INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**Strength of Materails - II**			
Course Code	**A40114**			
Regulation	**R13 – JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	2	-	4
Course Coordinator	Gude Ramakrishna, Associate Professor, Civil Engineering Department			
Team of Instructors	Gude Ramakrishna, Associate Professor, Civil Engineering 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 for the design of power transmission of shafts, springs, columns and struts, beams curved in plan, beam columns, dams, chimneys, retaining walls, unsymmetrical beams, thin and thick cylinders. This course also imports knowledge about the failure phenomenon and principles to present failure of structural members, pressure in cylinders.

II. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Engineering Mechanics.

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam marks	Total marks
Midterm Test There shall be two midterm examinations. Each midterm examination consists of essay paper, objective paper and assignment. The essay 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. 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	75	100

Sessional Marks	University End Exam marks	Total marks
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. To impart adequate knowledge to find stresses in various structural parts used in buildings, dams, bridges, retaining walls and pressure in vessels, etc.

II. To understand the failure phenomenon and to learn how to prevent the failure.

III. To impart adequate knowledge to continue the design and research activity in structural analysis.

VI. COURSE OUTCOMES:

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

a) Calculate the stresses developed in the shafts subjected to torque, bending moment and thrust and understand the design considerations to prevent the failure.
b) Able to apply the formulae for the design of springs.
c) Understand the failure phenomenon of columns and struts and finding the stresses developed in them.
d) Able to apply the design principles for the design of beams curved in plan.
e) Able to calculate the stresses induced in beam columns.
f) Able to apply the design principles for the design of dam, chimneys, retaining walls which are subjected to both direct and bending stresses.
g) Able to calculate the stresses developed in a beam subjected to unsymmetrical bending and also find shear centre.
h) Able to calculate the stresses induced in thin cylinders and thick cylinders and obtain safe dimensions.
i) Ability to correlate engineering knowledge to the social causes, impact of engineering solutions on the society
j) Ability to explore in research area.
k) Participate and succeed in competitive examinations like GATE, CEED, PSUs, etc.

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	H	Assignments, Exams

	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.	H	Assignments, 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.	H	Assignments
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	Assignments 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.	L	-
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.	L	Exams
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.	L	Assignments Exams
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	M	Quizzes, Discussions
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	M	Lectures, Discussions
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.	L	Lectures, 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.	M	Possible Projects

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.	H	Discussions

L – Low **M – Medium** **H - Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**UNDERSTANDING:** Graduates will have an ability to understand, analyze and solve problems using basic mathematics and apply the techniques related to irrigation, structural design, etc.	H	Lectures, Assignments, Exams
PSO2	**ANALYTICAL SKILLS:** Graduates will have an ability to design civil structures, using construction components and to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety manufacturability and reliability and learn to work with multidisciplinary teams.	H	Lectures, Assignments, Exams
PSO3	**BROADNESS:** Graduates will have an exposure to various fields of engineering necessary to understand the impact of other disciplines on civil engineering blueprints in a global, economic, and societal context and to have necessary focus for postgraduate education and research opportunities at global level.	M	Guest Lectures, Possible Group Projects, Industrial Internship

L – Low **M – Medium** **H - Highly Related**

IX. SYLLABUS:

Unit - I

TORSION OF CIRCULAR SHAFTS: Theory of pure torsion- derivation of torsion equations: $\frac{T}{J} = \frac{q}{r} = \frac{N\theta}{L}$ - assumptions made in the theory of pure torsion - torsional moment of resistance - polar section modulus - power transmitted by shaft - combined bending and torsion and end thrust - design of shafts according to theories of failure.

SPRINGS: Introduction - types of springs - deflection of close and open coiled helical springs under axial pull and axial couple - springs in series and parallel - carriage or leaf springs.

Unit - II

COLUMNS AND STRUTS: Introduction - Types of columns - Short, medium and long columns - Axially loaded compression members - Crushing load - Euler's theorem for long columns - assumptions - derivation of Euler's critical load formulae for various end conditions, Equivalent length of a column - slenderness ratio - Euler's critical stress - Limitations of Euler's theory - Rankine's and Gordon formula - Long columns subjected to eccentric loading - Secant formula - Empirical formulae - Straight line formula and Prof. Perry's formula.

BEAMS CURVED IN PLAN: Introduction - circular beams loaded uniformly and supported on symmetrically placed columns - semi-circular beam simply supported on three equally spaced supports.- maximum bending moment and stress due to transverse and lateral loading.

Unit - III

BEAM COLUMNS: Laterally loaded struts - subjected to uniformly distributed and concentrated loads - maximum bending moment and stress due to transverse and lateral loading.

DIRECT AND BENDING STRESSES: Stresses under the combined action of direct loading and bending moment, core of a section - determination of stresses in case of chimneys, retaining walls and dams - conditions for stability - stresses due to direct loading and bending moment about both the axes.

Unit - IV

UNSYMMETRICAL BENDING: Introduction - centroidal principle axes of section-graphical method for locating principle axes -moments of inertia referred to any set of rectangular axes -stresses in beams subjected to unsymmetrical bending -principle axes -resolution of bending moment into two rectangular axes through the centroid -location of neutral axis-direction of beams under unsymmetrical bending.

SHEAR CENTRE: Introduction, shear centre for symmetrical and unsymmetrical (I, T, L) sections.

Unit – V

UNSYMMETRICAL BENDING: Introduction - centroidal principle axes of section-graphical method for locating principle axes -moments of inertia referred to any set of rectangular axes -stresses in beams subjected to unsymmetrical bending -principle axes -resolution of bending moment into two rectangular axes through the centroid -location of neutral axis-direction of beams under unsymmetrical bending.

SHEAR CENTRE: Introduction, shear centre for symmetrical and unsymmetrical (I, T, L) sections.

Textbooks:

1. R. K. Bansal (2010), *A Text book of Strength of materials*, Laxmi Publications (P) ltd., New Delhi, India.

2. Strength of materials by Dr. Sadhu Singh, Khanna Publications Ltd

Reference Books:

1. R. S. Khurmi (2009), strength of Materials, s. chand, New Delhi, India.

2. S. Ramamrutham (2008), *Strength of Materials*, Dhanpat Rai Publications, New Delhi, India.

3. Bhavi Katti (2009), *Strength of Materials*, Vikas Publishing House Pvt Ltd, New Delhi, India.

4. B. S. Basavarajaiah (2010), *Strength of Materials*, Taylor Francis, USA.

5. R. K. Rajput (2010),*Strength of Materials***,** S. Chand**,** New Delhi, India.

X. COURSE PLAN:

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

Lecture No.	Topics to be covered	Course Learning Outcomes	References
1-2	**UNIT - I** Torsion of circular shafts: Introduction, Explain theory of pure torsion and assumptions made in pure torsion**.** Derive	**Explain** theory of pure torsion and assumptions made in pure torsion**. Derive** $\frac{T}{J} = \frac{q}{r} = \frac{N\theta}{L}$	T4: 2.1 to 2.2

	$\frac{T}{J}=\frac{q}{r}=\frac{N\theta}{L}$		
3-4	Define torsional moment of resistance and polar section modulus. Derive power transmitted by shafts and its efficiency	**Define** torsional moment of resistance and polar section modulus. **Derive** power transmitted by shafts	T4: 2.3 to 2.6
5-6	Derivation of Principal stresses due to combined bending and torsion for shafts. Derive expression for strain energy stored in a body due to torsion	**Explain** combined bending and torsion and end thrust	T4: 2.7 to 2.9
7-8	Strength of shaft for varying sections, composite shafts and problems	**Design** of shafts according to theory of failures.	T4: 3.1 to 3.6
9-10	Springs: Introduction, types of springs. Derive expressions for stiffness and efficiency for springs connected in series and parallel and problems	**Explain** types of springs- **Derive** springs connected in series and parallel	T4: 3.8 to 3.10
11-13	Derive the expressions for maximum shear stress induced in wire, expression for deflection of spring, expression for stiffness of springs. Brief explanation on leaf springs	**Derive** deflection of closed and open coiled helical springs under axial pull and axial couple. Define leaf springs	T4: 4.1 to 4.6
14-15	**UNIT - II** Columns & struts: Introduction, explain types of columns- long, medium and short. Brief explanation on axially compression members. Define crushing load.	**Explain** types of columns, axially loaded compression members, crushing load	T4: 6.1 to 6.3
16-17	Explain Euler's theorem for long columns - assumptions, limitations, derivation of Euler's critical load for various end conditions. Define Euler's critical stress.	**Explain** Euler's theorem for long columns	T4: 7.1 to 7.6
18-20	Explain briefly about equivalent length of column and slenderness ratio. Calculate the critical load for long column using Rankine, Gordan Secant, Perry and straight line formula.	**Define** Equivalent length of column, slenderness ratio. **Evaluate** critical load for long columns subjected to eccentric loading	T4: 8.1 to 8.9
21-23	Introduction to beams curved in plan and Derive stresses developed on Circular beams loaded uniformly and supported on symmetrically placed columns and solve problems.	**Derive** stresses developed on Circular beams loaded uniformly and supported on symmetrically placed columns	T1:9.6-11
24-26	Derive stresses developed on a semi-circular beam simply supported on three equally spaced supports and solve problems	**Derive** stresses developed on a semi-circular beam simply supported on three equally spaced supports	T4: 10.1 to10.7
27-29	**UNIT - III** Beam Columns: Introduction, explain laterally loaded struts for UDL and concentrated loads and solved problems. Discuss maximum bending moment and stress due to transverse and lateral	**Explain** laterally loaded struts for different loadings **Discuss** maximum bending moment and stress	T4: 11.4 to 11.7

	loading.		
30-31	Direct & Bending stress: Introduction, discuss: core of a section, problems related to stresses under combined action of direct loading and bending moment	**Define** core of a section. **Discuss** stresses under both bending and direct loading.	T4: 12.1 to 12.3
32-34	Determine stresses in chimneys, retaining walls and dams. Application - conditions for stability and solved problems	**Determine** stresses in chimneys, retaining walls and dams. **Discuss** conditions for stability	T4: 12.4 to 12.6
35-36	Explain stresses due to direct loading and bending moment about both axes and its application with solved problems.	**Explain** stresses due to direct loading and bending moment about both axes.	T4: 12.4 to 12.6
37-39	**UNIT -IV** Unsymmetrical bending: Introduction, concept of principle axes of section. Discuss the graphical method for locating principle axes and solved problems	**Explain** Centroidal Principle axes of section **Explain** graphical method for locating principle axes	T4: 16.1 to 16.9
40-41	Explain moment of inertia referred to any set of rectangular axes, explain stresses in beams subjected to unsymmetrical bending and problems	**Explain** moment of inertia for rectangular axes **Explain** stresses in beams subjected to unsymmetrical bending	T1: 17.1 to 17.6
42-44	Explain resolution of bending moment, define principle axes, evaluate location of neutral axis for symmetrical and unsymmetrical sections	**Explain** resolution of bending moment **Define** principle axes **Evaluate** location of neutral axis	T4: 18.1 to 18.6
45-46	Explain deflection of beams under unsymmetrical bending.	**Explain** deflection of beams	T4: 7.1-3
46-48	Shear centre: Introduction, define shear centre, shear centre for symmetrical and unsymmetrical (I,T,L) sections.	**Explain** shear centre	T4: 7.4-7
49-51	**UNIT -V** Thin cylinders: Introduction, explain thin seamless cylindrical shells. Derive longitudinal and circumferential stresses and problems	**Explain** thin seamless cylindrical shells **Derive** longitudinal and circumferential stresses	T4: 12.1-3
52-54	Explain hoop, longitudinal and volumetric strains - change in diameter and volume of thin cylinders. Discuss thin spherical shells and problems	**Explain** hoop, longitudinal and volumetric strains **Discuss** thin spherical shells	T4: 12.1-3
55-57	Thick cylinders: Introduction, explain Lame's theory for thick cylinders. Derivation of Lame's formulae.	**Derive** Lame's theory	T4: 12.1-3
58-60	Explain distribution of hoop and radial stresses across thickness. Design of thick cylinders using Lame's theory	**Discuss** distribution of hoop and radial stresses **Design** of thick cylinders	T4: 12.1-3
61-63	Brief explanation of compound cylinders, necessary difference of radii for	**Explain** compound cylinders **Explain** thick spherical shells	T4: 12.1-3

	shrinkage. Explain thick spherical shells.		

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XI. 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	H	H	L	L	L	M	M	M	M	H	H	H	M
II	H	H	H	H	L	L	L	M	M	M	M	H	H	H	M
III	H	H	H	H	L	L	L	M	M	M	M	H	H	H	M
IV	H	H	H	H	L	L	L	M	M	M	M	H	H	H	M
V	H	H	H	H	L	L	L	M	M	M	M	H	H	H	M
VI	H	H	H	H	L	L	L	M	M	M	M	H	H	H	M

L – Low **M – Medium** **H - Highly Related**

XII. 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	H	L	M	M	L	L	M	M	M	M	H	H	M
2	H	H	H	L	M	M	L	L	M	M	M	M	H	H	M
3	H	H	H	L	M	M	L	L	M	M	M	M	H	H	M
4	H	H	H	L	M	M	L	L	M	M	M	M	H	H	M
5	H	H	H	L	M	M	L	L	M	M	M	M	H	H	M
6	H	H	H	L	M	M	L	L	M	M	M	M	H	H	M

L – Low **M – Medium** **H - Highly Related**

Prepared by: Gude Ramakrishna, Assistant Professor, CE
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HOD, CE