Roll No.												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 1

Sem AY: Odd Sem 2019-20 | **Date**: 27.09.2019

Course Code: MEC 317 | **Time**: 11.00AM to 12.00PM

Course Name: EXPERIMENTAL STRESS ANALYSIS | **Max Marks**: 40

Program & Sem: B.Tech (Mech) & V DE | **Weightage**: 20%

Instructions:

(i) Answer the following question

Part A

Answer all the Questions. Each question carries five marks **(3Qx5M=15M)**

1. Explain with a neat sketch unbounded wire strain gauge (C.O.NO.1)[Knowledge]
2. Write the Expression for Wheatstone bridge Balanced condition (C.O.NO.2)[Knowledge]
3. What is temperature compensation of strain gauges? Explain with neat sketch any one type of temperature compensation method. (C.O.NO.1)[Knowledge]

Part B

Answer both the Questions. Each question carries five marks. **(2Qx5M=10M)**

4 What is strain rosette? Explain with neat sketch the different types of strain rosette configuration. (C.O.NO.2)[Comprehension]

5 When a member is stressed at point in three orientations like 0°,60° and 120°,In such case, which type of rosette configuration is used and list the related formulas

1. Principal stain
2. Principal Stresses
3. Maximum shear strain
4. Principal orientations and
5. Maximum shear stress. (C.O.NO.2)[Comprehension]

Part C

Answer the Question. The Question carries fifteen marks. (1QX15M=15M)

6 .The following readings of strain were obtained on a rectangular strain rosette mounted on aluminum for which

E = 70 GPa,

Poisson's ration μ=0.32, ε_a=285μm/m,

ε_b = 65μm/m,

ε_c =102μm/m.

Determine the Principal strain, Principal strain direction, Principal stresses and maximum shear stress. (C.O.NO.2) [Application]

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester: V

Course Code: MEC-317

Course Name:

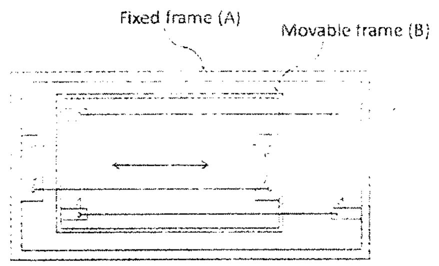
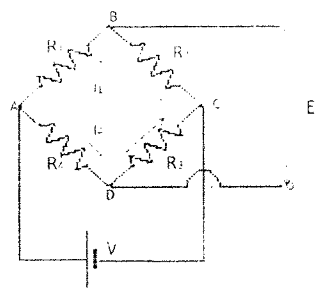
Date: 27/09/2019

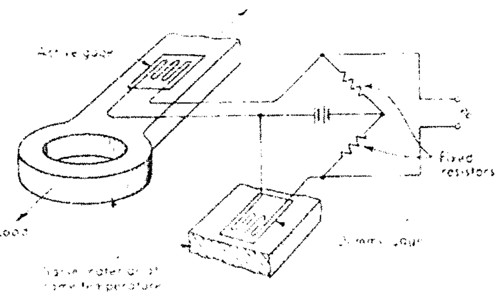
Time:

Max Marks: 40

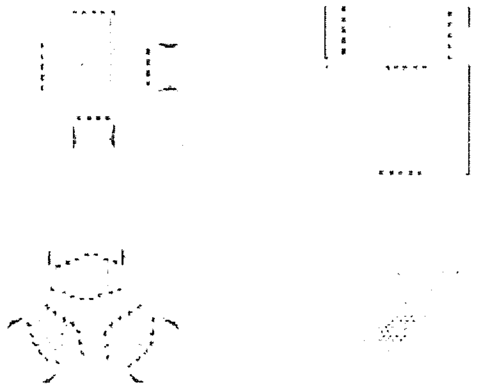
Weightage: 20%

Part A (3Q x 5M = 15Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**Unbonded strain Gauge**  	**Sketch (02M+03Explanation)**	**05**
2	**Wheatstone bridge circuit**  A dc wheatstone bridge consisting of four resistance arms with a battery and a meter is shown in fig below. In this bridge the resistance shown in each of the four arms of the bridge can represent a strain gauge. A voltage V is applied to the bridge.some mesureing instruments such as galvonometer is used to measure the output of the bridge.	**Sketch (01M)+Explanition(02M)+Balanced condtion(02M)**	**05**

	The reqirements for balance, i.e. zero potential difference E between points B and D can be determined as follows: [illegible]		
3	**Compensating Dummy Gauge** • This is the earliest form of temperature compensation technique. • The active gauge is connected with a dummy gauge to balance out the unwanted temperature induced resistance change. • The dummy gauge is identical to active gauge mounted on unstressed specimen exposed to same thermal environment. 	**Sketch(02M)+Explanation(03)**	**10**

Part B (2Q x 5M = 10Marks)

Q No.	Solution	Scheme of Marking	Max. Time required for each Question
4		Sketch (02)+Explanation (03)	10
5	D- rosette are arranged in 0deg.60deg and 90 deg by using standard notation Extract all the formula	Formula[05M)	15Min

$$\therefore \sigma_{1,2} = E\left[\frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3(1-\nu)} \pm \frac{1}{1+\nu}\sqrt{\left(\varepsilon_a - \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3}\right)^2 + \left(\frac{\varepsilon_b - \varepsilon_c}{\sqrt{3}}\right)^2}\right] \quad ...(4.25)$$

and the maximum shear stress

$$\tau_{max} = \frac{E}{2(1+\nu)}\gamma_{max}$$

$$= \frac{E}{1+\nu}\sqrt{\left(\varepsilon_a - \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3}\right)^2 + \left(\frac{\varepsilon_b - \varepsilon_c}{\sqrt{3}}\right)^2}$$

$$\varepsilon_a = \varepsilon_x$$

$$\varepsilon_b = \frac{1}{4}(\varepsilon_x + 3\varepsilon_y + 3\gamma_{xy})$$

$$\varepsilon_c = \frac{1}{4}(\varepsilon_x + 3\varepsilon_y - 3\gamma_{xy})$$

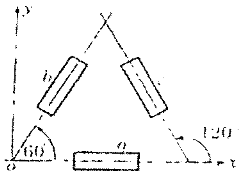


Fig 4.6 Delta rosette

Solving for ε_x, ε_y and γ_{xy} we get

$$\varepsilon_x = \varepsilon_a$$

$$\varepsilon_y = \frac{1}{3}(-\varepsilon_a + 2\varepsilon_b + 2\varepsilon_c) \quad ...(4$$

$$\gamma_{xy} = \frac{2}{\sqrt{3}}(\varepsilon_b - \varepsilon_c)$$

The principal strains are given by

$$\varepsilon_{1,2} = \frac{1}{2}(\varepsilon_x + \varepsilon_y) \pm \frac{1}{2}\sqrt{(\varepsilon_x - \varepsilon_y)^2 + \gamma_{xy}^2}$$

$$= \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3}$$

$$\pm\sqrt{\left(\varepsilon_a - \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3}\right)^2 + \left(\frac{\varepsilon_b - \varepsilon_c}{\sqrt{3}}\right)^2} \quad ...(4$$

and maximum shear strain

$$\gamma_{max} = \sqrt{(\varepsilon_x - \varepsilon_y)^2 + \gamma_{xy}^2}$$

$$= 2\sqrt{\left(\varepsilon_a - \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3}\right)^2 + \left(\frac{\varepsilon_b - \varepsilon_c}{\sqrt{3}}\right)^2} \quad (4$$

The principal strain directions are

$$\phi_1 = \frac{1}{2}\tan^{-1}\left(\frac{\gamma_{xy}}{\varepsilon_x - \varepsilon_y}\right)$$

$$= \frac{1}{2}\tan^{-1}\left[\frac{\frac{1}{\sqrt{3}}(\varepsilon_b - \varepsilon_c)}{\varepsilon_a - \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3}}\right] \quad ...(4$$

$$\phi_2 = 90° + \phi_1$$

The principal stresses are given by

$$\sigma_1 = \frac{E}{1-\nu^2}(\varepsilon_1 + \nu\varepsilon_2)$$

$$\sigma_2 = \frac{E}{1-\nu^2}(\varepsilon_2 + \nu\varepsilon_1)$$

Part C (1Q x15 M = 15Marks)

Q No	Solution	Scheme of Marking	Max. Time requirec for eacl Questio
	$\varepsilon 1 = 351.25$ $\varepsilon 2 = 35.75$ $\gamma_{max} = \sqrt{(\varepsilon_a - \varepsilon_c)^2 + (2\varepsilon_b - \varepsilon_a - \varepsilon_c)^2}$ $= 315.5 \times 10^{-6}$ rad $\phi_1 = \frac{1}{2}\tan^{-1}\left(\frac{2\varepsilon_b - \varepsilon_a - \varepsilon_c}{\varepsilon_a - \varepsilon_c}\right)$ $= \frac{1}{2}\tan^{-1}\left(\frac{130 - 285 - 102}{285 - 102}\right)$ $= \frac{1}{2}\tan^{-1}(-1.4037)$ $\phi_1 = -(27^\circ 16')$ $\phi_2 = -(117^\circ 16')$ $\sigma_1 = \frac{E}{1-\nu^2}(\varepsilon_1 + \nu\varepsilon_2)$ $= \frac{70 \times 10^9}{1-(0.32)^2}(351.25 + 0.32 \times 35.75) \times 10^{-6}$ $= 28.285$ MPa $\sigma_2 = \frac{E}{1-\nu^2}(\varepsilon_2 + \nu\varepsilon_1)$ $= \frac{70 \times 10^9}{1-(0.32)^2}(35.75 + 0.32 \times 351.25) \times 10^{-6}$ $= 11.553$ MPa $\tau_{max} = \frac{E}{2(1+\nu)}\gamma_{max} = \frac{70 \times 10^9}{2(1+0.32)} \times 315.5 \times 10^{-6}$ $= 8.365$ MPa	Principal strains and stresses (08M)+Principal Directions and Maximum shear strain (04M)+Maximum shear stress(03)	15

Roll No.												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem. 2019-20
Course Code: MEC 317
Course Name: EXPERIMENTAL STRESS ANALYSIS
Program & Sem: B.Tech (MEC) & V DE

Date: 16.11.2019
Time: 11.00 AM to 12:00 PM
Max Marks: 40
Weightage: 20%

Instructions:

I. Answer the following questions.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries five marks (3Qx5M=15M)

1. With a neat sketch show the plane Polariscope arrangement
(C.O.NO.3) [Knowledge]

2. Derive the stress optic law in two dimensional photoelasticity
(C.O.NO.3) [Comprehension]

3. Write a note on the calibration of Tensile specimen using polariscope
(C.O.NO.3)[Knowledge]

PART B [Thought Provoking Questions]

Answer both the Questions. Each Question carries seven and half marks (2Qx7.5M=15M)

4. In Machine Design Lab using the Plane Polariscope for the Dark field arrangement derive the expression for Intensity of light passing through the stressed-model.
(C.O.NO.3) [Application]

5. With neat sketch explain Scattered Light as an Interior Polarizer.
(C.O.NO.3) [Comprehension]

PART C [Problem Solving Questions]

Answer both the Questions. Each Question carries five marks **(2Qx5M=10M)**

6. Explain stress freezing techniques in 3D Photoelasticity
(C.O.NO.3) [Comprehension]
7. The max. shear stress at a point in a model of 5 mm thick is 12Mpa. The fringe order observed is 4.5, when observed with sodium light. Another model made of the same material and having a thickness of 8mm is subjected to a plane state of stress. Observations of this model under mercury light reveals the fringe order (N_2) when σ_2=0.5σ_1.
Find the following (C.O.NO.3) [Application]
   i) Material Fringe Constant
   ii) Fringe order(N_2)
   iii) Principal stresses

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Sem: **AY:Odd Sem 2019-20**
Course Code: Experimental Stress Analysis
Program & Sem: B.Tech (Mech) & V DE

Date: 16/11/2019
Time: 1.00hr
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	CO.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	CO3	3	5			5
2	CO3	3		5		5
3	CO3	3	5			5
4	CO3	3			7.5	7.5
5	CO3	3		7.5		7.5
6	CO3	3		5		5
7	CO3	3			5	5
	Total Marks		10	17.5	12.5	**40**

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Sem AY: Odd Sem 2019-20

Course Code: MEC-317

Course Name:

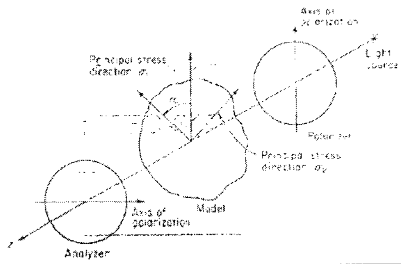
Date: 16/11/2019

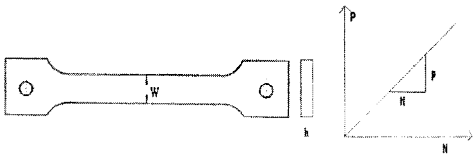
Time: 1.hour

Max Marks: 40

Weightage: 20%

Part A (3Q x 5M = 15Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**Plane Polariscope setup**  	**Sketch (02M+03Explanation)**	**08 Min**
2	Stress optic law relations For two dimensional plane-stress bodies where $\sigma_3 = 0$, the stress-optic for light at normal incident to the plane of the model without the subscript is $\Delta = \frac{2\pi hc}{\lambda}(\sigma_1 - \sigma_2)$ $n = \frac{\Delta}{2\pi} = \frac{hc}{\lambda}(\sigma_1 - \sigma_2) = \frac{h}{f_\sigma}(\sigma_1 - \sigma_2)$ Where $n = \frac{\Delta}{2\pi}$ is retardation in terms of cycles of retardation, and counted as the fringe order. $f_\sigma = \frac{\lambda}{c}$ is material fringe value, a property of the model material for a given λ and h	**Derivation(05M)**	**08 Min**

<table>
<tr>
<td>3</td>
<td>Calibration of Tensile Specimen in Photoelasticity


If we prepare a simple tensile specimen as shown in fig(a), whose width is w and thickness h, then under load P, the uniform stress in the test specimen is
$$\sigma_1 - \sigma_2 = P/wh$$
Then
$$\sigma_2 = 0$$
Applying stress optic law, we get
$$\sigma_1 - \sigma_2 = \frac{N\sigma_f}{h}$$
$$\frac{P}{wh} = \frac{N\sigma_f}{h}$$</td>
<td>Sketch(02M)+Explanation(03)</td>
<td>08 Min</td>
</tr>
</table>

Part B (2Q x 7.5M = 15Marks)

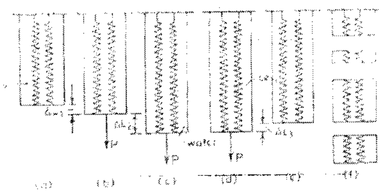
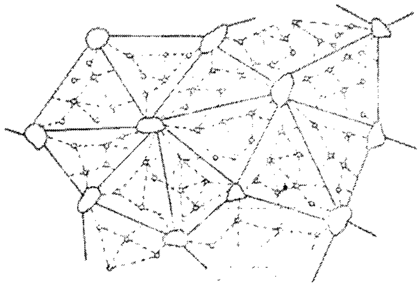
<table>
<tr>
<th>Q No</th>
<th>Solution</th>
<th>Scheme of Marking</th>
<th>Max. Time required for each Question</th>
</tr>
<tr>
<td>4</td>
<td>Stress Intensity for Dark Field Arrangement

When $2\alpha = n\pi$, where n = 0, 1, 2,..., $\sin^2 2\alpha = 0$ and extinction occurs.
This relation indicates that, when one of the principal-stress directions coincides with the axis of the polarizer ($\alpha = 0, \pi/2$, or any exact multiple of $\pi/2$) the intensity of the light is zero.
Since the analysis of the optical effects produced by a stressed model in a plane polariscope was conducted for an arbitrary point in the model, the analysis is valid for all points of the model.
When the entire model is viewed in the polariscope, a fringe pattern is observed; the fringes are loci of points where the principal-stress directions (either or a_2) coincide with the axis of the polarizer.
The fringe pattern produced by the $\sin^2 2\alpha$ term in Eq. is the isoclinic fringe pattern. $I = K \sin^2 2\alpha \sin^2 \frac{\Delta}{2}$
Isoclinic fringe patterns are used to determine the principal-stress directions at all points of a photo-elastic model.
</td>
<td>Sketch(2.5M)

Derivation(05M)</td>
<td>10 Min</td>
</tr>
</table>

5	Explain with neat sketch Scattered Light as an Interior Polarizer $N_{QR} = \frac{h}{\sigma_f}(\sigma_1' - \sigma_2')_{av\,QR}$ Where $(\sigma_1' - \sigma_2')_{av}$ is the average value of $\sigma_1' - \sigma_2'$ over the distance Q R $\Delta N = \frac{1}{\sigma_f}\left[h(\sigma_1' - \sigma_2')_{av\,QR} + \Delta h(\sigma_1' - \sigma_2')_{av\,\Delta h}\right] - \frac{h}{\sigma_f}(\sigma_1' - \sigma_2')_{av\,QR}$ $\Delta N = \frac{\Delta h}{\sigma_f}(\sigma_1' - \sigma_2')_{av\,\Delta h}$ This can be rewritten as $(\sigma_1' - \sigma_2')_{av\,\Delta h} = \frac{\Delta N}{\Delta h}\sigma_f$	Sketch(2.5M) Derivation(05M)	6 Min

Part C (2Q x05 M = 10Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	Stress locking Analogy   Primary and Secondary bonds	Sketch(02)+ Explanation(03M)	6 Min

7	$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$ = 9 MPa N_1 = 11.5 λ_1 = 5893 nm $(\sigma_1 - \sigma_2)$ = 18 × 10[6] Pa CASE (i): We know that $\sigma_1 - \sigma_2 = \frac{f_{\sigma_1} N_1}{d_1}$ f_{σ_1} = 20 kN/m CASE (ii): $(\sigma_1 - \sigma_2) = \frac{N\lambda}{Cd} = \frac{N f_\sigma}{d}$ Since C is constant $\frac{\lambda_1}{f_{\sigma_1}} = \frac{\lambda_2}{f_{\sigma_2}}$ $\frac{589.3}{20} = \frac{540.113}{f_{\sigma_2}}$ f_{σ_2} = 18.33 kN/m $\sigma_1 - \sigma_2 = \frac{N_2 f_{\sigma_2}}{d_2}$	Case 1 =2M Case 2 = 2M Final Answer =1M	6 Min

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GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019-20
Course Code: MEC 317
Course Name: EXPERIMENTAL STRESS ANALYSIS
Program & Sem: B.Tech (MEC) & V (DE-I)

Date: 20 December 2019
Time: 9.30 AM to 12.30 PM
Max Marks: 80
Weightage: 40%

Instructions:

(i) Answer the following questions

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 1 mark **(10Qx1M=10M)**

1. Define strain gauge (C.O.No.1) [Knowledge]
2. Write the condition for balanced Wheatstone circuit (C.O.No.1) [Knowledge]
3. What is gauge factor (C.O.No.1) [Knowledge]
4. Sketch the arrangement of the optical element in circular polariscope (C.O.No.3) [Knowledge]
5. Mention the Delta rosette arrangement with different orientations (C.O.No.2) [Knowledge]
6. Write four Optical arrangement conditions in photoelasticity (C.O.No.3) [Knowledge]
7. Write the stress intensity formula for Dark field arrangement in plane Polariscope setup (C.O.No.3) [Knowledge]
8. List some photo elastic materials (C.O.No.3) [Knowledge]
9. Write some different coating methods (C.O.No.4) [Knowledge]
10. Brittle coating does not responds for___________ (C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks (5Qx10M=50M)

11. Define gauge factor. Derive the expression for it. (C.O.No.1) [Application]

12. Explain stress freezing Technique in 3D Photo elasticity

(C.O.No.3) [Comprehension]

13. Derive the equation for Intensity of light for 2 dimensional stressed optical element

(C.O.No.3) [Application]

14. Explain the method of calibration of photo elastic circular disc under diametrical compression (C.O.No.3) [Comprehension]

15. Explain with a neat sketch calibration method in brittle coatings

(C.O.No.4) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries 10 marks (2Qx10M=20M)

16. The following readings of strain were obtained on a rectangular strain rosette mounted on Aluminium for which E = 70GPa, Poisson's ratio μ =0.32, ε_a=285μm/m, ε_b = 65 μm/m and ε_c = 102 μm/m. Determine the Principal strain, Stresses and Maximum shear stress.

(C.O.No.2) [Application]

17. i) Explain the bire fringent coatings (C.O.No.4) [Comprehension]

ii) Explain crack detection technique in brittle coatings

(C.O.No.4) [Comprehension]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
PART A Q. NO1 TO Q.NO10	CO 01 CO 02 CO 03 CO 04	All the 4 modules	10			10
PART B Q.NO.11	CO 01	MODULE 01 Per Unit System			10	10
PART B Q.NO.12	CO 03	MODULE 02 Load Flow Studies	-	10	-	10
PART B Q.NO.13	CO 02	MODULE 02 Load Flow Studies	-	10	-	10
PART B Q.NO.14	CO 03	MODULE 03 Fault Analysis	-	10	-	10

PART B Q.NO.15	CO 04	MODULE 04 Stability studies	-	10	-	10
PARTC Q.NO.16	CO 02	MODULE 02 Load Flow Studies	-	-	10	10
PARTC Q.NO.17	CO 03	MODULE 03 Fault Analysis	-	10		10
	Total Marks		10	50	20	80

K =Knowledge Level C = Comprehension Level, A = Application Level

C.O WISE MARKS DISTRIBUTION:

CO 01: 10 MARKS, CO 02: 26 MARKS, CO 03: 27 MARKS, CO 04:17 MARKS

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must

be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

SCHEME OF SOLUTION

Sem AY:Odd Sem 2019-20

Course Code:MEC 317

Course Name: Experimental Stress Analysis

Program & Sem: B.Tech (Mech) & V DE

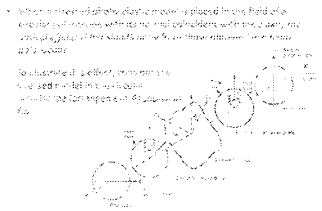
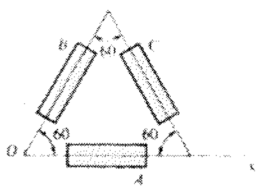
Date: 20/12/2019

Time: 3.00hr

Max Marks: 80

Weightage: 40%

Part A (10Q x 1M = 10Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1 To 10	**1.Strain gauge Definition** **2. R1R3 = R2 R4** **3. Gauge factor** **4.**   	**Each question carries 1 marks**	**25 Min**

	6.		

Conventional optical arrangements [illegible]

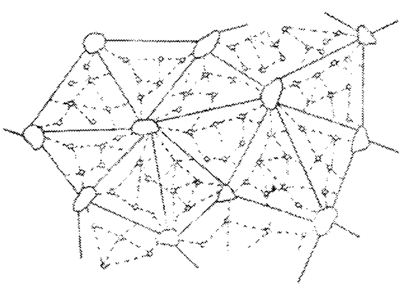
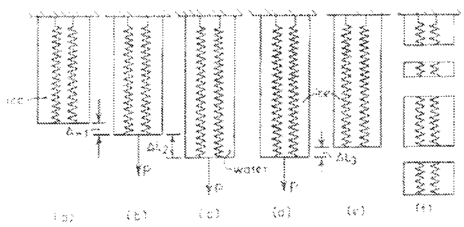
Setup	[illegible] Analyser	[illegible]	[illegible]
[illegible]	Crossed	None	Dark
[illegible]	Crossed	Crossed	Dark
	Parallel	Parallel	Dark
	Crossed	Parallel	Bright
	Parallel	Crossed	Bright

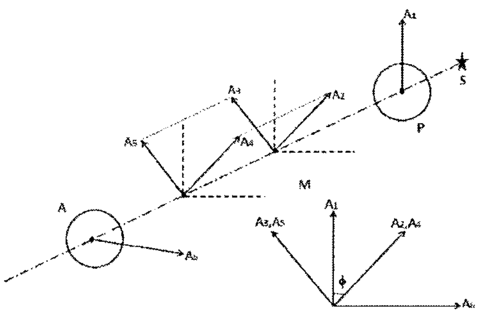
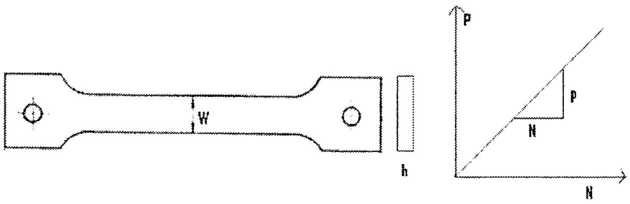
7.

8.glass,cellulose nitrate,polysterine, macro resin

9.resin based coating,ceramic coating, calibration etc.,

10.Compressive Loads

Q No	Solution	Scheme of Marking	Max. Time required for each Question
11	**Gauge Sensitivity and Gauge Factor:** The strain sensitivity of a single uniform length of a conductor was previously defined as $S_A = \frac{dR/R}{\epsilon} \approx \frac{\Delta R/R}{\epsilon} \ldots\ldots\ldots\ldots(1)$ **Derivation**	**Definition(02)+Derivation(08M)**	**15**
12	**Stress Freezing Method**  	**Sketch(03M)+Working principle(07M)**	**20**

13	**Effect of Stressed Model in Plane Polariscopes (Dark Field Set up)**  The component of light vector transmitted by the polarizer is $A_1 = a\cos\omega t$ The light vector when incident on the model is resolved into two components along principle stress direction $A_2 = a\cos\omega t\cos\phi$ $A_3 = a\cos\omega t\sin\phi$ A_2 and A_3 are incident on one side of photo-elastic model. These two components of the light vector propagate through the stressed model at different velocities. As a result, when these two components emerge from the model, these are out of phase. Upon leavening the model, the two vibrating components acquire a relative phase difference of Δ. We shall assume that A_2 leadsA_3. Hence, upon leavening the model, the vibrating component are $A_4 = a\cos(\omega t + \Delta)\cos\phi$ $b = a\sin 2\phi\, sin\frac{\Delta}{2}$ is the amplitude of emerging light vector. A measure of intensity of light is given by the square of amplitude. In our case, the intensity is $I = b^2 = a^2\sin^2 2\phi\, sin^2\frac{\Delta}{2}$ Intensity of light coming out of analyzer is zero under two conditions (1) When $\phi = o\ or\ 90$ (2) When Δ= $2m\pi(m = 0,1,2,3 \ldots)$ First condition tells that light extinction occur at a point when direction of principal stresses coincide with the direction of polarizer and analyzer. The locus of point when this happens is called the Isoclinic's Second condition tells that light extinction occur at a point when the relative phase difference is equal to$2m\pi$. The locus of point where this occurs is called Isochromatics.	**Sketch(03M)+Derivation(07M)**	**20**
14	**Calibration of Tensile Specimen**  	**Sketch(03M)+Derivation(07M)**	

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$$\sigma_1 - \sigma_2 = P/wh$$

Then

$$\sigma_2 = 0$$

Applying stress optic law, we get

$$\sigma_1 - \sigma_2 = \frac{N\sigma_f}{h}$$

$$\frac{P}{wh} = \frac{N\sigma_f}{h}$$

Hence, $\sigma_f = \left(\frac{P}{N}\right)\frac{1}{w}$

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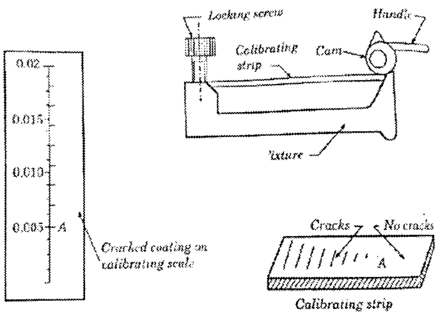
Calibration Method in Brittle coatings

Explannation



Calibrating fixture and scale for brittle coating.

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<td>Sketch(03M)+Derivation(07M)</td>
<td>25</td>
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<td>16</td>
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ε1 = 351.25 ε2 =35.75

$$\gamma_{max} = \sqrt{(\varepsilon_a - \varepsilon_c)^2 + (2\,\varepsilon_b - \varepsilon_a - \varepsilon_c)^2}$$

$$= 315.5 \times 10^{-6} \text{ rad.}$$

$$\phi_1 = \frac{1}{2}\tan^{-1}\left(\frac{2\,\varepsilon_b - \varepsilon_a - \varepsilon_c}{\varepsilon_a - \varepsilon_c}\right)$$

$$= \frac{1}{2}\tan^{-1}\left(\frac{130 - 285 - 102}{285 - 102}\right)$$

$$= \frac{1}{2}\tan^{-1}(-1.4037)$$

$$\phi_1 = -(27^\circ\ 16')$$

$$\phi_2 = -(117^\circ\ 16')$$

$$\sigma_1 = \frac{E}{1-\nu^2}(\varepsilon_1 + \nu\,\varepsilon_2)$$

$$= \frac{70 \times 10^9}{1-(0.32)^2}(351.25 + 0.32 \times 35.75) \times 10^{-6}$$

$$= 28.285 \text{ MPa}$$

$$\sigma_2 = \frac{E}{1-\nu^2}(\varepsilon_2 + \nu\,\varepsilon_1)$$

$$= \frac{70 \times 10^9}{1-(0.32)^2}(35.75 + 0.32 \times 351.25) \times 10^{-6}$$

$$= 11.553 \text{ MPa}$$

$$\tau_{max} = \frac{E}{2(1+\nu)}\gamma_{max} = \frac{70 \times 10^9}{2(1+0.32)} \times 315.5 \times 10^{-6}$$

$$= 8.365 \text{ MPa}$$

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<td>Formula(02M)
+
Principal stresses(03M)
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Phase angles(02M)
+
Shear stress(03M)</td>
<td>25</td>
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<tr>
<td>17</td>
<td>Explanation</td>
<td>Sketch(02M)+Explannation(03M)</td>
<td>15</td>
</tr>
</table>

18	Crack detection techniques	Sketch(02M)+Explannation(03M)	15

Part B (5Q x 10M = 50Marks)