INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**EXPERIMENTAL STRESS ANALYSIS**				
Course Code	BCCB13				
Programme	M.Tech				
Semester	II				
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Course Faculty	Dr.G.V.R.Seshagiri Rao, Professor, ME				

I. COURSE OVERVIEW:

Experimental methods exploit a particular physical phenomenon to make measurements and hence only certain information that can be recorded by an experimental technique. The course introduces the physical principle used by various experimental techniques and also provides a guideline to select an experimental technique for a given application.
The role of analytical, numerical and experimental methods in solving a problem in solid mechanics is discussed. Stress and strain at a point is discussed in most courses on solid mechanics but little attention is paid on the variation of these quantities over the field of the model. Attention is drawn on the richness of whole field information provided by most of the optical techniques.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME004	III	Mechanics of Solids	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Experimental Stress Analysis	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

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

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

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

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

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

Table 1: Assessment pattern for CIA

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

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9^{th} and 17^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Assignments
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Seminar
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Assignments
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Seminar
PO 5	Write and present a substantial technical report / document.	1	Seminar
PO 6	Independently carry out research/investigation and development work to solve practical problems	1	Assignments
PO 7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	-	Assignments

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	To Study the Various Experimental Techniques Involved for Measuring Displacements, Stresses, Strains in Structural Components.
II	Understand the shear force and bending moment diagrams of symmetrical beams
III	Distinguish bending and shear stresses developed in beams of various sections

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the types of strain gauges, mounting techniques and strain gauge circuits explain the measurement of strain under static and dynamic loads.	CLO 1	To Study the Various Experimental Techniques.
		CLO 2	InvolvedforMeasuringDisplacements,Stresses, Strains in Structural Components
		CLO 3	Understand the shear force and bending moment diagrams of symmetrical beams
CO 2	Explain the Mechanical, optical, pneumatic and electrical strain gauges for strain measurement. Analysis of measuring circuits and strains of different strain gauge rosettes.	CLO 4	To Study the Various Experimental Techniques.
		CLO 5	Involved forMeasuringDisplacements,Stresses, Strains in Structural Components
		CLO 6	To Study the Various Experimental Techniques.
CO 3	Explain different methods of 2 D photo-elasticity along with properties of different materials for strain measurement	CLO 7	Involved for Measuring Displacements, Stresses, Strains in Structural Components
		CLO 8	Distinguish bending and shear stresses developed in beams of various sections
		CLO 9	Involved for Measuring Displacements, Stresses Strains in Structural Components
CO 4	Identify the different types of coatings, test strain data using brittle coating and	CLO 10	Understand the shear force and bending moment diagrams of symmetrical beams

	birefringent coating	CLO 11	To Study the Various Experimental Techniques.
		CLO 12	Distinguish bending and shear stresses developed in beams of various sections
CO 5	Understand the Fundamentals Of NDT, Acoustic Emission Techniques.	CLO 13	Distinguish bending and shear stresses developed in beams of various sections
		CLO 14	To Study the Various Experimental Techniques
		CLO 15	Distinguish bending and shear stresses developed in beams of various sections

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCCB13.01	CLO 1	To Study the Various Experimental Techniques.	PO 1	3
BCCB13.02	CLO 2	Involved forMeasuringDisplacements,Stresses, Strains in Structural Components	PO 1	3
BCCB13.03	CLO 3	Understand the shear force and bending moment diagrams of symmetrical beams	PO 1,PO 2	3
BCCB13.04	CLO 4	To Study the Various Experimental Techniques.	PO 1,PO 2	2
BCCB13.05	CLO 5	Involved forMeasuringDisplacements,Stresses, Strains in Structural Components	PO 2	2
BCCB13.06	CLO 6	To Study the Various ExperimentalTechniques.	PO 1,PO 2,PO 3	2
BCCB13.07	CLO 7	Involved for Measuring Displacements, Stresses, Strains in Structural Components	PO 2	1
BCCB13.08	CLO 8	Distinguish bending and shear stresses developed in beams of various sections	PO 2, PO 3	1
BCCB13.09	CLO 9	Involved for MeasuringDisplacements,Stresses, Strains in Structural Components	PO 2	2
BCCB13.10	CLO 10	Understand the shear force and bending moment diagrams of symmetrical beams	PO 1,PO 2	2
BCCB13.11	CLO 11	To Study the Various Experimental Techniques.	PO 1,PO 2,PO 3	3
BCCB13.12	CLO 12	Distinguish bending and shear stresses developed in beams of various sections	PO 3, PO 6	3
BCCB13.13	CLO 13	Distinguish bending and shear stresses developed in beams of various sections	PO 2, PO 6	3
BCCB13.14	CLO 14	To Study the Various Experimental Techniques	PO 3,PO 2	3
BCCB13.15	CLO 15	Distinguish bending and shear stresses developed in beams of various sections	PO 3, PO 6	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CO 1	3	1	1		1	
CO 2		2	1		3	
CO 3	2		2			
CO 4	3			3	2	
CO 5				2	1	2

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	3						
CLO 2	3						
CLO 3	3	3					
CLO 4	3	2					
CLO 5		2					
CLO 6	2	2	2				
CLO 7		1					
CLO 8		1	1				
CLO 9		2					
Course Learning Outcomes (CLOs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CLO 10	2	2					
CLO 12			3			3	
CLO 13		3				3	
CLO 14		3	3				
CLO 15			1			1	
CLO 16						1	

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO3, PO5	SEE Exams	PO1, PO3, PO5	Seminar and Term Paper	PO1, PO2, PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES-INDIRECT

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

XIV. SYLLABUS

UNIT-I	EXTENSOMETERS AND DISPLACEMENT SENSORS
Principles of Measurements, Accuracy, Sensitivity and Range of Measurements, Mechanical, Optical, Acoustical and Electrical Extensometers and Their Uses, Advantages and Disadvantages, Capacitance Gauges, Laser Displacement Sensors.	
UNIT-II	**ELECTRICAL RESISTANCE STRAIN GAUGES**
Principle Of Operation And Requirements, Types And Their Uses, Materials For Strain Gauges, Calibration And Temperature Compensation, Cross Sensitivity, Wheatstone Bridge And Potentiometer Circuits For Static And Dynamic Strain Measurements, Strain Indicators, Rosette Analysis, Stress Gauges, Load Cells, Data Acquisition, Six Component Balance.	
UNIT-III	**PHOTOELASTICITY**
Two Dimensional Photo Elasticity, Photo Elastic Materials, Concept Of Light – Photoelastic Effects, Stress Optic Law, Transmission Photo elasticity, Jones Calculus, Plane And Circular Polariscopes, Interpretation Of Fringe Pattern, Calibration Of Photo elastic Materials, Compensation And Separation Techniques, Introduction To Three Dimensional Photo Elasticity.	
UNIT-IV	**BRITTLE COATING AND MOIRE TECHNIQUES**
Relation Between Stresses In Coating And Specimen, Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	
UNIT-V	**NON – DESTRUCTIVE TESTING**
Fundamentals Of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current Testing, and Fluorescent Penetrate Testing.	
Text Books:	
1. Dally, J.W., And Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 1998.	
2. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., And Ramachandra, K., "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.	
Reference Books:	
1. Abdul Mubeen "Experimental Stress Analysis" Dhanpat Rai & Co (P) Ltd.	
2. U. C. Jindal "Experimental Stress Analysis" Pearson India Publishers.	

XIV COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-2	**Classify** Principles of Measurements	Classify Principles of Measurements	T1:1.1, 1.2
3	Accuracy, Sensitivity and Range of Measurements,	Accuracy, Sensitivity and Range of Measurements	T1:2.1
4-6	**Illustrate** Mechanical, Optical, Acoustical and Electrical Extensometers and Their Uses, Advantages and Disadvantages,	Illustrate Mechanical, Optical, Acoustical and Electrical Extensometers and Their Uses, Advantages and Disadvantages,	T2:2.2, 2.3
7-8	**Analyze** Capacitance Gauges, Laser Displacement Sensors.	Analyze Capacitance Gauges, Laser Displacement Sensors.	T1:4.1, 4.2, 4.3

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
9-10	**List** Laser Displacement Sensors.	List Laser Displacement Sensors	T1:4.2, 4.4
11	**Explain** Principle Of Operation And Requirements.	Explain Principle Of Operation And Requirements	T2: 5.1, 5.2
12-13	**Compare** Relation Between Stresses In Coating And Specimen, Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	Compare Relation Between Stresses In Coating And Specimen, Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	T2:6.1, 6.2, 6.4
14	**Illustrate** Types And Their Uses, Materials For Strain Gauges,	Illustrate Types And Their Uses, Materials For Strain Gauges	T2:7.2, 7.3, 7.4
15	**Categorize & Describe** Calibration And Temperature Compensation, Cross Sensitivity,	Classify Wheatstone Bridge And Potentiometer Circuits For Static And Dynamic Strain Measurements	T2:8.1, 8.3
16	**Classify** Wheatstone Bridge And Potentiometer Circuits For Static And Dynamic Strain Measurements,	Explain Strain Indicators, Rosette Analysis, Stress Gauges, Load Cells, Data Acquisition, Six Component Balance Two Dimensional Photo Elasticity	T1:5.3
17-18	**Explain** Strain Indicators, Rosette Analysis, Stress Gauges, Load Cells, Data Acquisition, Six Component Balance Two Dimensional Photo Elasticity,	Describe Photo Elastic Materials, Concept Of Light – Photo elastic Effects	T1:5.5, 5.6, 5.7
21-22	**Describe** Photo Elastic Materials, Concept Of Light – Photo elastic Effects,	Describe Stress Optic Law, Transmission Photo elasticity, Jones Calculus, Plane And Circular Polariscopes	
23-24	**Describe** Stress Optic Law, Transmission Photo elasticity, Jones Calculus, Plane And Circular Polariscopes,	Define Interpretation Of Fringe Pattern	
25-26	**Define** Interpretation Of Fringe Pattern, Calibration Of Photo elastic Materials, Compensation And Separation Techniques, and Introduction To Three Dimensional Photo Elasticity.	Calibration Of Photo elastic Materials Compensation And Separation Techniques Introduction To Three Dimensional Photo Elasticity.	
27	**Compare** Relation Between Stresses In Coating And Specimen, Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	Compare Relation Between Stresses In Coating And Specimen, Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	
28	**Explain** Strain Indicators, Rosette Analysis, Stress	Explain Strain Indicators, Rosette Analysis, Stress	

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
	Gauges, Load Cells, Data Acquisition, Six Component Balance Two Dimensional Photo Elasticity.	Gauges, Load Cells, Data Acquisition, Six Component Balance Two Dimensional Photo Elasticity	
29	**Explain** Two Dimensional Photo Elasticity, Photo Elastic Materials, and Concept Of Light – Photo elastic Effects.	Explain Two Dimensional Photo Elasticity, Photo Elastic Materials, and Concept Of Light – Photo elastic Effects.	
30	**Explain** Stress Optic Law, Transmission Photo elasticity, Jones Calculus, Plane And Circular Polariscopes.	Explain Stress Optic Law, Transmission Photo elasticity, Jones Calculus, Plane And Circular Polariscopes.	
31-32	**Explain** Interpretation Of Fringe Pattern.	Explain Interpretation Of Fringe Pattern	
33-34	**Describe** Calibration Of Photo elastic Materials.	Describe Calibration Of Photo elastic Materials	
35-37	**Describe** Compensation And Separation Techniques, and Introduction To Three Dimensional Photo Elasticity.	Describe Compensation And Separation Techniques, and Introduction To Three Dimensional Photo Elasticity	
38	**Describe** Relation Between Stresses In Coating And Specimen, Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	Describe Relation Between Stresses In Coating And Specimen. Use Of Failure Theories In Brittle Coating, Moire Method Of Strain Analysis	
39-40	**Explain** Fundamentals Of NDT	Fundamentals Of NDT,	
41-43	**Explain** Acoustic Emission Technique,	Acoustic Emission Technique,	
44	**Explain** Radiography, Thermography,	Radiography, Thermography,	
45	**Explain** Ultrasonics, Eddy Current Testing,	Ultrasonics, Eddy Current Testing	
46	**Explain** and Fluorescent Penetrate Testing.	Fluorescent Penetrate Testing	

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

S No	Description	Proposed Actions	Relevance with POs
1	To improve standards and analyze the concepts.	Seminars	PO 1
2	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2,PO 6

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