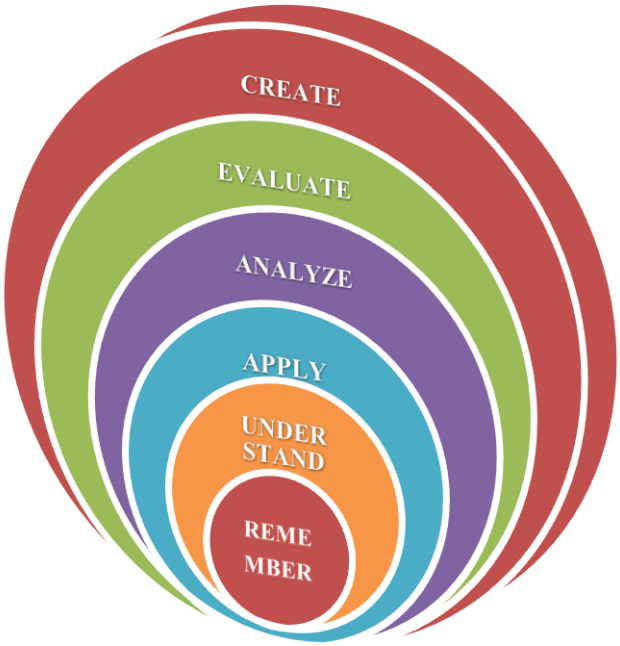
OUTCOME BASED EDUCATION BOOKLET

CIVIL ENGINEERING

B.Tech

For the Batch of Students admitted during Academic Year 2016-17 & 2017-18



.....Moving Towards Perfection in Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Approved by AICTE: Affiliated to JNTUH and Accredited by NAAC with 'A' Grade
Dundigal, Hyderabad - 500 043

VISION

The Vision of Civil Engineering Department is to produce eminent, competitive and dedicated Civil Engineers by imparting latest technical skills and ethical values to empower the students to play a key role in the planning and execution of infrastructural & developmental activities of the nation.

MISSION

To provide State-of-the-Art facilities for conducting experiments in the field of Civil Engineering as well as providing high quality research with latest technological knowledge so that the graduates present themselves as efficient and potential candidates for government and private sector organizations within and outside the country.

Contents

S. No.	*Program Educational Objectives and Outcomes*	*Page No.*
PART – I-A (As Per NBA Norms post June, 2015)		
1.	Program Educational Objectives, Outcomes and Assessment Criteria	
2.	B. Tech - Civil Engineering Program Educational Objectives	
3.	B. Tech – Civil Engineering Program Outcomes and Program Specific Outcomes	
4.	Mapping of Program Educational Objectives to Program Outcomes and Program Specific Outcomes	
5.	Relation between the Program Outcomes and Program Specific Outcomes and the Program Educational Objectives	
6.	Program Outcomes and Program Specific Outcomes of (B.Tech) Civil Engineering Graduates	
7.	Procedures for Outcome Delivery and Assessment with Respect to Program Outcomes and Program Specific Outcomes	
8.	Methods of Measuring Learning Outcomes and Value Addition	
PART – I-B (As Per NBA Norms pre June, 2015)		
1.	Program Educational Objectives, Outcomes and Assessment Criteria	
2.	B. Tech - Civil Engineering Program Educational Objectives	
3.	B. Tech - Civil Engineering Program Outcomes	
4.	Mapping of Program Educational Objectives to Program Outcomes	
5.	Relation between the Program Outcomes and the Program Educational Objectives	
6.	Program Outcomes of (B.Tech) CIVIL Graduates	
7.	Procedure for Outcome Delivery and Assessment with Respect to Program Outcomes	
8.	Methods of Measuring Learning Outcomes and Value Addition	
PART – II ASSESSMENT OF COURSE LEVEL STUDENT LEARNING OUTCOMES		
1.	Course Purpose	
2.	Expected Learning Outcomes	
3.	To Define Effective Learning Outcome Statements	
4.	Tips for Developing Course Level Expected Learning Outcomes Statements	
5.	Sample Expected Learning Outcomes Statements	
6.	An Overview of Assessment	
7.	Description of a Course Purpose	
8.	Procedure for Development of Expected Learning Outcomes for a Course	
9.	References	
ANNEXURE		
A.	Sample Course Description (As Per NBA Norms post June, 2015)	
B.	Sample Course Description (As Per NBA Norms pre June, 2015)	

As Per NBA Norms Post Sep, 2016
Semester: I, II, III, IV, V, VI, VII, VIII

Part - I A

PROGRAM EDUCATIONAL OBJECTIVES AND OUTCOMES

Civil Engineering Department Advisory Council:
The Civil Engineering Department Advisory Council (CEDAC) includes a diverse group of experts from academy and industry, as well as alumni representation. The Advisory council meets annually, or as needed, for a comprehensive review of the Civil Engineering Department strategic planning and programs. The Advisory Council meets with the administration, faculty and students and prepares a report, which is presented to the Principal. In each visit, the Department of Civil Engineering responds to the DAC report indicating improvements and amendments to the program.

Program Educational Objectives, Outcomes and Assessment Criteria: The "Program Educational Objectives" were initially drafted by a committee of CIVIL Engineering faculty and were vetted and approved by a group of faculty from peer department, Information Technology and the CIVIL Engineering Department Advisory Council.

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes and Assessment Criteria

The educational objectives of a module are statements of the broad intentions of the teaching team. They indicate what it is the teaching team intends to cover and the learning opportunities they intend to make available to the student. A learning outcome is a statement of what a learner (student) is expected to know, understand and/or be able to do at the end of a period of learning. It is advisable to express learning outcomes with the common prefix:

'On completion of (the period of learning e.g. module), the student **is expected to** be able to…'

Generally, learning outcomes do not specify curriculum, but more general areas of learning. It is not possible to prescribe precisely how specific a learning outcome statement should be. There is a balance to be struck between the degree of specificity in a learning outcome statement and that achieved by the assessment criteria.

If there are too many learning outcomes for a module, then either they are becoming assessment criteria or they are specifying too much curricular detail. The curriculum should be described in the range statement. Too few learning outcomes are unlikely to provide sufficient information on the course. As a guide, there should be between 3 and 4 learning outcomes for a course.

2. B. TECH - CIVIL ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES

The current set of Program Educational Objectives (PEO's) for the Civil Engineering Program at IARE was developed by integrating the ideas of the Civil Engineering Faculty, students, and the Departmental Advisory Council. The Advisory Council provides representation from alumni, local employers and the professional civil engineering community.

The Program Educational Objectives so developed reflect the professional needs of Civil Engineering Program graduate.

The PEO's developed for its undergraduate program reflect commitment of the department to providing a program that produces graduates who, within four years of graduation, will:

Program Educational Objective -1: *Professional Excellence*

- To impart proficiency in engineering knowledge and skills to analyze, design, build, maintain, or improve civil engineering based systems.

Program Educational Objective -2: *Understanding Socio-Economic Aspects*

- To offer broad education and practical skills so that the students can carry out technical investigations within realistic constraints such as economic, environmental, societal, safety and sustainability.

Program Educational Objective -3: *Technical collaboration*

- To impart ability to collaborate with and function on multidisciplinary teams to offer engineering solutions to the society

Program Educational Objective -4: *Continued Self-Learning*

- To create interest in the students to engage in life-long learning in advanced areas of civil engineering and related fields.

Program Educational Objective -5: *Effective Contribution to Society*

- To educate the students in ethical values and social responsibility to use engineering techniques and modern tools necessary for civil engineering practice to serve the society effectively.

These objectives are quite broad by intention, as Civil Engineering graduates may seek further education or work in diverse areas. To make these objectives meaningful, they may be demonstrated by performance, actions, or achievements.

1. **Students will establish themselves as effective professionals by solving real problems through the use of civil engineering knowledge and with attention to team work, effective communication, critical thinking and problem solving skills. These may be demonstrated by any of the following:**

    - Acceptance by and satisfactory progress in a graduate degree program;
    - Significantly contributing to delivery of desired component, product, or process;
    - Formulating and solving moderately complex engineering problems;
    - Skillfully using state-of-the-art tools for structural engineering processes;
    - Making practical recommendations that address engineering product and system level issues;
    - Producing clear written civil engineering documentation (papers, reports, and significant parts of proposals);
    - Communicating effectively in a group environment;
    - Being asked to make presentations or reports for internal colleagues or clients;
    - Publishing refereed paper in conference or journal, or producing an internally reviewed publication;
    - Making a significant contribution to a proposal;
    - Applying for a patent or making a useful invention;
    - Participating in the field through public speaking, activity in professional societies, technical associations, standards boards, etc.

2. **Students will develop skills that prepare them for immediate employment and for life-long learning in advanced areas of Civil Engineering and related fields may be demonstrated by any of the following:**

- Successfully completing a course for B. Tech;
- Successfully completing a tutorial at a conference;
- Learning a new skill, civil engineering application software's;
- Reading technical books, journals, conference papers, technical reports, or standards;
- Attending a technical conference, symposium, or workshop;
- Belonging to a professional society;

3. **Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies may be demonstrated by any of the following:**

    - Appropriately using tools for collaborating with Design and construction consultancy companies;
    - Skillfully using tools for project and configuration management, e.g., resource planning systems, software source control systems, etc;
    - Making appropriate decisions on when to outsource, when to use off-the-shelf components, and when to develop components in-house;
    - Seeking assistance or elevating problems when necessary;
    - Properly handling a situation involving intellectual property rights;

4. **Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career by the following any one:**

    - Leading a project or design team;
    - Working successfully on ethnically, technically, or gender diverse teams;
    - Effectively resolving problems encountered in team work;
    - Estimating correctly the required resources (time, team, equipment, etc.) for civil engineering projects;
    - Promotion to managerial position;
    - Election or appointment to leadership position in a professional society;
    - Delegating effectively;
    - Participating in one of your organization's NSS programs;
    - Volunteering in a college, civic, or other charitable organization;
    - Participating in team sports or coaching;
    - Accounting for larger societal, legal, business, and technical context while making decisions on a project;
    - Properly handling a situation involving ethics;

3. B. Tech – CIVIL ENGINEERING PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOME

A graduate of the Civil Engineering Program will demonstrate:

PROGRAM OUTCOMES:

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

PO2 **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first

principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **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.

PO5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

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

PO10 **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **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.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

B.TECH PROGRAM SPECIFIC OUTCOMES (PSO's)

The Program Specific outcomes (PSO's) listed below were developed specifically to help the aforementioned Program Educational Objectives (PEO's) are met. The focus of these PSO's is consistent with the set of required PO's identified in the NBA accreditation guidelines. Minimum NBA requirements have been supplemented with Program Specific Outcomes that address the uniqueness of a IARE civil engineering education.

The Civil Engineering PSO's require that graduates receiving a Bachelor of Technology in Civil Engineering degree from IARE demonstrate the following.

PSO1. ENGINEERING KNOWLEDGE: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.

PSO2. BROADNESS AND DIVERSITY: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.

PSO3. SELF-LEARNING AND SERVICE: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.

These **PEO's** and **PSO's** represent a formal manifestation of an educational philosophy and spirit that the Civil Engineering Department has operated under for many years.

4. MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The following Figure 1 shows the correlation between the PEOs and the POs and PSOs

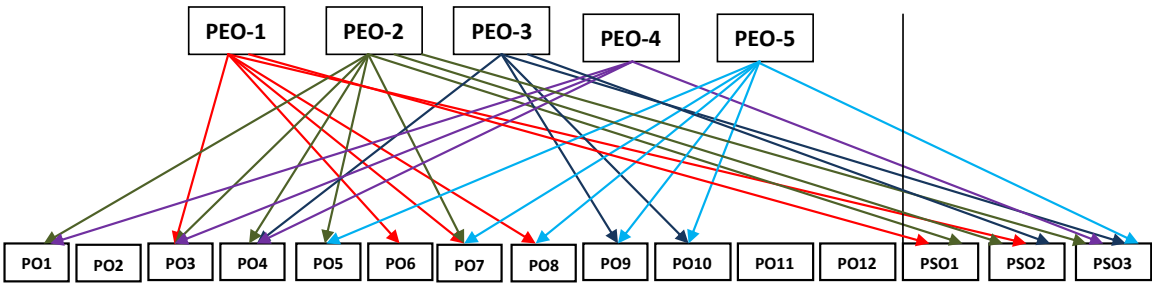


Figure 1: Correlation between the PEOs and the POs and PSOs

The following Table shows the correlation between the Program Educational Objectives and the Program Outcomes & Program Specific Outcomes

Table 1: Correlation between the Program Educational Objectives and the Program Outcomes & Program Specific Outcomes

Program Educational Objectives	Program Outcomes
Program Educational Objective -1 *To impart proficiency in engineering knowledge and skills to analyze, design, build, maintain, or improve civil engineering based systems*	**PO3: Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. **PO6: The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. **PO7: Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable

development.

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

PSO1. Engineering Knowledge: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.

PSO2. Broadness and Diversity: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage

Program Educational Objective -2

To offer broad education and practical skills so that the students can carry out technical investigations within realistic constraints such as economic, environmental, societal, safety and sustainability.

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

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: 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.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

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

PSO1. Engineering Knowledge: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.

PSO2. Broadness and Diversity: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with

	competence in modern tool usage **PSO3. Self-Learning and Service**: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.
Program Educational Objective -3 *To impart ability to collaborate with and function on multidisciplinary teams to offer engineering solutions to the society*	**PO4: 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. **PO9: Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **PO10: Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. **PO11: 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. **PSO2. Broadness and Diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage **PSO3. Self-Learning and Service**: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.
Program Educational Objective -4 *To create interest in the students to engage in life-long learning in advanced areas of civil engineering and related fields.*	**PO1: Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. **PO2: Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **PO3: Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. **PO4: 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.

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

PSO3. Self-Learning and Service: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.

Program Educational Objective -5

To educate the students in ethical values and social responsibility to use engineering techniques and modern tools necessary for civil engineering practice to serve the society effectively.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

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

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

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: 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.

PSO3. Self-Learning and Service: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly..

5. RELATION BETWEEN THE PROGRAM OUTCOMES AND PROGRAM EDUCATIONAL OBJECTIVES.

The following Table 2 shows the correlation between the PEOs and the Program Outcomes

Table 2: Relationships between Program Educational Objectives and Program Outcomes

Program Outcomes	PEO 1	PEO 2	PEO3	PEO4	PEO5
PO1: Engineering knowledge	--	2:Medium	--	2:Medium	--
PO2: Problem analysis	--	--	--	3:High	--
PO3: Design/development of solutions	3.High	2:Medium	--	2:Medium	--
PO4: Conduct investigations of complex problems	--	2:Medium	2:Medium	2:Medium	--
PO5: Modern tool usage	--	2:Medium	--	--	2:Medium
PO6: The engineer and society	2:Medium	--	--	--	--
PO7: Environment and sustainability	3:High	1:Low	--	--	2:Medium
PO8: Ethics	1:Low	--	--	--	2:Medium
PO9: Individual and team work	--	3:High	3:High	--	2:Medium
PO10: Communication	--	--	1:Low	--	1:Low
PO11: Project management and finance	--	--	2:Medium	--	1:Low
PO12: Life-long learning	--	--	--	1:Low	--

Note: PEO_1, PEO_2, PEO_n are distinct elements. Enter correlation levels 1,2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

RELATION BETWEEN THE PROGRAM SPECIFIC OUTCOMES AND THE PROGRAM EDUCATIONAL OBJECTIVES

The following Table shows the correlation between the PEO's and the PSO's

Table 4: Relationships between program Educational Objectives and program Specific Outcomes

	PEO1:	PEO2:	PEO3:	PEO4:	PEO5:
PSO1:	3: High	2: Medium			
PSO2:	2: Medium	3: High	1: Low		
PSO3:			3: High	2: Medium	1: Low

Note: PEO_1, PEO_2 PEO_n are distinct elements. Enter correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Note:

- The assessment process can be direct or indirect.
- The direct assessment will be through interim assessment by the faculty or by industry / technology experts.

- The indirect assessment on the other hand could be by students through course outcomes, lab evaluation, department associations, exit interviews, engineering services, GATE etc.
- Frequency of assessment can be once in a semester and justified by the programme coordinator.

6. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES OF (B.TECH) CIVIL GRADUATES

Graduates from accredited programmes must achieve the following learning outcomes, defined by the broad areas of learning.

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

- Knowledge and understanding of scientific principles and methodology necessary to strengthen their education in their engineering discipline, to enable appreciation of its scientific and engineering context, and to support their understanding of historical, current, and future developments and technologies;
- Knowledge and understanding of mathematical principles necessary to underpin their education in their engineering discipline and to enable them to apply mathematical problems;
- Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.

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

- Is based on the problem solving process that has been well documented in engineering texts. The elements of the process include:
    - Problem or opportunity identification
    - Problem statement and system definition
    - Problem formulation and abstraction
    - Information and data collection
    - Model translation
    - Validation
    - Experimental design
    - Solution development or experimentation
    - Interpretation of results
    - Implementation and documentation

As most engineers eventually learn, the problem solving process is never complete. Therefore, a final element here is feedback and improvement.

PO3: Design/development of solutions - Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Design is the creation and development of an economically viable product, process or system to meet a defined need. It involves significant technical and intellectual challenges and can be used to integrate all engineering understanding, knowledge and skills to the solution of real problems. Graduates will therefore need the knowledge, understanding and skills to:

- Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;

- Understand customer and user needs and the importance of considerations such as aesthetics;
- Identify and manage cost drivers;
- Use creativity to establish innovative solutions;
- Ensure fitness for purpose of all the aspects of the problem including production, operation, maintenance and disposal of the product;
- Manage the design process and evaluate the outcomes;

PO4: 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.

Practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills. This can include:

- Knowledge of characteristics of particular materials, equipment, processes, or products;
- Workshop and laboratory skills;
- Understanding of contexts in which engineering knowledge can be applied (for example, operations and management, technology development, etc.);
- Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues;
- Understanding of appropriate codes of practice and industry standards;
- Awareness of quality issues;
- Ability to work with technical uncertainty;
- Understanding of engineering principles and the ability to apply them to analyses key engineering processes;
- Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques;
- Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems;
- Understanding of and ability to apply a systems approach to engineering problems;

PO5: Modern tool usage - Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- Encompasses a wide range of tools and skills needed by engineering graduates including computer software, simulation packages, diagnostic equipment and use of technical library resources and literature search tools.

PO6: The engineer and society - Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

- Here the focus is on “knowledge” and is interpreted to mean the student’s obtaining in-depth knowledge of on contemporary issues. Three types of examples are given – socio economic, political and environmental excluding contemporary, technical engineering issues.

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

- Understanding of the requirement for engineering activities to promote sustainable development;
- Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues;

- Assess the effects of the engineering products or solutions provided to solve real-world problems within the context of applicable environment;

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

- Understanding the need for a high level of professional and ethical conduct in engineering.
- Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior;
- Stood up for what he/she believed in;
- High degree of trust and integrity;

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

- Independence;
- Maturity – requiring only the achievement of goals to drive their performance;
- Self-direction (take a vaguely defined problem and systematically work to resolution);
- Teams are used during the classroom periods, in the hands-on labs, and in the design projects;
- Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference;
- Teamwork is important not only for helping the students know their peers but also in completing assignments;
- Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continues into the workplace after graduation;
- Ability to work with all levels of people in an organization;
- Ability to get along with others;
- Demonstrated ability to work well with a team;

PO10: Communication - Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

"Students should demonstrate the ability to communicate effectively in writing."

a. Clarity
b. Grammar/Punctuation
c. References

Verbal Communication: "Students should demonstrate the ability to communicate effectively orally."

a. Speaking Style
b. Subject Matter

PO11: 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 as a leader in a team, to manage projects and in multidisciplinary environments.

- Knowledge of management techniques which may be used to achieve engineering objectives within that context;
- Knowledge and understanding of commercial and economic context of engineering processes;

- Understand the criteria in context of the product, application and users to deliver an effaceable project management process;
- Identify suitable management strategies and apply standard processes and procedures to achieve productive and conclusive effort;

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

- Inspire the students to further explore in his/her program to recognize the need for life-long learning. Some aspects of life-long learning:
    - Project management professional certification
    - MBA
    - Begin work on advanced degree
    - Keeping current in CSE and advanced engineering concepts
    - Personal continuing education efforts
    - Ongoing learning – stays up with industry trends/ new technology
    - Continued personal development
    - Have learned at least 2-3 new significant skills
    - Have taken up to 80 hours (2 wks) training per year

PROGRAM SPECIFIC OUTCOMES OF (B.Tech) CIVIL GRADUATES

PSO1. ENGINEERING KNOWLEDGE

Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.

Performance Criteria Definitions

- Problem or opportunity identification
- Problem formulation and abstraction
- Information and data collection.
- Model translation
- Experimental design and solution development.
- Implementation and documentation.

PSO2. BROADNESS AND DIVERSITY

Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.

Performance Criteria Definitions

- Problem or opportunity identification
- Problem formulation and abstraction
- Information and data collection.
- Model translation
- Experimental design and solution development.
- Implementation and documentation.

PSO3. SELF-LEARNING AND SERVICE

Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.

Performance Criteria Definitions

- Investigate and define a problem and identify constraints relating to health, safety,

environmental and sustainability and assessment of risks based on these constraints.

- Understand customer and user needs and the importance of considerations such as aesthetics Identify and manage costs and drivers thereof.
- Use creativity to establish innovative solution Ensure fitness of purpose, for all aspects of the problem including production, operation, maintenance and disposal.
- Manage the design process and evaluate outcomes.

Courses offered in Civil Engineering Curriculum (IARE-R16) –Vs- Program Outcomes and Program Specific Outcomes Attained through course modules for I, II, III, IV, V, VI, VII, VIII Semesters

Code	Subject	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03
I Semester																
AHS001	English for Communication									√	√					√
AHS002	Linear Algebra and Ordinary Differential Equations	√	√		√									√		
AHS005	Engineering Chemistry	√	√					√								
AHS007	Applied Physics	√	√		√											
AME001	Engineering Drawing	√							√					√		
AHS101	Communication Skills Laboratory									√	√		√			
AHS103	Engineering Chemistry Laboratory	√	√													
ACS113	IT Workshop		√			√			√							√
AME101	Basic Workshop	√		√										√	√	
II Semester																
AME002	Engineering Mechanics	√	√		√									√		
AHS003	Computational Mathematics and Integral Calculus	√	√		√									√		
AHS008	Modern Physics	√			√	√							√	√		√
AHS009	Environmental Studies	√		√		√		√						√		
ACS001	Computer Programming	√	√	√	√	√							√	√	√	√
AHS102	Computational Mathematics Laboratory	√	√	√	√	√							√	√	√	√
AHS105	Engineering Physics Laboratory	√			√	√							√	√		√
ACS101	Computer Programming Laboratory	√	√	√	√	√							√	√	√	√
AME102	Computer Aided Engineering Drawing Practice	√	√	√		√								√		
III Semester																
AHS010	Probability and Statistics	√	√		√									√		
ACE001	Strength of Materials - I	√	√	√	√			√						√	√	√
ACE002	Surveying	√	√			√								√	√	
ACE003	Engineering Geology	√		√			√	√						√	√	
AEE018	Basic Electrical and Electronics Engineering	√	√		√									√		
AHS017	Gender Sensitivity								√	√	√		√			√

Code	Subject	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03
ACE101	Surveying Laboratory	√					√			√				√	√	√
ACE102	Computer Aided Drafting of Buildings	√		√		√	√			√	√			√	√	
ACE103	Engineering Geology Laboratory	√		√				√					√	√	√	√
IV Semester																
AHS011	Mathematical Transforms Techniques	√	√		√									√		
ACE004	Strength of Materials - II	√	√	√	√									√		
ACE005	Fluid Mechanics	√	√	√	√						√		√	√		√
ACE006	Geotechnical Engineering	√	√	√	√		√			√			√	√		√
ACE007	Building Materials Construction and Planning	√		√	√									√	√	
ACE104	Strength of Materials Laboratory	√	√	√									√	√	√	√
ACE105	Geotechnical Engineering Laboratory	√		√	√		√					√	√	√	√	
ACE106	Advanced Surveying Laboratory	√	√		√	√	√			√		√	√	√	√	√
V Semester																
ACE008	Structural Analysis	√	√	√										√		
ACE009	Reinforced Concrete Structures Design and Drawing	√	√	√							√	√		√	√	√
ACE010	Concrete Technology	√	√	√	√	√								√	√	√
ACE011	Hydraulics and Hydraulic Machinery	√	√		√									√	√	
AHS015	Business Economics and Financial Management	√	√	√						√		√				√
ACE107	Fluid Mechanics and Hydraulic Machinery Laboratory	√		√				√						√	√	
ACE108	Concrete Technology Laboratory	√		√	√	√	√	√		√		√	√	√	√	√
ACE111	Building Information Modeling Laboratory	√		√		√				√		√	√	√	√	√
VI Semester																
ACE012	Design of Steel Structures and Drawing	√	√	√	√									√	√	√
ACE013	Transportation Engineering	√	√	√	√									√		
ACE014	Water Resources Engineering	√	√	√	√			√		√				√		√
ACE109	Advanced Material Testing Laboratory				√	√	√					√	√		√	
ACE110	Transportation Materials Laboratory				√	√	√					√	√		√	
AHS106	Technical Writing and Content Development Laboratory		√		√				√		√					
ACE201	Mini Project	√	√	√		√				√	√			√		
VII Semester																
ACE015	Environmental Engineering	√	√	√			√	√						√		
ACE016	Advanced Structural Analysis	√	√	√	√					√		√		√	√	
ACE017	Estimation and Costing	√					√		√		√			√	√	
ACE112	Environmental Engineering Laboratory	√						√						√		
ACE113	Advanced Analysis and Design Laboratory	√	√	√	√	√							√	√		√
ACE114	Project Planning and Development	√	√	√	√	√	√			√	√	√	√	√	√	√

Code	Subject	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03
	Laboratory															
ACE301	Project Work (Phase - I)	√	√	√		√		√		√	√			√	√	
VII Semester																
ACE018	Foundation Engineering	√	√	√	√		√							√	√	
AHS016	Industrial Management and Psychology								√	√	√	√			√	
ACE401	Comprehensive Examination	√									√			√		
ACE302	Project Work (Phase - II)	√	√	√		√		√		√	√			√	√	
Professional Electives																
ACE505	Rehabilitation & Retrofitting of Structures	√	√		√			√			√	√		√	√	√
ACE509	Ground Improvement Techniques	√	√	√			√							√		√
ACE515	Water Resources Planning and Management	√	√	√		√		√			√	√		√	√	
ACE520	Pavement Design	√	√	√			√	√				√		√	√	
ACE526	Industrial Waste Water Treatment	√		√			√	√						√		
ACE533	Disaster Management and Mitigation	√			√			√		√	√			√	√	

7. PROCEDURES FOR OUTCOME DELIVERY AND ASSESSMENT WITH RESPECT TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The categorization of the Program Outcomes and Program Specific Outcomes of the above Civil Engineering courses is grouped as follows:

Code	Subject	Code	Subject
PO1: Engineering knowledge - Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.			
AHS002	Linear Algebra and Ordinary Differential Equations	ACE103	Engineering Geology Laboratory
AHS005	Engineering Chemistry	AHS011	Mathematical Transforms Techniques
AHS007	Applied Physics	ACE004	Strength of Materials - II
AME001	Engineering Drawing	ACE005	Fluid Mechanics
AHS103	Engineering Chemistry Laboratory	ACE006	Geotechnical Engineering
ACS113	IT Workshop	ACE007	Building Materials Construction and Planning
AME101	Basic Workshop	ACE104	Strength of Materials Laboratory
AME002	Engineering Mechanics	ACE105	Geotechnical Engineering Laboratory
AHS003	Computational Mathematics and Integral Calculus	ACE106	Advanced Surveying Laboratory
AHS102	Computational Mathematics Laboratory	ACE008	Structural Analysis
AHS008	Modern Physics	AHS009	Environmental Studies
AME102	Computer Aided Engineering Drawing Practice	ACE009	Reinforced Concrete Structures Design and Drawing
AHS105	Engineering Physics Laboratory	ACE010	Concrete Technology
ACS101	Computer Programming Laboratory	ACE011	Hydraulics and Hydraulic Machinery
AHS010	Probability and Statistics	AHS015	Business Economics and Financial Management
ACE001	Strength of Materials – I	ACE107	Fluid Mechanics and Hydraulic Machinery Laboratory

Code	Subject	Code	Subject
ACE002	Surveying	ACE108	Concrete Technology Laboratory
ACE003	Engineering Geology	ACE111	Building Information Modeling Laboratory
AEE018	Basic Electrical and Electronics Engineering	ACE012	Design of Steel Structures and Drawing
AHS017	Gender Sensitivity	ACE013	Transportation Engineering
ACE101	Surveying Laboratory	ACE014	Water Resources Engineering
ACE102	Computer Aided Drafting of Buildings	ACS001	Computer Programming
ACE015	Environmental Engineering	ACE201	Mini Project
ACE016	Advanced Structural Analysis	ACE018	Foundation Engineering
ACE017	Estimation and Costing	ACE401	Comprehensive Examination
ACE112	Environmental Engineering Laboratory	ACE302	Project Work (Phase - II)
ACE113	Advanced Analysis and Design Laboratory	ACE505	Rehabilitation & Retrofitting of Structures
ACE114	Project Planning and Development Laboratory	ACE509	Ground Improvement Techniques
ACE301	Project Work (Phase - I)	ACE515	Water Resources Planning and Management
ACE533	Disaster Management and Mitigation	ACE520	Pavement Design
ACE526	Industrial Waste Water Treatment		
PO2: Problem analysis - Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.			
ACS001	Computer Programming	AHS011	Mathematical Transforms Techniques
AHS002	Linear Algebra and Ordinary Differential Equations	ACE004	Strength of Materials - II
AHS005	Engineering Chemistry	ACE005	Fluid Mechanics
AHS007	Applied Physics	ACE006	Geotechnical Engineering
AME101	Basic Workshop	ACE104	Strength of Materials Laboratory
AHS103	Engineering Chemistry Laboratory	ACE008	Structural Analysis
ACS113	IT Workshop	ACE009	Reinforced Concrete Structures Design and Drawing
AME002	Engineering Mechanics	ACE010	Concrete Technology
AHS003	Computational Mathematics and Integral Calculus	ACE011	Hydraulics and Hydraulic Machinery
AHS102	Computational Mathematics Laboratory	AHS015	Business Economics and Financial Management
AME102	Computer Aided Engineering Drawing Practice	ACE014	Water Resources Engineering
ACE012	Design of Steel Structures and Drawings	ACE013	Transportation Engineering
AHS010	Probability and Statistics	AHS106	Technical Writing and Content Development Laboratory
ACE001	Strength of Materials – I	ACE201	Mini Project
ACE002	Surveying	ACE016	Advanced Structural Analysis
ACS101	Computer Programming Laboratory	ACE113	Advanced Analysis and Design Laboratory
AEE018	Basic Electrical and Electronics Engineering	ACE114	Project Planning and Development Laboratory
AHS017	Gender Sensitivity	ACE301	Project Work (Phase - I)
ACE106	Advanced Surveying Laboratory	ACE018	Foundation Engineering
ACE302	Project Work (Phase - II)	ACE509	Ground Improvement Techniques
ACE505	Rehabilitation & Retrofitting of Structures	ACE515	Water Resources Planning and Management
ACE520	Pavement Design	ACE015	Environmental Engineering
PO3: Design/development of solutions - Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.			

Code	Subject	Code	Subject
AME101	Basic Workshop	ACE103	Engineering Geology Laboratory
AHS009	Environmental Studies	ACE003	Engineering Geology
ACS001	Computer Programming	ACE004	Strength of Materials - II
ACS101	Computer Programming Laboratory	ACE006	Geotechnical Engineering
AHS102	Computational Mathematics Laboratory	ACE104	Strength of Materials Laboratory
AME102	Computer Aided Engineering Drawing Practice	ACE007	Building Materials Construction and Planning
ACE001	Strength of Materials – I	ACE106	Advanced Surveying Laboratory
ACE102	Computer Aided Drafting of Buildings	ACE105	Geotechnical Engineering Laboratory
ACE005	Fluid Mechanics	ACE009	Reinforced Concrete Structures Design and Drawing
ACE008	Structural Analysis	ACE010	Concrete Technology
ACE012	Design of Steel Structures and Drawing	AHS015	Business Economics and Financial Management
ACE013	Transportation Engineering	ACE107	Fluid Mechanics and Hydraulic Machinery Laboratory
ACE014	Water Resources Engineering	ACE108	Concrete Technology Laboratory
ACE015	Environmental Engineering	ACE111	Building Information Modeling Laboratory
ACE016	Advanced Structural Analysis	ACE201	Mini Project
ACE533	Disaster Management and Mitigation	ACE113	Advanced Analysis and Design Laboratory
ACE018	Foundation Engineering	ACE114	Project Planning and Development Laboratory
ACE302	Project Work (Phase - II)	ACE301	Project Work (Phase - I)
ACE515	Water Resources Planning and Management	ACE509	Ground Improvement Techniques
ACE520	Pavement Design	ACE526	Industrial Waste Water Treatment
PO4: 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.			
AHS002	Linear Algebra and Ordinary Differential Equations	ACE105	Geotechnical Engineering Laboratory
AHS003	Computational Mathematics and Integral Calculus	ACS101	Computer Programming Laboratory
ACS001	Computer Programming	ACE106	Advanced Surveying Laboratory
AHS010	Probability & Statistics	AEE018	Basic Electrical and Electronics Engineering
AME002	Engineering Mechanics	ACE010	Concrete Technology
AHS007	Applied Physics	ACE011	Hydraulics and Hydraulic Machinery
AHS102	Computational Mathematics Laboratory	ACE108	Concrete Technology Laboratory
AHS105	Engineering Physics Laboratory	ACE013	Transportation Engineering
ACE001	Strength of Materials – I	ACE109	Advanced Material Testing Laboratory
AHS011	Mathematical Transforms Techniques	ACE013	Transportation Engineering
ACE012	Design of Steel Structures and Drawing	ACE014	Water Resources Engineering
ACE004	Strength of Materials – II	ACE110	Transportation Materials Laboratory
ACE005	Fluid Mechanics	AHS106	Technical Writing and Content Development Laboratory
ACE006	Geotechnical Engineering	ACE113	Advanced Analysis and Design Laboratory
ACE007	Building Materials Construction and Planning	ACE114	Project Planning and Development Laboratory
ACE018	Foundation Engineering	ACE505	Rehabilitation & Retrofitting of Structures
ACE533	Disaster Management and Mitigation	ACE016	Advanced Structural Analysis
PO5: Modern tool usage - Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.			

Code	Subject	Code	Subject
ACS113	IT Workshop	AHS009	Environmental Studies
AHS008	Modern Physics	ACS001	Computer Programming
AHS105	Engineering Physics Laboratory	ACS101	Computer Programming Laboratory
AME102	Computer Aided Engineering Drawing Practice	ACE002	Surveying
ACE102	Computer Aided Drafting of Buildings	ACE106	Advanced Surveying Laboratory
ACE010	Concrete Technology	ACE108	Concrete Technology Laboratory
ACE111	Building Information Modeling Laboratory	ACE109	Advanced Material Testing Laboratory
ACE110	Transportation Materials Laboratory	ACE201	Mini Project
ACE113	Advanced Analysis & Design Laboratory	ACE114	Project Planning and Development Laboratory
ACE301	Project Work (Phase – I)	ACE302	Project Work (Phase – II)
ACE515	Water Resources Planning and Management		
PO6: The engineer and society - Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			
ACE003	Engineering Geology	ACE101	Surveying Laboratory
ACE102	Computer Aided Drafting of Buildings	ACE006	Geotechnical Engineering
ACE105	Geotechnical Engineering Laboratory	ACE106	Advanced Surveying Laboratory
ACE108	Concrete Technology Laboratory	ACE109	Advanced Material Testing Laboratory
ACE110	Transportation Materials Laboratory	ACE015	Environmental Engineering
ACE017	Estimation & Costing	ACE114	Project Planning and Development Laboratory
ACE018	Foundation Engineering	ACE509	Ground Improvement Techniques
ACE520	Pavement Design	ACE526	Industrial Waste Water Treatment
PO7: Environment and sustainability - Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.			
AHS005	Engineering Chemistry	AHS009	Environmental Studies
ACE001	Strength of Materials –I	ACE003	Engineering Geology
ACE103	Engineering Geology Laboratory	ACE108	Concrete Technology Laboratory
ACE107	Fluid Mechanics & Hydraulic Machinery Laboratory	ACE014	Water Resources Engineering
ACE015	Environmental Engineering	ACE112	Environmental Engineering Laboratory
ACE301	Project Work (Phase – I)	ACE302	Project Work (Phase – II)
ACE505	Rehabilitation & Retrofitting of Structures	ACE526	Industrial Waste Water Treatment
ACE520	Pavement Design	ACE515	Water Resources Planning and Management
ACE533	Disaster Management & Mitigation		
PO8: Ethics - Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
AME001	Engineering Drawing	ACS113	IT Workshop
AHS017	Gender Sensitivity	AHS106	Technical Writing & Content Development Laboratory
ACE017	Estimation & Costing	AHS016	Industrial Management and Psychology
ACE401	Comprehensive Examination	ACE301	Project Work (Phase – I)
ACE114	Project Planning and Development Laboratory	ACE302	Project Work (Phase – II)
PO9: Individual and team work - Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
AHS001	English for Communication	AHS017	Gender Sensitivity
ACE102	Computer Aided Drafting of Buildings	ACE005	Fluid Mechanics
ACE106	Advanced Surveying Laboratory	AHS105	Business Economics & Financial Analysis
ACE111	Building Information Modeling Laboratory	ACE108	Concrete Technology Laboratory
ACE014	Water Resources Engineering	ACE201	Mini Project

Code	Subject	Code	Subject
ACE016	Advanced Structural Analysis	ACE114	Project Planning and Development Laboratory
ACE301	Project Work (Phase - I)	ACE302	Project Work (Phase - II)
AHS016	Industrial Management and Psychology	ACE505	Rehabilitation & Retrofitting of Structures
ACE533	Disaster Management and Mitigation	ACE505	Rehabilitation & Retrofitting of Structures
PO10: Communication - Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.			
AHS001	English for Communication	ACE005	Fluid Mechanics
AHS101	Communication Skills Laboratory	ACE103	Surveying Laboratory
ACE102	Computer Aided Drafting of Buildings	ACE004	Strength of Materials - II
ACE009	Reinforced Concrete Structures Design and Drawing	ACE005	Fluid Mechanics
AHS106	Technical Writing & Content Development Laboratory	ACE201	Mini Project
ACE017	Estimation and Costing	ACE301	Project Work (Phase - I)
ACE114	Project Planning and Development Laboratory	AHS016	Industrial Management and Psychology
ACE401	Comprehensive Examination	ACE302	Project Work (Phase - II)
ACE505	Rehabilitation & Retrofitting of Structures	ACE533	Disaster Management and Mitigation
ACE515	Water Resources Planning and Management		
PO11: 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.			
ACE105	Geotechnical Engineering Laboratory	ACE009	Reinforced Concrete Structures Design and Drawing
ACE106	Advanced Surveying Laboratory	AHS015	Business Economics and Financial Management
ACE108	Concrete Technology Laboratory	ACE016	Advanced Structural Analysis
ACE111	Building Information Modeling Laboratory	ACE114	Project Planning and Development Laboratory
ACE109	Advanced Material Testing Laboratory	ACE110	Transportation Materials Laboratory
AHS016	Industrial Management and Psychology	ACE520	Pavement Design
ACE505	Rehabilitation & Retrofitting of Structures	ACE515	Water Resources Planning and Management
PO12: Life-long learning - Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
AHS101	Communication Skills Laboratory	AHS008	Modern Physics
ACS001	Computer Programming	AHS102	Computational Mathematics Laboratory
AHS105	Engineering Physics Laboratory	ACS101	Computer Programming Laboratory
ACE103	Engineering Geology Laboratory	ACE005	Fluid Mechanics
ACE104	Strength of Materials Laboratory	ACE006	Geotechnical Engineering
ACE105	Geotechnical Engineering Laboratory	ACE108	Concrete Technology Laboratory
ACE106	Advanced Surveying Laboratory	ACE111	Building Information Modeling Laboratory
ACE109	Advanced Material Testing Laboratory	ACE113	Advanced Analysis and Design Laboratory
ACE110	Transportation Materials Laboratory	ACE114	Project Planning and Development Laboratory
PSO1: ENGINEERING KNOWLEDGE: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.			
AHS002	Linear Algebra and Ordinary Differential Equations	AME001	Engineering Drawing
AME101	Basic Workshop	AHS008	Modern Physics

Code	Subject	Code	Subject
AME002	Engineering Mechanics	ACS101	Computer Programming Laboratory
AHS003	Computational Mathematics and Integral Calculus	ACE103	Engineering Geology Laboratory
AHS105	Engineering Physics Laboratory	ACE001	Strength of Materials - I
ACS001	Computer Programming	ACE002	Surveying
AHS009	Environmental Studies	ACE003	Engineering Geology
AHS102	Computational Mathematics Laboratory	AEE018	Basic Electrical and Electronics Engineering
AME102	Computer Aided Engineering Drawing Practice	ACE101	Surveying Laboratory
AHS010	Probability and Statistics	ACE102	Computer Aided Drafting of Buildings
AHS011	Mathematical Transforms Techniques	ACE105	Geotechnical Engineering Laboratory
ACE004	Strength of Materials - II	ACE106	Advanced Surveying Laboratory
ACE005	Fluid Mechanics	ACE008	Structural Analysis
ACE006	Geotechnical Engineering	ACE009	Reinforced Concrete Structures Design and Drawing
ACE007	Building Materials Construction and Planning	ACE010	Concrete Technology
ACE104	Strength of Materials Laboratory	ACE011	Hydraulics and Hydraulic Machinery
ACE107	Fluid Mechanics and Hydraulic Machinery Laboratory	ACE111	Building Information Modeling Laboratory
ACE108	Concrete Technology Laboratory	ACE012	Design of Steel Structures and Drawing
ACE201	Mini Project	ACE013	Transportation Engineering
ACE015	Environmental Engineering	ACE014	Water Resources Engineering
ACE016	Advanced Structural Analysis	ACE113	Advanced Analysis and Design Laboratory
ACE017	Estimation and Costing	ACE114	Project Planning and Development Laboratory
ACE112	Environmental Engineering Laboratory	ACE301	Project Work (Phase - I)
ACE018	Foundation Engineering	ACE401	Comprehensive Examination
ACE505	Rehabilitation & Retrofitting of Structures	ACE302	Project Work (Phase - II)
ACE509	Ground Improvement Techniques	ACE515	Water Resources Planning and Management
ACE526	Industrial Waste Water Treatment	ACE520	Pavement Design
ACE533	Disaster Management and Mitigation		
PSO2: BROADNESS AND DIVERSITY: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage			
AME101	Basic Workshop	ACS001	Computer Programming
ACS101	Computer Programming Laboratory	AHS102	Computational Mathematics Laboratory
ACE001	Strength of Materials - I	ACE101	Surveying Laboratory
ACE002	Surveying	ACE102	Computer Aided Drafting of Buildings
ACE003	Engineering Geology	ACE103	Engineering Geology Laboratory
ACE007	Building Materials Construction and Planning	ACE105	Geotechnical Engineering Laboratory
ACE104	Strength of Materials Laboratory	ACE106	Advanced Surveying Laboratory
ACE009	Reinforced Concrete Structures Design and Drawing	ACE107	Fluid Mechanics and Hydraulic Machinery Laboratory
ACE010	Concrete Technology	ACE108	Concrete Technology Laboratory
ACE011	Hydraulics and Hydraulic Machinery	ACE111	Building Information Modeling Laboratory
ACE012	Design of Steel Structures and Drawing	ACE109	Advanced Material Testing Laboratory
ACE016	Advanced Structural Analysis	ACE110	Transportation Materials Laboratory
ACE017	Estimation and Costing	ACE114	Project Planning and Development Laboratory

Code	Subject	Code	Subject
ACE018	Foundation Engineering	ACE301	Project Work (Phase - I)
AHS016	Industrial Management and Psychology	ACE302	Project Work (Phase - II)
ACE505	Rehabilitation & Retrofitting of Structures	ACE515	Water Resources Planning and Management
ACE533	Disaster Management and Mitigation	ACE520	Pavement Design
PSO3: SELF-LEARNING AND SERVICE: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.			
AHS001	English for Communication	ACS113	IT Workshop
AHS008	Modern Physics	ACE001	Strength of Materials - I
ACS001	Computer Programming	AHS017	Gender Sensitivity
AHS102	Computational Mathematics Laboratory	ACE101	Surveying Laboratory
AHS105	Engineering Physics Laboratory	ACE103	Engineering Geology Laboratory
ACS101	Computer Programming Laboratory	ACE005	Fluid Mechanics
ACE104	Strength of Materials Laboratory	ACE006	Geotechnical Engineering
ACE106	Advanced Surveying Laboratory	ACE009	Reinforced Concrete Structures Design and Drawing
AHS015	Business Economics and Financial Management	ACE010	Concrete Technology
ACE108	Concrete Technology Laboratory	ACE012	Design of Steel Structures and Drawing
ACE111	Building Information Modeling Laboratory	ACE014	Water Resources Engineering
ACE113	Advanced Analysis and Design Laboratory	ACE505	Rehabilitation & Retrofitting of Structures
ACE114	Project Planning and Development Laboratory	ACE509	Ground Improvement Techniques

8. METHODS OF MEASURING LEARNING OUTCOMES AND VALUE ADDITION

Methodologies that are used to measure student learning each have their own limitations and biases, and no method can be counted on to be completely error free. That is why best practice in educational research dictates triangulating the data. If several different sources of data are used, it increases the probability that the findings present an accurate picture. We employ the following formal assessment procedures:

1) End-of-semester course evaluations
2) Departmental mid-semester course evaluations
3) Departmental course objective surveys
4) Course portfolio evaluations
5) Exit Interviews
6) Alumni feedback
7) Employer surveys
8) Department academic council meetings
9) Faculty meetings
10) Project work
11) Job Placements

Each is described in more detail below:

1) ***End-of-semester course evaluations:*** The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with 'either' 'or' choice will be drawn from each unit. Each question carries 14 marks. There could be a maximum of three sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept
30 %	To test the analytical skill of the concept
20 %	To test the application skill of the concept

2) ***Departmental mid-semester course evaluations***: For each theory course the mid semester shall be conducted by the faculty/teacher handling the course. Mid semester is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz / Alternative Assessment Tool (AAT).

Continuous Internal Examination (CIE): Two CIE exams shall be conducted at the end of the 8^{th} and 17^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams. The valuation and verification of answer scripts of CIE exams shall be completed within a week after the conduct of the Internal Examination.

Quiz / Alternative Assessment Tool (AAT): Two Quiz exams shall be online examination consisting of 20 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in the testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quizzes for every course.

In order to encourage innovative methods while delivering a course, the faculty members have been encouraged to use the Alternative Assessment Tool (AAT) in place of two quizzes. This AAT enables faculty to design own assessment patterns during the CIA. However, the usage of AAT is completely optional. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning centre. The AAT may include seminars, assignments, term paper, open ended experiments, micro-projects, five minutes video, MOOCs etc.

However, it is mandatory for a faculty to obtain prior permission from the concerned HOD and spell out the teaching/assessment pattern of the AAT prior to commencement of the classes.

3) ***Departmental course objective surveys:*** The Civil Engineering department conducts end-of-semester course objective surveys for all of our courses. All departmental students are encouraged to fill out a brief survey on the state of the courses they are currently taking, and space is provided for a written comment. Faculty are strongly encouraged to review these evaluations, and draft a brief response on how they will react to correct any deficiencies noted by the students. The results are reviewed by the departmental faculty (all faculty have permission to read results for all courses). The results of how courses satisfy their objectives are discussed at a faculty meeting.

4) ***Course portfolio evaluations:*** We collect course portfolios of each course offered in the given semester from the instructor. They remain on file for our entire faculty to study. These portfolios help the course coordinator monitor how the course is being taught, and help new faculty understand how more experienced colleagues teach the given course. With respect to the assessment, each portfolio contains two surveys to be filled out by the instructor of the course. The beginning-of-semester survey encourages faculty members to think about what they can do to improve the teaching and administration of their course, compared with the last time they taught it.

The end-of-semester survey encourages faculty to record what did and did not work well during this course offering and what changes should be made for the future.

5) ***Exit Interviews:*** Inputs from final year students are solicited annually through Civil Engineering Exit Survey. The results are disseminated to the faculty and department advisory council for analysis and discussion. The questionnaire is designed to survey program outcomes, solicit about program experiences, career choices as well as suggestions and comments. This instrument seeks to assess how students view the department's program in retrospect.

6) ***Alumni feedback:*** The alumni survey is a written questionnaire which alumni are asked to complete. We use this survey seeking input on the Program Objectives and Learning Outcomes based on their experience after graduation and after they have spent time in the working world. Alumni are an excellent resource with perspective on the value and advantages of their education. They are also resource for current students for potential networking and employment. The data will be analyzed and used in continuous improvement.

7) ***Employer surveys:*** The employer survey is a written questionnaire which employers of the program's graduates are asked to complete. We review the effectiveness of our curriculum and how well the student is prepared in the department of Civil Engineering. To do this, we survey Employers and Advisors of alumni who graduated four years ago. We ask about several categories of preparation, and for each category, how well does they think he or she was prepared, and how important you think preparation in that area is to him or her in the current position. This survey will greatly assist us in determining the college overall level of achievement of our Program Educational Objectives.

8) ***Department academic council meetings:*** The Civil Engineering Department Advisory Council (CEDAC) include a diverse group of experts from academe and industry, as well as alumni representation. The Advisory Board meets annually, or as needed, for a comprehensive review of the Civil Engineering department strategic planning and programs. The Advisory Council meets with administration, faculty and students and prepares a report, which is presented to principal. In each visit, the Department of Civil Engineering responds to the report indicating improvements and amendments to the program.

9) ***Faculty meetings:*** The state of undergraduate program is always on the agenda at the monthly meeting of the faculty. The faculty devotes a substantial amount of time to formal and informal discussions assessing the state of program and searching for improvements.

10) ***Project work:*** In the non-FSI (Full Semester Internship) Model, the project work shall be evaluated for 100 marks out of which 30 marks for internal evaluation and 70 marks for semester end evaluation. The project work shall be spread over in VII semester and in VIII semester. The project work shall be somewhat innovative in nature, exploring the research bent of the mind of the student. A project batch shall comprise not more than three students. At the end of VII semester, students should submit synopsis summarizing the work done in VII semester. The project is expected to be completed by the end of VIII semester. In VII semester, a first mid review is conducted by Project Review Committee (PRC) (on the progress) for 10 marks. In VIII semester, a second mid review is conducted by PRC (on the progress) for 10 marks. On completion of the project, a third evaluation is conducted for award of internal marks of another 10 marks before the report is submitted, making the total internal marks 30. The end semester examination shall be based on the report submitted and a viva-voce exam for 70 marks by a committee comprising the Head of the department, project supervisor and an external examiner nominated by the Principal. A minimum of 40% of maximum marks shall be obtained to earn the corresponding credits.

11) ***Job Placements:*** Data from the Placement and Training Centre on graduates' job placement reflects how successful our graduates are in securing a job in a related field.

Part - II

METHODOLOGY FOR PREPARATION AND ASSESSMENT OF COURSE LEVEL STUDENT LEARNING OUTCOMES

Although the term "Expected Learning Outcome" may be new, the process of identifying the key concepts or skills that students are expected to learn during specific courses is not. Many people are more familiar with the terms "course objective" or "course competency". Expected learning outcomes are really very similar to both of these concepts. So if course objectives or competencies are available, the process of having expected learning outcomes for class is closer.

This will provide information on exactly what expected learning outcomes are and what methods can be used to assess them. This is designed to assist faculty with the process of developing expected learning outcomes and methods for assessing those outcomes in their courses. This provides basic information related to (1) course purpose; (2) expected learning outcomes; (3) methods for assessing expected learning outcomes; (4) criteria for grade determination; and (5) a course outline.

Expected Learning Outcomes:

After reading and completing this, individuals will be able to:

- Prepare a description of the course as well as a written statement regarding the course's purpose;
- Construct/develop expected learning outcomes for the course;
- Create an assessment plan that outlines the specific methods that will be used to assess the expected student learning outcomes for a course;
- Describe how grades will be determined in a process that is separate and distinct from assessing the expected learning outcomes;
- Identify the common components of a course outline ;
- Revise their course syllabi to incorporate a course purpose, expected learning outcomes, methods to assess those outcomes, the criteria for grade determination, and a course outline;
- This process uses some terminology related to the expected learning outcomes and assessment. A brief glossary of terms has been provided below for reference purposes;

Assessment of expected learning outcomes:

The process of investigating

a) What students are learning?
b) How well they are learning it in relation to the stated expected learning outcomes for the course?

Assessment plan:

The proposed methods and timeline for assessment-related activities in a given course (e.g., when are you going to check what/how well the students are learning and how are you going to do that?).

Classroom Assessment Technique (CAT): Angelo and Cross (1993) developed a variety of techniques/activities than can be used to assess students' learning. These CATs are often done anonymously and are not graded. These activities check on the class' learning while students are still engaged in the learning process. An example of a CAT is a non-graded quiz given a few weeks before the first exam.

Course description:

A formal description of the material to be covered in the course.

Course purpose:
The course purpose describes the intent of the course and how it contributes to the programme. The course purpose goes beyond the course description.

Expected learning outcome:
A formal statement of what students are expected to learn in a course (synonyms for "expected learning outcome" include learning outcome, learning outcome statement, and student learning outcome).

Evaluation:
Making a judgment about the quality of student's learning/work and assigning marks based on that judgment. Evaluation activities (such as exams, papers, etc.) are often seen as formal ways to assess the expected learning outcomes for a course.

Methods for assessing student learning outcomes:
This term refers to any technique or activity that is used to identify what students are learning or how well they are learning. Formal methods for evaluating student learning outcomes include Continuous Assessment Tests, Mid Semester Test, Tutorials, End Semester Examination etc. The assessment methods are used to identify how the well students have acquired the learning outcomes for the course.

1. COURSE PURPOSE

One of the first steps in identifying the expected learning outcomes for a course is identifying the *purpose* of teaching in the course. By clarifying the purpose of the course, faculty can help discover the main topics or themes related to students' learning. These themes help to outline the expected learning outcomes for the course.

The course purpose involves the following:

a) What role does this course play within the programme?
b) How is the course unique or different from other courses?
c) Why should/do students take this course? What essential knowledge or skills should they gain from this experience?
d) What knowledge or skills from this course will students need to have mastered to perform well in future classes or jobs?
e) Why is this course important for students to take?

The "Course Description" provides general information regarding the topics and content addressed in the course, the "Course Purpose" goes beyond that to describe how this course fits in to the students' educational experience in the programme.

2. EXPECTED LEARNING OUTCOMES

Expected Learning Outcome (definition)
An expected learning outcome is a formal statement of what students are expected to learn in a course. Expected learning outcome statements refer to specific knowledge, practical skills, areas of professional development, attitudes, higher-order thinking skills, etc. that faculty members expect students to develop, learn, or master during a course (Suskie, 2004). Expected learning outcomes are also often referred to as "learning outcomes", "student learning outcomes", or "learning outcome statements".

Simply stated, expected learning outcome statements describe:

1. What faculty members want students to *know* at the end of the course?
2. What faculty members want students *to be able to do* at the end of the course?

Learning outcomes have three major characteristics

1. They specify an action by the students/learners that is *observable;*
2. They specify an action by the students/learners that is *measurable;*
3. They specify an action that is done by the *students/learners* (rather than the faculty members);

Effectively developed expected learning outcome statements should possess all three of these characteristics. When this is done, the expected learning outcomes for a course are designed so that they can be assessed (Suskie, 2004).

3. TO DEFINE EFFECTIVE LEARNING OUTCOME STATEMENTS

When stating expected learning outcomes, it is important to use verbs that describe exactly what the learner(s) will be able to *do* upon completion of the course.

Examples of good action words to include in expected learning outcome statements:

Compile, identify, create, plan, revise, analyze, design, select, utilize, apply, demonstrate, prepare, use, compute, discuss, explain, predict, assess, compare, rate, critique, outline, or evaluate

There are some verbs that are unclear in the context of an expected learning outcome statement (*e.g., know, be aware of, appreciate, learn, understand, comprehend*). These words are often vague, have multiple interpretations, or are simply difficult to observe or measure (American Association of Law Libraries, 2005). As such, it is best to avoid using these terms when creating expected learning outcome statements.

For example, please look at the following learning outcomes statements:

- *The students will understand basic Designing techniques .*
- *The students will appreciate knowledge discovery from field reports.*

Both of these learning outcomes are stated in a manner that will make them difficult to assess. Consider the following:

- *How do you observe someone "understanding" a theory or "appreciating" designing techniques?*
- *How easy will it be to measure "understanding" or "appreciation"?*

These expected learning outcomes are more effectively stated the following way:

- *The students will be able to identify and describe what techniques are used to extract knowledge from the field reports.*
- *The students will be able to identify the characteristics of Classification techniques from the designing and the analysis.*

Incorporating Critical Thinking Skills into Expected Learning Outcomes Statements

Many faculty members choose to incorporate words that reflect critical or higher-order thinking into their learning outcome statements. Bloom (1956) developed a taxonomy outlining the different types of thinking skills people use in the learning process. Bloom argued that people use different levels of thinking skills to process different types of information and situations. Some of these are basic cognitive skills (such as memorization) while others are complex skills (such as creating new ways to apply information). These skills are often referred to as *critical thinking skills* or *higher-order thinking skills*.

Bloom proposed the following taxonomy of thinking skills. All levels of Bloom's taxonomy of thinking skills can be incorporated into expected learning outcome statements. Recently, Anderson and Krathwohl (2001) adapted Bloom's model to include language that is oriented towards the language used in expected learning outcome statements. A summary of Anderson and Krathwohl's revised version of Bloom's taxonomy of critical thinking is provided below.

Figure 3: List of Action Words (Ref: Revised Version of Bloom's Taxonomy)

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Count	Associate	Add	Analyze	Appraise	Categorize
Define	Compute	Apply	Arrange	Assess	Combine
Describe	Convert	Calculate	Breakdown	Compare	Compile
Draw	Defend	Change	Combine	Conclude	Compose
Identify	Discuss	Classify	Design	Contrast	Create
Label	Distinguish	Complete	Detect	Criticize	Drive
List	Estimate	Compute	Develop	Critique	Design
Match	Explain	Demonstrate	Diagram	Determine	Devise
Name	Extend	Discover	Differentiate	Grade	Explain
Outline	Extrapolate	Divide	Discriminate	Interpret	Generate
Point	Generalize	Examine	Illustrate	Judge	Group
Quote	Give examples	Graph	Infer	Justify	Integrate
Read	Infer	Interpolate	Outline	Measure	Modify
Recall	Paraphrase	Manipulate	Point out	Rank	Order
Recite	Predict	Modify	Relate	Rate	Organize
Recognize	Rewrite	Operate	Select	Support	Plan
Record	Summarize	Prepare	Separate	Test	Prescribe
Repeat		Produce	Subdivide		Propose
Reproduce		Show	Utilize		Rearrange
Select		Solve			Reconstruct
State		Subtract			Related
Write		Translate			Reorganize
		Use			Revise
					Rewrite
					Summarize
					Transform
					Specify

Definitions of the different levels of thinking skills in Bloom's taxonomy

1) **Remember** – recalling relevant terminology, specific facts, or different procedures related to information and/or course topics. At this level, a student can remember something, but may not really understand it.
2) **Understand** – the ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.
3) **Apply** – being able to use previously learned information in different situations or in problem solving.
4) **Analyze** – the ability to break information down into its component parts. Analysis also

refers to the process of examining information in order to make conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support statements/arguments.

5) **Evaluate** – being able to judge the value of information and/or sources of information based on personal values or opinions.
6) **Create** – the ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas.

List of Action Words Related to Critical Thinking Skills

Figure 3 shows a list of action words that can be used when creating the expected student learning outcomes related to critical thinking skills in a course. These terms are organized according to the different levels of higher-order thinking skills contained in Anderson and Krathwohl's (2001) revised version of Bloom's taxonomy.

4. TIPS FOR DEVELOPING COURSE LEVEL EXPECTED LEARNING OUTCOMES STATEMENTS

- Limit the course-level expected learning outcomes to 5 - 10 statements for the entire course (more detailed outcomes can be developed for individual units, assignments, chapters, etc.).

- Focus on overarching or general knowledge and/or skills (rather than small or trivial details).

- Focus on knowledge and skills that are central to the course topic and/or discipline.
- Create statements that are student-centered rather than faculty-centered (e.g., "upon completion of this course students will be able to list the names of all Data Mining techniques " versus "one objective of this course is to teach the names of all Data Mining techniques").

- Focus on the learning that *results* from the course rather than describing activities or lessons in the course.

- Incorporate or reflect the institutional and departmental missions.

Incorporate various ways for students to show success (outlining, describing, modeling, depicting, etc.) rather than using a single statement such as "at the end of the course, students will know _____ " as the stem for each expected outcome statement.

5. SAMPLE COURSE LEARNING OUTCOMES

The following depict some sample expected learning outcomes statements from the selected courses.

Probability & Statistics:
After completing this course the student must demonstrate the knowledge and ability to:

CAHS010.01 Understand the basic concepts of probability and random variables.
CAHS010.02 Analyze the concepts of discrete and continuous random variables, probability distributions, expectation and variance.
CAHS010.03 Use the concept of random variables in real-world problem like graph theory, machine learning, Natural language processing.
CAHS010.04 Apply the binomial distribution and poisson distribution to find mean and variance.
CAHS010.05 Understand binomial distribution to the phenomena of real-world problem like sick versus healthy.
CAHS010.06 Use poission distribution in real-world problem to predict soccer scores.
CAHS010.07 Apply the inferential methods relating to the means of normal distributions.
CAHS010.08 Understand the mapping of normal distribution in real-world problem to analyze the stock market.
CAHS010.09 Explain multiple random variables and the covariance of two random variables.
CAHS010.10 Understand the concept of multiple random variables in real-world problems aspects of wireless communication system.
CAHS010.11 Calculate the correlation coefficient to the given data**.**
CAHS010.12 Understand the correlation and regression to the real-world such as stock price and interest rates
CAHS010.13 Calculate the regression to the given data.
CAHS010.14 Understand the concept of sampling distribution of statistics and in particular describe the behavior of the sample mean.
CAHS010.15 Understand the concept of estimation for classical inference involving confidence interval.
CAHS010.16 Understand the concept of estimation in real-world problems of signal processing.
CAHS010.17 Understand the foundation for hypothesis testing.
CAHS010.18 Understand the concept of hypothesis testing in real-world problem to selecting the best means to stop smoking.
CAHS010.19 Apply testing of hypothesis to predict the significance difference in the sample means.
CAHS010.20 Apply testing of hypothesis to predict the significance difference in the sample proportions.
CAHS010.21 Apply Student t-test to predict the difference in sample means.
CAHS010.22 Apply F-test to predict the difference in sample variances.
CAHS010.23 Understand the characteristics between the samples using Chi-square test.
CAHS010.24 Understand the assumptions involved in the use of ANOVA technique.
CAHS010.25 Understand the concept ANOVA to the real-world problems to measure the atmospheric tides.

Geotechnical Engineering:
After completing this course the student must demonstrate the knowledge and ability to:

CACE006.01 Calculate the unit weights in various field conditions using different relationships
CACE006.02 Examine water content, specific gravity, bulk density and dry densities of a soil using various laboratory and field tests.
CACE006.03 Identify the type of soil present in the site by using particle size distribution curve & other index properties of soils as per IS soil classification system
CACE006.04 Find the Atterberg limits of soils which is used in classifying the fine grained soils
CACE006.05 Understand the permeability of soil & find out the range of coefficient of permeability in various soil types.
CACE006.06 Explain the importance of permeability in calculation of seepage through earthen dams, amount of water to be pumped when the soil is excavated below ground water table.
CACE006.07 Evaluate the coefficient of permeability using falling head tests and constant head tests
CACE006.08 Evaluate the coefficient of permeability using pumping in and pumping out tests
CACE006.09 Calculate the stresses beneath the ground level due to self weight of soil
CACE006.10 Analyze the importance of total, neutral and effective stress in load carrying capacity of soil
CACE006.11 Sketch the total, neutral and effective stress distribution diagram for various field conditions
CACE006.12 Explain quick sand condition, its occurrence and its significance CACE006.13 Understand the importance of flow net in calculating seepage loss, uplift pressure, exit hydraulic gradient
CACE006.14 Calculate the stress below the ground due to externally applied load using Boussinesq‟s theory
CACE006.15 Calculate stress due to load using Westergaard‟s and approximate method of stress distribution
CACE006.16 Importance of compaction in reducing the immediate settlement, improving the load carrying capacity
CACE006.17 Determining the maximum dry density and optimum moisture content of soil using standard proctor test soil. List the various field equipments used for compacting the different types of soils.
CACE006.18 Recognize the importance of consolidation in settlement calculation & calculate the consolidation settlement especially in clayey soils.
CACE006.19 Determination of consolidation parameters of a soil using laboratory test such as using square root of time fitting method, logarithmic square method and height of solids method.
CACE006.20 Understand the shear failure criteria proposed by Mohr-coulomb and shear parameters of soil
CACE006.21 Determination of shear strength of soil using direct shear test and tri-axial test in various drainage conditions.
CACE006.22 Recognize the behaviour of soil in normal, over and under consolidated soil. Understand the concept of dilatancy in sandy soil
CACE006.23 Posses the Knowledge and Skills for employability and to succeed in national and international level competitive examinations.

Reinforced Concrete Structures Design & Drawing:
After completing this course the student must demonstrate the knowledge and ability to:

CACE009.01 Understand the basic concepts in the behaviour and design of reinforced concrete systems and elements.

CACE009.02 Ability to differentiate between working stress design and limit state design.
CACE009.03 Understand the general mechanical behavior of reinforced concrete in accordance with IS 456:2000.
CACE009.04 Analyze the applicable industry design codes relevant to the design of reinforced concrete members.
CACE009.05 Able to analyze and design with detailing of reinforced concrete flexural members.
CACE009.06 Analyze and design of members subjected to shear using IS 456:200
CACE009.07 Analyze and design of concrete members subjected to torsion.
CACE009.08 Analyze and design for bond for structural members as per code
CACE009.09 Ability to design and check for serviceability (crack and deflection).
CACE009.10 Ability to design ultimate limit state conditions.
CACE009.11 Understand the behavior and design of reinforced concrete systems and elements when subjected to loading
CACE009.12 Design with detailing for vertical and horizontal shear in reinforced concrete.
CACE009.13 Understand in detail about of reinforced concrete compression members.
CACE009.14 Design of axially loaded columns when subjected to compressive loads
CACE009.15 Analyze transfer and development length of concrete reinforcement.
CACE009.16 Differentiate short and long columns and design them for axial loads.
CACE009.17 Understand the designing and detailing of footings as per the code IS456:2000
CACE009.18 Remember the designing of square and rectangle footings with code provisions
CACE009.19 Understand the steps involved in designing of square and rectangle Footings.
CACE009.20 Understand the designing and detailing of stair case as per IS456:2000

Surveying:
After completing this course the student must demonstrate the knowledge and ability to:

CACE002.01 Analyze the sources of errors in linear measurements.
CACE002.02 Evaluate the corrections for true length, true area and true volumes of calculated data
CACE002.03 Determine the errors in chain and tape length
CACE002.04 Obtain directions of a surveying line with a prismatic compass.
CACE002.05 Determine the bearing angles by a prismatic compass
CACE002.06 Draw a traverse and calculate area enclosed within the traverse.
CACE002.07 Measure the corrected bearing angles without local attraction
CACE002.08 Differentiate the whole circle and quadrant bearing systems
CACE002.09 Draw cross section and prepare a contour maps for road works, rail works, canals etc.
CACE002.10 Predict Reduced Levels with reference to a common assumed datum
CACE002.11 sketch the profile the of land from the reduced levels
CACE002.12 Differentiate the basic concepts in leveling such as datum and bench mark etc.
CACE002.13 Calculate the volume of earth work, the sectional areas of the cross- section
CACE002.14 Compute an area of filed which is surrounded by irregular boundaries
CACE002.15 Calculate an area by latitudes and departures of a closed traverse
CACE002.16 Explain the importance of theodolite and the principle of measuring angles in horizontal and vertical plains.
CACE002.17 Understand the components of theodolite and errors in elimination of parallax
CACE002.18 Calculate the error of closure in a closed traverse
CACE002.19 Differentiate the advantages of global positioning system and geographical information
CACE002.20 Analyze the basic principle of total station in recording the field data.
CACE002.21 Derive an equation for calculation of heights and distances using principles of tacheometry survey

CACE002.22 Derive an equation for calculation of heights and distances using principles of triangulation survey
CACE002.23 Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.

6. AN OVERVIEW OF ASSESSMENT

What is assessment?
According to Palomba and Banta (1999) assessment involves the systematic collection, review, and use of evidence or information related to student learning. Assessment helps faculty understand how well their students understand course topics/lessons. Assessment exercises are often anonymous. This anonymity allows students to respond freely, rather than trying to get the "right" answer or look good. Assessment exercises attempt to gauge students' understanding in order to see what areas need to be re-addressed in order to increase the students' learning.

In other words, assessment is the process of investigating (1) *what* students are learning and (2) *how well* they are learning it in relation to the stated *expected learning outcomes* for the course. This process also involves providing feedback to the students about their learning and providing new learning opportunities/strategies to increase student learning.

For example, Dr. JVR initiates a class discussion on material from Chapter One and determines that most of the students are confused about Topic X. This class discussion served as a method for assessing student learning and helped determine the fact that student learning related to Topic X is somewhat lacking. Dr. JVR now has the opportunity to (1) inform the students that there is some confusion and (2) make adjustments to address this confusion (e.g., ask student to re-read Chapter One, re-lecture over Topic X, etc.). This assessment process helps increase students' learning.

What is the difference between "evaluation" and "assessment"?
Evaluation focuses on making a judgment about student work to be used in assigning marks that express the level of student performance. Evaluation is usually used in the process of *determining marks*. Evaluation typically occurs after student learning is assumed to have taken place (e.g., a final exam). Evaluation is part of the assessment process. Course assignments that are evaluated/graded (e.g., exams, papers, tutorials, etc.) are often seen as formal assessment techniques.

While evaluation is an important component of most classrooms, it does have some limitations. For example, if the class average on an exam is a 45%, is seems pretty clear that something went wrong along the way. When one has only evaluated the final learning product, it can be challenging to go back and discover what happened. It can also be difficult to address the situation or provide opportunities for students to learn from their mistakes. Yes, a curve on an exam can help address a low class average, but does it help the students learn? Engaging in informal assessment activities throughout the course can help avoid this situation.

What is involved in the assessment process?
1. Establishing *expected learning outcomes* for the course;
2. Systematically gathering, analyzing, and interpreting evidence *(through formal assessment activities such as exams or papers and informal assessment activities such as in-class discussions exercises)* to determine how well the students' learning matches:
    - Faculty expectations for what students will learn;
    - The stated expected learning outcomes for the course;
3. Faculty members should use this evidence/assessment of student learning to:

- Provide questionnaire to students about their learning (or lack thereof);
- Adjust their teaching methods and/or students' learning behaviors to ensure greater student learning (Maki, 2004);

The Best Practice in a Classroom Assessment and is an example of a method that can be used to assess learning outcomes. At the end of a class period or major topic, faculty ask students to anonymously write down what point(s) were the most unclear to them. After class, faculty members review these responses and then re-teach or re-address any confusing topics, thus increasing student learning (Angelo & Cross, 1993).

7. WRITING A COURSE PURPOSE

When planning a course and determining the Learning Outcomes for that course, it is important to examine the course's purpose within the context of the college, and/or the department/program. This process will assist faculty in determining the intent of the course as well as how the course fits into the curriculum. This will help identify the essential knowledge, skills, etc. that should be incorporated into the course and the stated expected learning outcomes for the course. The course purpose section should clarify the course's standing within the programme *(e.g., is the course required or an elective?, does this class have a pre-requisite?, etc.)*. It should also describe the course's role in the departmental/programmatic curriculum by addressing the intent (importance, main contribution, intrinsic value, etc.) of the class.

Determine how the course fits into the departmental curriculum
Here are some questions to ask to help determine how a course fits in the departmental curriculum:

What role does the course play in the departmental/programmatic curriculum?

- Is this course required?
- Is this course an elective?
- Is this course required for some students and an elective for others?
- Does this class have a pre-requisite?
- Is this class a pre-requisite for another class in the department?
- Is this course part of IEEE / ACM / AICTE Model Curriculum?

How advanced is this course?

- Is this course an undergraduate or graduate course?
- Where does this course fall in students' degree plan - as an introductory course or an advanced course?
- Can I expect the students taking this course to know anything about the course topic?
- Are other faculty members counting on students who have taken this course to have mastered certain knowledge or skills?

When students leave this course, what do they need to know or be able to do?

- Is there specific knowledge that the students will need to know in the future?
- Are there certain practical or professional skills that students will need to apply in the future?
- Five years from now, what do you hope students will remember from this course?

What is it about this course that makes it unique or special?

- Why does the program or department offer this course?
- Why can't this course be "covered" as a sub-section of another course?

- What unique contributions to students' learning experience does this course make?
- What is the value of taking this course? How exactly does it enrich the program or department?

8. WRITING EXPECTED LEARNING OUTCOMES FOR A COURSE

The following pages should be of assistance in developing several broad, effectively stated expected learning outcomes for a course. When beginning to construct expected learning outcome statements, it is always good to think about the learners.

Please take a moment to think about the student learners in the course. Please consider the following questions:

- What are the most essential things the students need to know or be able to do at the end of this course?
- What knowledge and skills will they bring with them?
- What knowledge and skills should they learn from the course?

When you begin thinking about the expected learning outcomes for a course, it is a good idea to think broadly. Course-level expected learning outcomes do not need to focus on small details; rather, they address entire classes of theories, skill sets, topics, etc.

The "Course Description" contains the following contents: **(Annexure - A)**

- Course Overview
- Prerequisite(s)
- Marks Distribution
- Evaluation Scheme
- Course Objectives
- Course Outcomes
- How Program Outcomes are assessed
- How Program Specific Outcomes are assessed
- Syllabus
- List of Text Books / References / Websites / Journals / Others
- Course Plan
- Mapping course objectives leading to the achievement of the program outcomes and program specific outcomes
- Mapping course outcomes leading to the achievement of the program outcomes and program specific outcomes

9. REFERENCES

1. American Association of Law Libraries (2005). *Writing learning outcomes.*
2. Retrieved May 31, 2005 from http://www.aallnet.org/prodev/outcomes.asp .
3. Anderson, L.W., and Krathwohl, D.R. (Eds.) (2001). A taxonomy of learning, teaching, and assessment: A revision of Bloom's taxonomy of educational objectives. New York: Longman.
4. Angelo, T.A. & Cross, K.P. (1993). Classroom assessment techniques: A handbook for college teachers (2nd Ed.). San Francisco, CA: Jossey-Bass. Ball State University, (1999).

5. *Bloom's Classification of Cognitive Skills*. Retrieved
6. June 10, 2005 from http://web.bsu.edu/IRAA/AA/WB/chapter2.htm .
7. Bloom, B.S., (1956) Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain. Longmans, Green: New York, NY.
8. Hales, L.W. & Marshall, J.C. (2004). Developing effective assessments to improve teaching and learning. Norwood, MA: Christopher-Gordon Publishers, Inc.
9. Huba, M.E., (2005). Formulating intended learning outcomes. Retrieved June 16, 2005
10. Fromhttp://www.viterbo.edu/academic/titleiii/events/files/Jun04/Intended%20Learning %20Outcomes.ppt#256,1,Formulating Intended Learning Outcomes .
11. Kansas State University, (2004). *Assessment of student learning plan*. Retrieved
12. May 15, 2005 from http://www.k-state.edu/assessment/Library/templatew.doc.
13. Kansas State University, (2004). *Form for identifying strategies and processes for*
14. *the assessment of student learning outcome(s)*. Retrieved May 15, 2005 from http://www.k-state.edu/assessment/Library/strategies.pdf .
15. Kansas State University, (2005). *How to write student learning outcomes: Action*
16. *verb List – suggested verbs to use in each level of thinking skills*. Retrieved May 15, 2005 from http://www.k-state.edu/assessment/Learning/action.htm.
17. Krumme, G (2001). *Major categories in the taxonomy of educational objectives*
18. *(Bloom 1956)*. Retrieved June 6, 2005 from http://faculty.washington.edu /krumme/guides/bloom1.html .
19. Maki, P.L. (2004). Assessing for learning: Building a sustainable commitment across the institution. Stylus: Sterling, VA.
20. Palomba, C.A. & Banta, T.W. Eds. (2001). Assessing student competence in accredited disciplines: Pioneering approaches to assessment in higher education. Stylus: Sterling, VA.
21. Siebold, R. & Beal, M. (May 2005). Online course development guide: The workbook. Presented at The Teaching Professor Conference in Shaumburg, IL.
22. Suskie, L. (ed) (2001). Assessment to promote deep learning: Insight from AAHE's 2000 and 1999 Assessment Conferences.
23. Suskie, L. (2004). Assessing student learning: A common sense guide. Anker Publishing Company: Bolton, MA.
24. St. Edward's University Center for Teaching Excellence (2004). *Task Oriented Question*
25. *Construction Wheel Based on Bloom's Taxonomy*. Retrieved on May 17, 2005 from http://www.stedwards.edu/cte/resources/bwheel.htm.
26. Texas Tech University (2005). Texas Tech University 2005-06 Undergraduate and Graduate Catalog Volume LXXXII. Published by the Office of Official Publications: Lubbock.
27. TX. Texas Tech University Office of the Ombudsman, (2005). Syllabus Guide for Faculty: Tips for creating a conflict free syllabus. Retrieved June 9, 2005 from
28. http:// www.depts.ttu.edu/ombudsman/publications/SyllabusGuideforFaculty.doc.

ANNEXURE - A: SAMPLE COURSE DESCRIPTION (As per NBA norms post June, 2015**)**

INSTITUTE OF AERONAUTICAL ENGINEERING
Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	**GEOTECHNICAL ENGINEERING**				
Course Code	ACE006				
Programme	B.Tech				
Semester	IV	CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mrs. J. Hymavathi, Assistant Professor				
Course Faculty	Mr. Y. Ravi Kumar, Assistant Professor				

I. COURSE OVERVIEW:

Civil Engineers are required to construct structures on the soil. The loads coming onto these structures, along with the self-weight, have to be safely transmitted to the soil beneath it. A geotechnical engineer must be able to design a footing in such a way that soil below it will not fail there will not be any excessive settlements in the soil. This foundational course in civil engineering is intended to introduce to concepts of types of soils present in nature, properties of soil on which the load carrying capacity of the soil depends For this, the concept of (a) types of soil present in nature and their properties which in turn effect the load carrying capacity of soil, (b) shear strength of the soils, (c) settlement reduction by compaction and consolidation are covered in depth. The important calculations of stresses due to self weight and externally applied loads and the consequent theory of failures for prediction of the strength of the soils are also discussed. Through this course content engineers can design the foundation for safety and serviceability.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Geotechnical Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✔	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments/ Exams
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Assignments/ Exams
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignments/ Mini project
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Open Ended Experiments
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	Mini Project
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Seminars/Mini Project
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	Seminars/ Workshop

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Engineering Knowledge**: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	2	Assignments/ Exams
PSO 2	**Broadness and Diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	-	-
PSO 3	**Self-Learning and Service:** Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	1	Seminars/ Workshop

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Identify the type of soil based on index properties of soils, soil formation & its structure
II	Recognize the importance of permeability for calculating the seepage through soils. Find out the coefficient of permeability using various laboratory & field tests.
III	Analyze the stress at any point below the ground surface due to self weight and externally applied load. Interpret the importance of consolidation and compaction on the settlement of footing.
IV	Recognize the importance of shear strength in load carrying capacity of soil. Calculate the shear strength of soil using various laboratory tests.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACE006.01	CLO 1	Calculate the unit weights in various field conditions using different relationships	PO 1, PO 3, PO4, PO6, PO9	2
ACE006.02	CLO 2	Examine water content, specific gravity, bulk density and dry densities of a soil using various laboratory and field tests.	PO1,PO2, PO4,PO12	1
ACE006.03	CLO 3	Identify the type of soil present in the site by using particle size distribution curve & other index properties of soils as per IS soil classification system	PO3	1
ACE006.04	CLO 4	Find the Atterberg limits of soils which is used in classifying the fine grained soils	PO3	1
ACE006.05	CLO 5	Understand the permeability of soil & find out the range of coefficient of permeability in various soil types.	PO1,PO3 PO9	1
ACE006.06	CLO 6	Explain the importance of permeability in calculation of seepage through earthen dams, amount of water to be pumped when the soil is excavated below ground water table.	PO3,PO4, PO6	1
ACE006.07	CLO 7	Evaluate the coefficient of permeability using falling head tests and constant head tests	PO3,PO4, PO9,PO12	1
ACE006.08	CLO 8	Evaluate the coefficient of permeability using pumping in and pumping out tests	PO4,PO6, PO9	2
ACE006.09	CLO 9	Calculate the stresses beneath the ground level due to self weight of soil	PO1,PO2, PO3,PO12	1
ACE006.10	CLO 10	Analyze the importance of total, neutral and effective stress in load carrying capacity of soil	PO1,PO2, PO4,PO6, PO12	1
ACE006.11	CLO 11	Sketch the total, neutral and effective stress distribution diagram for various field conditions	PO1,PO2, PO4,PO12	1
ACE006.12	CLO 12	Explain quick sand condition, its occurrence and its significance	PO1,PO2, PO3,PO4, PO12	1
ACE006.13	CLO 13	Understand the importance of flow net in calculating seepage loss, uplift pressure, exit hydraulic gradient	PO1,PO2, PO3,PO4	1
ACE006.14	CLO 14	Calculate the stress below the ground due to externally applied load using Boussinesq's theory	PO1,PO2, PO3,PO4	1
ACE006.15	CLO 15	Calculate stress due to load using Westergaard's and approximate method of stress distribution	PO1,PO2, PO4,PO12	1
ACE006.16	CLO 16	Importance of compaction in reducing the immediate settlement, improving the load carrying capacity	PO1,PO2, PO3,PO4, PO12	1
ACE006.17	CLO 17	Determining the maximum dry density and optimum moisture content of soil using standard proctor test soil.	PO1,PO2, PO3,PO4,	1

		List the various field equipments used for compacting the different types of soils.	PO9,PO12	
ACE006.18	CLO 18	Recognize the importance of consolidation in settlement calculation & calculate the consolidation settlement especially in clayey soils.	PO1,PO2, PO3,PO4, PO12	1
ACE006.19	CLO 19	Determination of consolidation parameters of a soil using laboratory test such as using square root of time fitting method, logarithmic square method and height of solids method.	PO1,PO2, PO3,PO4, PO12	1
ACE006.20	CLO 20	Understand the shear failure criteria proposed by Mohr-coulomb and shear parameters of soil	PO1,PO2, PO3,PO12	2
ACE006.21	CLO 21	Determination of shear strength of soil using direct shear test and tri-axial test in various drainage conditions.	PO1,PO2, PO3,PO9, PO12	2
ACE006.22	CLO 22	Recognize the behavior of soil in normal, over and under consolidated soil. Understand the concept of dilatancy in sandy soil.	PO1,PO2, PO3,PO4, PO6,PO12	1
ACE006.23	CLO 23	Posses the Knowledge and Skills for employability and to succeed in national and international level competitive examinations.	PO1,PO2, PO3,PO4, PO6,PO12	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLO	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3		2	1		1			1				3		
CLO 2	2	3		1								1	1		
CLO 3			3												1
CLO 4			2										3		
CLO 5	2		1						2				2		
CLO 6			3	1		1							3		
CLO 7			2	1					2			1	3		1
CLO 8				3		1			3				1		
CLO 9	3	3	1									1	3		1
CLO 10	3	2		1		1						1	3		1
CLO 11	2	2		1								1	1		1
CLO 12	2	1	1	1								1	1		
CLO 13	2	2	1	1									2		1
CLO 14	2	3	2	2									1		2
CLO 15	3	3		1								1	3		1

CLO 16	2	2	1	1								2	2		1
CLO 17	2	1	1	2					2			1			1
CLO 18	3	3	1	1								2	3		1
CLO 19	2	2	1	1								1	2		1
CLO 20	1	2	2									1			
CLO 21	3	2	1						2			1	3		
CLO 22	2	1	1	1		1						1	2		
CLO 23	1	1	1	1		1						1			1

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO2, PO3, PO4, PO6, PO 9, PO12	SEE Exams	PO1,PO2,PO3, PO4, PO6, PO9, PO12	Assignments	PO 1, PO2, PO3	Seminars	PO 9, PO12
Laboratory Practices	PO 1	Student Viva	PO1,PO2,PO3, PO4, PO6, PO9, PO12	Mini Project	PO3, PO6,PO9	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	**INTRODUCTION AND INDEX PROPERTIES OF SOILS**
Soil formation, clay mineralogy and soil structure, moisture content, weight-volume relationships, relative density. Grain size analysis, sieve analysis, principle of hydrometer method, consistency limits and indices, I.S. classification of soils.	
Unit-II	**PERMEABILITY, EFFECTIVE STRESS AND SEEPAGE THROUGH SOILS**
Capillary rise, flow of water through soils, Darcy's Law, Permeability, Factors affecting permeability, Laboratory & field tests for determination of coefficient of permeability, Permeability of layered soils.Total, neutral and effective stress, upward & downward seepage through soils, quick sand condition, flow nets: characteristics and uses.	
Unit-III	**STRESS DISTRIBUTION IN SOILS & COMPACTION**

Boussinesq's theory for point load, uniformly loaded circular and rectangular areas, Westergaard's theory for point load condition, pressure bulb, variation of vertical stress under point load along vertical and horizontal plane, Newmark's influence chart for irregular areas. Mechanism of compaction, factors affecting compaction, effects of compaction on soil properties, field compaction equipment and compaction quality control.
Unit-IV **CONSOLIDATION**
Types of compressibility, immediate settlement, primary consolidation and secondary consolidation, stress history of clay, e-p and e-log p curves, normally consolidated soil , over and under consolidated soil, pre-consolidation pressure and its determination, Terzaghi's 1-D consolidation theory, coefficient of consolidation square root time and logarithm of time fitting methods, computation of total settlement and time rate of settlement.
Unit-V **SHEAR STRENGTH OF SOILS**
Importance of shear strength, Mohr's-Coulomb failure theories, types of laboratory tests for strength parameters, strength tests based on drainage conditions, strength envelops, shear strength of sands, dilatancy, critical void ratio, liquefaction, shear strength of clays.
Text Books:
1. Braja M. Das, "Principles of geotechnical engineering" Cengage learning publishers, 2002 2. VNS Murthy, "Soil mechanics and foundation engineering", CBS publishers and distributors, 2003. 3. Gopal Ranjan and ASR Rao, "Basic and Applied Soil Mechanics", New age international Pvt. Ltd, New Delhi, 2000.
Reference Books:
1. C. Venkataramiah, "Geotechnical engineering", New Age International Pvt. Ltd, 2002. 2. Manoj dutta and Gulati, "Geotechnical engineering", Tata Mc Grawhill publishers New Delhi, 2005. 3. K.R .Arora, "Soil mechanics and foundation engineering", standard publishers and distributors, New Delhi, 2005. 4. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, "Soil mechanics and foundation", Laxmi publications Pvt. Ltd, New Delhi, 2005.

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction to geotechnical engineering, properties of soils	CLO 1	T1:1.1, R2:2.2
3	Formation of soil and soil structures	CLO 1	T1:1.4, R2:2.3
4	Clay mineralogy and adsorbed water	CLO 2	T:6.6, R2:2.6
5-6	Mass volume relationship	CLO 2	T1:3.1, R2:2.8
7	Relative density	CLO 4	T3:3.15,R2:2.9
8-9	Index properties of soils: grain sizes analysis	CLO 3	T1:3.3, R2:2.10
10-11	Sieve and hydrometer method of analysis	CLO 3	T1:3.8, R2:2.11
12-13	Consistency limit and indices of soil	CLO 4	T1:3.9, R2:2.12
14	I.S. classification of soils	CLO 3	T1:4.3, R2:2.13
15-16	Permeability - soil water –capillary rise	CLO 5	T1:5.9, R1:3.1
17-18	Flow of water through soil	CLO 5	T1:5.4, R1:3.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
19-20	Darcy's law	CLO 6	T1:5.4.1, R1:3.3
21-22	Permeability and factors effecting, laboratory determination of coefficient of permeability	CLO 7	T1:5.6, R1:3.4
23-24	Permeability of layered systems	CLO 8	T1:5.8, R1:3.4.1
25-26	Seepage through soils –total, neutral and effective stresses quick sand conditions	CLO 12	T1:6.9 to 6.10, R1:3.5
27	Seepage through soils	CLO 11	T1:6.5, R1:3.5.2
28-30	Flow nets, characteristics and uses	CLO 13	T1:6.3 , R1:3.6
31	Stress distribution in soils – Boussinesq's theory for point loads and areas of different shapes	CLO 14	T1:7.22, R2:4.6
32-33	Westergaard's theory for point loads and area of different shapes	CLO 15	T1:7.22, R2:4.7
34-35	Newmark's influences chart	CLO 15	T1:12.3.2, R2:4.8
36-37	Compaction- mechanism of compaction	CLO 16	T1:12.6.1, R1: 4.1
38	Factors effecting compaction of soils properties	CLO 16	T1:12.6.2, R1: 4.1.2
39-40	Effect of compaction on soil properties	CLO 17	T1:12.6.2, R1: 4.2
41-42	Field compaction equipment	CLO 17	T1:12.6.2, R1: 4.3
43-44	Compaction control	CLO 17	T1:12.6.3, R1: 4.4
45-46	Consolidation –stress history of clay	CLO 18	T1:7.4, R1: 6.1
47-49	e-p and e- log p curves	CLO 19	T1:10.2.1, R1: 6.4
50-52	Magnitude and rates of 1-d consolidation	CLO 19	T1:10.2.4, R1: 6.6
53-54	Terzaghi's theory	CLO 18	T1:10.7, R1: 6.7
55-57	shear strength of soils –Mohr and Coulomb failure theories	CLO 20	T1:8.4.2, R2: 8.1
58-60	Types of laboratory strength test	CLO 21	T1:8.8, R2: 8.2
61-62	Strength test based on drainage conditions	CLO 21	T1:8.12.2, R2: 8.2.4
63-64	Shear strength of sands	CLO 22	T1:8.11.3, R2: 8.4
65-66	Critical void ratio of clay	CLO 22	T1:8.11.2, R2: 8.5
67-68	Liquefaction and shear strength of clay	CLO 22	T1:8.12, R2: 8.6

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Methods for obtaining flow nets, seepage in anisotropic soils	Seminars/Guest Lectures/NPTEL	PO 3, PO 4	PSO 1

2	Stresses in soil due to externally applied line, strip and trapezoidal loading	Seminars/Guest Lectures/NPTEL	PO 1	PSO 1
3	Fields tests to determine the shear strength of soils	Seminars/NPTEL	PO 4	PSO 1

Prepared by:
Mrs. J. Hymavathi, Assistant Professor

HOD, CIVIL ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043.

CIVIL ENGINEERING DEPARTMENT

COURSE DESCRIPTOR

Course Title	**CONCRETE TECHNOLOGY**				
Course Code	ACE010				
Programme	B.Tech				
Semester	V	CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. N Venkat Rao, Assistant Professor				
Course Faculty	Mr. N Venkat Rao, Assistant Professor Mr. Suraj Baraik, Assistant Professor				

I. COURSE OVERVIEW:

Concrete technology provides a comprehensive coverage of the theoretical and practical aspects of the subject and includes the latest developments in the field of concrete construction. It incorporates the latest Indian standard specifications and codes regulating concrete construction. The properties of concrete and it constituent materials and the role of various admixtures in modifying these properties to suit specific requirements, such as ready mix concrete, reinforcement detailing, disaster-resistant construction, and concrete machinery have been treated exhaustively the and also special concrete in addition to the durability maintenance and quality control of concrete structure**.**

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	ACE007	IV	Building Material Construction and Planning

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Concrete Technology	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✘	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	1	Presentation on real-world problems
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Open Ended Experiments
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Open Ended Experiments
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations	1	Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Engineering knowledge:** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication	2	Assignments
PSO 2	**Broadness and Diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	1	Open Ended Experiments
PSO 3	**Self-learning and Service:** Graduates will be motivated for continuous self-learning in engineering practice and/ or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	1	Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Discuss the physical and chemical properties of cement and admixtures
II	Understand the workability of concrete, manufacturing processes of concrete and the behavior of the hardened concrete
III	Identify, formulate and solve problems in concrete mix design
IV	Enrich the practical knowledge on mix design principles, concepts and methods.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACE002.01	CLO 1	Explain the different types of cement, grades of cement and hydration process.	PO1; PO3	2
ACE002.02	CLO 2	Classify different types of admixture and their usage.	PO2;PO5	1
ACE002.03	CLO 3	Understand aggregates and classification of aggregate depending upon shape, size, texture etc.	PO1;PO3	2
ACE002.04	CLO 4	Understand the Alkali Aggregate Reaction.	PO1;PO4	2
ACE002.05	CLO 5	Understand Sieve Analysis and grading of aggregate.	PO2;PO3; PO5	2
ACE002.06	CLO 6	Understand the concept of workability of concrete and factors affecting workability.	PO1;PO2; PO4	2
ACE002.07	CLO 7	Explain the measurement of workability by different test.	PO3	2
ACE002.08	CLO 8	Understand the concept of segregation and bleeding in concrete.	PO1;PO4; PO5	2
ACE002.09	CLO 9	Explain the various steps involved in the manufacturing process of concrete.	PO3	2
ACE002.10	CLO 10	Understand the importance of quality of mixing water.	PO2;PO3	2
ACE002.11	CLO 11	Understand hardened concrete and its properties.	PO2;PO4; PO5	1
ACE002.12	CLO 12	Explain the importance of water cement ratio, maturity concept in hardened concrete	PO1	2
ACE002.13	CLO 13	Understand the various methods of curing of concrete.	PO1;PO2; PO3;PO5	2
ACE002.14	CLO 14	Explain the different tests involved in testing of hardened concrete.	PO2	1
ACE002.15	CLO 15	Understand the concept of creep and how it effects hardened concrete.	PO2;PO3; PO5	1
ACE002.16	CLO 16	Explain shrinkage and its effect on concrete.	PO1;PO4	2
ACE002.17	CLO 17	Understand the importance of Mix proportions.	PO2;PO3	2
ACE002.18	CLO 18	Understand durability and quality control of concrete.	PO2;PO5	1
ACE002.19	CLO 19	Explain Acceptance criteria involved in concrete mix proportioning.	PO2;PO3; PO4	2
ACE002.20	CLO 20	Explain proportioning of concrete method by different methods.	PO1	2
ACE002.21	CLO 21	Design the concrete mix by BIS method.	PO2;PO3; PO4;PO5	2
ACE002.22	CLO 22	Explain the different types of special concrete.	PO1	2
ACE002.23	CLO 23	Explain the effect of fibre in the concrete.	PO1;PO4	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3		3											2	2
CLO 2		2			2								2		
CLO 3	3		3											1	
CLO 4	1			3										1	
CLO 5		1	3		1								2		
CLO 6	1	1		3										2	
CLO 7			3											1	
CLO 8	3			3	1								1		
CLO 9			2											2	
CLO 10		1	1											2	
CLO 11		2		3	1								2		1
CLO 12	3														1
CLO 13	1	2	2		1										2
CLO 14		1													2
CLO 15		1	1		2								2		
CLO 16	3			3										1	
CLO 17		2	1											2	
CLO 18		2			2									2	
CLO 19		2	1	2									2		
CLO 20	3													1	2
CLO 21		1	2	1	2										1
CLO 22	2													2	
CLO 23	3			2									1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1; PO2; PO5	SEE Exams	PO 1; PO2; PO5	Assignments	PO 2	Seminars	-
Laboratory Practices	PO 5	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Unit-I	CEMENT ADMIXTURES AND AGGREGATES
Portland cement :chemical composition , hydration, setting of cement , structure of hydrate cement , test on physical properties , different grades of cement Admixtures: Mineral and chemical admixtures, properties, dosage, effects usage. Aggregates: Classification of aggregate, particle shape & texture bond, strength & other mechanical properties of aggregate, specific gravity, bulk density, porosity, adsorption & moisture content of aggregate, bulking of sand, deleterious substance in aggregate, soundness of aggregate , alkali aggregate reaction, thermal properties, sieve analysis, fineness modulus, grading curves, grading of fine & coarse aggregates, gap graded aggregate, maximum aggregate size.	
Unit-II	**FRESH CONCRETE**
Workability :factors affecting workability , measurement of workability by different tests, setting times of concrete, effect of time and temperature on workability, segregation & bleeding, mixing and vibration of concrete, steps in manufacture of concrete, quality of mixing water.	
Unit-III	**HARDENED CONCRETE AND ITS TESTING**
Water / Cement ratio: Abram's Law, Gel space ratio, Nature of strength of concrete, Maturity concept, Strength in tension & compression, factors affecting strength, relation between compression & tensile strength curing. Testing of hardened concrete: compression tests, tension tests, factors affecting strength, flexure tests, splitting tests, non-destructive testing methods, codal provisions for NDT. elasticity, creep & shrinkage, modulus of elasticity, dynamic modulus of elasticity, Poisson's ratio, creep of concrete, factors influencing creep, relation between creep & time, nature of creep, effects of creep, shrinkage, types of shrinkage.	
Unit-IV	**MIX DESIGN**
Factors in the choice of mix proportions, Durability of concrete, Quality Control of concrete, Statistical methods, Acceptance criteria, Proportioning of concrete mixes by various methods, BIS method of mix design	
Unit-V	**SPECIAL CONCRETE**
Light weight aggregates, light weight aggregate concrete, cellular concrete , no fines concrete, high density concrete, fiber reinforced concrete, different types of fibers , factors affecting properties of F.R.C, applications, polymer concrete, types of polymer concrete, properties of polymer concrete applications, high performance concrete, self consolidating concrete SIFCON	
Text Books:	
1. Shetty, M.S., "Concrete Technology, Theory & Practice", S. Chand and Co, 2004. 2. Gambhir, M.L., "Concrete Technology", Tata McGraw Hill, 2004.	
Reference Books:	

1.V.N.Vazirani & S.P.Chandola, Ed. by Vineet Kumar," Concrete technology", 6th edition reprint.
2.Santakumar A.R., "Concrete Technology", Oxford University Press, New Delhi, 2007..

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	History of port land cement	CLO 1	T1: 1.1-1.2
2	Manufacturing of Portland cement	CLO 2	T1: 1.3-1.5
3	Chemical composition & bogues compounds of Portland cement.	CLO 3	T1: 1.6-1.7
4-5	Hydration, setting of cement, structure of hydrate cement	CLO 2	T1: 2.8-2.11
6-7	Test on physical properties	CLO 6	T1:2.1-.2.6
8-9	Different grades of cement	CLO 7	T1: 2.6-2.10
10	Classification of aggregate, particle shape and texture, bond, strength and other mechanical properties of aggregate	CLO 9	T1: 4.1-4.4
11	Specific gravity, bulk density, porosity, adsorption and moisture content of aggregate, bulking of sand, deleterious substance in aggregate	CLO 10	T1: 4.6-4.7
12-13	Soundness of aggregate, alkali aggregate reaction, thermal properties	CLO 11	T2 :7.13-16
14	Sieve analysis, fineness modulus, grading curves, grading of fine and coarse aggregates, gap graded aggregate, maximum aggregate size	CLO 12	T2:7.17-19
15-16	Introduction, workability, factors affecting workability	CLO 13	T2: 7.20
17	Measurement of workability by different tests, setting times of concrete	CLO 11	T1:17.1-17.3
18	Effect of time and temperature on workability, segregation and bleeding	CLO 10	T1: 17.4-17.5
19	Mixing and vibration of concrete, steps in manufacture of concrete, quality of mixing water	CLO 14	T1: 17.5-17.7
20	Water / cement ratio, Abram's law, gel space ratio and problems	CLO 14	T1: 17.8
21	Nature of strength of concrete, maturity concept, strength in tension and compression	CLO 12	T1: 17.9
22-23	Factors affecting strength, relation between compression and tensile strength, curing	CLO 14	T1: 17.12
24-25	Introduction on hardened concrete	CLO 14	T1: 14.7
26	Compression tests, tension tests	CLO 17	T1:15.1-3
27	Factors affecting strength, flexure tests	CLO 17	T1:15.3-4
28-30	Splitting tests, non-destructive testing methods, codal provisions for NDT.	CLO 19	T1:15.5
31-32	Modulus of elasticity, dynamic modulus of elasticity, Poisson's ratio	CLO 19	T1:15.6
33-34	Creep of concrete, factors influencing creep, relation between creep and time	CLO 20	T1:15.7
35-36	Nature of creep, effects of creep	CLO 20	T1:15.7
37-38	Shrinkage, types of shrinkage.	CLO 21	T1:15.8
39	Problems on modulus of elasticity, shrinkage, creep of concrete	CLO 22	T1:15.8
40-41	Introduction on different mixes of concrete	CLO 23	T1:15.8
42	Factors in the choice of mix proportions, durability of concrete	CLO 23	T1:15.9

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
43	Quality control of concrete, statistical methods	CLO 23	T1:15.9
44	Acceptance criteria, proportioning of concrete mixes by various methods	CLO 23	T1:15.3-4
45	BIS method of mix design	CLO 23	T1:15.5
46	Problems on different mix designs of concrete.	CLO 23	T1:15.6
47-48	Introduction to special concrete	CLO 23	T1:15.7
49	Light weight aggregates, light weight aggregate concrete	CLO 18	T1:15.7
50	Cellular concrete, no-fines concrete, high density concrete	CLO 23	T1:15.8
51	Fibre reinforced concrete, different types of fibres, factors affecting properties of f.r.c	CLO 18	T1:15.8
52	Applications, polymer concrete, types of polymer concrete, properties of polymer concrete	CLO 23	T1: 12.1-12.2
53-54	Applications, high performance concrete, self-consolidating concrete, sifcon	CLO 20	T1: 12.3-12.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Design a concrete mix for lower grade concrete using BIS	Seminars	PO 1	PSO 1
2	Design a concrete mix for higher grade concrete using BIS	Seminars / NPTEL	PO 5	PSO 1

Prepared by:
Mr. N Venkat Rao, Assistant Professor

HOD, CIVIL ENGINEERING