separate information related to a procedure or technique into its constituent parts for better understanding and distinguish between facts and inferences.
K5 (Evaluate) (Expert Level only)	Make judgements based on criteria and standards. Detect inconsistencies or fallacies within a process or product, determine whether a process or product has internal consistency, and detect the effectiveness of a procedure as it is being implemented.
K6 (Create) (Expert Level only)	Put elements together to form a coherent or functional whole. A typical application is to reorganize elements into a new pattern or structure, devise a procedure for accomplishing some task, or invent a product.

- Remember
- Understand
- Apply
- Analyze
- Evaluate
- Create

Remember

- Remembering involves retrieving relevant knowledge from long-term memory
- The relevant knowledge may be factual, conceptual, procedural, or some combination of these
- Remembering knowledge is essential for meaningful learning and problem solving as that knowledge is used in more complex tasks
- Action verbs: Recognize, recall, list, mention, state, draw, label, define, name, describe, prove a theorem etc.

Understand

- We are said to understand when we are able to construct meaning from instructional messages
- Instructional messages can be verbal, pictorial/ graphic or symbolic
- Instructional messages are received during lectures, demonstrations, field trips, performances, or simulations, in books or on computer monitors

Apply

- Using procedures to perform exercises or solve problems
- Closely linked with procedural knowledge

Analyze

Involves breaking material into its constituent parts and determining how the parts are related to one another and to an overall structure

- Differentiate: Discriminate, differentiate, focus and select (Distinguishing relevant parts or important parts from unimportant parts of presented material)
- Organize: Structure, integrate, find coherence, outline, and parse (Determine how elements fit or function within a structure)
- Attribute: Deconstruct (Determine a point of view, bias, values, or intent underlying presented material

Evaluate

- Make judgments based on criteria and standards
- Criteria used include quality, effectiveness, efficiency and consistency
- The standards may be either quantitative or qualitative

Create

- Involves putting elements together to form a coherent or functional whole
- While it includes objectives that call for unique production, also refers to objectives calling for production that students can and will do

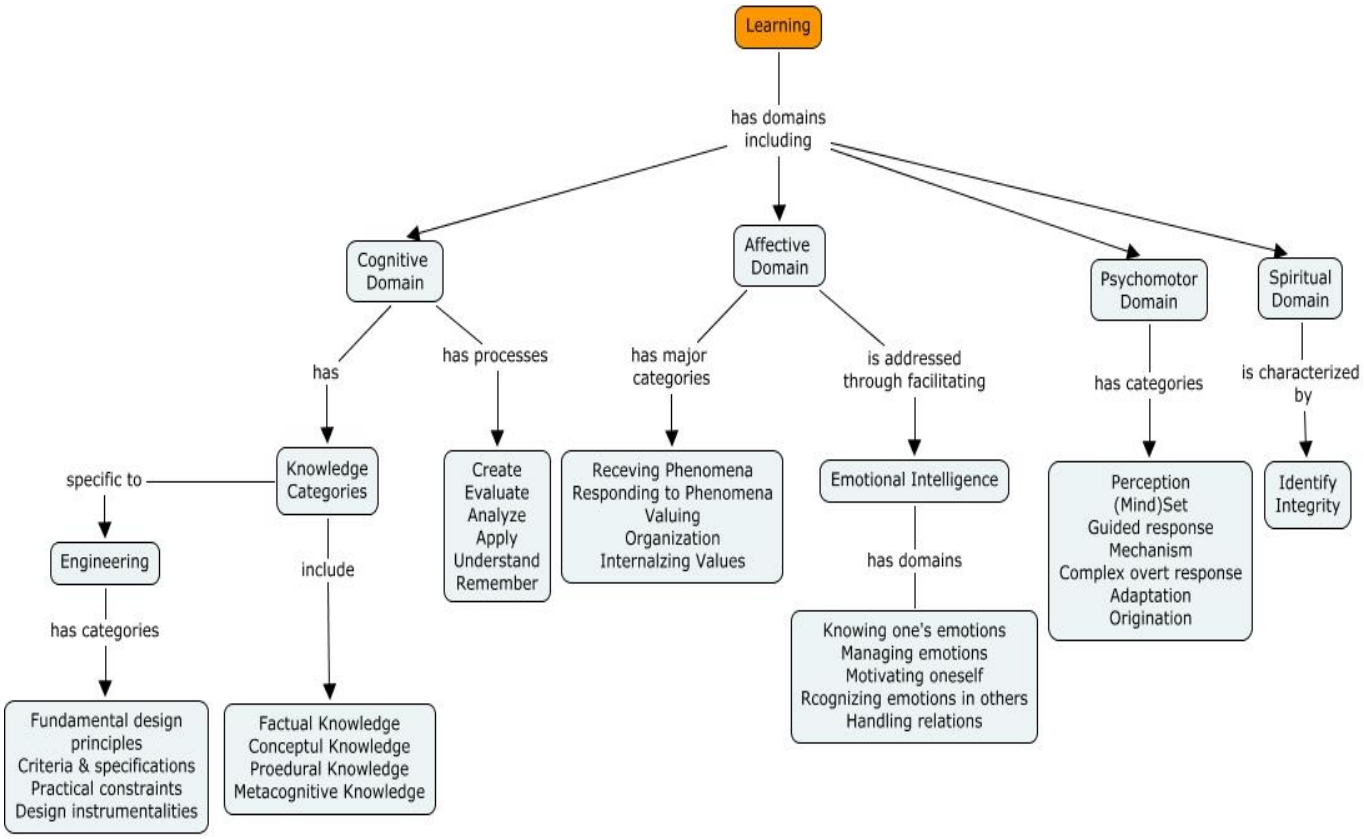


Figure 5: Relationship between Domain

Course Outcomes

Students learn well when

- They are clear about what they should be able to do at the end of a course
- Assessment is in alignment with what they are expected to do
- Instructional activities are designed and conducted to facilitate them to acquire what they are expected to achieve

Assessment

- Understanding what students know and are able to do as a result of their engineering education is fundamental to students success and to the quality and effectiveness of engineering education

Many academics still view

- The assessment of student learning as an obligatory, externally imposed chore of compliance and accountability
- Gathering evidence of students learning is not compliance with external demands but rather, an institutional strategy, a core function of continuous improvement and a means for faculty to elevate student success and strengthen institutional health

Outcomes of Learning

- When we teach we want our students to learn.
- **Outcomes of any learning:** Outcomes, Course Outcomes, Learning Outcomes, Intended Learning Outcomes, Instructional Objectives, Educational Objectives, Behavioral Objectives, Performance Objectives, Terminal Objectives, Subordinate Skills,
Subordinate Objectives, General Instructional Objectives, Specific Learning Outcomes and **Competencies**.

What is Course Outcome?

- Course Outcomes are what the student should be able to do at the end of a course
- It is an effective ability, including attributes, skills and knowledge to successfully carry out some activity which is totally identified
- The most important aspect of a CO is that it should be measurable

Structure of a CO Statement

✓ **Action**: Represents a cognitive/ affective/ psychomotor activity the learner should perform. An action is indicated by an action verb representing the concerned cognitive process.

✓ **Knowledge**: Represents the specific knowledge from any one or more of the eight knowledge categories

✓ **Conditions**: represents the process the learner is expected to follow or the conditions under which to perform the action (This is an optional element of CO)

✓ **Criteria**: represent the parameters that characterize the acceptability levels of performing the action (This is an optional element of CO)

Sample 1

Determine the input-output characteristics of active two-port networks using Microcap simulator and TI Analog Laboratory unit and compare their characteristics as obtained by simulation and Lab Unit

- Action: Determine (Apply)
- Knowledge: input-output characteristics of active two-port networks (Conceptual)
- Condition: using Microcap simulator and TI Analog Laboratory unit
- Criteria: compare its characteristics as obtained by simulation and Lab Unit

Sample 2

Macro model signal processing functions of resistors, capacitors, inductors, crystals, diodes, Amplifiers, Op Amps, Comparators and Multipliers as one-port and two-port networks

- Action: Macro model (Understand)
- Knowledge: signal processing functions of .....(Conceptual and Procedural)
- Condition: One-port and two-port networks
- Criteria: None

Sample 3

Calculate major and minor losses associated with fluid flow in piping networks

- Action: Calculate (Apply)
- Knowledge: major and minor losses associated with fluid flow in piping networks (Conceptual and Procedural)
- Condition: None
- Criteria: None

Sample 4

Determine the dynamic unbalanced conditions of a given mechanical system of rigid objects subjected to force and acceleration

- Action: Determine (Apply)
- Knowledge: Dynamic unbalanced conditions (Conceptual and Procedural)
- Condition: given mechanical system of rigid objects subjected to force and acceleration
- Criteria: None

Dos and Don'ts

- Use only one action verb
- Do not use words including 'like', 'such as', 'different', 'etc.' with respect to knowledge elements. Enumerate all the knowledge elements.
- Put in effort to make the CO statement as specific as possible and measurable

Check List

1. Does the CO begin with an action verb (e.g., state, define, explain, calculate, determine, identify, select, and design)?
2. Is the CO stated in terms of student performance (rather than teacher performance or subject matter to be covered)?
3. Is the CO stated as a learning product (rather than in terms of the learning process)?
4. Is the CO stated at the proper level of generality and relatively independent of other COs (i.e., is it clear, concise, and readily definable)?
5. Is the CO attainable (do they take into account students' background, prerequisite competences, facilities, time available and so on)?

COs: Samples and comments

- Students will execute mini projects

-Instructional activities are designed to facilitate the attainment of COs by learners, but themselves are not COs

- Have the concepts of compensators and controllers (P, PD, PI, PID)

-COs are competencies / behaviours that can be demonstrated; not descriptions of internal changes in the students (though these are necessary)

- Optimal Generator scheduling for thermal power plants by using software package in the lab

-No action verb; no way of assessing; no way of determining attainment level; syllabus part is rewritten.

- Will get knowledge of protection schemes for Generator, Transformer and Induction Motor

-COs are competencies / behaviours that can be demonstrated; not descriptions of internal changes in the students (though these are necessary) - See the comments in the previous slide!

- Apply problem solving techniques to find solutions to problems.

-Too general; no clear way of assessing!

- Study variety of advanced abstract data type (ADT) and data structures and their Implementations

-Activity that the student engages in during the Course; not what he / she become capable of demonstrating at the end of the course?

- Know the stress strain relation for a body subjected to loading within elastic limit.

-See the earlier comment; Not an action that can be demonstrated; Internal change

- Students will be able to learn the structure, properties and applications of modern metallic materials, smart materials non-metallic materials and advanced structural ceramics.

-An outcome? How to assess?

- Students will be aware of base band signal concepts and different equalizers.

-See the earlier comment; Not an action that can be demonstrated; Internal change

- Get complete knowledge regarding adaptive systems

-See the earlier comment; Not an action that can be demonstrated; Internal change; Too ambitious to be realistic?

Exercise

Write a set of COs a student should acquire at the end of your course, emphasizing particularly the relevant higher cognitive levels.

- Make sure that the CO does not appear to be like a single question.
- Avoid using the action verbs Apply, Analyze, Evaluate and Create. Use the action verbs associated with these cognitive levels.
- Mark the number of classroom sessions you would need to conduct the instructional activities for each competency

REVISED Bloom's Taxonomy Action Verbs (For EGSPEC Reference)

Definitions	I.Remember	II. Understand	III.Apply	IV.Analyze	V.Evaluate	VI.Create
Bloom's Definition	Exhibit memory of Previously learned Material by Recalling facts, terms, basic concepts, and answers.	Demonstrate Understanding of Facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to New situations By applying Acquired knowledge, facts, Techniques and Rules in a different way.	Examine and break Information into parts By identifying Motives or causes Make inferences and Find evidence to Support generalizations.	Present and defend Opinions by Making judgments About information, Validity of ideas, Or quality of Work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Verbs	Choose Cite Copy Count Draw Define Diagram Find Highlight How Identify Label List Listen Locate Match Memorize Mention Name Observe Omit Plot Point Quote Read Recall Recite Recognize Record Relate Remember Repeat Reproduce Retell Select Sketch Specify Spell State Tell Trace Underline What When	Arrange Ask Associate Calculate Classify Communicate Compare Comprehend Compute Construct Contrast Convert Defend Demonstrate Describe Determine Differentiate Discuss Disprove Distinguish Draw Elaborate Estimate Explain Express Extend Extrapolate Find Give example How Illustrate Indicate Infer Interpret Interrelate Outline Paraphrase Predict Prove Purpose Relate Rephrase Report Represent	Act/React Add Administer Apply Assemble Build Calculate Change Collect Combine Complete Comply Compose Conduct Connect Construct Correlate Classify Compute Demonstrate Design Determine Develop Divide Do Dramatize Employ Examine Experiment Experiment with Generalize Graph Group Implement Interpolate Interview Link Make use of Manipulate Maximize Measure Minimize Model Modify	Analyze Arrange Argue Assume Breakdown Categorize Cause and effect Combine Conclusion Design Debate Detect Devise Develop Diagram Differentiate Discover Discriminate Dissect Distinct Distinguish Divide Establish Focus Function Group In-depth Infer Inference Illustrate Inspect Investigate Isolate Motive Order Outline point out Prioritize Quantify Question Rank Relate Rate	Agree Appraise Argue Assess Award Bad Compare Conclude Contrast Consider Convince Criteria Criticize Critique Decide Deduct Determine Direct Dispute Effective Evaluate Give reasons Good Grade How do we know? Importance Influence Interpret Judge Justify Manage Mark Measure Opinion Perceive Persuade Present a case for Rank Rate Recommend Report on Rule on	Adapt Add to Categorize Combine Compile Compose Create Delete Discover Drive Design Devise Express Formulate Generate Group Happen Hypothesize Imagine Improve Integrate Invent Inventory Make up Modify Order Organize Original Originate Plan Prescribe Propose Rearrange Reconstruct Reorganize Reframe Revise Rewrite Setup Solution Speculate Specify Suppose Summarize

	Where Which Who	Restate Review Reword Rewrite Schedule Show Simplify Solve Summarize Tabulate Translate Verify Why Write	Operate Organize Paint Perform Plan Practice Prepare Produce Propose Respond Show Shop Solve Subtract Simulate Teach, Test Transfer, Translate Use, Utilize	Relationships Reorganize Research See Select Separate Similar to subdivide Survey Take part in Test for Theme Utilize	Score Select Support Test Useful Validate Value Weight	Theorize Theory Think Transform Visualize Write

Watch Out for Verbs that are not Measurable

In order for an objective to give maximum structure to instruction, it should be free of vagueor ambiguous words or phrases. The following lists notoriously ambiguous words or phraseswhich should be avoided so that the intended outcome is concise and explicit.

Words to Avoid

- Believe
- Hear
- Realize
- Capacity
- Intelligence
- Recognize
- Comprehend
- Know
- See
- Conceptualize
- Listen
- Self-Actualize
- Memorize
- Think
- Experience
- Perceive
- Understand
- Feel

Phrases to Avoid

Evidence a (n): To Become: To Reduce:

- Appreciation for
- Acquainted with
- Adjusted to
- Awareness of
- Capable of
- Comprehension of .
- Cognizant of
- Enjoyment of
- Conscious of
- Familiar with
- Interest in
- Interested in .
- Knowledge of
- Knowledgeable about .
- Understanding of

SUGGESTED INSTRUCTIONAL STRATEGIES

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Lecture, Test, Visual, Films Strips, Audio, Videos, Examples, Illustrations, Recordings, Newspaper, Plays, Peoples, Events, Analogical, Magazine, Articles, Text Reading, Explicit Teaching, Essays, Reports, Mastery Lectures, Structured Overview, Inquiry, Interviewing, Reports, Learning contracts, Computed associated Instructions	Questions, Discussions, Test, Review, Assembles, Reports, Writing, Learners, Presentations, Drama, Skit, Cartoon, Story, Tape, Recording, Speech, Photograph, Diagram, Statements, Model, Conclusion, Summary, Compare, Demonstration, Co-operative, Circle of Knowledge, Peer Practice, Debates, Own Statements	Exercises, Practice, Demonstrational, Projects, Sketches, Diagrams, Simulations, Role Plays, Micro teach, Map, Illustrations, Forecast, Learning games, Puzzle, Hierarchy, Scrapbook, Painting, Problem Solving, Home Work, Field Trips, Conducting Experiments, Simulations, Drill and Practice, Tutorial Groups	Problems, Exercises, Case Studies, Critical Incidents, Discussions, Questions, Test, Survey, Report, Graph, Support, Forums, Advice, Commercial, Games, Focused Imagine, Synaptic, Field Observations,	Case Studies, Projects, Exercises, Critiques, Simulations, Self-evaluation, Valuing, Recommendations, Ratings, Appraisals, Mentoring, Panel, Group Discussions, Evaluations, Research Projects, Model Building, Reflective Discussions	Projects, Problems, Case Studies, Creative Exercise, Constructs, Simulations, Article, Play, Book, Questions, Planning, Reviewing, Collaborations, Play, Game, Song, Machine, Set of rules, Set of standards, invention, Report

Attainment of COs of the Course

- Attainment of COs can be measured **directly** and **indirectly**
- Direct attainment of COs can be determined from the performances of students in all the relevant assessment instruments.
- Indirect attainment of COs can be determined from the course exit surveys.
- The exit survey form should permit receiving feedback from students on individual COs.
- Computation of indirect attainment of COs may turn out to be complex; the percentage weightage to indirect attainment can be kept at a low percentage, say 10%.

Direct CO attainment

- Semester End Examination (SEE) is conducted and evaluated by the affiliating University.
- The Department will have access only to the marks obtained by each student in the course
- As the information on performance in SEE on each student in individual COs is not available, the Institution/Department has to take that attainment (percentage marks) for all COs of the course is the same.

- The proportional weightages of CIE: SEE may be 20:80, 25:75 or 30:70.
- The number of assessment instruments used for CIE is decided by the instructor and/or Department and sometimes by the affiliating University

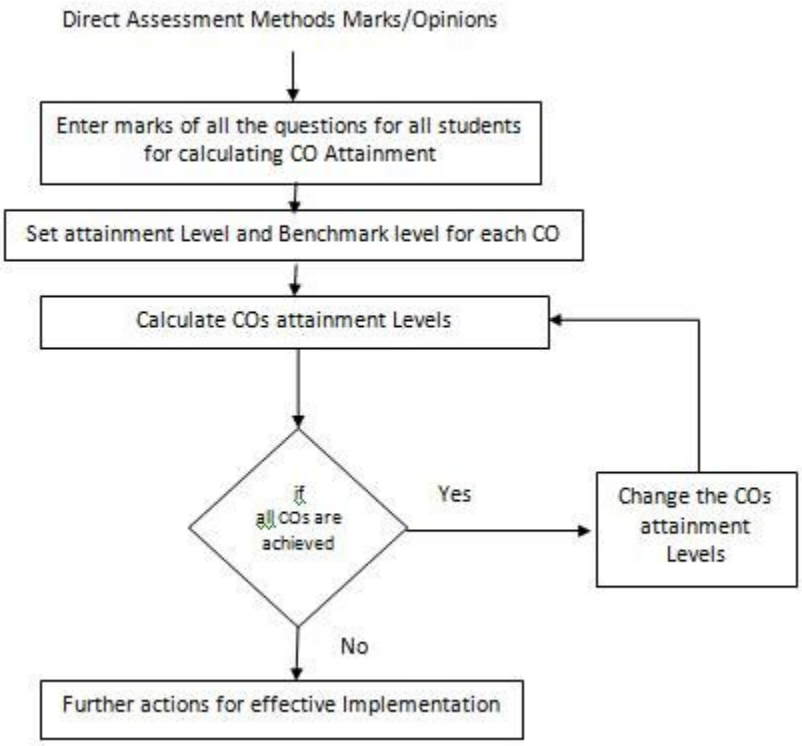


Figure 6: Direct Attainment Calculation

Process for Attainment Calculation of POs and PSOs using Direct Assessment

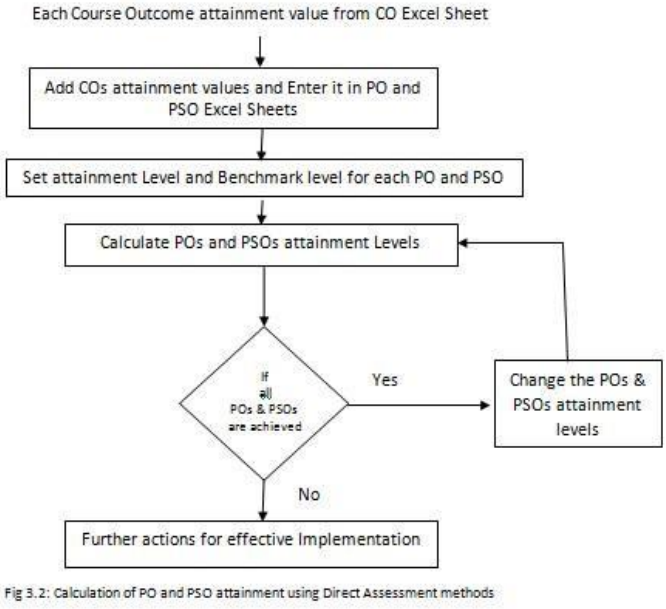


Fig 3.2: Calculation of PO and PSO attainment using Direct Assessment methods

Figure 7: Direct Attainment Calculation – PO/PSO

Process for Attainment Calculation of POs and PSOs using Indirect Assessment

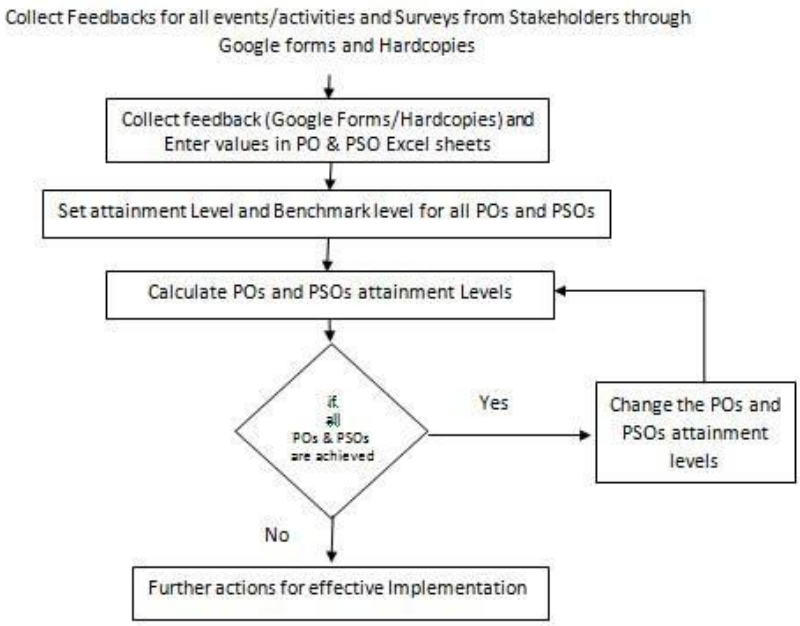


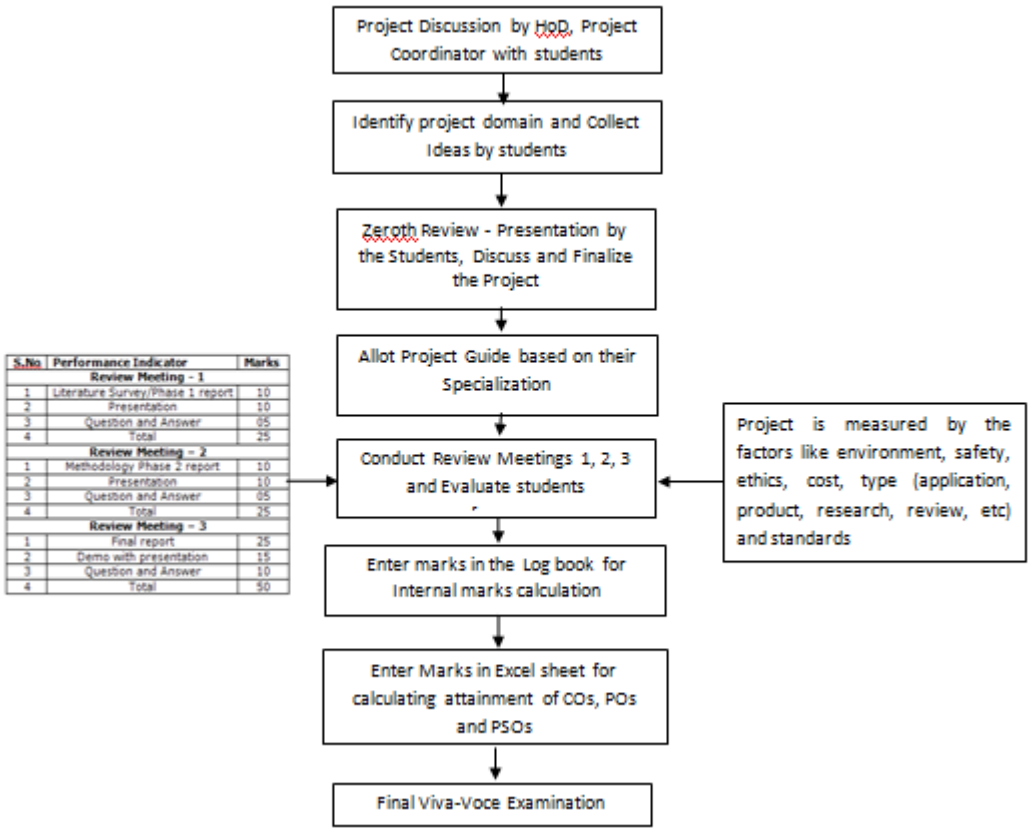
Fig 3.3: Calculation of PO and PSO attainment using Indirect Assessment methods

Figure 8: Indirect Attainment Calculation – PO/PSO

DIRECT AND INDIRECT ASSESSMENT

POs	Direct Assessment methods	Indirect Assessment methods
PO1	Tests, Assignments, Tutorials	Course End Survey Events feedback Alumni Survey Employer Survey Graduate Exit Survey
PO2	Tests, Assignments, Tutorials	
PO3	Tests, Assignments, Tutorials	
PO4	Tests, Assignments, Tutorials, Projects, Lab Tests	
PO5	Tests, Assignments, Tutorials, Projects, Lab Tests, Asynchronous Discussions	
PO6	Communication Course, Value added Courses, Skill Development courses, Mini-projects, Participating Seminars, Organizing and attending Symposiums, Participating Guest Lectures & Conferences, Project and Design Contests, Organizing Association Activities, Industrial Visits, In-plant Training, Group Discussion, etc	
PO7		
PO8		
PO9		
PO10		
PO11		
PO12		
PSOs	**Direct Assessment**	**In-Direct Assessment**
PSO 1..N	Tests, Assignments, Tutorial, Projects, Lab Tests,	Course End Surveys Events feedback Alumni Survey Employer Survey Graduate Exit Survey

STUDENTS PROJECTS



S.No	Performance Indicator	Marks
	Review Meeting - 1	
1	Literature Survey/Phase 1 report	10
2	Presentation	10
3	Question and Answer	05
4	Total	25
	Review Meeting – 2	
1	Methodology Phase 2 report	10
2	Presentation	10
3	Question and Answer	05
4	Total	25
	Review Meeting – 3	
1	Final report	25
2	Demo with presentation	15
3	Question and Answer	10
4	Total	50

Figure 9: Process of handling student project and Evaluation

Observation on Course Outcome Attainment

CO #	Expected attainment (%)	Actual Attainment (%)	Observations
CO1			
CO2			
CO3			
CO4			
CO5			
CO6			
CO7			

Summary of Students Course Feedback

Faculty Reflective Report

Action To be taken for further improvement

COURSE FILE Index

1. Syllabus
2. Students list
3. Faculty time table
4. Follow up of End of Course Report of the previous course offering
5. Course Plan – Introduction and Implementation part
6. CAT 1 -question paper with scheme of evaluations
7. CAT 1 –Result analysis
8. CAT 2 -question paper with scheme of evaluation
9. CAT 2 –Result analysis
10. Model Exam -question paper with scheme of evaluations
11. Model Exam –Result analysis
12. Activity -1 questions
13. Activity -1 sample copies
14. Activity -2 questions
15. Activity -2 sample copies
16. Activity -3 questions
17. Activity -3 sample copies
18. Innovative teaching methods - Evidence
19. Handouts/PPTs/Notes
20. Semester Exam question paper
21. Semester Exam result analysis
22. Course End Survey analysis
23. COs attainment calculation
24. Course End report – Observation on COs attainment
    - Faculty observations based on course outcome attainment and Course End Survey analysis
    - Action to be taken for further improvement

WHAT SHOULD I DO EVERY SEMESTER?

BEGINNING THE SEMESTER	DURING THE SEMESTER	END OF SEMESTER
➢ Submission of **Course Plan** and **Course Evaluation Form** ➢ Start filling in mapping, weightage of assessment	➢ Design of Final Examination Questions Conduct **Student Survey** (upon completion of syllabus)	➢ Submission of **report** ➢ Submission of Student Survey Analysis

BEFORE SEMESTER STARTS	➢ Document to be completed: COURSE PLAN ➢ In Course Plan, design the Learning Unit expected to be delivered throughout the course. ➢ Learning Unit should be aligned with the Course Outcomes (CO) and follow the taxonomy level. ➢ For each Learning Unit, decide the delivery and assessment methods and the assessment frequency. The information should be clarified in the Course Plan. ➢ Distribute the Course Plan to students to share the responsible in achieving the outcomes with them.
DURING THE SEMESTER	➢ Document to be completed: Course Plan, Course End Report ➢ After each assessment is conducted, fill in the analysis in ESR. ➢ Use the ESR to monitor whether each assessment method is assessing the Course Outcomes (CO) ➢ Do not conduct any evaluation that is not assessing or reflecting any expected outcomes declared in the Course Plan.
END OF SEMESTER	➢ Document to be completed: Course Plan, Course End Report ➢ Study the ESR analysis and evaluate the teaching and learning activities that we have conducted. ➢ Identify whether the content, delivery and assessment methods conducted throughout the semester is aligned with teaching plan constructed at the beginning of semester.

HOW CAN I CONDUCT MY CLASS?

Lecturers can conduct their classes using the conventional method or student -centered learning methods.

CONVENTIONAL METHODS

Method	Implementation
Lecture	Lecturer delivers the course in lecture hall for a maximum of 3 hours per week for 14 weeks. 1 hour of lecture is equivalent to 1 credit.
Tutorial	Tutorial is a session where the lecturer gives students sets of questions to strengthen the student's knowledge.

	2 hours tutorial session is equivalent to 1 credit, provided the students' attendance is compulsory.
Laboratory/ Experimental Session	Lecturer delivers the entire course or few topics in one course through laboratory session or by conducting experiments. For the case where entire syllabus in a course is delivered through laboratory or experimental works, 2 hours laboratory session is equivalent to 1 credit hour.
Project	Lecturer gives topics to students to be solved or to design. Projects can be completed in group or individual within the duration given.
STUDENT-CENTERED LEARNING METHODS	
Problem Based Learning (PBL)	Lecturer can use the PBL method to deliver the whole syllabus in the course or choose few topics to be delivered through PBL method. The problem statement given to students is called "trigger" The direct lecturer-student contact hour is minimum where the students spend more time to do group discussions. Lecturers observe the discussion sessions and evaluate the students.
Project-oriented Based Learning (PoBL)	PoBL is an approach similar to PBL where the students are given problems/ triggers to analyze. However PoBL method is different from PBL because; 1. PoBL is a Project based instead of Topic Based 2. The trigger comprises of bigger problem that may consists of small problems 3. In PoBL the students learn new knowledge as well as apply previous knowledge 4. Often multidisciplinary 5. Requires longer time 6. Conducted in a permanent group member
Case Studies	Case study approach is an approach where the students are given a problem to discuss and analyze. In this approach, the knowledge acquirers are the students who are the one that initiate and participate actively in the acquisition process while lecturer facilitates and acts as a coach.

HOW DO I ASSESS MY STUDENTS?

All assessment methods must adhere with the course plan. The following methods can be used to assess the students.

QUIZ

Quiz questions must be within the designed course outcomes. The distribution of marks depends on the lecturer themselves.

ASSIGNMENT

Assignment questions must be within the designed course outcomes. The distribution of marks depends on the lecturer themselves. The assignment can be either individual or group (less than 5 students per group).

PROJECT

Project questions must be within the designed course outcomes. The distribution of marks depends on the lecturer themselves. The project basically implemented in group (less than 5 students per group).

TEST

Test questions must be within the designed course outcomes. The distribution of marks depends on the lecturer themselves. Test can be conducted either open or close book test.

PRESENTATION

Presentation comes up when the course outcomes emphasize on communication skills. The presentation implemented to present the results obtained by the students from for example; project, case study or assignment. The distribution of marks depends on the lecturer themselves.

PEER EVALUATION

Peer Evaluation evaluates team work and leadership skills. This usually implemented in order to get comments from team member on their satisfaction towards their team performance. The distribution of marks depends on the lecturer themselves.

WRITTEN REPORT

Written report comes to measure communication skill based on report skills. The distribution of marks depends on the lecturer themselves.

REFLECTION REPORT

Reflection report basically used when there is industry visit by the student. The distribution of marks depends on the lecturer themselves.

FINAL EXAMINATION

Final Exam questions must be within the designed course outcomes. It is measure the cognitive level domain. The designed questions need to utilize bloom's taxonomy cognitive wheel to ensure the questions are measureable. The distribution of marks depends on the lecturer themselves. Usually the marks for final exam are 50%.

Formal Evaluation/Assessment Activities for Assessing Expected Learning Outcomes

- ✓ Exams
- ✓ Homework
- ✓ Assignments
- ✓ Quizzes
- ✓ In-Class Activities
- ✓ Papers
- ✓ Class Discussion

Informal Assessment Activities for Assessing Expected Learning Outcomes

- ✓ Non-Graded Quizzes
- ✓ Active Learning Techniques "Muddiest Point"
- ✓ Activities Polling the class

✓ One Minute Papers
✓ Application Cards

Checkpoint!- It is best to use ***BOTH*** Traditional Evaluation/Assessment strategies and Classroom Assessment Techniques to create the best assessment plan for an expected learning outcome in a course. When developing an Assessment Plan, it is a good idea to include activities from both of these groups.

Minute Paper	No other technique has been used more often or by more college teachers than the*Minute Paper*. This technique alsoknown as the *OneMinutePaper* and the *HalfSheetResponse* providesa quick and extremely simple way to collect writtenfeedback on student learning. To use the *Minute Paper*, an instructor stops class two orthree minutes early and asks students to respond briefly to some variation on thefollowing two questions: "What was the most important thing you learned during thisclass?" and "What important question remains unanswered?" Students they write theirresponses on index cards or halfsheetsof scrap paper and hand them in.
Muddiest Point	The *Muddiest Point* is just about the simplest technique one can use. It is alsoremarkable efficient, since it provides a high information return for a very lowinvestment of time and energy. The technique consists of asking students to jot down aquick response to one question: "What was the muddiest point in .....?" The focus ofthe *Muddiest Point* assessment might be a lecture, a discussion, a homeworkassignment, a play, or a film.
One Sentence Summary	This simple technique challenges students to answer the questions "Who does what towhom, when, where, how, and why?" (represented by the letters WDWWWWHW)about a given topic, and then to synthesize those answers into a simple informative,grammatical, and long summary sentence.
Student Generated Test Questions	This activity allows instructors to collect written feedback about what students thinkare the most important concepts discussed in lecture.
Classroom Opinion Poll	Instead of raising hands to poll students, a written poll assures anonymity and more accuratedata. Students can be polled about material they will encounter in the course. This activityassists in determining an effective starting point and the appropriate level of a lesson.
Group Work Evaluations	Simple questionnaires used to collect feedback on students' reactions to group work. GroupWork Evaluations can help students and teachers see what is going well and what is notgoing well.
Think-pair-share	In a think-pair-share, faculty members pose a question to the class and then allow a couple of minutes for each individual student to ***think*** it through. Next, each student turns to the student next to him/her to discuss the question/answer as a ***pair***. Finally, the faculty member will ask student pairs *to* ***share*** their response with the class
Concept mapping.	Concept mapping is a technique that helps the students to organize the lecture and/or recognize the relationships between ideas by creating a visual map of the connections. This technique may be useful to draw together all of the concepts and interrelationships used in solving the lengthy problems inherent in engineering

HOW TO MEASURE THE ACHIEVEMENT OF PO & CO?

Direct and Indirect Attainment of CO

Assessment Pattern

All assessment items in all CIE assessment instruments are to be tagged with

- Cognitive Level (CL)
- Course Outcome (CO)
- Marks

For Example:

Academic Year	2018-2019	Semester	Odd
Year/Semester/Class	IV/VII-MECH-A	Course Code	ME6010
Course Name	ROBOTICS	Faculty Name	Dr.S.RAMABALAN, P/MECH
Course Outcomes			
CO1	Explain the basics of robots and applications of robots in industries and other fields. (K2)		
CO2	Make use of end effectors and actuators of robots.(K3)		
CO3	Experiment with sensors and machine vision system of robots.(K3)		
CO4	Prepare kinematics and programming of robots.(K3)		
CO5	Describe safety aspects, economic analysis and implementation of robot project.(K2)		
CO6	Explain AGV and RGV.(K2)		
K1: Rembering, K2: Understanding, K3: Apply, K4: Analysis, K5: Evaluate, K6: Create			

CO to PO Mapping

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	-	3	-	-	-	1
CO2	3	2	1	3	-	3	-	-	3	-	3	1
CO3	3	2	1	3	-	3	-	-	3	-	3	1
CO4	3	2	1	3	2	3	-	-	3	-	3	1
CO5	2	1	-	-	-	2	-	3	-	-	-	1
CO6	2	1	-	-	-	2	-	-	-	-	-	1

CO to PSO Mapping

Course Outcome	PSO1	PSO2	PSO3	
CO1	-	2	-	
CO2	-	3	-	

CO3	-	3	-	
CO4	-	3	-	
CO5	-	2	-	
CO6	-	2	-	

Attainment of CO using Direct and Indirect Method

ME6010-ROBOTICS			Attainment					
	IV/VII-MECH-A							
S.No	Reg.No	Course Outcomes / Name of the Student	CO1	CO2	CO3	CO4	CO5	CO6
			1	2	3	4	5	6
Total (Max.Marks)			47	74	80	91	53	65
70% of Total Marks			32.9	51.8	56	63.7	37.1	45.5
Course Attainment								
Benchmark (Marks) %			70	70	70	70	70	70
Total no. Of students			65	65	65	65	65	65
No. of students who got the above benchmark in Internal Assesment			68	68	68	68	68	68
No. of students who got the above benchmark in University Exam			45	45	45	45	45	45
% of Attainment Internal Assessment			100	100	100	100	100	100
% of Attainment University Examination			66	66	66	66	66	66
% of Course Attainment (Direct Assessment)			83	83	83	83	83	83
% of Attainment Course End Survey (Indirect Assessment)			98.5	98.5	98.5	98.5	98.5	98.5
Course Attainment			**83.775**	**83.78**	**83.78**	**83.78**	**83.78**	**83.78**
Attainment level			**3**	**3**	**3**	**3**	**3**	**3**

Attainment level calculation:

>=60%-69%	1-1.9
>=70%-79%	2-2.9
>=80%	3

Attainment of PO and PSO

PO Attainment												
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	-	3	-	-	-	1
CO2	3	2	1	3	-	3	-	-	3	-	3	1
CO3	3	2	1	3	-	3	-	-	3	-	3	1
CO4	3	2	1	3	2	3	-	-	3	-	3	1
CO5	2	1	-	-	-	2	-	3	-	-	-	1
CO6	2	1	-	-	-	2	-	-	-	-	-	1
PO Attainment	2.5	1.5	1	3	2	2.5		3	3		3	1

PSO Attainment				
Course Outcome	**PSO1**	**PSO2**	**PSO3**	
CO1	-	2	-	
CO2	-	3	-	
CO3	-	3	-	
CO4	-	3	-	
CO5	-	2	-	
CO6	-	2	-	
PSO Attainment	-	2.5	-	

COURSE END SURVEY

COURSE CODE & NAME : SEMESTER :

NAME & REG NO OF THE STUDENT: DATE:

s.no	PARAMETER	RATINGS				
	COURSE	Excellent	Very Good	Good	Satisfactory	Poor
1	Relevance of course to the programme					
2	The appropriation of the content to the Bloom's level of course outcomes					
3	The appropriation of the content delivery methodologies adopted					
4	The appropriation of the assessment methodologies used for assessment of course outcomes					
	COURSE Faculty	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	Motivated my interest in the course by giving practical examples and well organized presentations					
6	Taught innovatively and used education media well					
7	Provided counseling and was available outside the class					
	GENERAL	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8	I understand the basic concepts of the course					
9	Assignments preparation contributed to my learning					
10	I can apply the concepts of this course in future					
	Course Outcomes Attainment	Excellent	Very Good	Good	Satisfactory	Poor
11	Rate your level of attainment of CO1					
12	Rate your level of attainment of CO2					
13	Rate your level of attainment of CO3					
14	Rate your level of attainment of CO4					
15	Rate your level of attainment of CO5					
16	Rate your level of attainment of CO6					

Any other comments:

Signature

E.G.S Pillay Engineering College, Nagapattinam
Department of Computer Science and Engineering

GRADUATE EXIT SURVEY

Program of study : B.E – Computer Science and Engineering

The purpose of this survey is to give you an opportunity to provide feedback about your graduate education experiences. Your feedback will be helpful in our efforts to improve graduate education. Responses will be kept strictly confidential and individual responses will not be identified or reported so please be candid.

Please tell us about yourself:

1. Name of the Student :
2. Register Number of the Student :
3. What year did you enter this program at EGSPEC? :
4. What year did you complete your degree? :

1. Impression towards teaching and learning at EGSPEC.

Impression towards	Marginal	Fair	Satisfactory	Good	Excellent
Overall quality of educational experience received at EGSPEC	1	2	3	4	5
Overall Quality of teaching received at Department of CSE	1	2	3	4	5

2. Impression towards quality improvement of teaching and learning

Impression towards	No change	Somewhat better	Much Better
Overall quality improvement of teaching and learning at Department of CSE			

- Put tick mark on specific area of choice

3. Ratings for the importance of skills and knowledge to student performance related to PO's

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Strongly disagree :2 = Disagree : 3 = Neutral : 4 = Agree : 5 = Strongly agree

*	Programme Outcome	1	2	3	4	5
PSO1	An ability to apply knowledge of mathematics and engineering to solve the complex engineering problems in Computing sciences and Information technology					
PSO2	An ability to effectively integrate IT-based solutions into the user environment					
PSO3	An ability to use the techniques, skills, and modern engineering tools necessary for computer engineering practice.					
PSO4	An ability to use research methods to design and conduct experiments to investigate complex problems, as well as to analyze and interpret data					
PSO5	An ability to acquire new knowledge in the computing discipline and to engage in life-long learning					
PSO6	An ability to work individually or as a member with responsibility to function on multi-disciplinary teams.					
PSO7	An ability to communicate effectively in speech and in writing, including documentation of hardware and software systems.					
PSO8	An understanding of the engineering and management principles required for project and finance management					

4. Ratings for student skills and knowledge preparation related to PO's

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Poor :2 = Average : 3 = Good : 4 = Very Good : 5 = Excellent

*	Programme Outcome	1	2	3	4	5
PSO1	An ability to apply knowledge of mathematics and engineering to solve the complex engineering problems in Computing sciences and Information technology					
PSO2	An ability to effectively integrate IT-based solutions into the user environment					
PSO3	An ability to use the techniques, skills, and modern engineering tools necessary for computer engineering practice.					
PSO4	An ability to use research methods to design and conduct experiments to investigate complex problems, as well as to analyze and interpret data					
PSO5	An ability to acquire new knowledge in the computing discipline and to engage in life-long learning					
PSO6	An ability to work individually or as a member with responsibility to function on multi-disciplinary teams.					
PSO7	An ability to communicate effectively in speech and in writing, including documentation of hardware and software systems.					
PSO8	An understanding of the engineering and management principles					

	required for project and finance management					

5. Ratings for lecturers/academic advisor contributions

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Average :2 = Good : 3 = Excellent

Criteria	1	2	3
Set high expectations for learning			
Encourage student to be active learner			
Exhibit proficiency in the field of instruction			
Show concern for student learning			
Provide feedback frequently and promptly			
Communicate critical concepts and ideas effectively			
Encourage student and to devote sufficient time and energy to course work			
Incorporate teamwork as part of the learning process			
Proficiency in the area of instruction			
Overall teaching ability			
Responsibilities to quality and problem resolution			

6. Ratings on academic advising of their major

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Poor :2 = Average : 3 = Good : 4 = Very Good : 5 = Excellent

Satisfaction with	1	2	3	4	5
Career Advising					
Access to advisors					
Amount of time spent with advisors					
Accuracy of information about the degree requirements and course sequencing					

Assistance on major concentration and elective selection					
Overall quality of advising					

7. Ratings on library services

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Poor :2 = Average : 3 = Good : 4 = Very Good : 5 = Excellent

Satisfaction with	1	2	3	4	5
Hours of operation					
Access to databases and collections both physically and online					
Staff responsiveness					

8. Ratings on information technology/computer services provided

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Poor :2 = Average : 3 = Good : 4 = Very Good : 5 = Excellent

Satisfaction with	1	2	3	4	5
Access to the internet					
Network functioning					
Quality of computer labs in the faculty					
Helpfulness of the labs personnel					
Overall staff responsiveness					
Quality of classrooms					
Quality of laboratories					
Standard of technology available in classrooms					

9. Other comments:

Signature of the student with date

Thank you for your time and assistance in providing information which will assist EGSPEC in improving its programs and services.

E.G.S Pillay Engineering College, Nagapattinam
Department of Information Technology

EMPLOYER SATISFACTION SURVEY

Program of study :B.Tech – Information Technology

The purpose of this survey is to give you an opportunity to provide feedback about your graduate education experiences. Your feedback will be helpful in our efforts to improve graduate education. Responses will be kept strictly confidential and individual responses will not be identified or reported so please be candid.

Name of the Employee :

Year of passing out :

Part-I:

1. Please describe your type of firm or agency, specify area of work, and kind of employee you hire.

2. Have you recruited students from our program before?

3. What are the most important characteristics that you look for in engineering undergraduates?

Please rank 1 (most important) → 9 (least important):

_____High grades
_____Professionalism and poise
_____Communication skills
_____Engineering mentality
_____Intern experience
_____Appreciation of societal and global issues
_____Research experience
_____Recommendation letters

_____Specific coursework

Other: _____

Part II:

1. How satisfied are you with the quality of students from our department?
   - Extremely satisfied
   - Pretty good
   - Average
   - Below average
   - Too much variation to characterize

2. Please evaluate the skill level of our students *upon entering the workforce* in the following areas.

Please also rank the importance of each skill.

*	SKILL LEVEL					IMPORTANCE				
	Poor	Fair	Good	Very Good	Excellent	Poor	Fair	Good	Very Good	Excellent
Communication Skills										
Analysis Skills										
Design Skills										
Technology and Computer Skills										

3. Which skill areas do you put the most effort into developing?
Check all that received significant effort

- Communication
- Analysis
- Design
- Technology and computer related
- Project management

4. Please break down responsibilities for the average new employee in terms of percentages of thefollowing:

Analysis % _____
Design % _____

Management % _____
Other % _____

Total **100 %**

5. Please evaluate the performance of our students in your organization with respect to:

Characteristic	Excellent	Good	Fair	Poor	Not Applicable
An ability to apply knowledge of mathematics and engineering to solve the complex engineering problems in computing sciences and Information technology					
Comment:					
An ability to effectively integrate IT-based solutions into the user environment					
Comment:					
An ability to use the techniques, skills, and modern engineering tools necessary for computer engineering practice.					
Comment:					
An ability to use research methods to design and conduct experiments to investigate complex problems, as well as to analyze and interpret data					
Comment:					
An ability to acquire new knowledge in the computing discipline and to engage in life-long learning					
Comment:					
An ability to work individually or as a member with responsibility to function on multi-disciplinary teams.					
Comment:					
An ability to communicate effectively in speech and in writing, including documentation of hardware and software systems.					
Comment:					
An understanding of the engineering and management principles required for project and finance management					
Comment:					

6. Please evaluate the performance of our students in your organization with respect to:

1. What about the levels of competence and knowledge on current employment

Poor / Average / Good / Very good / Excellent

2. At which level/position our graduates (year -) are working inyour organization

---

Organization _____

Name of person completing survey _____

Contact information _____

Signature with seal

E.G.S Pillay Engineering College, Nagapattinam
Department of Information Technology

ALUMNI SURVEY

Program of study : B.Tech – Information Technology

The purpose of this survey is to give you an opportunity to provide feedback about your graduate education experiences. Your feedback will be helpful in our efforts to improve graduate education. Responses will be kept strictly confidential and individual responses will not be identified or reported so please be candid.

Please tell us about yourself:

5. Name of the Student :
6. Period of Graduation :
7. Current Employer :
8. Position and Job Function :

1. The Department of Information Technology has formulated three Educational Objectives. Please rate how well you feel you have obtained these objectives in your respective program(s).

Directions: Please indicate your level of agreement or disagreement with each of the following statements about your experiences at EGSPEC.

1 = Strongly disagree :2 = Disagree : 3 = Neutral : 4 = Agree : 5 = Strongly agree

Related PEO	Evaluation Criteria	1	2	3	4	5
PEO1	My education provided the up-to-date theory necessary for my professional development					
PEO1	My education provided the up-to-date laboratory experience necessary for my professional development					
PEO1	My education influenced my ability to remain current in my professional career					
PEO1	The technical experiences that I received in my curriculum prepared me for immediate productivity in my chosen profession					
PEO1	The non-technical education that I received at EGSPEC prepared me as a well-rounded professional					
PEO2	My education at EGSPEC prepared me for leadership and responsibility in my chosen profession					
PEO2	Gave me a foundation in culture and cultural values					
PEO2	Gave me a foundation in ethics and integrity					

PEO2	Gave me a foundation in social responsibility					
PEO2	Provided a climate that fostered independent thinking					
PEO1,2	Enhanced my communication skills					
PEO1	Enhanced my skills in Computing Science and Information Technology					
PEO1	Prepared me well in the natural sciences for the requirements of my career					
PEO1	Prepared me well in mathematics for the requirements of my career					
PEO3	Provided me with a foundation in business and economics					
PEO3	Hold a membership in one or more professional organizations					
PEO3	I have enrolled in a formal graduate program since graduating					
PEO3	I have taken individual university-level courses since graduating					
PEO3	I have attended one or more seminars/workshops since graduating					

1. **PEO1:** Prepare graduates to have knowledge and competency for careers in and related to Information Technology.
2. **PEO2:** Prepare graduates to become leader in fields related to Information Technology
3. **PEO3:** Prepare graduates to pursue higher education in Engineering or other Professional fields

2. Are you working for pay now?: *Yes/No*

If no, present status :

Looking for work / studying / raising a family / volunteer / not working for other reasons

3. Which of the following best describes your academic / profession career?

Working in private sector / Govt or Public sector / Social service or NGO / Self employed / pursing post-graduation / doctoral degree / others (specify)

4. Which of the following best describe your current position?

Entry level / Mid-Level / Senior level / Executive level

5. Is your current position related to your undergraduate field(s) of study (ie : IT)

Yes, same field / Yes, slightly related / No, Not related

6. Are there relevant topics the department did not cover or topics/courses which should have been covered in greater depth?

4. What aspects of B.Tech - IT curriculum do you feel could be improved?

Other comments:

Signature of the Alumni with date

Thank you for your time and assistance in providing information which will assist EGSPEC in improving its programs and services.

COURSE PLAN – INTRODUCTION SHEET

E.G.S. PILLAY ENGINEERING COLLEGE, NAGAPATTINAM(AUTONOMOUS)
DEPARTMENT OF MECHANICAL ENGINEERING
SEVENTH SEMESTER B.E. (MECH. ENGG.)- A & B Sections
ME6010 – ROBOTICS (2018- 2019)
COURSE PLAN – INTRODUCTION PART

I. GENERAL DETAILS

Subject Code	**:** ME6010
Subject Name	**:** Robotics
Programme	: B.E. (Mech. Engg.)
Prepared By Course Coordinator	**:** Dr.S.Ramabalan
Reviewed By 1.Domain Coordinator	**:** Dr.N.Ramanujam
2. HOD	**:**Prof.G.Gurumoorthy
Approved By Programme Coordinator	**:** Prof.V. Manathunainathan
Effective Date	**:**01.07.2018
Version No.	**:** 01

II. VISION AND MISSION STATEMENTS

COLLEGE VISION	COLLEGE MISSION	DEPARTMENT VISION	DEPARTMENT MISSION
Envisioned to transform our institution into a Global Center of Academic Excellence	1.To provide world class education to the students and to bring out their inherent talents 2.To establish state-of-the-art facilities and resources required to achieve excellence in teaching-learning and supplementary processes 3.To recruit competent faculty and staff and to provide opportunity to upgrade their knowledge and skills 4.To have regular interaction with the the industries in the areas of R&D and offer consultancy training and testing services 5.To establish centres of excellence in the emerging areas of research 6.To offer continuing education, and non-formal	To foster academic excellence in Mechanical Engineering Education and Research and turn out students into competent professionals to serve the society	**M1:** To produce successful mechanical engineers through innovative teaching and learning processes and by enhancing the knowledge and skills of faculty members and supporting staff through various training programmes. **M2:** To establish state-of-art laboratories and centers of excellence to promote good quality education, research and consultancy for industrial and societal needs. **M3:** To prepare the students for higher education and successful engineering careers by inculcating leadership and entrepreneurial

	vocational education programmes that are beneficial to the society.		qualities, team work capability, interpersonal skills, lifelong learning, moral and ethical values.

III Programme Educational Objectives (PEO)

After successful completion of the programme, graduates will be able to

PEO 1: Have successful career in mechanical and associated industries or become an entrepreneur or pursue higher education and research.

PEO 2: Apply fundamental technical knowledge and skills to find practical solutions to technological challenges and problems in core and allied areas of mechanical engineering.

PEO 3: Complement the class room teaching with live projects, fieldworks, seminars to build self-learning, and lifelong learning capability, and to develop out of box thinking. Also, adapt to evolving technological challenges, communicate effectively,work effectively as individuals and as team members and adhering to professional ethics.

IV Program Outcomes (PO)

After successful completion of the programme, Graduates will be able to

PO1	Application knowledge of mathematics, science, engineering fundamentals
PO2	Problem Analysis.
PO3	Design and Development of Solutions
PO4	Conduct investigations by designing experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions
PO5	Modern Tool Usage
PO6	Assessing societal, health, safety, legal and cultural issues
PO7	Examining Environmental impact and Sustainability
PO8	Commitment to professional ethics.
PO9	Function effectively as an individual, and as a member or leader in diverse teams and in multi disciplinary settings
PO10	Communicate effectively at oral, written, and presentation level
PO11	Examine Project Management and Financial aspects
PO12	Instil Life-long Learning

V. Program Specific Outcomes (PSO)

After successful completion of the programme, Graduates will be able to

PSO1: Design, develop, test and maintain advanced thermal engineering systems for industrial and other applications.

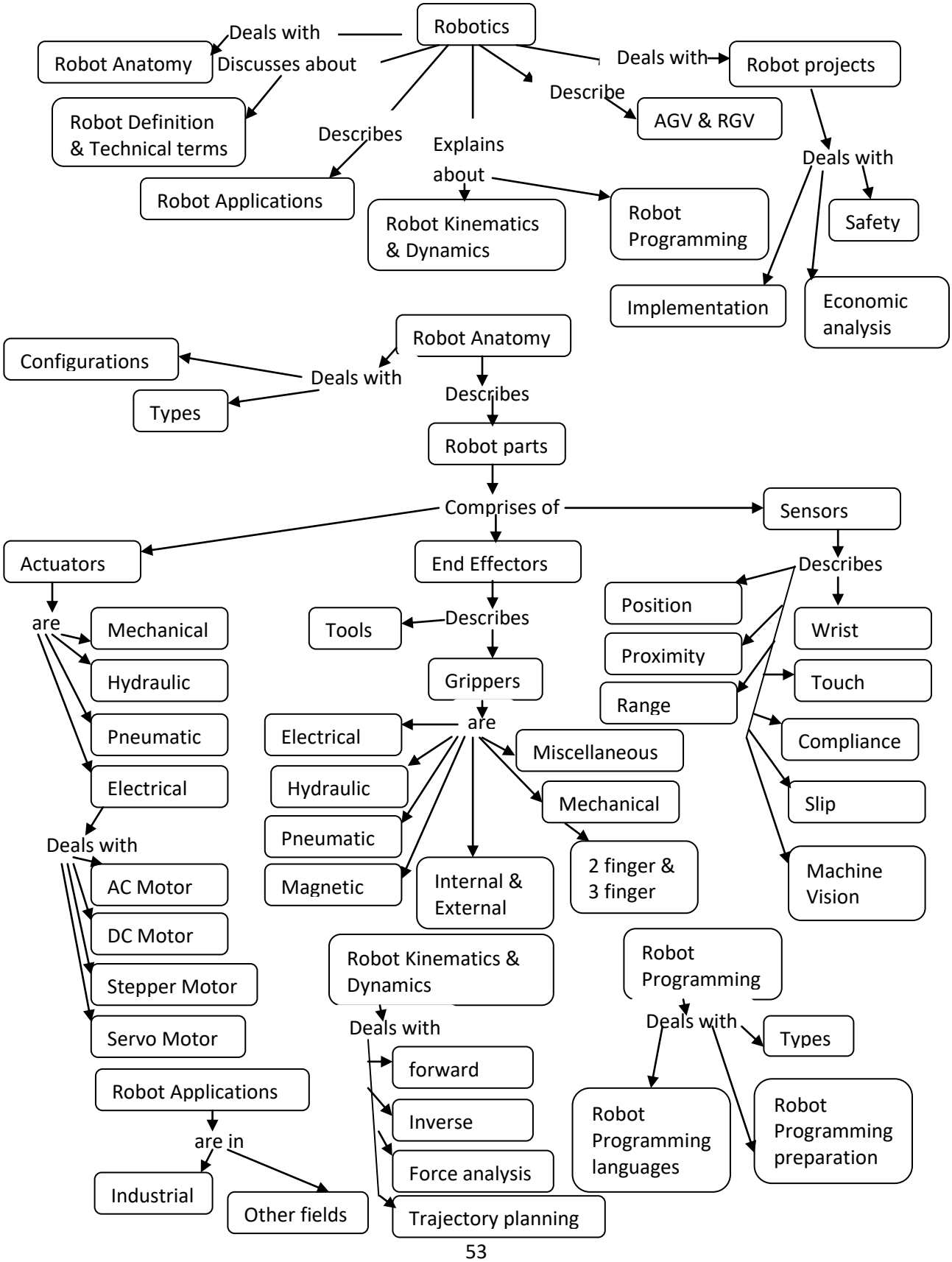
PSO2: Apply the concepts of modern manufacturing and industrial engineering techniques in industries.

PSO3: Modeling, design and analysis of mechanical components using Computer Aided Design and Analysis software tools.

VI PEO vs PO/PSO Correlation Matrix

Programme Educational Objectives (PEOs)	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓						✓	✓	✓
3								✓	✓	✓	✓	✓	✓	✓	✓

VII. Concept Map



VIII. a) Tests and Examinations: (Marks)

BLOOM'S LEVEL	UNIT 1 TEST	CYCLE TEST 1	CYCLE TEST 2	MODEL EXAM
Remember	14	20	20	20
Understand	16	80	80	80
Apply	-	-	-	-
Analyze	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

b) Internal Marks Assessment Pattern:

CYCLE TEST 1	100
CYCLE TEST 2	100
MODEL EXAM	100
TOTAL	300/3=100

Course Co-ordinator **HoD**

COURSE PLAN – IMPLEMENTATION SHEET

E.G.S. PILLAY ENGINEERING COLLEGE, NAGAPATTINAM(AUTONOMOUS)
DEPARTMENT OF MECHANICAL ENGINEERING
SEVENTH SEMESTER B.E. (MECH. ENGG.)- A & B SECTIONS
ME6010 – ROBOTICS (2018- 2019)
COURSE PLAN - IMPLEMENTATION PART

III. GENERAL DETAILS

Subject Code	**:** ME6010
Subject Name	**:** Robotics
Programme	: B.E. (Mech. Engg.)
Prepared By Course Coordinator	**:** Dr.S.Ramabalan
Reviewed By 1.Domain Coordinator	**:** Dr.N.Ramanujam
2. HOD	**:**Prof.G.Gurumoorthy
Approved By Programme Coordinator	**:**Prof.V. Manathunainathan
Effective Date	**:**01.07.2018
Version No.	**:** 01

II Course Context and Overview

Robotics is anelective subject in 7th semester in B.E. (Mech. Engg.) curriculum. In order to take this course, a student should have a prerequisite knowledge of Manufacturing Technology I & II courses.Robots are used as material handling devices in industries. Also robots are used in various other sectors like home, agriculture, police, defence, medical, etc. They are used in earth, space and in water. At present, robots are becoming unavoidable component in human life.

This course starts with the needs and basic concepts of robots. It describes the application of robots in industries and various other fields. The second part of the course provides a discussion about robot's important components such as end effectors, sensors, machine vision system, actuators. It emphasis on the robot's kinematic analysis, dynamic analysis and programming concepts. It also discuss about safety aspects, implementation of robot project, AGV and RGV. By the completion of the course the students will be able to explain and use various components of robot.

Course designed by		Anna University, Chennai (R2013)					
1	Category	Basic Sciences (B)	Engineering Sciences (ES)	Humanities and Social Sciences(HSS)	Professional Core (PC)	Professional Elective (PE)	Employability Enhancement Course (EEC)
						x	
2	Broad area	Manufacturing	Design	Thermal	General		
		x					

III. Prerequisite

Manufacturing Technology I & II, Matrix manipulations

IV. (a). Course Outcomes (COs):

After successful completion of the course, students will be able to

	Competency	Cognitive level
CO1	Explain the basics of robots and applications of robots in industries and other fields.	Understand
CO2	Make use of end effectors and actuators of robots.	Apply
CO3	Experiment with sensors and machine vision system of robots.	Apply
CO4	Prepare kinematics and programming of robots.	Apply
CO5	Describe safety aspects, economic analysis and implementation of robot project.	Understand
CO6	Explain the AGV and RGV.	Understand

(b). Program Outcomes (PO)

After successful completion of the programme, Graduates will be able to

PO1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: 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.

PO4: 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.

PO5: 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.

PO6: 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.

PO7: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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.

PO11: 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.

PO12: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

(c). Program Specific Outcomes (PSO)
After successful completion of the programme, Graduates will be able to

PSO1: Design, develop, test and maintain advanced thermal engineering systems for industrial and other applications.
PSO2: Apply the concepts of modern manufacturing and industrial engineering techniques in industries.

PSO3: Modeling, design and analysis of mechanical components using Computer Aided Design and Analysis software tools.

V.COs Vs POs/PSOs Matrix

Comp.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P1O	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	M	-	S	-	-	-	L	-	M	-
CO2	S	M	L	S	-	S	-	-	S	-	S	L	-	S	-
CO3	S	M	L	S	-	S	-	-	S	-	S	L	-	S	-
CO4	S	M	L	S	M	S	-	-	S	-	S	L	-	S	-
CO5	M	L	-	-	-	M	-	S	-	-	-	L	-	M	-
CO6	M	L	-	-	-	M	-	-	-	-	-	L	-	M	-

Support provided by COs to POs/PSOs: L = lightly(1); M = Moderately (2); S = Substanially (3)

Explanations:
CO1: Explain the basics of robots and applications of robots in industries and other fields.
This CO contributes to
-(moderately) (PO1): Apply the robotics fundamentals to solve complex industrial and societial problems,
-(lightlly) (PO2):Analyze theusage of robotics fundamentals to solve complex industrial and societial problems,
-(moderately) (PO6):Use the robots to find solutions to societial and health related issues,
-(substanially) (PO8):Adhere to ethical codes of robotics,
-(moderately) (PO11):Able to use robotics fundamentals for doing robot fabrication and material handling systems fabrication projects and
-(lightlly) (PO12):Induce the learner to know more about the advances in robotics and robot's applications by life-long learning.
Also, this CO contributes to (moderately) (PSO2): Apply the concepts of robotics fundamentals in automation, modern manufacturing and industrial engineering.

CO2: Make use of end effectors and actuators of robots.
This CO contributes to
-(substanially) (PO1): Use the end effectors and actuators of robots to solve complex industrial and societial problems,
-(moderately) (PO2):Analyze the usage of end effectors and actuators of robots incomplex industrial and societial problems,

-(lightly) (PO3): Design and development of robots using end effectors and actuators,

-(substanially) (PO4): Examining and evaluating how the end effectors and actuators are applied to find valid solutions
-(substanially) (PO6):Use the end effectors and actuators of robots to find solutions to societial and health related issues,
-(substanially) (PO9):Function effectively as the individual and as a team member in robot fabrication project using sensors and machine vision system,
-(substanially) (PO11):able to use of end effectors and actuators for doing robot fabrication and material handling systems fabrication projects and
-(lightly) (PO12):Induce the learner to know more about the advancement in robot end effectors and actuators by life-long learning.
Also, this CO contributes to (substanially) (PSO2): Apply the concepts of robot end effectors and actuators in automation, modern manufacturing and industrial engineering.

CO3: Experiment with sensors and machine vision system of robots.
This CO contributes to
-(substanially) (PO1): Use the sensors and machine vision system of robotsto solve complex industrial and societial problems,
-(moderately) (PO2):Analyze the usage of sensors and machine vision system of robotsincomplex industrial and societial problems,
-(lightly) (PO3): Design and development of robots using sensors and machine vision system,
-(substanially) (PO4): Examining and evaluating how the sensors and machine vision system of robotsare applied to find valid solutions
-(substanially) (PO6):Use of sensors and machine vision system of robotsto find solutions to societial and health related issues,
-(substanially) (PO9):Function effectively as the individual and as a team member in robot fabrication project using sensors and machine vision system,
-(substanially) (PO11):able to use of sensors and machine vision system of robotsfor doing robot fabrication and material handling systems fabrication projects and
-(lightly) (PO12):Induce the learner to know more about the advancement in sensors and machine vision system of robotsby life-long learning.
Also, this CO contributes to (substanially) (PSO2): Apply the concepts of sensors and machine vision system of robotsin automation, modern manufacturing and industrial engineering.

CO4: Prepare kinematics and programming of robots.
This CO contributes to
-(substanially) (PO1): Use the robots' kinematics and programming to solve complex industrial and societial problems,
-(moderately) (PO2):Analyze the robots' kinematics and programming incomplex industrial and societial problems,
-(lightly) (PO3): Design and development of robots usingthe robots' kinematics and programming,
-(substanially) (PO4): Examining and evaluating how the robots' kinematics and programming are applied to find valid solutions
-(moderately) (PO5): how the robots' kinematics and programming are prepared using advanced computer languages and software packages like Workspace, RobotAnalyzer, RoKiSim,etc,
-(substanially) (PO6):Use the robots' kinematics and programming to find solutions to societial and health related issues,

-(substanially) (PO9):Function effectively as the individual and as a team member in robot fabrication project using the robots' kinematics and programming,

-(substanially) (PO11):able to use the robots' kinematics and programming for doing robot fabrication and material handling systems fabrication projects and
-(lightly) (PO12):Induce the learner to know more about the advancement in the robots' kinematics and programmingby life-long learning.
Also, this CO contributes to (substanially) (PSO2): Apply the concepts of the robots' kinematics and programmingin automation, modern manufacturing and industrial engineering.

CO5: Describe safety aspects, economic analysis and implementation of robot project.
This CO contributes to
-(moderately) (PO1): Apply the safety aspects, economic analysis and implementation of robot project to solve complex industrial and societial problems,
-(lightlly) (PO2):Analyze thesafety aspects, economic analysis and implementation of robot project to solve complex industrial and societial problems,
-(moderately) (PO6):Use the robots to find solutions to societial and health related issues,
-(substanially) (PO8):Adhere to ethical codes of robotics,
-(lightlly) (PO12):Induce the learner to know more about the safety aspects, economic analysis and implementation of robot project by life-long learning.
Also, this CO contributes to (moderately) (PSO2): Apply the concepts of safety aspects, economic analysis and implementation of robot project in automation, modern manufacturing and industrial engineering.

CO6: Explain the AGV and RGV.
This CO contributes to
-(moderately) (PO1): Apply the the AGV and RGV to solve complex industrial and societial problems,
-(lightlly) (PO2):Analyze theusage of the AGV and RGV to solve complex industrial and societial problems,
-(moderately) (PO6):Use the AGV and RGV to find solutions to societial and health related issues,
-(lightlly) (PO12):Induce the learner to know more about the advances in AGV and RGV by life-long learning.
Also, this CO contributes to (moderately) (PSO2): Apply the concepts of the AGV and RGV in automation, modern manufacturing and industrial engineering.

VI. Delivery Technologies:

S. No.	Teaching Aids
i.	Classroom with LCD Projector

VII. Syllabus

ME6010- ROBOTICS – SYLLABUS **L T P C**
3 0 0 3

UNIT I FUNDAMENTALS OF ROBOT **7**

Robot – Definition – Robot anatomy – Co-ordinate systems, work envelope, types and classification – Specifications – Pitch, yaw, roll, joint notations, speed of motion and pay load – Robot parts and their functions – Need for robots – Different applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 10

Pneumatic drives – Hydraulic drives – Mechanical drives – Electrical drives – D.C. servo motors, Stepper motor and A.C. servo motors – Salient features, applications and comparison of all these drives – End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers – Two fingered and three fingered grippers – Internal grippers and external grippers – Selection and design considerations.

UNIT III SENSORS AND MACHINE VISION 10

Requirements of a sensor, principles and applications of the following types of sensors – Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors) – Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters) – Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors) – Touch sensors (Binary sensors, Analog sensors) – Wrist Sensors – Compliance Sensors – Slip Sensors.

Camera, frame grabber, sensing and digitizing image data – Signal conversion – Image Storage – Lighting techniques – Image processing and analysis – Data reduction – Segmentation – Feature extraction – Object recognition – Other algorithms – Applications – Inspection, identification, visual serving and navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 10

Forward kinematics – Inverse kinematics – Differences: Forward kinematics and Reverse kinematics of manipulators with two and three degrees of freedom (In 2 dimensional), four degrees of freedom (In 3 dimensional) – Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator,

Manipulator Mechanism Design-Derivations and problems – Teach pendant programming – Lead through programming – Robot programming languages – VAL programming – Motion commands – Sensor commands – End effecter commands – Simple programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 8

RGV – AGV – Implementation of robots in industries – Various steps: Safety considerations for robot operations – Economic analysis of robots – Pay back method, EUAC method and Rate of return method.

TOTAL: 45 Periods

Text / Reference Books

Sl. No.	Title of the Book	Author(s)	Publisher
TEXT BOOKS			
T1	Industrial Robotics – Technology, Programming and Applications	Groover, M.P.	McGraw- Hill, 2001.
T2	Robotic Engineering - An Integrated Approach	Klafter R.D., Chmielewski T.A and Negin M.	Prentice Hall, 2003.
REFERENCES			
R1	Robotics Control, Sensing, Vision and Intelligence	Fu, K.S., Gonzalz, R.C. and Lee C.S.G.	McGraw-Hill Book Co., 1987.

R2	Robotics for Engineers	Yoram Koren	McGraw-Hill Book Co., 1992.
R3	Robotics and Image Processing	Janakiraman, P.A.,	Tata McGraw-Hill, 1995.
R4	Robotics	G. Kalivaradhan, C. Aravind	Anuradha Publications, Chennai, 2009.

REFERENCE WEBSITES	
1	http://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/lecture-notes/
2	http://www.academicearth.org/courses/introduction-to-robotics
3	http://robotics.cucei.udg.mx/Index_files/page0004.html
4	http://www.learnerstv.com/Free-Engineering-Video-lectures-ltv071-Page1.htm
5	http://www.used-robots.com/robot-education.php?page=robots+in+medicine
6	http://www.informationweek.com/news/galleries/healthcare/patient/229100383
7	http://rapidlibrary.com/files/wearable-robots-biomechatronic-exoskeletons-pdf_35446369.html
8	http://www.wtec.org/robotics/report/03-Space.pdf
9	http://uni-obuda.hu/conferences/SAMI2004/smrcek.pdf

VIII. Detailed Course Plan

S.No.	Topic(s)	Hours	Teaching Method
Unit – IFUNDAMENTALS OF ROBOT			
CO1 - Explain the basics of robots and applications of robots in industries and other fields.			
1.	Robot – Definition – Robot anatomy – Co-ordinate systems, work envelope -basic definitions, notations and scheme of representations of robots.	1	Lecture with discussion
2.	Robot parts and their functions	1	
3.	Specifications – Pitch, yaw, roll, joint notations, speed of motion and pay load	2	
4.	Need for robots, Industrial applications of robots	2	
5.	Recent trends and development in the field of robotics (Evolutionary robots, swarm robots, nano robots, micro robots, medical robots, space robots, wearable robots, intelligent robots, autonomous robots, etc.) Applications of robots in other fields like medical robots, space robots, wearable robots, etc.	2	Lecture with discussion
Total Number of hours for Unit I:		**8(LH-08, TH-0, PH-0)**	

Unit II ROBOT DRIVE SYSTEMS AND END EFFECTORS			
CO2 – Make use of end effectors and actuators of robots.			
6.	Pneumatic drives – Hydraulic drives – Mechanical drives	2	Lecture with discussion, Mini project
7.	Electrical drives – D.C. servo motors, Stepper motor and A.C. servo motors	2	
8.	Salient features, applications and comparison of all these drives	1	

9.	End effectors	1	
10.	Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, etc.	2	
11.	Two fingered and three fingered gripper, Internal grippers and external grippers.	1	
12.	Selection and design considerations of grippers.	2	
Total No. of hours for Unit II :		**11(LH-11, TH-0, PH-0)**	

Unit III SENSORS AND MACHINE VISION			
CO3 - Experiment with sensors and machine vision system of robots			
13.	Requirements of a sensor	1	Lecture with discussion, Mini project
14.	Construction, working principle and applications of various position sensors namely Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors.	1	
15.	Construction, working principle and applications of various Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters).	1	
16.	Construction, working principle and applications of various Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors).	2	Lecture with discussion, Mini project
17.	Construction, working principle and applications of various Touch sensors (Binary sensors, Analog sensors).	1	
18.	Construction, working principle and applications of Wrist Sensors, Compliance Sensors and Slip Sensors.	1	
19.	Camera, frame grabber, sensing and digitizing image data – Signal conversion – Image Storage – Lighting techniques – Image processing and analysis – Data reduction – Segmentation – Feature extraction – Object recognition – Other algorithms – Applications – Inspection, identification, visual serving and navigation.	3	
20.	Correlate all sensors used for robots	1	
21.	Selection of suitable sensor for design of a robot	1	
Total No. of hours for Unit III:		**12(LH-12, TH-0, PH-0)**	

Unit IV ROBOT KINEMATICS AND ROBOT PROGRAMMING			
CO4- Prepare kinematics and programming of robots			
22.	Forward kinematics – Inverse kinematics – Differences: Forward kinematics and Reverse kinematics of manipulators with two and three degrees of freedom (In 2 dimensional), four degrees of freedom (In 3 dimensional)	3	Lecture with discussion, Mini project
23.	Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator	1	

24.	Manipulator Mechanism Design	1	
25.	Teach pendant programming – Lead through programming – Robot programming languages – VAL programming – Motion commands – Sensor commands – End effecter commands	2	
26.	Simple robot programs preparation	5	
Total No. of hours for Unit IV: 12(LH-12, TH-0, PH-0)			
Unit V IMPLEMENTATION AND ROBOT ECONOMICS			
CO5- Describe safety aspects, economic analysis and implementation of robot project.			
27.	Safety considerations for robot operations	1	Lecture with discussion
28.	Economic analysis of robots – Pay back method, EUAC method and Rate of return method	3	
29.	Implementation of robots in industries – Various steps	1	
CO6- Explain the AGV and RGV.			
30.	Construction, working principle, types, merits, demerits and applications of AGV	2	Lecture with discussion
31.	Construction, working principle, types, merits, demerits and applications of RGV	2	
	Total No. of hours for Unit V : 9 (LH-09, TH-0, PH-0)		
	Total No of hours	**54**	

IX. Test Items for Competencies/Course Outcomes

	Competencies	**Cognitive Levels**
CO1	**Explain the basics of robots and applications of robots in industries and other fields.**	**Understand**
TI1	Explainabout need and applications of robot.	Understand
TI2	Briefly explain the need for robots in industries. Justify the use of robots in Indian industries.	Understand
TI3	Describe the specifications of an industrial robot and explain each of them briefly.	Understand
TI4	Describe various parts of robots with sketches	Understand
TI5	With neat sketches explain the classification of robot based on (i) configurations (ii) Degrees of freedom (iii) Work volume (iv) Controls	Understand
CO2	**Make use of end effectors and actuators of robots.**	**Apply**
TI1	Use a suitable actuator and end effector for fabrication of a robot for a home application.	Apply
TI2	Use a suitable actuator and end effector for fabrication of a pick and place robot.	Apply
TI3	Use a suitable actuator and end effector for fabrication of a fire fighting robot.	Apply
TI4	Use a suitable actuator and end effector for fabrication of a dancing robot.	Apply

	Competencies	Cognitive Levels
TI5	Use a suitable actuator and end effector for fabrication of an agriculture robot.	Apply
CO3	**Experiment with sensors and machine vision system of robots**	**Apply**
TI1	Use suitable sensors for fabrication of an agriculture robot.	Apply
TI2	Use suitable sensors for fabrication of a dancing robot.	Apply
TI3	Use suitable sensors for fabrication of a fire fighting robot.	Apply
TI4	Use suitable sensors for fabrication of a pick and place robot.	Apply
TI5	Use suitable sensors for fabrication of a mining robot.	Apply
CO4	**Prepare kinematics and programming of robots**	**Apply**
TI1	Use suitable kinematics equations and programming for fabrication of an agriculture robot.	Apply
TI2	Use suitable kinematics equations and programming for fabrication of a dancing robot.	Apply
TI3	Use suitable kinematics equations and programming for fabrication of a fire fighting robot.	Apply
TI4	Use suitable kinematics equations and programming for fabrication of a pick and place robot.	Apply
TI5	Use suitable kinematics equations and programming for fabrication of a mining robot.	Apply
CO5	**Describe safety aspects, economic analysis and implementation of robot project.**	**Understand**
TI1	Explain the features of safety sensors and safety monitoring of robots.	Understand
TI2	Explain in detail the implementation of robots in assembly.	Understand
TI3	Explain briefly different methods of economic analysis.	Understand
TI4	List and explain direct and indirect costs and savings in a robot application project.	Understand
CO6	**Explain the AGV and RGV.**	**Understand**
TI1	Explain about automated guided vehicle in detail.	Understand
TI2	Explain about rail guided vehicle in detail.	Understand

X. a)Course Outcomes – Evaluation Strategy

Comp.	Internal Tests	Assignment	Mini Project
CO1	100%		
CO2	75%		25%
CO3	75%		25%
CO4	75%		25%
CO5	100%		
CO6	25%	75%	

XII. GAP ANALYSIS:

1. To satisfy the Course Outcome number (CO6) (After completion of this course, students can able to **Explain the AGV and RGV.)**, an assignment will be submitted by the students.

2. To satisfy Course outcomes CO2-CO4, Mini project will be done by the students.
   Mini Project title: Make a mini robot for a particular application. Students can select any application. Maximum 4 students can be in a group.

Course Co-ordinator **HoD**

The following chart can be used for new curriculum development.

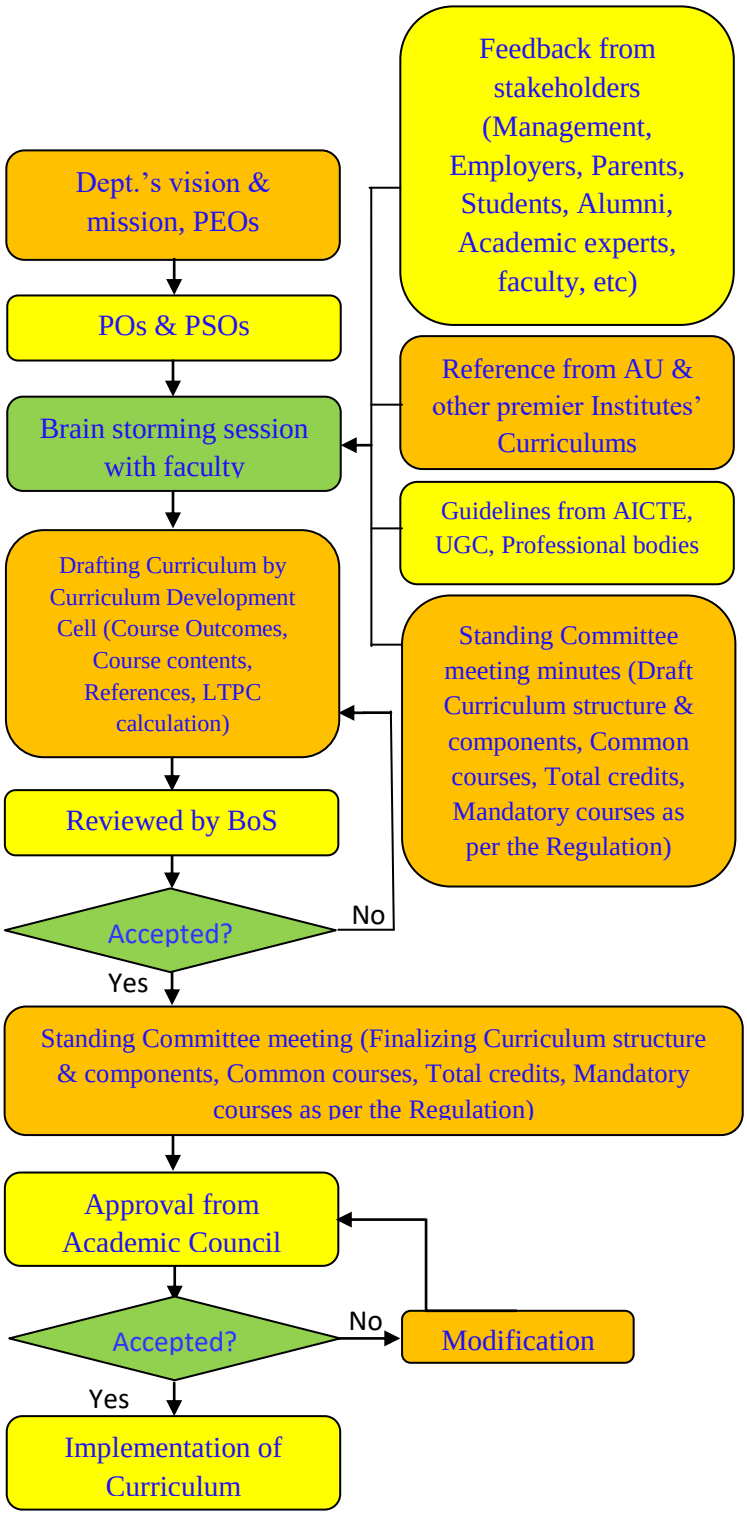


Figure 10. Programme Curriculum design process

The following chart can be used for identification of curricular gaps.

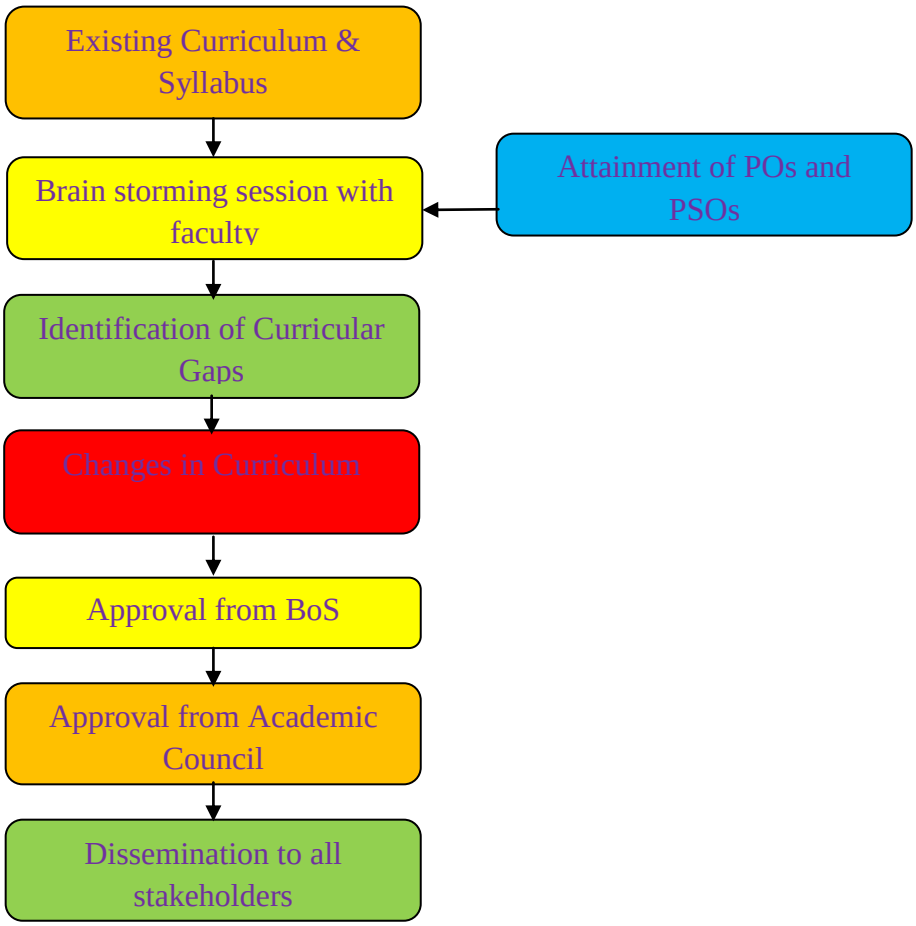


Figure 11. Identification of Curricular Gaps