INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**PRESTRESSED CONCRETE STRUCTURES**			
Course Code	**A80150**			
Regulation	**R13 – JNTUH**			
Course Structure	Lectures	Tutorials	Practical's	Credits
	4	-	-	4
Course Coordinator	Dr. J.S.R. Prasad, Professor, Civil Engineering Mr. K. Anand Goud, Assistant Professor, Civil Engineering			
Team of Instructors	Dr. J.S.R. Prasad, Professor, Civil Engineering Mr. K. Anand Goud, Assistant Professor, Civil Engineering			

I. COURSE OVERVIEW

A prestressed concrete structure is different from a conventional reinforced concrete structure due to the application of an initial load on the structure prior to its use. In prestressed concrete high strength concrete and high strength steel are combined such that the full section is effective in resisting tension and compression. This is an active combination of the two materials. This subject provides students an understanding and ability to analyse and design prestressed concrete structural elements. The primary topics includes the concept and principles of prestressing, methods of prestressing concrete, stress limits, losses of prestress, selection of section, serviceability and strength requirements. Students will also be able to complete analysis and design procedure of simply supported prestressed concrete non-composite and composite beams.

II. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Reinforced cement concrete

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam marks	Total marks
Mid term Test There shall be two midterm examinations. Each midterm examination consists of descriptive paper, objective paper and assignment. The descriptive paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of 20 minutes duration. It consists of 10 multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark.	75	100

Sessional Marks	University End Exam marks	Total marks
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. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem solving in nature with critical thinking. Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES

The objective of the teacher is to impart knowledge and abilities to the students to:

I. Understand the importance of Pre-stressed concrete and the evolution of pre-stressing to overcome the shortcoming of reinforced concrete.
II. Acquire knowledge about the methods of pre-stressing and pre-stressing devices for pre-tensioning and post-tensioning.
III. Assess the losses of pre-stress in PSC members due various causes like friction, elastic shortage of concrete, shrinkage, creep, etc.
IV. Analyze sections of PSC beams with straight, concentric, eccentric, bent and parabolic tendons and design PSC beams of rectangular and I sections for flexure.
V. Design shear reinforcements, structural elements for shear, torsion and anchorage as per the provisions of BIS.
VI. Interpret the transmission mechanism of pre-stressing force by bond and compute deflection of beams under loads.

VI. COURSE OUTCOMES

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

1. Understand the concept of pre-stressing and the behaviour of concrete structures.
2. Recognize the general principles, methods of pre-stressing, and pre-stressing devices for pre-tensioning and post-tensioning.
3. Determine losses of pre-stress in pre-stressed concrete structures.
4. Apply the provisions of IS-1343(1980) code to the design of pre-stressed concrete structures for flexure and shear.
5. Design the shear reinforcements for pre-stressed concrete beams.
6. Determine the stresses at end block and deflection of pre-stressed concrete members.
7. Analyze the sections for flexure and shear.
8. Analyse the stresses in anchorage zones and design end anchorages for prestressed concrete beams
9. Explain stress distribution methods.
10. Analyze the distribution methods like Guyon, Magnel, Zielinski and Rowe's.
11. Evaluate the Importance of control of deflections.
12. Categorize propped and unpropped composite beams

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments, Exams
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.		Assignment, Exams
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.		Assignment, Exams
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.	H	Assignment, Exams
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.		-
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.		
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.		
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.		
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.		
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	H	Discussions
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.		

S – Supportive **H - Highly Related**

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

	Program Specific Outcomes	Level	Proficiency assessed by
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.	H	Lectures, Assignments
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 model tool usage.	H	Projects

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.		Guest Lectures

S – Supportive **H - Highly Related**

VIII. SYLLABUS

UNIT I

Introduction: Historic development- General principles of pre-stressing pre-tensioning and post tensioning- Advantages and limitations of Prestressed concrete- General principles of PSC- Classification and types of pre-stressing Materials- high strength concrete and high tensile steel their characteristics. Methods and Systems of pre-stressing: Pre-tensioning and Post-tensioning methods and systems of pre-stressing like Hoyer system, Magnel Blaton system, Freyssinet system and Gifford- Udall System- Lee McCall system.

UNIT – II

Losses of Pre-stress: Loss of pre-stress in pre-tensioned and post-tensioned members due to various causes like elastic shortage of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, slip in anchorage, frictional losses.

UNIT – III

Flexure: Analysis of sections for flexure- beams pre-stressed with straight, concentric, eccentric, bent and parabolic tendons- stress diagrams- Elastic design of PSC beams of rectangular and I sections- Kern line — Cable profile and cable layout.

Shear: General Considerations- Principal tension and compression- Improving shear resistance of concrete by horizontal and vertical pre-stressing and by using inclined or parabolic cables- Analysis of rectangular and I beams for shear — Design of shear reinforcements- Bureau of Indian Standards (BIS) Code provisions.

UNIT – IV

Transfer of Pre-stress in Pre-Tensioned Members: Transmission of pre-stressing force by bond — Transmission length — Flexural bond stresses — IS code provisions — Anchorage zone stresses in post tensioned members — stress distribution in End block —Analysis by Guyon, Magnel, Zielinski and Rowe's methods — Anchorage zone reinforcement- BIS Provisions.

UNIT – V

Composite Beams: Different Types- Propped and Unpropped- stress distribution- Differential shrinkage- Analysis of composite beams- General design considerations.

Deflections: Importance of control of deflections- Factors influencing deflections — short term deflections of uncracked beams- prediction of long time deflections- BIS code requirements.

TEXT BOOKS:

Pre-stressed concrete by N. Krishna Raju, 5 th Edition, Tata McGraw Hill Book Education Pvt. Ltd.

REFERENCE BOOKS

1. Design of pre-stress concrete structures by T.Y. Lin and Burn, John Wiley, New York1
2. Prestressed concrete by S. Ramarnrutham, Dhanpat Rai & Sons, Delhi.
3. Prestressed Concrete by N. Rajagopalan, Narosa Publishing House

IX. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture Number	Topics Planned to cover	Learning Objectives	References
1- 3	UNIT-I: Historic development of pre-stressing technology, general principles of pre-tensioning and post-tensioning	Understands the importance of pre-stressed concrete and types of pre-stressing	T1: 1
3-7	Advantages and limitations of pre-stressed concrete, General principles of PSC, classifications and types of pre-stressing Materials - high strength concrete and high tensile steel	Summarize the types of pre-stressing methods	T1: 1.2
8-10	Characteristics, Methods and Systems of pre-stressing.	Provides information regarding characteristics of materials adopted in pre-stressed concrete structures.	T1: 1.5
11,12	Pre-tensioning and Post-tensioning methods.	To understand how pre-stressing force is imparted to structural elements by different methods and devices.	T1: 2.1, 2.2
13-15	Systems of pre-stressing like Hoyer system, Magnel Blaton system, Freyssinet system and Gifford- Udall System- Lee McCall system	To understand how pre-stressing force is imparted to structural elements by different methods and devices.	T1: 4.1, 4.2
16-18	UNIT-II: Nature of loss of prestress, Loss of prestress in pre-tensioned and post-tensioned members due to elastic deformation, shrinkage and creep.	Calculate the Loss of prestress in pre-tensioned and post-tensioned members.	T1: 3.1,3.2
19-21	Loss of prestress due to Relaxation of stress in steel	Computes losses of prestess due to Relaxation of stress in steel	T1: 4.1, 4.2
22-24	Slip in anchorage, frictional losses.	Compute slip in anchorage, frictional losses.	T1: 4.3, 4.4
24-26	UNIT-III: FLEXURE - Analysis of sections for flexure, beams prestressed with straight, concentric, eccentric, bent and parabolic tendons	To recognize the tendon profiles in beams , analyze beams foe flexure	T1: 4.4, 4.5
27,28	Stress diagrams- Elastic design of PSC beams of rectangular and I sections, Kern line	To know the Elastic design of PSC beams of rectangular and I sections- Kern line	T1: 4.6, 4.7
29,30	Cable profile and cable layout.	Classification of Cable profile and cable layout.	T1: 5.1, 5.2
31,32	SHEAR: General Considerations, Principal tension and compression	Discuss the general consideration	T1: 5.3, 5.4
37, 38	Analysis of rectangular and I beams for shear	Describe Analysis of rectangular and I beams for shear	T1: 6.1, 6.2
39, 40	Design of shear reinforcements- Bureau of Indian Standards (BIS) Code provisions.	Design of shear reinforcements as per Indian Standards provisions.	T1: 6.3, 6.4
41	Improving shear resistance of concrete by horizontal and vertical prestressing and by using inclined or	Describe the effects of using inclined or parabolic cables and methods of improving shear	T1: 6.4, 6.5

	parabolic cables	resistance	
42	UNIT IV: Transmission of prestressing force by bond as per IS code provisions.	Discuss transmission of prestressing force by bond.	T1: 7.1, 7.2
43,44	Transmission length, Flexural bond stresses	Discuss the importance of Transmission length and flexural bond stresses.	T1: 8.1, 8.2
45-47	Anchorage zone stresses in post tensioned members, stress distribution in End block	Understand the importance of the post tensioned members, stress distribution in End block	T1: 8.2, 8.3
48-50	Analysis by Guyon, Magnel, Zielinski and Rowe's methods, Anchorage zone reinforcement, BIS Provisions	To understand the importance of Guyon, Magnel, Zielinski and Rowe's methods, Anchorage zone reinforcement, BIS Provisions	T1: 5.2, 5.3
51-53	UNIT V: Composite Beams: Different Types, Propped and Unpropped, stress distribution.	Analyze different Types, Propped and Unpropped, stress distribution.	T1: 5.3,5.4
54-57	Differential shrinkage-, Analysis of composite beams- General design considerations.	Discuss differential shrinkage- Analysis of composite beams- General design considerations.	T1: 4.5, 4.6
58-61	Deflections: Importance of control of deflections , Factors influencing deflections	Analyze Importance of control of deflections , Factors influencing deflections	T1: 4.7, 4.8
62-65	Short term deflections of uncracked beams and Problems.	Discuss short term deflections of uncracked beams.	T1: 5.4, 5.5
66-68	Prediction of long. time deflections, BIS code requirements	To understand long time deflections, BIS code requirements	T1: 5.6, 5.7
69-70	Deflections: importance of control of deflections	Discuss short term deflections of uncracked beams.	T1: 8.1, 8.2
71	Prediction of long time deflections, bis code requirements.	Discuss short term deflections of uncracked beams.	T1: 8.3, 834

X. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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							S			H		
II	H	S	S							S			H	S	
III	S	H	S							S			S	H	
IV	S	H								S			H	S	
V	H	H								S			S	S	
VI	H	H								S			H		

S- Supportive **H - Highly Related**

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	H	S							S			H		
2	H	S	S							S			S	S	
3	H	H	S							S			H		
4	S	H								S			S	H	
5	H	S								S			H	S	
6	H	S	S							S			H		
7	H	S			S		S	S				S	H	H	
8	H	H													
9											S		H		
10		H	H				S						H	H	
11			H						H				S	S	
12	H		H	S						S			H		

S- Supportive **H - Highly Related**

Prepared by: Dr. J.S.R. Prasad, Professor, Civil Engineering
Mr. K. Anand Goud, Assistant Professor, Civil Engineering

HOD, Civil Engineering