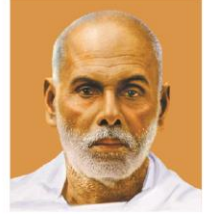
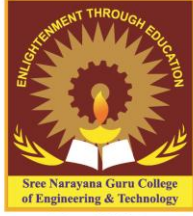


Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307

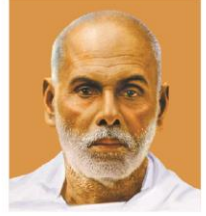


SAMPLE ASSIGNMENT OR TUTORIAL



Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307



ASSIGNMENT

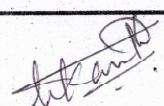
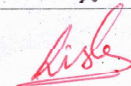


SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY,
PAYYANUR

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY)

DEPARTMENT OF Electronic And Communication

Assignment No :	1
Semester :	S ₇
Register Number :	SNICISEC004
Name :	ASWATHI SREEKANTH
Roll No :	03
Course Code :	EC405
Course Name :	OPTICAL COMMUNICATION
Date of Submission :	15.9.2018.

Maximum Marks :	10
Marks Obtained :	7
Student Signature :	
Staff Signature :	


Dr. IFENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PAYYANUR
KANNUR

Questions

- (1) Consider a fiber that has a core refractive index of 1.48, a cladding index of 1.476, and a core radius of 4.4 μm . Is the wavelength at which the fiber becomes single mode is $\lambda = 1250 \text{ nm}$.
- (2) Consider a multimode step index fiber with a 62.5 μm core diameter and a core cladding index difference of 1.5%. If the core refractive index is 1.48, estimate the normalized freq. of the fiber and the total no. of modes supported in the fiber at a wavelength of 850 nm.
- (3) The refractive indices of core and cladding materials of a step index fiber are 1.48 & 1.45 respectively. Calculate,
(a) numerical aperture
(b) acceptance angle
(c) Critical angle at the core cladding interface.

Done
Dr. LEENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PATTANUR
KANNUR

(4) The numerical aperture of an optical fiber is 0.39. If the difference in refractive index of the material of the core and the cladding is 0.05, calculate the refractive index of material of the core.

(5) Calculate the no. of allowed modes in a multimode step index fiber, $a = 100 \text{ Nm}$, core index of 1.468 and cladding index of 1.447 at wavelength of 850 nm

Answer

1)

$$V = \frac{2\pi a NA}{\lambda}$$

$$n_1 = 1.48$$

$$n_2 = 1.476$$

$$a = 4.4 \text{ Nm}$$

$$\lambda = 850 \text{ nm}$$

$$V = \frac{2\pi a}{\lambda} \sqrt{n_1^2 - n_2^2}$$

$$= \frac{2 \times 3.14 \times 4.4 \times 10^{-9}}{850 \times 10^{-9}} \times \sqrt{(1.48)^2 - (1.476)^2}$$

$$= 2.403$$

DR. JEEVA A.V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PATTANAMUR

Dr. JEEVA A.V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PATTANAMUR

Answers

2)

Given

$$a = 31.25 \text{ } \mu\text{m}$$

$$\Delta = 1.5\%$$

$$n_1 = 1.48$$

$$\begin{aligned} N_A &= n_1 \sqrt{2\Delta} \\ &= 1.48 \sqrt{2 \times 0.015} \\ &= 0.256 \end{aligned}$$

$$V = \frac{2\pi a}{\lambda} N_A$$

$$\lambda = 850 \text{ nm}$$

$$\begin{aligned} V &= \frac{2 \times 3.14 \times 31.25 \times 10^{-6} \times 0.256}{850 \times 10^{-9}} \\ &= \frac{5.024 \times 10^5}{850 \times 10^9} = \underline{\underline{59.1}} \end{aligned}$$

$m = ?$

3) $n_1 = 1.48$

$n_2 = 1.48$

$N_A = ?$

$\phi_c = ?$

$O_A = ?$

Leena
Dr. LEENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PATTANUR
KANNUR

$$\begin{aligned}\text{Numerical Aperture, } NA &= \sqrt{n_1^2 - n_2^2} \\ &= \sqrt{2.1904 - 2.1025} \\ &= \underline{0.29}\end{aligned}$$

$$\begin{aligned}\text{Acceptance angle } \theta_a &= \sin^{-1}(NA) \\ &= \sin^{-1}(0.29) \\ &= \underline{16.85^\circ}\end{aligned}$$

$$\begin{aligned}\text{Critical angle } \phi_c &= \sin^{-1}(n_2/n_1) \\ &= \sin^{-1}(1.45/1.48) \\ &= \underline{78.44^\circ}\end{aligned}$$

Given

$$4) NA = 0.39$$

$$\Delta = 0.05$$

$$n_1 = ?$$

$$NA = n_1 \sqrt{2\Delta}$$

$$0.39 = n_1 \sqrt{2 \times 0.05}$$

$$\frac{0.39}{0.316} = 1.234$$

Dr. Leena A. V.
Principal
Sree Narayana Guru College of
Engineering & Technology, Pattanam
Kannur

Dr. Leena A. V.
Principal
Sree Narayana Guru College of
Engineering & Technology, Pattanam
Kannur

(1) Consider a fiber that has a core refractive index of 1.48, a cladding index of 1.476 and a core radius of 4.4 μm . ST the wavelength at which the fiber becomes single mode is $\lambda = 1250 \text{ nm}$

(2) Consider a multimode step index fiber with a 62.5 μm core diameter and a core cladding index difference of 1.5%. If the core refractive index is 1.48, estimate the normalized freq of the fiber and the total no. of modes supported in the fiber at a wavelength of 850 nm.

(3) The numerical aperture of an optical fiber is 0.39. If diff in refractive index of the material of the core and cladding is 0.05, calculate refractive index of core.

(5) Calculate the no. of allowed modes in a multimode step index fiber. 2.100 μm core index of 1.468 & cladding index of 1.447 at a wavelength of 850 nm

Dr. LEENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PANNUR
KANNUR

2)

lywen

$$\text{diameter} = 62.5 \mu\text{m}$$

$$\therefore a = 3.125 \times 10^{-5}$$

$$\Delta = 1.5\%$$

$$n_1 = 1.48$$

$$\begin{aligned} N_A &= n_1 \sqrt{2\Delta} \\ &= 1.48 \times \sqrt{2 \times 0.015} \\ &= \underline{\underline{0.256}} \end{aligned}$$

$$V = \frac{2\pi a}{\lambda} N_A$$

$$\lambda = 850 \text{ nm}$$

$$V = \frac{2 \times 3.14 \times 31.25 \times 10^{-6} \times 0.256}{850 \times 10^{-9}}$$

$$= \underline{\underline{59.1}}$$

$$M = \frac{V^2}{2} = \underline{\underline{1746}}$$

3) lywen

$$N_A = 0.39$$

$$\Delta = 0.05$$

$$\Delta = n_1 - n_2 = 0.05$$

$$n = ?$$

$$n_1 = n_2 + 0.05$$

$$\lambda/A = \sqrt{n_1^2 - n_2^2}$$

$$NA = \sqrt{(n_1 - n_2)(n_1 + n_2)}$$

$$0.39 = \sqrt{0.05 \times (n_1 + n_2)}$$

$$\frac{0.39^2}{0.05} = n_1 + n_2 = 3.042$$

$$3.042 = n_2 + 0.05 + n_2 = 2n_2 + 0.05$$

$$n_2 = 1.496$$

$$n_1 = n_2 + 0.05 = 1.496 + 0.05 = 1.546$$

(1) given

$$n_1 = 1.48$$

$$n_2 = 1.476$$

$$a = 4.4 \times 10^{-6} \text{ } \mu\text{m}$$

$$M = 2.40$$

$$\lambda = \frac{2\pi a}{NA} \times NA$$

$$\lambda = \frac{2\pi \times 4.4 \times 10^{-6} \times \sqrt{1.48^2 - 1.476^2}}{2.4}$$

DR. LEENA A. V.
PRINCIPAL
SREE NARAYAN GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PUTHUR
KANNUR

$$= 1.251 \times 10^{-6} \approx \underline{\underline{1250 \text{ nm}}}$$

DR. LEENA A. V.
PRINCIPAL
SREE NARAYAN GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PUTHUR
KANNUR

(5). Lywin

$$a = 100 \text{ nm}$$

$$n_1 = 1.468$$

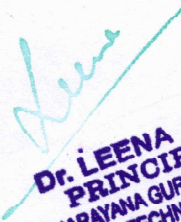
$$n_2 = 1.447$$

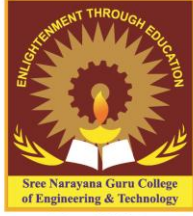
$$\lambda = 850 \text{ nm}$$

$$V = \frac{2\pi a \times n/a}{\lambda}$$

$$= \underline{\underline{182}}$$

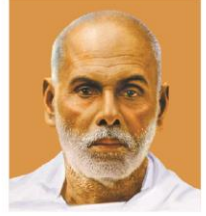
$$M = \underline{\underline{16,862}}$$


Dr. LEENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY, PAYANUR
KANNUR



Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307



TUTORIAL

I N D E X

NAME: Aslaha.B ROLL NO.: 4

STD.: Civil DIV./SEC.: _____ SUBJECT: NDS-T

S. No.	Date	Title	Page No.	Teacher's Sign / Remarks
1	28/9/22	problems on stress & strain		10 ✓
2	30/9/22	stress and strain		10 ✓
3	12/10/22	problems on compound stress.		10 ✓
4	19/10/22	shear force & bending moment.		10 ✓
5	9/11/22	problems on temperature stress.		10 ✓
6	16/11/22	problems on shear force and bending moment.		10 ✓
				10 ✓
				10 ✓

Leena
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PATTANUR, KANNUR

Tutorial - 1

- 1- Find the young's modulus of brass rod of dia. 25mm & of length 250mm. Which is subjected to a tensile load of 50kN. When the extension of the rod is 0.3mm.
- 2- A tensile test was conducted on a mild steel bar. The following data obtained where the dia. of steel bar is 3cm. gauge length of the bar 20cm, load at the elastic limit 250kN, extension at a load of 150kN = 0.21mm, max^m load 880kN. Total extension 60mm, dia of rod at failure 2.25cm. Determine Young's modulus, stress at elastic limit, % elongation & % rise in area.
- 3) The same safe stress for a hollow steel column carries an axial load of 2.1×10^3 kN is 125 MN/m^2 . If the external dia. of the column is 80cm determine the internal diameter.

Leena
Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYANUR, KANNUR

1) Diameter = 25 mm
 length = 250 mm
~~Force~~ = 50 kN
 extension of length $\Delta L = 0.3$ mm

$$\text{Area} = \frac{\pi D^2}{4} = \frac{3.14 \times (25)^2}{4} = 490.625 \text{ mm}^2$$

$$\text{Young's modulus} = \frac{FL}{A \Delta L} = \frac{50 \times 250 \times 1000}{490.625 \times 0.3}$$

$$= 84925.690 \text{ N/mm}^2$$

$$= 84883.33 \times 10^6 \text{ N/m}^2$$

2) Diameter = 3 cm
 = 30 mm

length = 200 mm

2) Diameter = 3 cm = 30 mm
 length = 200 mm = 200 mm

Force at elastic limit = 250 kN

$$\text{Area at elastic limit} = \frac{\pi}{4} \times (30)^2 = 706.5$$

$$\text{Stress at elastic limit} = \frac{F}{A} = \frac{250}{706.5} = 0.3538 \text{ kN/mm}^2$$

$$\text{Young's modulus} = \frac{FL}{A \Delta L} = \frac{150 \times 1000 \times 30}{706.5 \times 0.2}$$

$$= 3033.060 \text{ N/mm}^2$$

$$= 3033.060 \text{ N/mm}^2$$

$$353.68 \text{ N/mm}^2$$


 Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

$$\begin{aligned} \% \text{ elongation} &= \frac{\text{total extension}}{\text{original length}} \times 100 \\ &= \frac{60}{30} \times 100 = 200\% \\ \text{Dra} &= 2.25 \text{ cm} = 22.5 \text{ mm} \\ \text{Area decreased} &= \frac{\pi}{4} \times (22.5)^2 = 397.40625 \text{ mm}^2 \\ \% \text{ decrease in Area} &= \frac{706.5 - 397.4}{706.5} \times 100 = 43.75\% \\ F &= 2.1 \times 10^3 \text{ kN} \\ &= 2.1 \times 10^6 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{stress} &= \frac{125 \text{ MN/m}^2 \cdot 2.0 \times 10^6}{125 \times 10^6 \text{ N/m}^2} \\ &= 125 \text{ N/mm}^2 \\ \text{external dia} &= 30 \text{ mm} \\ \text{Area} &= \frac{\pi (D^2 - d^2)}{4} = \frac{\pi (30^2 - 22.5^2)}{4} = 397.40625 \text{ mm}^2 \\ \text{Stress} &= F/A \\ A &= F/s \\ \frac{\pi (D^2 - d^2)}{4} &= \frac{2.1 \times 10^6}{125} \\ \frac{\pi D^2}{4} - \frac{\pi d^2}{4} &= \frac{2.1 \times 10^6}{125} \end{aligned}$$

Leena
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

$$\frac{\pi D^2}{4} = \frac{2.1 \times 10^6}{125} = \frac{\pi d^2}{4} \quad \text{Given}$$

$$D^2 - d^2 = \frac{2.1 \times 10^6 \times 4}{125 \times \pi}$$

$$D^2 - d^2 = 21401.27329 \quad \text{Given}$$

$$21401.27329 - (300)^2$$

$$d = 261.9135 \text{ mm}$$

1- Given: Dia of rod, $D = 25 \text{ mm}$

$$\text{Area of rod, } A = \frac{\pi (25)^2}{4} = 490.87 \text{ mm}^2$$

$$P = 50 \text{ kN} = 50 \times 1000 = 50,000 \text{ N}$$

$$\Delta L = 0.3 \text{ mm}$$

$$L = 250 \text{ mm}$$

$$\sigma = \frac{P}{A} = \frac{50,000}{490.87} = 101.86 \text{ N/mm}^2$$

$$e = \frac{\Delta L}{L} = \frac{0.3}{250} = 0.0012 \text{ m}$$

$$\text{Young's modulus } Y = \frac{\sigma}{e} = \frac{101.86}{0.0012} = 84883.33 \text{ N/mm}^2$$

$$= 84883.33 \times 10^6 \text{ N/m}^2 = 84.8833 \times 10^9 \text{ N/m}^2$$

$$\text{Area of the rod, } A = \frac{\pi b^2}{4} = \frac{\pi (30)^2}{4} \text{ cm}^2$$

$$= 7.0685 \text{ cm}^2 = 7.0685 \times 10^{-4} \text{ m}^2$$

$$3) \sigma = 125 \text{ MN/m}^2 = 125 \times 10^6 \text{ N/m}^2$$

$$P = 2.1 \times 10^3 \text{ kN} = 2.1 \times 10^6 \text{ N}$$

$$D = 30 \text{ cm} = 0.30 \text{ m}, \quad d = \text{internal diameter}$$

$$\text{Area of cross-section, } A = \frac{\pi (D^2 - d^2)}{4} = \frac{\pi (30^2 - d^2)}{4} \text{ m}^2$$

$$\sigma = \frac{P}{A}$$

$$125 \times 10^6 = \frac{2.1 \times 10^6}{\frac{\pi (30^2 - d^2)}{4}}$$

$$(30^2 - d^2) = \frac{4 \times 2.1 \times 10^6}{\pi \times 125 \times 10^6}$$

$$0.09 - d^2 = 213.9$$

$$d = \sqrt{0.09 - 0.02139}$$

$$= 0.2619 \text{ m}$$

$$= 26.19 \text{ cm}$$

2) Area of rod, $A = \pi/4 b^2 = \pi/4 3^2 \text{ cm}^2$
 $= 7.0685 \text{ cm}^2 = 7.0685 \times 10^{-6} \text{ m}^2$

3) stress = $\frac{\text{load}}{\text{Area}} = \frac{150 \times 1000}{7.0685 \times 10^{-6}} = 21220.9 \times 10^4 \text{ N/m}^2$

Strain = $\frac{\text{Increase in length}}{\text{original length}} = \frac{0.21}{20 \times 10} = 0.00105$

Young's modulus, $E = \frac{\text{Stress}}{\text{Strain}} = \frac{21220.9 \times 10^4}{0.00105} = 20209523.8$
 $= 202.095 \times 10^9 \text{ N/m}^2$
 $= 202.095 \text{ GN/m}^2$

4) The % elongation is obtained as,
 $\% \text{ elongation} = \frac{\text{total } \Delta \text{ in length}}{\text{original length}} \times 100$
 $= \frac{60 \text{ mm}}{20 \times 10 \text{ mm}} \times 100 = 30\%$

5) The stress at the elastic limit
 $\text{Stress} = \frac{\text{load at elastic limit}}{\text{Area}}$
 $= \frac{250 \times 1000}{7.0685 \times 10^{-6}}$
 $= 35362 \times 10^4 \text{ N/m}^2$

$= 353.62 \times 10^4$

d) The percentage decrease in area is obtained as,
 $\% \text{ decrease in area} = \frac{\text{original area} - \text{area at the elastic limit}}{\text{original area}} \times 100$

$= \frac{\pi/4 \times 3^2 - \pi/4 \times 2.25^2}{\pi/4 \times 3^2} \times 100$
 $= \frac{3^2 - 2.25^2}{3^2} \times 100$
 $= \frac{9 - 5.0625}{9} \times 100$

$= 40.416\%$

10/10

Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PATTANUR, KANNUR

1) Define stress & strain.

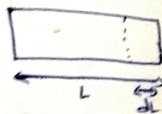
2) Draw the stress strain graph & explain all the important points on the graph.

1) Stress

Strain

It is the ratio of changing dimension to the original dimension.

$$\text{Strain } \epsilon = \frac{\Delta L}{L}$$



It is a unit less quantity.

Stress

When a body is subjected to a force per unit area. When the body against the deforming force.

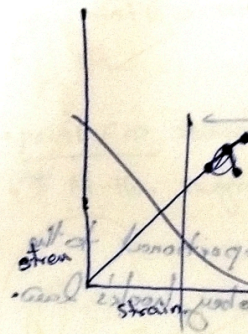
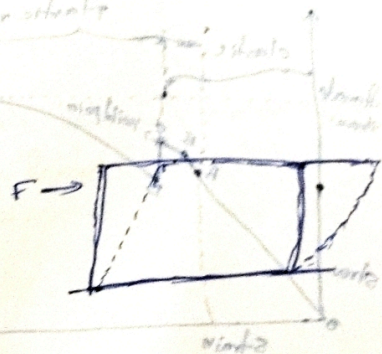
$$\text{Stress, } \sigma = \frac{\text{Force}}{\text{Area of cross-section.}}$$

unit is N/m^2

unit is N/m^2 .

$$\sigma = \frac{F}{A}$$

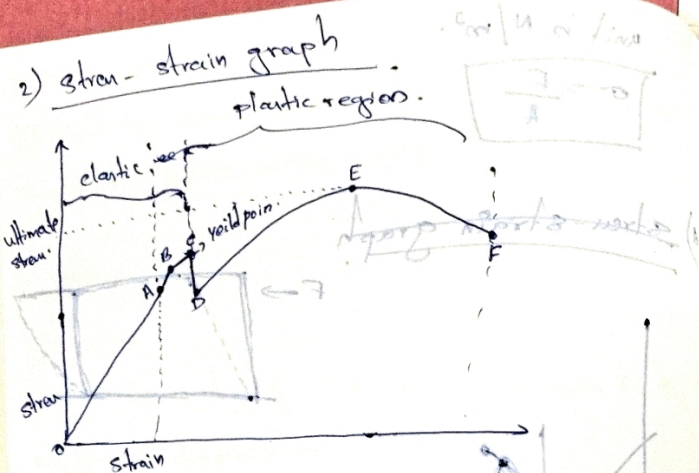
2) Stress strain graph



When a body is subjected to a force per unit area. When the body against the deforming force.

Leena

Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYYANUR, KANNUR



- ⇒ O-A ⇒ proportionality limit.
- In this point stress is directly proportional to the strain. In this region graph obeys Hooke's law.
- ⇒ A-B ⇒ elastic limit.
- In this region the body regain its original shape after the removal of deforming force.
- After the elastic limit body doesn't regain its original shape. This body is called plastic.

⇒ point C - D ⇒ yield point.

• the body

- C is minimum yield point.
- D is max^m yield point.

• The body doesn't regain its original shape after the removal of deforming force.

• Point E ⇒ ultimate stress.

• point F ⇒ ~~break~~ ~~break~~

• At this region the steel breaks.

10/10

Leena
Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYANUR, KANNUR

Tutorial-3

1) A compound tube consist of steel tube 140mm internal diameter and 160mm external diameter and outer to brass tube 160mm internal diameter and external diameter 180mm. The 2 tubes are of same length. The compound tube carries an axial load of 900 kN. Find the stresses and load carry by each tube and the amount shortens. Length of each tube is 140mm take $E_{\text{steel}} = 2 \times 10^5 \text{ N/mm}^2$ and $E_{\text{brass}} = 1 \times 10^5 \text{ N/mm}^2$.

2) 2 vertical rods one of steel and other of copper are each rigidly fixed at top 50cm apart. Diameter and lengths of each rod are 2cm, and 4cm. A cross sectional bar fix to the rods at lower end carries a load of 500N such that the cross bar remains horizontal even after bending. Find the stresses in each rod & position of the load on bar. take $E_s = 2 \times 10^5 \text{ N/mm}^2$ & $E_{\text{cu}} = 1 \times 10^5 \text{ N/mm}^2$.

3) A load of 2MN is applied on a short concrete column 500x500mm. The column is reinforced by 4 steel bars of 10mm dia. one in each column. Find the stress in concrete & steel bar. $E_s = 2 \times 10^5 \text{ N/mm}^2$ & $E_c = 1 \times 10^4 \text{ N/mm}^2$.

Answer

Internal Diameter of steel

rod = 140mm

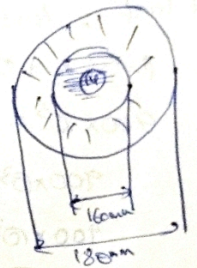
External dia of steel rod = 160mm

Area of steel rod,

$$A = \frac{\pi}{4} (160^2 - 140^2)$$

$$= \frac{\pi}{4} \times 6000$$

$$= 4710 \text{ mm}^2$$



$$\frac{\sigma_{\text{brass}}}{E_{\text{brass}}} = \frac{\sigma_{\text{steel}}}{E_{\text{steel}}}$$

$$\sigma_b = \frac{E_b}{E_s} \times \sigma_s$$

$$= \frac{1 \times 10^5}{2 \times 10^5} \times \sigma_s$$

$$\text{Area of brass rod} = \frac{\pi}{4} (180^2 - 160^2)$$

$$= \frac{\pi}{4} (32400 - 25600)$$

$$= 5338 \text{ mm}^2$$

Leena
Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PATTANUR, KANNUR

Total load = load on steel + load on brass

$$P = \sigma_s A_s + \sigma_b A_b$$

$$900 \times 10^3 = \sigma_s \times 4710 + 0.5 \sigma_s \times 5338$$

$$900 \times 10^3 = 4710 \sigma_s + 2669 \sigma_s$$

$$900 \times 10^3 = 7379 \sigma_s$$

$$\sigma_s = \frac{900 \times 10^3}{7379}$$

$$\therefore \sigma_s = 121.967 \text{ N/mm}^2$$

$$\sigma_b = 0.5 \times 121.967$$

$$= 60.983 \text{ N/mm}^2$$

$$P_s = \sigma_s A_s$$

$$= 121.967 \times 4710$$

$$= 574464.57$$

$$P_b = \sigma_b A_b$$

$$= 60.983 \times 5338 = 325527.254$$

$$\Delta_s = \frac{P_s L_s}{A_s E_s}$$

$$= \frac{574464.57 \times 140}{4710 \times 2 \times 10^5}$$

$$= 0.08537 \text{ mm}$$

$$\Delta_b = \frac{P_b L_b}{A_b E_b} = \frac{325527.254 \times 140}{5338 \times 1 \times 10^5}$$

$$= 0.08537 \text{ mm}$$

2) Dia of each rod = 2 cm = 20 mm

Length of each rod = 4 m = 4×10^3 mm

$$P = 5000 \text{ N}$$

$$E_s = 2 \times 10^5 \text{ N/mm}^2$$

$$E_c = 1 \times 10^5 \text{ N/mm}^2$$

$$A_s = A_c = \frac{\pi}{4} (20^2) = 314.159 \text{ mm}^2$$

$$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c}$$

$$\sigma_s = \sigma_c \times \frac{E_s}{E_c}$$

Leena

Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYYANUR, KANNUR

$$\sigma_s = \frac{2 \times 10^5}{1 \times 10^5} \sigma_c$$

$$\sigma_s = 2\sigma_c$$

Total load = load on Ca + load on steel.

$$5000 = \sigma_s A_s + \sigma_c A_c$$

$$5000 = 2\sigma_c \times 314.159 + \sigma_c \times 314.159$$

$$5000 = 628.318\sigma_c + 314.159\sigma_c$$

$$5000 = 942.477\sigma_c$$

$$\sigma_c = \frac{5000}{942.477} = 5.305 \text{ N/mm}^2$$

$$\therefore \sigma_s = 2 \times 5.305 = 10.61 \text{ N/mm}^2$$

$$\sigma_s = 10.61 \text{ N/mm}^2$$

$$\frac{50}{23} = \frac{20}{23}$$

$$A_s = \frac{\pi}{4} 10^2 \times 4 = 314.159 \text{ mm}^2$$

$$A_c = 500 \times 500 = 249685.841 \text{ mm}^2$$

Total load = load of steel + load of concrete.

$$2 \times 10^6 = P_s + P_c \quad (1)$$

$$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c}$$

$$\sigma_s = \frac{E_s}{E_c} \sigma_c$$

$$= \frac{2 \times 10^5}{1.4 \times 10^5} \sigma_c$$

$$\sigma_s = 1.5\sigma_c$$

$$\sigma_s A_s + \sigma_c A_c = 2 \times 10^6$$

$$1.5\sigma_c \times 314.159 + \sigma_c \times 249685.841 = 2 \times 10^6$$

$$4712.385\sigma_c + \sigma_c 249685.841 = 2 \times 10^6$$

$$254398.226\sigma_c = 2 \times 10^6$$

$$\sigma_c = \frac{2 \times 10^6}{254398.226}$$

Leena

Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYANUR, KANNUR

$$\sigma_c = 7.861 \text{ N/mm}^2$$

$$\sigma_s = 15 \times 7.861 = 117.915 \text{ N/mm}^2$$

10/2

$$\frac{50}{23} = \frac{20}{23}$$

$$\frac{50}{23} = \frac{20}{23}$$

$$\frac{201 \times 1.5}{201 \times 1.1}$$

$$5021 = 20$$

$$201 \times 5 = 5A_{50} + 2A_{20}$$

$$148.28 \text{ MPa} \times 50 + 21.415 \times 20 = 5021$$

$$701 \times 5 =$$

$$701 \times 5 = 148.28 \text{ MPa} \times 50 + 21.415 \times 20$$

$$701 \times 5 = 50285.8 \text{ MPa}$$

$$701 \times 5 = 50$$

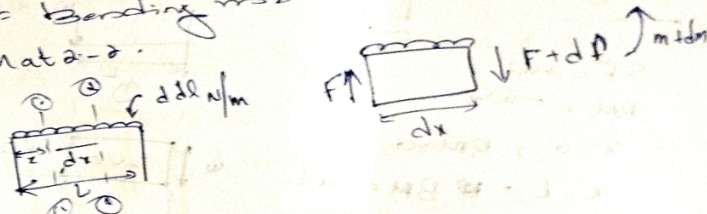
$$255.38 \text{ MPa}$$

10

Tutorial-4

1. Label the relation b/w intensity of loading, SF & BM.

→ Consider a beam carrying uniformly distributed load w per unit length. Consider a length dx of beam between section 1-1 & 2-2. This portion is at a distance x from left support. Let F = shear force at 1-1, $F + dF$ = shear force at 2-2, M = bending moment at 1-1, $M + dM$ = BM at 2-2.



Equilibrium of vertical forces,

$$F - w dx - (F + dF) = 0$$

$$F = w dx - F - dF = 0$$

$$1 - w dx - dF = 0$$

$$w = \frac{-dF}{dx}$$

Leena

Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYYANUR, KANNUR

moment at ②-②

$$M + Fdx - w dx \times \frac{dx}{2} - (M + dM) = 0$$

$$M + Fdx - \frac{w dx^2}{2} - M - dM = 0$$

$$Fdx - dM = 0$$

$$P = \frac{dM}{dx} \quad \frac{w dx^2}{2} \text{ is } -ve.$$

integrate BMD & SFD for cantilever beam subjected to central concentrated load

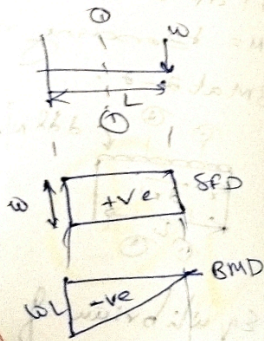
①-①

$$SF = +w$$

$$BM = -wx$$

$$x=0, BM=0$$

$$x=l, BM = -wL$$



10/10

Tutorial-5

1) A steel rod of length 900 mm & dia 25 mm has a bronze sleeve BC of length 300 mm. Securely bonded to its for a rise in temp of 200°C. solve

- i) stress in steel rod & bronze sleeve.
- ii) compressive force developed in bronze sleeve
- iii) Elongation of bronze sleeve.
- iv) Total elongation of steel rod.

$$E_s = 200 \text{ GPa} \quad E_B = 100 \text{ GPa} \quad \alpha_s = 1.2 \times 10^{-5} / ^\circ\text{C}$$

$$\alpha_B = 2.03 \times 10^{-5}$$

Length of steel rod = 900 mm

bronze sleeve = 300 mm

internal dia = 25 mm.

external dia = 30 mm.

$$\text{area of steel} = \frac{\pi}{4} \times 25^2 = 490.87 \text{ mm}^2$$

$$\text{bronze} = \frac{\pi}{4} (30^2 - 25^2) = 215.984 \text{ mm}^2$$

Leena

Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYYANUR, KANNUR

ii) Compressive force in bronze = stress in bronze
 $= 406 \times 215.9 \times 10^{-3}$
 $= 37629.54 \text{ N}$

iii) Elongation of bronze sleeve = $\frac{\text{stress}}{\text{strain}} = \text{Young's modulus}$
 $= \frac{406}{\text{strain}} = 1 \times 10^5$ strain = $\frac{406}{1 \times 10^5}$
 $= 4.06 \times 10^{-3}$

Strain = $\frac{\text{Change in length}}{\text{original length}}$
 $4.06 \times 10^{-3} = \frac{\Delta L}{300}$

$4.06 \times 10^{-3} \times 300 = \Delta L$

$\Delta L = 1.218 \text{ mm}$

iv) Total elongation of steel rod,
 strain = $\frac{400}{1 \times 10^5} = 2.4 \times 10^{-3}$

Elongation = strain $\times$ Original length
 $= 2.4 \times 10^{-3} \times 900$
 $= 2.16 \text{ mm}$


Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

~~Q.10~~ Draw the SFD & BMD of given beam.

Tutorial - 6

1) Draw the SFD & BMD of given beam.

$$\sum F_y = 0$$

$$3 \times 20 + 40 = R_A + R_B$$

$$R_A + R_B = 60 + 40$$

$$R_A + R_B = 100$$

$$\sum M_A = 0$$

$$20 \times 1.5 + 40 \times 3 + 120 = R_B \times 4.5$$

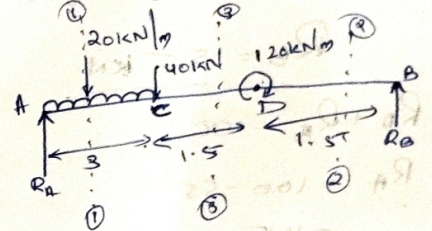
$$30 + 120 + 120 = R_B \times 4.5$$

$$240 + 120 = R_B \times 4.5 \quad 243 = R_B \times 4.5$$

$$R_B = \frac{243}{4.5} = 54 \text{ kN}$$

$$R_A + 100 = R_B$$

$$= 100 - 54 = 46 \text{ kN}$$



Leena
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYANUR, KANNUR

$$\sum M_A = 0$$

$$20 \times 3 \times 1.5 + 40 \times 3 + 120 = R_B \times 6$$

$$90 + 120 + 120 = R_B \times 6$$

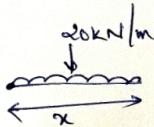
$$R_B = 55 \text{ kN}$$

$$R_A + R_B = 100$$

$$R_A = 100 - 55$$

$$= 45 \text{ kN}$$

① - ① (A-C)



$$SF = -20x + 45$$

$$x=0 \quad SF = 45 \text{ kN}$$

$$x=3 \quad SF = 20 \times 3 + 45$$

$$= 60 \text{ kN}$$

$$= 60 + 45$$

$$= 15 \text{ kN}$$

$$BM = -20x \times x/2 + 45x$$

$$= -10x^2 + 45x$$

$$x=0 \quad BM=0$$

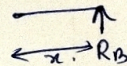
$$x=3 \quad BM = -10 \times 3^2 + 45 \times 3$$

$$BM = 45 \times 3 - 90$$

$$= 45 \times 3 - 90$$

$$= 45 \text{ kN}$$

② - ② AD



$$SF = 55 \text{ kN}$$

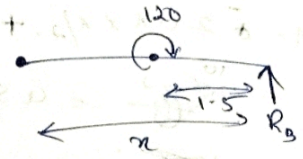
$$BM = +55x$$

$$x=0 \quad BM=0$$

$$x=1.5 \quad BM = 55 \times 1.5 = 82.5 \text{ kNm}$$

Leena
Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYYANUR, KANNUR

⑧-③ (C D)



$SF = -55 \text{ kN}$

$BM = 55x - 120$

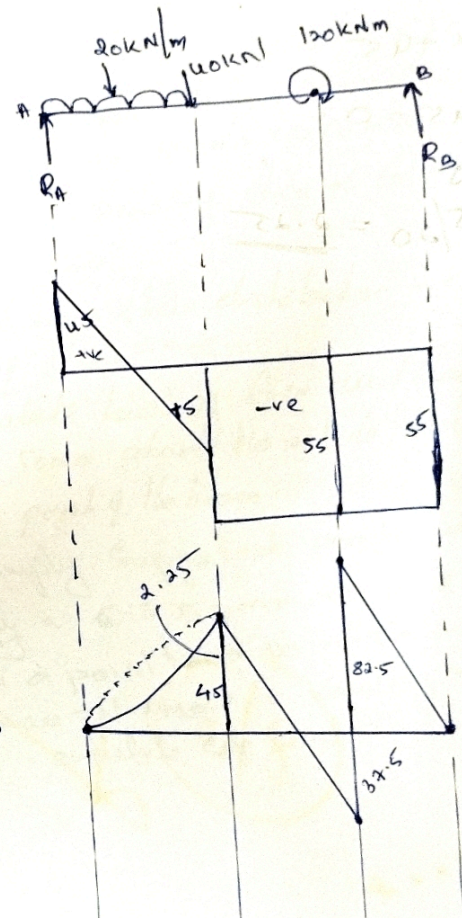
$x = 1.5$

$BM = 55 \times 1.5 - 120 = -37.5 \text{ kNm}$

$x = 3$

$BM = 55 \times 3 - 120 = 45 \text{ kNm}$

18/10



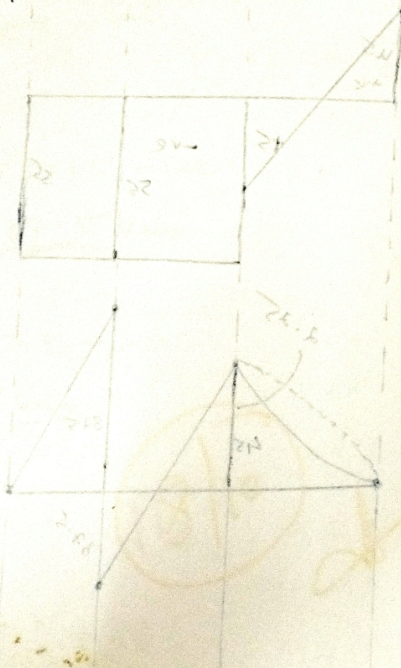
Leena
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

$$SF = -20x + 45$$

$$-20x + 45 = 0$$

$$20x = 45$$

$$x = 45/20 = \underline{\underline{2.25}}$$



Tutorial 7

1) A simply supported beam AB of 5m span is carrying a UDL of 20 kN/m. The beam is made up of a rectangular CS of dimension 300 mm x 450 mm.

i) Draw the bending stress distribution at critical sections.

ii) Draw shear stress distribution considering critical section of beam.

iii) Calculate bending stress and shear stress on layer located 50 mm above the neutral axis on the CS at mid point of the beam.

2) A simply supported wooden beam of span 1.3m having a 50 mm wide & 250 mm deep carries a point load at the centre. The permissible stress is 7 N/mm² in bending and 1 N/mm² in shear. Calculate safe load.

Leena
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

$$2) b = 180 \text{ mm}, d = 250 \text{ mm}, L = 1.3 \text{ m}$$

$$\sigma_b = 7 \text{ N/mm}^2 \quad q_{\text{max}} = 1 \text{ N/mm}^2$$

$$M = \frac{WL}{4} = \frac{W \times 1.3}{4} = 0.325W - \text{Nm}$$

$$\text{Max SF} = \frac{W}{2} = 0.5W \text{ N}$$

For rectangular Sectⁿ

$$A = b \times d = 180 \times 250 = 45000 \text{ mm}^2$$

$$I = \frac{bd^3}{12} = \frac{180 \times 250^3}{12} = 1.9531 \times 10^8 \text{ mm}^4$$

$$y_{\text{max}} = d/2 = \frac{250}{2} = 125 \text{ mm}$$

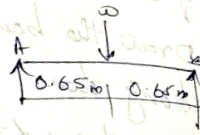
$$\frac{M}{I} = \frac{\sigma}{y} \therefore M = \frac{\sigma}{y} \times y$$

$$0.325W = \frac{7 \times 1.9531 \times 10^8}{125}$$

$$W = 33653.41 \text{ N} = 33.65 \text{ kN}$$

Value of W for shear stress Criteria

$$q_{\text{max}} = \frac{1.55}{A}$$



$$1 = \frac{1.55 \times W}{37500} = 33.65 \text{ kN}$$

$$W = 50000 \text{ N} = 50 \text{ kN}$$

$$W = 50000 \text{ N} = 50 \text{ kN}$$

$$\text{Safe Value, } W = 33.65 \text{ kN}$$

$$1) \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

Given $\rightarrow$

$$W = 20 \text{ kN}$$

$$L = 5 \text{ m}$$

$$b = 300$$

$$d = 450$$

$$I = \frac{bd^3}{12} = \frac{300 \times 450^3}{12} = 2.278125 \times 10^9 \text{ mm}^4$$

$$M = \frac{WL^2}{8} = \frac{20 \times 5^2}{8} = 62.5 \text{ kNm}$$

$$y = \frac{450}{2} = 225$$

$$\frac{M}{I} = \frac{\sigma}{y}$$

Leena
Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYYANUR, KANNUR

$$\therefore \sigma = \frac{62.5 \times 10^6 \times 225}{2278125000} = 6.172$$

$$F = \frac{WL}{2} = \frac{20 \times 5}{2} = 50 \text{ W}$$

$$A = 300 \times 225 = 67500$$

$$\bar{y} = \frac{225}{2} = 112.5$$

$$I = 2278125000$$

$$b = 300$$

$$\therefore z = 0.55$$

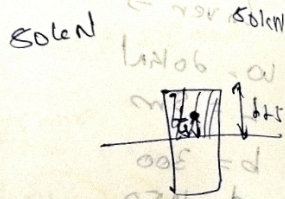
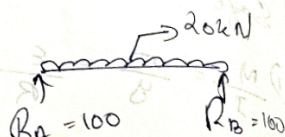
$$\text{ii) } \frac{M}{I} = \frac{\sigma}{y}$$

$$y = 50$$

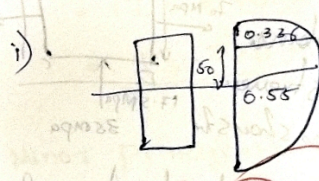
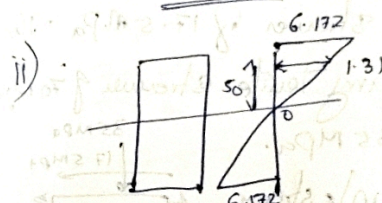
$$\sigma = \frac{62.5 \times 10^6 \times 50}{2278125000} = 1.37$$

$$\bar{y} = \frac{175}{2} = 87.5$$

$$A = 175 \times 300 = 52500 \text{ m}^2$$



$$z = \frac{50 \times 10^3 \times 52500 \times 87.5}{2278125000 \times 300} = 0.336$$

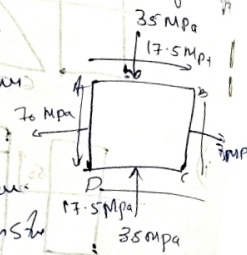


Handwritten notes and calculations in the right margin, including a circled '10' and various scribbles.

Dr. Leena A V
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

Tutorial - 8

1) A rectangular element ABCD of an elastic material is subjected to a shear stress of 17.5 MPa . The planes at right angle carry tensile stress of 70 MPa and compressive stress of 35 MPa .



- The magnitude of principle stress
- The direction of principle planes
- Magnitude of max shear stress
- Orientation of plane of max shear

2) An elemental cube is subjected to tensile stress of 30 N/mm^2 and 15 N/mm^2 acting on two mutually perpendicular planes and a shear stress of 25 N/mm^2 is there. Determine magnitude and direction of principle stress and its planes.

$\sigma_1 = 70 \text{ MPa}$
 $\sigma_2 = -35 \text{ MPa}$

i) Major principle

$$\begin{aligned}
 \tau &= -17.5 \text{ MPa} \\
 \sigma_1 &= \frac{\sigma_1 + \sigma_2}{2} + \sqrt{\left(\frac{\sigma_1 - \sigma_2}{2}\right)^2 + \tau^2} \\
 &= \frac{70 - 35}{2} + \sqrt{\left(\frac{70 + 35}{2}\right)^2 + (17.5)^2} \\
 &= 17.5 + \sqrt{50.625^2 + 306.25} \\
 &= 17.5 + 58.7807 \\
 &= 76.2807 \text{ MPa}
 \end{aligned}$$

Minor principle stress

$$\begin{aligned}
 \sigma_2 &= \frac{\sigma_1 + \sigma_2}{2} - \sqrt{\left(\frac{\sigma_1 - \sigma_2}{2}\right)^2 + \tau^2} \\
 &= \frac{70 - 35}{2} - \sqrt{\left(\frac{70 + 35}{2}\right)^2 + (17.5)^2} \\
 &= 17.5 - 58.7807 \\
 &= -41.2807 \text{ MPa}
 \end{aligned}$$


Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR

$$ii) \tan 2\theta = \frac{2\tau}{\sigma_1 - \sigma_2} = \frac{2 \times 14.5}{70 + 35} = -1/3$$

$$2\theta = \tan^{-1}(-1/3)$$

$$\theta = -9.217^\circ$$

$$= -9^\circ 13' 2.91''$$

$$iii) (\sigma_x)_{\max} = \frac{1}{2} \sqrt{(\sigma_1 + \sigma_2)^2 + 4\tau^2}$$

$$= \frac{1}{2} \sqrt{(70 + 35)^2 + 4 \times (-17.5)^2}$$

$$= 55.33985 \text{ N/mm}^2$$

$$iv) \tan 2\theta = \frac{2\tau}{\sigma_1 - \sigma_2}$$

$$= \frac{2 \times -17.5}{70 + 35}$$

$$= -1/3$$

$$2\theta = \tan^{-1}(1/3)$$

$$\theta = -9.217^\circ$$

$$= -9^\circ 13' 2.91''$$

$$1) \sigma_1 = 30 \text{ N/mm}^2$$

$$\sigma_2 = 15 \text{ N/mm}^2$$

$$\tau = 25 \text{ N/mm}^2$$

Major principle stress

$$= \frac{\sigma_1 + \sigma_2}{2} + \sqrt{\left(\frac{\sigma_1 - \sigma_2}{2}\right)^2 + \tau^2}$$

$$= \frac{30 + 15}{2} + \sqrt{\left(\frac{30 - 15}{2}\right)^2 + 25^2}$$

$$= 49.65 \text{ N/mm}^2$$

Major Principle stress

$$= \frac{\sigma_1 + \sigma_2}{2} - \sqrt{\left(\frac{\sigma_1 - \sigma_2}{2}\right)^2 + \tau^2}$$

$$= -4.65 \text{ N/mm}^2$$

Directⁿ 2 principle stress

$$\tan 2\theta = \frac{2\tau}{\sigma_1 - \sigma_2} = 3.33$$


Dr. LEENA A V
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF
ENGINEERING & TECHNOLOGY
PAYANUR, KANNUR

$$\tan \theta = \tan^{-1}(3.83) \cdot P = 0$$

$$\therefore \theta = 36^\circ 32'$$

$$(\sigma_t)_{\max} = \frac{1}{2} \sqrt{(\sigma_1 - \sigma_2)^2 + 4\tau^2}$$

$$= 26.100$$

10/10

$$\frac{(\sigma_1 - \sigma_2)}{2} + \sqrt{\left(\frac{\sigma_1 - \sigma_2}{2}\right)^2 + \tau^2}$$

$$= \frac{50 + 12}{2} + \sqrt{\left(\frac{50 - 12}{2}\right)^2 + 21^2}$$

$$= 30 + 12 + \sqrt{19^2 + 21^2}$$

$$= 42 + 28.2 = 70.2$$

$$= 70.2 \text{ N/mm}^2$$

Major principal stress

$$\frac{(\sigma_1 - \sigma_2)}{2} - \sqrt{\left(\frac{\sigma_1 - \sigma_2}{2}\right)^2 + \tau^2}$$

$$= \frac{50 + 12}{2} - \sqrt{\left(\frac{50 - 12}{2}\right)^2 + 21^2}$$

$$= 42 - 28.2 = 13.8$$

$$= 13.8 \text{ N/mm}^2$$

Minor principal stress

$$\tan \theta = \frac{50}{13} = 3.83$$

Leena
Dr. LEENA A V
 PRINCIPAL
 SREE NARAYANA GURU COLLEGE OF
 ENGINEERING & TECHNOLOGY
 PAYYANUR, KANNUR