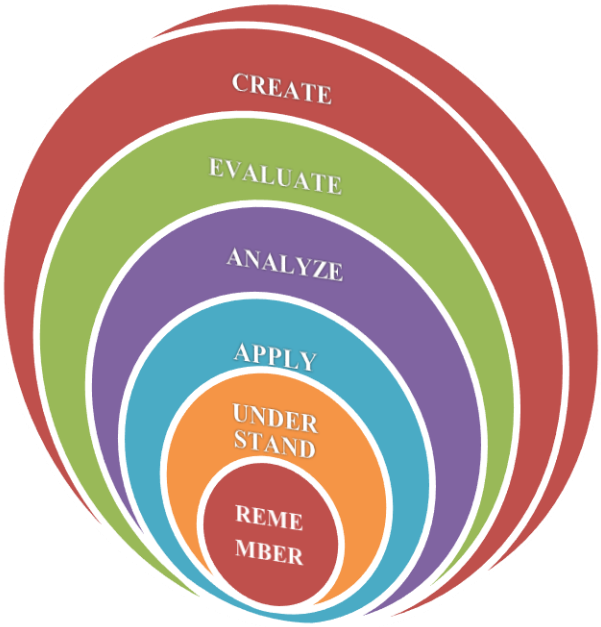
OUTCOME BASED EDUCATION BOOKLET

B.Tech
CIVIL ENGINEERING

For the batch of students admitted during
Academic Year 2015-2016



.....Moving Towards Perfection in Engineering

VISION

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 exceptional education in civil engineering through quality teaching, state-of-the-art facilities and dynamic guidance to produce civil engineering graduates, who are professionally excellent to face complex technical challenges with creativity, leadership, ethics and social consciousness.

CONTENTS

S. No.		Page No.
PART- I PROGRAM EDUCATIONAL OBJECTIVES AND OUTCOMES 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 – 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 a Development of Expected Learning Outcomes for a Course	
9	References	
ANNEXURES		

A	Sample Course Description (as per NBA norms post June , 2015)	

Part – I

Genesis and Growth

The Department of Civil Engineering was established in the year 2008 with a student intake of 30. The intake has been increased to 60 in 2009 and to 120 in 2013. Besides, an additional 20% seats are under lateral entry scheme.

The department also started offering a two year M.Tech program in Structural Engineering specialization with an intake of 24 from the year 2014.

The department since its formation is committed to development in teaching and research. It strived to offer exposure to students to various challenges in Structural Engineering, Geotechnical Engineering, Environmental Engineering, and Transportation Engineering. It also handles consultancy works and projects.

It consists of well qualified, experienced and dedicated faculty and committed supporting staff. The department is headed by *Prof* J S R Prasad with a total experience of 15 years. Currently, he is ably supported by two eminent professors, Dr. K Narasimha Murthy, Dr. Akshay S. K. Naidu, two Associate Professors, thirteen Assistant Professors and two Scientific Officers.

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.

Goals

- To impart value-based education and motivate students to focus their efforts in the right direction.
- Design and equip the laboratories in the department to the emerging needs of the technology.
- Achieve 100% pass percentage in external examinations.
- Near 100% placement of all eligible students of the department.
- Establishing MoUs with reputed industries and universities for research, knowledge sharing and student placements.

Civil Engineering Department Advisory Council: The Civil Engineering Department Advisory Council (CEDAC) includes a diverse group of experts from academe 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 CEDAC report indicating improvements and amendments to the program.

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes, 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 (below).

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 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
    - 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 OUTCOMES

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

Program Outcomes	
	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.

PROGRAM SPECIFIC OUUTCOMES

PSO1. UNDERSTANDING: 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

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

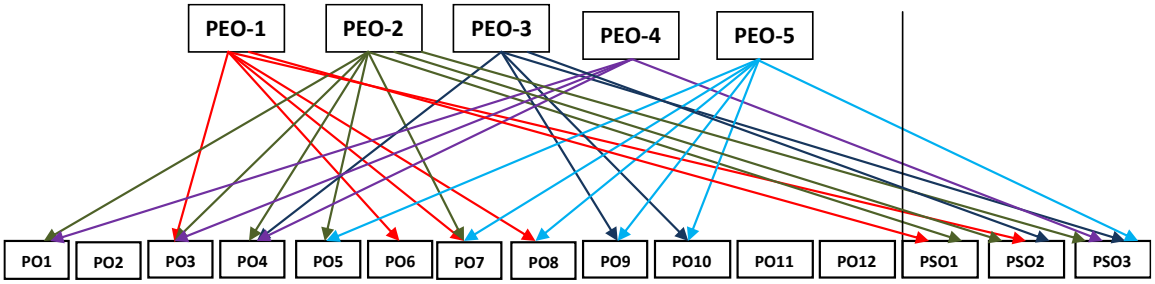


Figure 1: Correlation between the PEOs and the POs and PSOs

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

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. UNDERSTANDING:** Graduates will have an ability to describe, analyze, and solve problems using mathematics and systematic problem-solving techniques. **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 & 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 & 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*	**PO1: Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex

engineering and related fields.	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 & 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 & 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 3 shows the correlation between the PEOs and the Program Outcomes

Table 3: 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 ENGINEERING GRADUATES

Graduates from accredited programs 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 analyse 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

- Comprehension and thorough understanding of the underlying physical and mathematical concepts involved in all sub-branches of civil engineering
- Ability to analyze and communicate the technical intricacies of the problem at hand and the solutions
- Ability to analyze experimental and survey data to derive meaningful technical conclusions
- Ability to use fundamental civil engineering concepts to solve problems

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

- Ability to comprehend and analyze the economic, environmental and social constraints in planning and executing a civil engineering project
- Ability to design civil engineering structures considering public safety and long-term sustainability
- Ability to plan, design and execute the projects ensuring health and safety of all the workers involved and also the ecosystem.

PSO3. SELFLEARNING AND SERVICE - Graduates will have a broad education necessary to understand the impact of engineering solutions in a global, economic, and societal context.

Performance Criteria Definitions

- Having basic understanding of the other engineering disciplines and ability to correlate interrelation of civil engineering with other engineering disciplines

Courses offered in Civil Engineering Curriculum (JNTUH-R13) –Vs- Program Outcomes and Program Specific Outcomes Attained through course modules for II-II, III-I, III-II, IV-I, IV-II 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 B. Tech																
A10001	English						X	X	X		X		X			X
A10002	Mathematics - I	X	X													
A10003	Engineering Mechanics	X	X													
A10004	Engineering Physics	X	X													
A10005	Engineering Chemistry	X	X													
A10501	Computer Programming	X	X											X	X	
A10301	Engineering Drawing	X	X	X	X					X		X	X			
A10581	Computer Programming Lab	X	X	X									X	X	X	X
A10081	Engineering Physics & Engineering Chemistry Lab	X			X											
A10083	English Language Communication Skills Lab					X			X	X	X		X			X
A10082	IT Workshop/ Engineering Workshop	X				X							X	X		
II B. Tech I Semester																
A30006	Mathematics-II	X	X													
A30203	Electrical & Electronics Engineering	X	X											X	X	
A30107	Strength of Materials - 1	X	X	X										X	X	
A30108	Surveying	X	X				X		X					X		
A30101	Fluid Mechanics	X	X	X		X	X			X			X	X		X
A30010	Managerial Economics and Financial Analysis		X	X	X	X			X	X	X	X	X	X		
A30185	Surveying Lab -1		X										X			
A30183	Strength of Materials Lab		X	X									X	X	X	X
II B. Tech II Semester																
A40008	Probability & Statistics	X	X				X	X						X		
A40114	Strength of Materials - II	X	X		X	X			X					X	X	
A40111	Hydraulics & Hydraulic Machinery	X	X		X	X			X					X	X	
A40009	Environmental Studies						X	X	X				X			
A40115	Structural Analysis-1	X	X				X							X		
A40109	Building Materials, Construction & Planning	X	X	X	X		X	X						X	X	
A40186	Computer Aided Drafting of Buildings		X	X		X							X	X	X	X
A40190	Surveying Lab-II		X	X									X	X	X	X
III B. Tech I Semester																

Code	Subject	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03
A50116	Concrete Technology	X	X											X		
A50121	Reinforced Concrete Structures Design and Drawing						X		X	X						X
A50118	Engineering Geology	X	X				X		X	X				X	X	
A50120	Geotechnical Engineering	X					X	X							X	
A50122	Water Resources Engineering-1	X		X	X								X	X		
A50117	Disaster Management	X	X	X		X									X	
A50017	Intellectual Property Rights	X	X												X	X
A50018	Human Values and Professional Ethics	X	X	X									X		X	X
A50181	Fluid Mechanics & Hydraulic Machinery Lab		X											X	X	X
A50191	Engineering Geology Lab		X											X	X	X
III B. Tech II Semester																
A60130	Steel Structures Design and Drawing	X	X	X									X	X		X
A60119	Environmental Engineering	X	X	X	X									X	X	X
A60132	Transportation Engineering-1	X	X	X		X						X		X	X	X
A60126	Foundation Engineering	X		X		X								X		X
A60131	Structural Analysis-II	X	X							X		X				X
A60123	Elements of Earthquake Engineering	X	X	X		X								X	X	X
A60127	Ground Improvement Techniques		X	X		X							X	X	X	X
A60128	Ground Water Hydrology					X			X		X		X			X
A60124	Environmental Impact Assessment	X					X	X	X						X	X
A60129	Principles of Entrepreneurship						X				X	X			X	
A60194	Geotechnical Engineering Lab	X	X		X						X			X	X	
A60086	Advanced Communication Skills Lab									X	X				X	X
IV B. Tech I Semester																
A70140	Remote Sensing & GIS	X	X											X	X	
A70143	Transportation Engineering-II	X	X	X										X		
A70138	Estimating & Costing	X		X	X	X	X	X	X	X	X	X	X	X	X	X
A70133	Water Resources Engineering-II	X	X	X		X							X	X	X	X
A70330	Finite Element Methods	X	X		X		X	X		X				X		X
A70134	Advanced Foundation Engineering	X	X											X		
A70145	Watershed Management	X	X	X	X	X								X	X	
A70136	Air Pollution and Control	X	X			X								X	X	
A70135	Advanced Structural Design		X							X		X				X
A70137	Earth and Rock fill Dams and Slope Stability	X	X	X		X								X	X	
A70144	Water Resources Systems Analysis	X	X	X	X									X	X	
A70139	Industrial Waste Water Treatment	X	X											X	X	
A70195	Concrete & Highway Materials Lab	X	X	X	X									X	X	
A70192	Environmental Engineering Lab	X	X			X			X					X	X	
IV B. Tech II Semester																

Code	Subject	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03
A80151	Rehabilitation and Retrofitting of Structures (Elective IV)	X					X			X		X				X
A80148	Geo-environmental Engineering (Elective IV)	X	X	X		X							X	X	X	X
A80147	Design and Drawing of irrigation Structures (Elective IV)	X				X			X					X		
A80141	Solid Waste Management (Elective IV)	X				X			X					X		
A80150	Prestressed Concrete Structures	X				X			X				X	X		X
A80146	Construction Management	X	X	X										X	X	X
A80087	Industry Oriented Mini Project	X	X	X										X	X	
A80089	Seminar	X	X	X			X		X					X	X	X
A80088	Project Work	X	X	X										X		
A80090	Comprehensive Viva	X	X	X		X				X	X			X	X	

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.			
A40008	Probability & Statistics	A60126	Foundation Engineering
A40114	Strength of Materials – II	A60131	Structural Analysis-II
A40111	Hydraulics & Hydraulic Machinery	A60123	Elements of Earthquake Engineering
A40009	Environmental Studies	A60127	Ground Improvement Techniques
A40115	Structural Analysis-1	A60128	Ground Water Hydrology
A40109	Building Materials, Construction & Planning	A60124	Environmental Impact Assessment
A40186	Computer Aided Drafting of Buildings	A60129	Principles of Entrepreneurship
A40190	Surveying Lab-II	A60194	Geotechnical Engineering Lab
A50116	Concrete Technology	A60086	Advanced Communication Skills Lab
A50121	Reinforced Concrete Structures Design and Drawing	A70140	Remote Sensing & GIS
A50118	Engineering Geology	A70143	Transportation Engineering-II
A50120	Geotechnical Engineering	A70138	Estimating & Costing
A50122	Water Resources Engineering-1	A70133	Water Resources Engineering-II
A50117	Disaster Management	A70330	Finite Element Methods
A50017	Intellectual Property Rights	A70134	Advanced Foundation Engineering
A50018	Human Values and Professional Ethics	A80146	Construction Management
A50181	Fluid Mechanics & Hydraulic Machinery Lab	A80087	Industry Oriented Mini Project
A50191	Engineering Geology Lab	A80089	Seminar
A60130	Steel Structures Design and Drawing	A80088	Project Work
A60119	Environmental Engineering	A80090	Comprehensive Viva

Code	Subject	Code	Subject
A60132	Transportation Engineering-1		
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.			
A40114	Strength of Materials – II	A60194	Geotechnical Engineering Lab
A40111	Hydraulics & Hydraulic Machinery	A60086	Advanced Communication Skills Lab
A40009	Environmental Studies	A70140	Remote Sensing & GIS
A40115	Structural Analysis-1	A70143	Transportation Engineering-II
A40109	Building Materials, Construction & Planning	A70138	Estimating & Costing
A40186	Computer Aided Drafting of Buildings	A70133	Water Resources Engineering-II
A40190	Surveying Lab-II	A70330	Finite Element Methods
A50116	Concrete Technology	A70134	Advanced Foundation Engineering
A50121	Reinforced Concrete Structures Design and Drawing	A70145	Watershed Management
A50118	Engineering Geology	A70136	Air Pollution and Control
A50120	Geotechnical Engineering	A70135	Advanced Structural Design
A50122	Water Resources Engineering-1	A70137	Earth and Rock fill Dams and Slope Stability
A50117	Disaster Management	A70144	Water Resources Systems Analysis
A50017	Intellectual Property Rights	A70139	Industrial Waste Water Treatment
A50018	Human Values and Professional Ethics	A70195	Concrete & Highway Materials Lab
A50181	Fluid Mechanics & Hydraulic Machinery Lab	A70192	Environmental Engineering Lab
A50191	Engineering Geology Lab	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A60130	Steel Structures Design and Drawing	A80148	Geo-environmental Engineering (Elective IV)
A60119	Environmental Engineering	A80147	Design and Drawing of irrigation Structures (Elective IV)
A60132	Transportation Engineering-1	A80141	Solid Waste Management (Elective IV)
A60126	Foundation Engineering	A80150	Prestressed Concrete Structures
A60131	Structural Analysis-II	A80146	Construction Management
A60123	Elements of Earthquake Engineering	A80087	Industry Oriented Mini Project
A60127	Ground Improvement Techniques	A80089	Seminar
A60128	Ground Water Hydrology	A80088	Project Work
A60124	Environmental Impact Assessment	A80090	Comprehensive Viva
A60129	Principles of Entrepreneurship		
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.			
A40114	Strength of Materials – II	A60130	Steel Structures Design and Drawing
A40111	Hydraulics & Hydraulic Machinery	A60119	Environmental Engineering
A40009	Environmental Studies	A60132	Transportation Engineering-1
A40115	Structural Analysis-1	A60126	Foundation Engineering
A40109	Building Materials, Construction & Planning	A60123	Elements of Earthquake Engineering
A40186	Computer Aided Drafting of Buildings	A70134	Advanced Foundation Engineering
A40190	Surveying Lab-II	A70139	Industrial Waste Water Treatment
A50116	Concrete Technology	A70195	Concrete & Highway Materials Lab
A50121	Reinforced Concrete Structures Design and Drawing	A80150	Prestressed Concrete Structures
A50118	Engineering Geology	A80087	Industry Oriented Mini Project
A50121	Reinforced Concrete Structures Design and	A80089	Seminar

Code	Subject	Code	Subject
	Drawing		
A50120	Geotechnical Engineering	A80088	Project Work
A50181	Fluid Mechanics & Hydraulic Machinery Lab		
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.			
A50121	Reinforced Concrete Structures Design and Drawing	A60132	Transportation Engineering-1
A50120	Geotechnical Engineering	A60123	Elements of Earthquake Engineering
A30107	Strength of Materials – 1	A70134	Advanced Foundation Engineering
A40114	Strength of Materials – II	A80087	Industry Oriented Mini Project
A40109	Building Materials, Construction & Planning	A80089	Seminar
A50116	Concrete Technology	A80088	Project Work
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.			
A40186	Computer Aided Drafting of Buildings	A50018	Human Values and Professional Ethics
A40190	Surveying Lab-II	A70134	Advanced Foundation Engineering
A50181	Fluid Mechanics & Hydraulic Machinery Lab	A60123	Elements of Earthquake Engineering
A50191	Engineering Geology Lab	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A60194	Geotechnical Engineering Lab	A80148	Geo-environmental Engineering (Elective IV)
A60086	Advanced Communication Skills Lab	A80089	Seminar
A40114	Strength of Materials – II	A80087	Industry Oriented Mini Project
A50117	Disaster Management	A80088	Project Work
A50017	Intellectual Property Rights		
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.			
A10001	English	A50017	Intellectual Property Rights (Open Elective)
A40186	Computer Aided Drafting of Buildings	A50117	Disaster Management (Open Elective)
A40009	Environmental Studies	A80148	Geo-environmental Engineering (Elective IV)
A60194	Geotechnical Engineering Lab	A80014	Management Science
A60086	Advanced Communication Skills Lab	A80089	Seminar
A50018	Human Values and Professional Ethics (Open Elective)	A80087	Industry Oriented Mini Project
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.			
A60119	Environmental Engineering	A50191	Engineering Geology Lab
A40009	Environmental Studies	A50117	Disaster Management (Open Elective)
		A80148	Geo-environmental Engineering (Elective IV)
PO8: Ethics - Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
A60119	Environmental Engineering	A50118	Engineering Geology
A40009	Environmental Studies	A60123	Elements of Earthquake Engineering
A50117	Disaster Management (Open Elective)	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A50018	Human Values and Professional Ethics (Open Elective)	A80014	Management Science
A50017	Intellectual Property Rights (Open Elective)	A80148	Geo-environmental Engineering (Elective IV)
A60086	Advanced Communication Skills Lab	A80089	Seminar

Code	Subject	Code	Subject
PO9: Individual and team work - Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
		A50118	Engineering Geology
		A80148	Geo-environmental Engineering (Elective IV)
A50018	Human Values and Professional Ethics (Open Elective)	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A50017	Intellectual Property Rights (Open Elective)	A80014	Management Science
A50117	Disaster Management (Open Elective)	A80087	Industry Oriented Mini Project
A60010	Managerial Economics and Financial Analysis	A80088	Project Work
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.			
		A80087	Industry Oriented Mini Project
		A80089	Seminar
A60086	Advanced Communication Skills Lab	A80088	Project Work
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.			
A40186	Computer Aided Drafting of Buildings	A50117	Disaster Management (Open Elective)
A60010	Managerial Economics and Financial Analysis	A80014	Management Science
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.			
A40186	Computer Aided Drafting of Buildings	A80148	Geo-environmental Engineering (Elective IV)
A10083	English Language Communication Skills Lab	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A10082	IT Workshop/ Engineering Workshop	A60086	Advanced Communication Skills Lab
A50017	Intellectual Property Rights (Open Elective)	A80089	Seminar
A50118	Engineering Geology	A60119	Environmental Engineering
A40009	Environmental Studies	A60123	Elements of Earthquake Engineering
A50018	Human Values and Professional Ethics (Open Elective)	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A60010	Managerial Economics and Financial Analysis	A80014	Management Science
A50117	Disaster Management (Open Elective)	A80088	Project Work
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. .			
A50118	Engineering Geology	A50116	Concrete Technology
A40009	Environmental Studies	A50121	Reinforced Concrete Structures Design and Drawing
A60127	Ground Improvement Techniques	A50118	Engineering Geology
A60128	Ground Water Hydrology	A60123	Elements of Earthquake Engineering
A60124	Environmental Impact Assessment	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A60129	Principles of Entrepreneurship	A50117	Disaster Management (Open Elective)
A60194	Geotechnical Engineering Lab	A80148	Geo-environmental Engineering (Elective IV)
A60086	Advanced Communication Skills Lab	A70139	Industrial Waste Water Treatment
A40008	Probability & Statistics	A80087	Industry Oriented Mini Project
A40111	Hydraulics & Hydraulic Machinery	A80088	Project Work
A40009	Environmental Studies	A80089	Seminar

Code	Subject	Code	Subject
A40115	Structural Analysis-1	A80090	Comprehensive Viva
A40109	Building Materials, Construction & Planning	A80014	Management Science
A40186	Computer Aided Drafting of Buildings		
A40190	Surveying Lab-II		
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.			
A30202	Basic Electrical Engineering	A40111	Hydraulics & Hydraulic Machinery
A60194	Geotechnical Engineering Lab	A80148	Geo-environmental Engineering (Elective IV)
A50121	Reinforced Concrete Structures Design and Drawing	A60124	Environmental Impact Assessment
A50017	Intellectual Property Rights (Open Elective)	A60086	Advanced Communication Skills Lab
A60123	Elements of Earthquake Engineering	A80088	Project Work
A60127	Ground Improvement Techniques	A80089	Seminar
A60130	Steel Structures Design and Drawing	A80090	Comprehensive Viva
A50118	Engineering Geology	A80014	Management Science
A70139	Industrial Waste Water Treatment	A70134	Advanced Foundation Engineering
A30010	Managerial Economics and Financial Analysis		
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.			
A40114	Strength of Materials – II	A50118	Engineering Geology
A40115	Structural Analysis-1	A50120	Geotechnical Engineering
A40111	Hydraulics & Hydraulic Machinery	A50122	Water Resources Engineering-1
A40009	Environmental Studies	A80148	Geo-environmental Engineering (Elective IV)
A60123	Elements of Earthquake Engineering	A80151	Rehabilitation and Retrofitting of Structures (Elective IV)
A70139	Industrial Waste Water Treatment	A60086	Advanced Communication Skills Lab
A40111	Hydraulics & Hydraulic Machinery	A70133	Water Resources Engineering-II
A50122	Water Resources Engineering-1	A70134	Advanced Foundation Engineering
A60124	Environmental Impact Assessment	A70145	Watershed Management
A40109	Building Materials, Construction & Planning	A70136	Air Pollution and Control
A40186	Computer Aided Drafting of Buildings	A50117	Disaster Management
A40190	Surveying Lab-II	A80014	Management Science
A60010	Managerial Economics and Financial Analysis	A80090	Comprehensive Viva
A50116	Concrete Technology	A80088	Project Work
A50121	Reinforced Concrete Structures Design and Drawing		

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) ***University end-of-semester course evaluations:*** J N T University conducts end-of-semester examination for all courses. Summary results for each course are distributed to the appropriate instructor and the HOD, summarizing the course-specific results and comparing them to the average across the university. Students are encouraged to write specific comments about the positive and negative aspects of the course. The statistical summary and student comments presented are submitted to the principal and department academic council for review.

2) ***Departmental mid-semester course evaluations:*** The Civil Engineering department conducts mid-semester reviews for all 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).

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) includes 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:*** The final project reports, must demonstrate that students produced solutions to research/industry problems involving contemporary issues. There is no scale for this tool as the reports provide qualitative data.

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 program. 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 program.

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, and 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 Structural components.
- The students will appreciate knowledge discovery from survey 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" Structural components?
- 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 structural components design 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.

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

The Figure below 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.

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

. **Figure 3:** List of Action Words (Ref: 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 EXPECTED LEARNING OUTCOMES STATEMENTS

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

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

- **Understand** the basic properties of various building materials used in concrete making.
- **Evaluate** raw materials for their suitability for concrete production and durability.
- **Analyse the** properties of fresh concrete.
- **Analyse the** properties of hardened concrete.
- **Demonstrate** the properties of concrete through experimentation.
- **Evaluate** the risk of deterioration of structural concrete and the influence of the environment and loading conditions.
- **Design** concrete mixes.
- **Understand** various advancements in types of concretes.
- **Demonstrate** knowledge of professional and ethical responsibilities.
- **Understand** the impact of engineering solutions on the society and also be aware of contemporary issues.
- **Create** new technologies to develop concrete for more ethical and enhanced usage.

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

- **Analyze** the elastic settlement of footings in sands and clays of infinite thickness
- **Ability** to learn the settlement of footings in soils of finite thickness
- **Apply** knowledge of lateral stability of wells though Terzaghis analysis .
- **Understand** earth pressure theories and the stability of retaining walls
- **Ability** to learn stabilization of expansive soils
- **Understand** the concept of foundations in expansive soils
- **Ability** to understand the concept of pile foundation, well foundation, sheet piles and bulk heads

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

- **Understand** the use of three basic surveying tools: the tape, the level, and the (Theodolite).
- **Apply** geometric and trigonometric principles to basic surveying calculations.
- **Understand** field procedures in basic types of surveys, and the responsibilities of a surveying team
- **Apply** drawing techniques in the development of a topographic map.
- **Demonstrate** knowledge of professional and ethical responsibilities.
- **Understand** the different methods of calculation of areas and volumes of irregular boundaries.
- **Understand** the different methods of calculation of heights and distances using angular measurements.

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. DESCRIPTION OF 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 program *(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. The following are the elaborations for each of the considerations.

Does the course form a part of the ASCE/IEI/AICTE recommendation?
The American Society of Civil Engineers (ASCE), the Institution of Engineers, India (IEI) and the All India Council of Technical Education (AICTE) have prescribed a model curriculum for civil engineering and regularly keep updating to meet the needs of the fast developing technology and industry. These form a reference to verify whether our course being offered meets the national and international standards.

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?

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. PROCEDURE FOR DEVELOPMENT OF 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

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ANNEXURE - A: SAMPLE COURSE DESCRIPTION

INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**STRUCTURAL ANALYSIS - I**			
Course Code	A40115			
Regulation	R13			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	6	-	-	4
Course Coordinator	K. VARSHA REDDY, Assistant Professor, Civil Department			
Team of Instructors	K. VARSHA REDDY, Assistant Professor, Civil Department			

I. COURSE OVERVIEW:

Civil Engineers are required to design structures like buildings, dams, bridges, etc. This course is intended to introduce the basic principles to impart adequate knowledge and successfully apply fundamentals of Structural Engineering within their chosen engineering application area. Take advantage of a strong technical education at the undergraduate level to embark on successful professional careers in industry or to continue with a graduate education in their area of specialization. Apply broad multi-disciplinary skills necessary to accomplish professional objectives in a rapidly changing technological world. Understand the ethical issues pertaining to engineering, adopt industry standards of ethical behavior, and apply appropriate communication and collaboration skills essential for professional practice

II. PREREQUISITES:

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Engineering Mechanics, Strength of Materials-1

III. COURSE ASSESSMENT METHODS:

Session Marks	University End Exam Marks	Total Marks
Mid Semester Test There shall be two midterm examinations. Each midterm examination consists of subjective type and objective type tests. The subjective test is for 10 marks of 60 minutes duration. Subjective test of shall contain 4 questions; the student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks of 20 minutes duration. It consists of 10 Multiple choice and 10 objective type questions, the student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. **Assignment** Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	90 minutes	20
2	I Assignment	-	5
3	II Mid Examination	90 minutes	20
4	II Assignment	-	5
5	External Examination	3 hours	75

V. COURSE OBJECTIVES:

1. To introduce design concept and process of structures.
2. To review analysis of statically determinate structures.
3. To understand the deformations of structures under loading.
4. To introduce flexibility method for analysis of statically indeterminate structures.
5. To introduce stiffness method for analysis of statically indeterminate structures.

VI. COURSE OUTCOMES:

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

1. An ability to apply knowledge of mathematics, science, and engineering appropriate to the degree discipline
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to design a system, component or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
4. An ability to function on multi-disciplinary teams
5. An ability to identify, formulate and solve engineering problems
6. An ability to understand professional and ethical responsibility
7. An ability to communicate effectively
8. An ability to understand the impact of engineering solutions in a global and societal context, especially the importance of health, safety and environmental considerations to both workers and the general public
9. An ability to stay abreast of contemporary issues
10. An ability to recognize the need for, and to engage in life-long learning
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice appropriate to the degree discipline
12. An ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	An ability to apply knowledge of computing, mathematical foundations, algorithmic principles, and civil engineering theory in design of computer-based systems to real-world problems	H	Assignments, Tutorials, Exams

PO2	The ability to practice civil engineering using up-to- date techniques, skills, and tools as a result of life – long learning ability to design and conduct experiments, as well as to analyze and interpret data.	N	--
PO3	An ability to design , implement, and evaluate a field program to meet desired needs, within realistic constraints such as economic, environmental, social, political, health and safety, manufacturability, and sustainability.	H	Assignments, Tutorials, Exams
PO4	An ability to design a system or component to satisfy stated or code requirements of Civil Engineering	N	--
PO5	An ability to analyze a problem, identify, formulate and use the appropriate computing and Civil engineering requirements for obtaining its solution.	H	Assignments, Tutorials, Exams
PO6	An understanding of professional, ethical, legal, security and social issues and responsibilities.	N	--
PO7	An ability to communicate effectively, both in writing and orally	N	--
PO8	The broad education necessary to analyze the local and global impact of computing and engineering solutions on individuals, organizations, and society	N	--
PO9	Recognition of the need for, and an ability to engage in continuing professional development and life-long learning	N	--
PO10	Knowledge of contemporary issues as they affect the professional and ethical practice of engineering.	N	--
PO11	An ability to use current techniques, skills, and tools necessary for computing and engineering practice	H	Assignments and Tutorials, Exams
Po12	An ability to design and development principles in the construction of Civil Engineering of varying complexity.	N	--
PO13	An ability to recognize the importance of civil Engineering professional development by pursuing post graduate studies or face competitive examinations that offer challenging and rewarding careers in computing.	N	--

N – None **S - Supportive** **H - Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program specific outcomes		Level	Proficiency Assessed By
PSO 1	An ability to apply knowledge of computing, mathematical foundations, algorithmic principles, and civil engineering theory in design of computer-based systems to real-world problems	H	Lectures, Exercises and Assignments
PSO 2	An ability to design , implement, and evaluate a field program to meet desired needs, within realistic constraints such as economic, environmental, social, political, health and safety, manufacturability, and sustainability.	H	Project
PSO 3	An ability to use current techniques, skills, and tools necessary for computing and engineering practice	S	Guest lectures

N - None **S - Supportive** **H - Highly Related**

IX. SYLLABUS:

UNIT - I

Analysis of Perfect Frames: Types of frames- Perfect, Imperfect and Redundant pin jointed frames. Analysis of determinate pin jointed frames using method of joints, method of sections and tension co-effective method for vertical loads, horizontal loads and inclined loads.

UNIT - II

Energy Theorems: Introduction-Strain energy in linear elastic system, expression of strain energy due axial load, bending moment and shear forces- Castiglione's first theorem - Unit Load Method. Deflections of simple beams and pin - jointed plain tresses. Deflections of statically determinate bent frames.

Three Hinged Arches: Introduction - Types of arches - comparison between three hinged arches and two hinged arches. Linear Arch. Eddy's theorem. Analysis three hinged arches. Normal Thrust and radial shear in an arch. Geometrical properties of parabolic and circular arch. Three Hinged circular arch at Different levels. Absolute maximum bending moment diagram for a three hinged arch.

UNIT - III

Propped Cantilever and Fixed beams: Analysis of Propped Cantilever and Fixed beams, including the beams with varying moments of inertia, subjected to uniformly distributed load, central point load, eccentric point load, number of point loads, uniformly varying load, couple and combination of loads- shear force and bending moment diagrams for Propped cantilever and Fixed beams; effect of sinking of support, effect of rotation of a support.

UNIT - IV

Slope - Deflection Method and Moment Distribution Method: Introduction - Continuous beams. Clapeyron's theorem of three moments- Analysis of continuous beams with constant variable moments of inertia with one or both ends fixed- continuous beams with overhang. Effects of sinking of supports. Derivation of slope- Deflection Equation, Application to continuous beams with and without settlement of supports. Analysis of continuous beams with and without settlement of supports using Moment Distribution Method. Shear force and bending moment diagrams, Elastic curve.

UNIT - V

Moving Loads and Influence Lines: Introduction maximum SF and BM at a given section and absolute maximum S.F. and B.M. due to single concentrated load U.D. load longer than the span, U.D load shorter than the span, two point loads with fixed distance between them and several point loads- Equivalent uniformly distributed load- Focal length. Definition of influence line for SF, influence line for BM- load position for maximum SF at a section- load position for maximum BM at a section- Point load, UDL longer than the span, UDL shorter than the span- influence line for forces in members of Pratt and Warren trusses.

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X. COURSE PLAN:

Unit	Lecture Number	Topics Planned to cover	Learning Objectives
Course Content Delivery --- Lecture Wise Break-up of Topics I SPELL			
I	1	**Analysis of Perfect Frames:** Types of frames- Perfect, Imperfect and Redundant pin jointed frames.	**Analysis of Perfect Frames:** Types of frames- Perfect, Imperfect and Redundant pin jointed frames.
	2-4	Analysis of determinate pin jointed frames using method of joints for vertical loads, horizontal loads and inclined loads.	Solved problems on Analysis of determinate pin jointed frames using method of joints for vertical loads, horizontal loads and inclined loads.
	5-7	Analysis of determinate pin jointed frames method of sections for vertical loads, horizontal loads and inclined loads.	Solved problems on Analysis of determinate pin jointed frames method of sections for vertical loads, horizontal loads and inclined loads.
	8-10	Analysis of determinate pin jointed frames using tension co-effective method for vertical loads, horizontal loads and inclined loads.	Solved problems on Analysis of determinate pin jointed frames using tension co-effective method for vertical loads, horizontal loads and inclined loads.
II	11-12	**Energy Theorems:** Introduction- Strain energy in linear elastic system	**Energy Theorems:** Introduction-Strain energy in linear elastic system
	13-16	expression of strain energy due axial load, bending moment and shear forces	expression of strain energy due axial load, bending moment and shear forces
	17-18	Castiglione's first theorem - Unit Load Method.	Castiglione's first theorem - Unit Load Method.
	19-21	Deflections of simple beams and pin - jointed plain tresses.	Deflections of simple beams and pin - jointed plain tresses.
	22-23	Deflections of statically determinate bent frames.	Deflections of statically determinate bent frames.
	24	**Three Hinged Arches:** Introduction - Types of arches - comparison between three hinged arches and two hinged arches.	Introduction - Types of arches - comparison between three hinged arches and two hinged arches.
	25	Linear Arch. Eddy's theorem.	Linear Arch. Eddy's theorem.
	26-28	Analysis three hinged arches. Normal Thrust and radial shear in an arch. Geometrical properties of parabolic and circular arch.	Solved problems on Analysis three hinged arches. Normal Thrust and radial shear in an arch. Geometrical properties of parabolic and circular arch.
	29-30	Three Hinged circular arch at Different levels. Absolute maximum bending moment diagram for a three hinged arch.	Three Hinged circular arch at Different levels. Absolute maximum bending moment diagram for a three hinged arch.
III	31-36	**Propped Cantilever:** Analysis of Propped Cantilever, including the beams with varying moments of inertia, subjected to uniformly distributed load, central point load, eccentric point load, number of point loads, uniformly varying load, couple and combination of	Solved problems on Analysis of Propped Cantilever, including the beams with varying moments of inertia, subjected to uniformly distributed load, central point load, eccentric point load, number of point loads, uniformly varying load, couple and combination of loads- shear force and bending moment diagrams for Propped cantilever; effect of sinking of support,

Unit	Lecture Number	Topics Planned to cover	Learning Objectives
		loads- shear force and bending moment diagrams for Propped cantilever; effect of sinking of support, effect of rotation of a support.	effect of rotation of a support.
	35-36	**Fixed beams:** Analysis of Fixed beams, including the beams with varying moments of inertia, subjected to uniformly distributed load, central point load, eccentric point load, number of point loads, uniformly varying load, couple and combination of loads- shear force and bending moment diagrams for Fixed beams; effect of sinking of support, effect of rotation of a support.	Solved problems on Analysis of Fixed beams, including the beams with varying moments of inertia, subjected to uniformly distributed load, central point load, eccentric point load, number of point loads, uniformly varying load, couple and combination of loads- shear force and bending moment diagrams for Fixed beams; effect of sinking of support, effect of rotation of a support.
IV	37-39	**Slope - Deflection Method and Moment Distribution Method:** Introduction - Continuous beams. Clapeyron's theorem of three moments	Introduction - Continuous beams. Clapeyron's theorem of three moments
	40-42	Analysis of continuous beams with constant variable moments of inertia with one or both ends fixed- continuous beams with overhang. Effects of sinking of supports.	Solved problems on Analysis of continuous beams with constant variable moments of inertia with one or both ends fixed- continuous beams with overhang. Effects of sinking of supports.
	43-46	Derivation of slope- Deflection Equation, Application to continuous beams with and without settlement of supports.	Derivation of slope- Deflection Equation, Application to continuous beams with and without settlement of supports.
	47-50	Analysis of continuous beams with and without settlement of supports using Moment Distribution Method. Shear force and bending moment diagrams	Solved problems on Analysis of continuous beams with and without settlement of supports using Moment Distribution Method. Shear force and bending moment diagrams
	51-52	Elastic curve	Solved problems on Elastic curve
V	53-57	**Moving Loads and Influence Lines:** Introduction maximum SF and BM at a given section and absolute maximum S.F. and B.M. due to single concentrated load U.D. load longer than the span, U.D load shorter than the span, two point loads with fixed distance between them and several point loads-	Introduction maximum SF and BM at a given section and absolute maximum S.F. and B.M. due to single concentrated load U.D. load longer than the span, U.D load shorter than the span, two point loads with fixed distance between them and several point loads- solved problems
	58-59	Equivalent uniformly distributed load- Focal length.	Solved problems on Equivalent uniformly distributed load- Focal length.
	60-64	Definition of influence line for SF, influence line for BM- load position for maximum SF at a section- load position for maximum BM at a section- Point load, UDL longer than the span, UDL shorter than the span-	Definition of influence line for SF, influence line for BM- load position for maximum SF at a section- load position for maximum BM at a section- Point load, UDL longer than the span, UDL shorter than the span- solved problems
	65-66	Influence line for forces in	Influence line for forces in members of Pratt

Unit	Lecture Number	Topics Planned to cover	Learning Objectives
		members of Pratt trusses.	trusses. Solved problems
	67-68	Influence line for forces in members of Warren trusses.	Influence line for forces in members of Warren trusses. Solved problems

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H										S	H	S	
II	H	H	S										H	S	
III	H	H	S	S									S	H	
IV	H	S											H	S	
V		H			S								H		

S= Supportive H = Highly Related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	S	S										H	S	
2	H			S									S	H	
3		H			S								H	S	
4	H	H											H		
5	H	S											S		
6	H											S	H	S	
7	S												S		
8	S	H											H	S	
9	S	H										S	H		
10	S	H										S	H		
11	S	H										S	H		
12	S	H										S	H		
13	S	H										S	H		

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