Guidelines to Teach the Course

Chapter	Title of the chapter	Lectures required to cover each chapter
1	Overview of Mechanics of Solids	4 – 6
2	Overview of Experimental Stress Analysis	9 –12
3	Transmission Photoelasticity	15 – 18
4	Photoelastic Coatings	4 – 5
5	Digital Photoelasticity	15 – 20
6	Strain Gauges	11–13
7	Strain Gauge Selection and Installation	2 – 3
8	Strain Gauge based Transducers	4 – 6
9	Brittle Coatings	3 – 5
10	Caustics	3 – 5
11	Brief Introduction to Selected Techniques	9 –12
12	Experimental Evaluation of Fracture Parameters	10 – 12
	Total	85 –115

A sample one semester 3 credit course pattern (42 lectures of each 50 mts. duration) that gives overviews on various techniques (about ten in numbers) with exhaustive treatment of only Photoelasticity and Strain Gauges including highlights on Brittle coatings.

Lecture	Concepts to Cover	Slides
1	Introduction, Analytical methods, Numerical methods, Experimental methods – Advantages and disadvantages.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (1–11)
2	Optical methods work as a computer, Direct information provided by various Experimental methods – brief description.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (12–17)
3	Recap of introduction, Typical results for various problems, Beam under pure bending, Analytical solution, Fringe contours from various experimental methods.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (18–22a)
4	Disc under diametral compression – Analytical solution, Fringe contours from various experimental techniques, Clamped circular plate under a central load – Analytical solution, Fringe contours from various experimental techniques, Strain gauge, physical principle, Photoelasticity.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (23–32)
5	Photoelasticity contd., Plate with a hole model, Moiré, Grids for determining plastic strains, Geometric moiré, grating details – *u* and v displacement, Brittle coatings.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (33–42)
6	Holography – details with animation, Speckle methods – with images, Thermoelastic stress analysis (TSA).	Chapter: 1 Overview of Experimental Stress Analysis. Slides (43–52)

Lecture	Concepts to Cover	Slides
7	Digital image correlation, Caustics in a tea cup, dimple formation, Coherent gradient sensor, Naming of Experimental methods, Fringe patterns – Richness of Qualitative Information.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (53–64)
8	Fringe patterns – Richness of Qualitative Information, Disc under diametral compression Spanner better designs – streamline fillet, Key Technologies that has Influenced Experimental Mechanics, Multi-scale analysis in Experimental Mechanics, Trends in Experimental Mechanics.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (64–73)
9	Trends in Experimental Mechanics, Selection of an Experimental Technique, Typical measurement, References.	Chapter: 1 Overview of Experimental Stress Analysis. Slides (74–86)
10 (1.5 hrs session to start the lab classes)	Strain gauging, surface preparation, solvent degreasing, surface abrading, preparation of bonding, strain gauge bonding, soldering, clean up.	Chapter:7 Strain Gauge Selection and Installation Slides (20, 31–71)
11	Transmission photoelasticity, Birefringence, Nature of light, Polarisation, Methods to get polarized light.	Chapter:3 Transmission photoelasticity : Slides (1–12c)
12	Passage of light through isotropic media, Passage of light through crystalline media, Light ellipse.	Chapter:3 Transmission photoelasticity : Slides (13 – 22)

Lecture	Concepts to Cover	Slides
13	Light ellipse (contd.) Retardation plates and wave plates.	Chapter:3 Transmission photoelasticity : Slides (23 – 25)
14	Retardation plates and wave plates contd, stress-optic law.	Chapter:3 Transmission photoelasticity : Slides (26 – 30)
15	Plane Polariscope, Formation of Fringes, Trigonometric resolution.	Chapter:3 Transmission photoelasticity : Slides (31 – 35)
16	Trigonometric and resolution (contd.) Jones Calculus, Representation of a retarder, Elements of the polariscope, Circular polariscope.	Chapter:3 Transmission photoelasticity : Slides (36 – 46)
17	Circular Polariscope (contd.) Use of white light, Summary of Photoelastic fringes.	Chapter:3 Transmission photoelasticity : Slides (47 – 50)
18	Determination of photoelastic parameters at an arbitrary point, Compensation techniques.	Chapter:3 Transmission photoelasticity : Slides (50a – 51c)

Lecture	Concepts to Cover	Slides
19	Tardy's method of compensation.	Chapter:3 Transmission photoelasticity : Slides (51d – 54)
20	Calibration of photoelastic model materials, Stress fields in a circular disc under diametral compression, Linear least squares analysis.	Chapter:3 Transmission photoelasticity : Slides (55 – 64)
21	Experimental evaluation, Theoretical reconstruction of fringe pattern, Comments on fringe ordering.	Chapter:3 Transmission photoelasticity : Slides (65 – 70)
22	Comments on fringe ordering (contd.), Roles of principles of solid mechanics in fringe ordering, Resolving the ambiguity on the principal stress direction.	Chapter:3 Transmission photoelasticity : Slides (71 – 77)
23	Model to prototype relations, Three dimensional photoelasticity and Integrated photoelasticity.	Chapter:3 Transmission photoelasticity : Slides (78 – 85)
24	Integrated photoelasticity (contd.), Three dimensional photoelasticity, Stress freezing, Principle of optical equivalence.	Chapter:3 Transmission photoelasticity : Slides (86 – 93)

Lecture	Concepts to Cover	Slides
25	Photoelastic coating, Historical development, Overview and photoelastic strain gauges, Strain-Optic relation for coating, Evaluation of coating and specimen stresses.	Chapter:4 Photoelastic coating Slides (1 – 14)
26	Correction factors for photoelastic coatings, Correction factor for bending, Combined in-plane and bending loads, Correction factor for torsion.	Chapter:4 Photoelastic coating Slides (15 – 28)
27	Correction factor for pressure vessel, Coating Materials, Properties of photoelastic coating materials.	Chapter:4 Photoelastic coating Slides (31 – 40)
28	Selection of the coating thickness, Maximum fringe order obtainable.	Chapter:4 Photoelastic coating Slides (41 – 44)
29	Brittle coating techniques: Introduction, Historical development, methodology of Brittle coatings	Chapter: 9 Brittle coatings: Slides (1 – 9).
30	Crack patterns produced by direct loading, uniaxial stress field, Isotropic stress field, steps in Brittle coating, coating selection, surface preparation, undercoating, drying.	Chapter: 9 Brittle coatings: Slides (10 – 19).

Lecture	Concepts to Cover	Slides
31	Coating stresses, Failure theory, Uniaxial specimen stress, Crack patterns by refrigeration, Crack patterns by relaxation, Stresscoat, Evidence of principal stress directions being mutually perpendicular.	Chapter: 9 Brittle coatings: Slides (20 – 24c, 34 – 41).
32	Strain Gauges – Introduction, strain sensitivity, Gauge construction, Gauge length, Gauge length error in measurement, Thumb rule in selection of gauge length.	Chapter: 6 Strain gauges: Slides (1 – 10).
33	Commonly used strain gauge materials, Strain sensitivity of a strain gauge, Transverse sensitivity factor, Experimental determination of gauge factor, Wheatstone bridge.	Chapter: 6 Strain gauges: Slides (11– 16).
34	Strain measurement options, Bridge sensitivity, Bridge factor, Accuracy achievable in Foil strain gauges, Linearity, Hysteresis and Zero shift.	Chapter: 6 Strain gauges: Slides (17 – 22b).
35	Determination of strain at a point, Three element rectangular rosette, Delta rosette, Metallic alloys commonly employed, Advance, Isoelastic alloy, Karma alloy, Thermally induced apparent strain, Nichrome-D, Carriers, Types, cements	Chapter: 6 Strain gauges: Slides (25 – 38).
36	Cynoacrylate, Epoxy cements, Polyester cements, ceramic cements, High temperature strain gauge, Flame spraying Rokide process.	Chapter: 6 Strain gauges: Slides (39 – 49).

Lecture	Concepts to Cover	Slides
37	Performance characteristics of foil strain gauges, Strain gauge linearity, Hysteresis, Drift, Stability, Heat dissipation, Allowable power density, Selection of bridge voltage.	Chapter: 6 Strain gauges: Slides (50 – 64).
38	Temperature compensation, Temperature compensated gauges, Measurement techniques.	Chapter: 6 Strain gauges: Slides (60 – 73).
39	Two-wire circuit, Gauge factor desensitization, Role of change in temperature, three wire circuit, benefits of 3-wire circuits.	Chapter: 6 Strain gauges: Slides (74 – 86).
40	Transverse sensitivity, Actual and apparent strains, Corrections for transverse strain effects, T–rosette, Rectangular rosette, Correction factors for special applications.	Chapter: 6 Strain gauges: Slides (87 – 98).
41	Effect of hydrostatic pressure, Effect of nuclear radiation, Effect of high temperature.	Chapter: 6 Strain gauges: Slides (99 – 112).
42	Effect of cryogenic temperature, Effect of strain cycling, Environmental effects, Torque Gauge, Stress gauge – principle.	Chapter: 6 Strain gauges: Slides (113 – 134).

* A possible plan for 42 hrs lectures is given here. This information is based on actual class room experience.

* Certain portions of the course may also be given as self-study exercise to the students.

Apart from a three credit (42 lectures) first level course on *Experimental Stress Analysis*, with judicious planning, one can use the material in the book in a variety of ways to suit different audiences like a one day course to senior executives on *Experimental Methods* (Chapter 2), one day course on *Experimental Evaluation of Fracture Parameters* (Selected portions of Chapter 2, Chapter 12), one day course on *Strain Gauge Based Transducers* (Chapter 8, Selected portions of Chapters 6 and 7) and three day workshop on *Strain Gauge Technology* (Selected portions of Chapters 6,7 and 8), a 2 credit course (28 lectures) on *Advanced Experimental Methods* (Chapters 2, 10 and 11), a 2 credit course on *Digital Photoelasticity* (Chapter 5 and Selected portions from Chapters 1, 2 and 3), 2 credit course on *Strain Gauges* (Chapters 1, Selected portions from Chapter 2, Chapters 6, 7, 8 and 9), 3 credit course on *Photoelasticity* (Chapters 1, 2, 3, 4 and 5) and so on.
