CBCS SCHEME

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BPHYC102/202

First/Second Semester B.E./B.Tech. Degree Examination, June/July 2023
Applied Physics for Civil Engineering Stream

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. VTU Formula Hand Book is permitted.
3. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	**M**	**L**	**C**
Q.1	**a.**	Define Hooke's law and hence derive expressions for the effective spring constant of springs in series and parallel combination.	**07**	**L2**	**CO1**
	b.	With necessary diagram explain construction and working of Reddy Shock Tube and mention any four of its applications.	**08**	**L2**	**CO1**
	c.	A car has a spring that supports the in-built mass 1000 kg, when a person with a weight 980 N sits at the centre of gravity, the spring system sinks by 2.8 cm. When the car hits a bump, it stood oscillating vertically. Find the period and frequency of oscillation.	**05**	**L3**	**CO5**
		OR			
Q.2	**a.**	Explain various forces acting on a system under damped oscillations, setup differential equation and assuming the solution mention the variation of amplitude with respect to time.	**08**	**L2**	**CO1**
	b.	Explain Mach number, Mach angle, Resonance, Sharpness of resonance.	**07**	**L2**	**CO1**
	c.	A mass 0.5 kg causes an extension 0.03 m in a spring and the system is set for oscillations. Find (i) Force constant K of the spring, (ii) Angular frequency w, (iii) Period T of the resulting oscillation.	**05**	**L3**	**CO5**
		Module – 2			
Q.3	**a.**	Define Poisson's ratio and derive the relation between Young's modulus, Rigidity modulus and Poisson's ratio.	**08**	**L2**	**CO1**
	b.	Define 3 types of Moduli and discuss stress-strain curve.	**08**	**L2**	**CO1**
	c.	Calculate the extension produced in a wire of length 2 m and radius 0.013×10^{-2} m due to a force of 14.7 Newton applied along its length. Given Young's modulus of the material of the wire, $Y = 2.1\times10^{11}$ N/m^2.	**04**	**L3**	**CO5**
		OR			
Q.4	**a.**	Explain elongation, compression strain and Poisson's ratio and also arrive at the relation between them and explain limiting values of Poisson's ratio.	**08**	**L2**	**CO1**
	b.	Explain Beam, Types of Beams, bending moment, ductile fracture and brittle fracture.	**08**	**L2**	**CO1**
	c.	Calculate the force required to produce an extension of 1mm in steel wire of length 2 meter and diameter 1mm. Given Young's modulus $Y = 2.1\times10^{11}$ N/m^2.	**04**	**L3**	**CO5**
		Module – 3			
Q.5	**a.**	With some relevant points define and explain Lambert's cosine law and Inverse Square law.	**08**	**L2**	**CO2**
	b.	Define Reverberation and Reverberation Time. Discuss Reverberation time optimum value for good auditorium.	**08**	**L2**	**CO2**
	c.	A hall having volume of 1500 m^3 has total absorption equivalent to 100 m^2 Sabine. Calculate the reverberation time of the hall.	**04**	**L3**	**CO2**

OR

Q.6	a.	Define Photometry and Radiometry and also define 4 photometric quantities and 4 radiometric quantities.	10	L2	CO2
	b.	Explain Impact of Noise in Multi-Storied buildings.	05	L2	CO2
	c.	The volume of room is 1500 m^3. The wall area of the room is 260 m^2, the floor area is 140 m^2, and the ceiling area is 140 m^2. The average sound absorption co-coefficient for wall is 0.03, for the ceiling is 0.8 and for the floor is 0.06. Calculate the average absorption co-efficient and the reverberation time.	05	L3	CO2
		Module – 4			
Q.7	a.	Explain construction and working of semiconductor LASER with necessary diagram.	08	L2	CO3
	b.	With necessary diagram, explain propagation of light through optical fibre and obtain expression for Numerical Aperture and angle of acceptance.	08	L2	CO3
	c.	The average output power of Laser source emitting a laser beam of wavelength 6328 A° is 5 mW. Find the number of photons emitted per second by the laser source.	04	L3	CO5
		OR			
Q.8	a.	What are optical fibers? Explain principle of optical fiber. With neat diagrams explain types of optical fibers.	10	L2	CO3
	b.	Define Attenuation co-efficient, induced absorption, spontaneous emission, stimulated emission, population inversion, metastable state.	06	L2	CO3
	c.	An optical fiber has a core material with reactive index 1.55 and its cladding material has a refractive index of 1.5. The light is launched into it in air. Calculate the numerical aperture, the acceptance angle and also the fractional index change.	04	L3	CO5
		Module – 5			
Q.9	a.	Explain the classification of natural hazards and man-made hazards with examples.	10	L2	CO4
	b.	Define earthquake and discuss four types of earthquake.	05	L2	CO4
	c.	A recent earthquake in San Francisco measured 7.1 on the Richter scale. How many times more intense was the San Francisco earthquake earlier registered 8.3 on the Richter scale.	05	L3	CO4
		OR			
Q.10	a.	Enumerate the causes and adverse effects of tsunami waves.	08	L2	CO4
	b.	Define landside and describe the causes for landslides.	08	L2	CO4
	c.	Early in the century the earthquake in San Francisco registered 8.3 on the Richter scale. In the same year, another earthquake was recorded in South America that was four time stronger. What was the magnitude of the earthquake in South America?	04	L3	CO4

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BPHYC-202 – Applied Physics for Civil Engineering - BPHYC102/202

Exam: June/July 2023

Q. 1

MODULE – 1.

ⓐ Define Hooke's law and hence derive expression for the effective spring constant of springs in series and parallel combination. (M- 07.)

Soln: If 'F' is the restoring force & 'x' is the displacement then

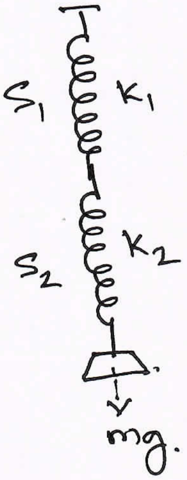
$$F \propto -x$$

$$F = -kx$$

where $k \rightarrow$ force constant / spring constant

The above equation is called Hooke's law, and the law states that "the restoring force in oscillating body is directly proportional to displacement and acting in a direction opposite to displacement.

Expression for spring constant for series combination of springs.



Let us suppose, two springs S_1 & S_2 are connected in series. When weight 'mg' is attached to the series combination, the restoring force in each spring will be same, say F but increase in length will be different.

If y_1 & y_2 are extensions in the lengths of the springs S_1 & S_2, then

$$F = -k_1 y_1 \quad \text{and} \quad F = -k_2 y_2$$

So that

$$y_1 = \frac{-F}{k_1} \quad \& \quad y_2 = \frac{-F}{k_2}$$

The total extension in series combination is given by

$$y = y_1 + y_2$$

$$= \frac{-F}{k_1} + \left(\frac{-F}{k_2}\right)$$

$$= -F\left[\frac{1}{k_1} + \frac{1}{k_2}\right]$$

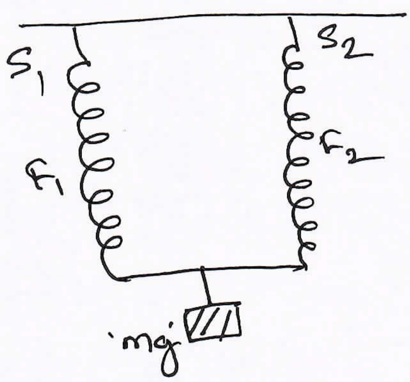
$$y = -\left(\frac{k_1 + k_2}{k_1 k_2}\right)F$$

$$\text{or} \quad F = -\left(\frac{k_1 k_2}{k_1 + k_2}\right)y$$

If k_s is the effective spring constant in series, then

$$\boxed{k_s = \left(\frac{k_1 k_2}{k_1 + k_2}\right)}$$

Springs in Parallel.



Suppose the two springs S_1 & S_2 having spring factors k_1 & k_2 are connected in parallel, when weight 'mg' is attached to the parallel combination, each spring will undergo same amount of extension 'y'.

However, the restoring force developed in the two springs will be different as they have different spring factors.

If F_1 & F_2 are restoring forces developed in the two springs, then

$$F_1 = -k_1 y \quad \& \quad F_2 = -k_2 y$$

The restoring force 'F' is given by

$$F = F_1 + F_2$$

$$F = -k_1 y + (-k_2 y)$$

$$F = -(k_1 + k_2) y$$

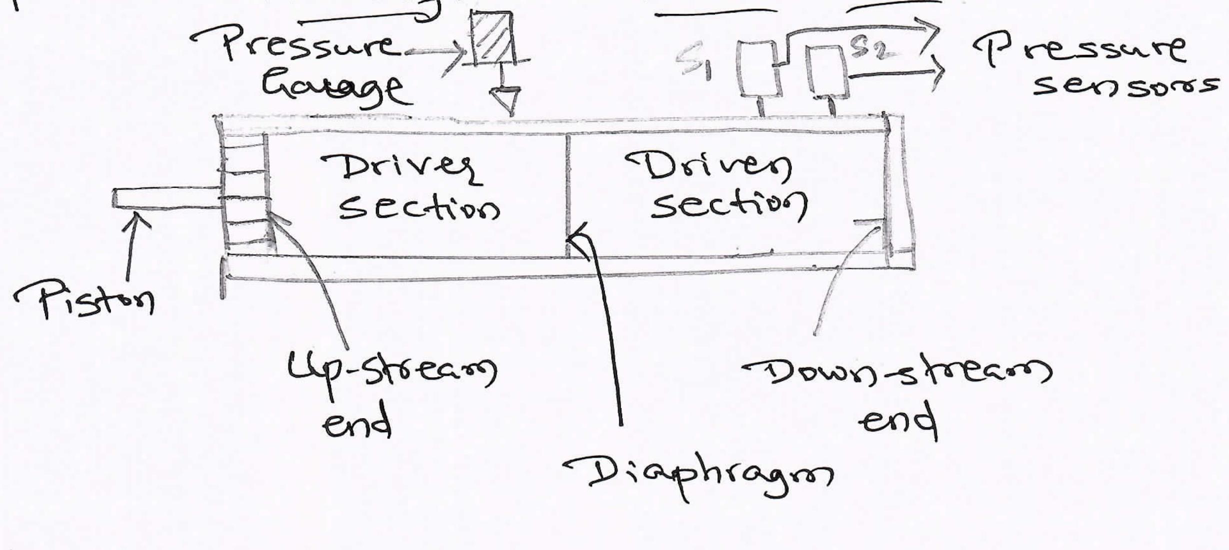
If k_p is the force constant or effective spring constant of the parallel combination of the springs, then it follows that

$$\boxed{k_p = k_1 + k_2}$$

Q.1 (b) With necessary diagram, explain construction and working of Reddy shock tube and mention any four of its applications - (8M)

Soln.

Reddy's Shock tube.



Construction:

It consists of stainless steel cylindrical tube of length 1m and about 30mm in diameter. The tube is divided into two parts of each length 50 cm by placing a diaphragm of thickness 0.1mm, made up of paper or aluminium at the center. One part of the tube acts as driver tube and other part acts as driven tube. A moveable frictionless piston is placed at the beginning of the driver section. Digital pressure gauge is mounted on the driver section close to the diaphragm.

Two piezoelectric sensors S_1 & S_2 are placed at a distance of 7cm towards the closed end of the shock tube. A Helium gas at high pressure is filled at the driver section and relatively lower pressure gas (Argon) is filled at driven section.

Working:

The driver gas is compressed by pushing the piston hard until the diaphragm breaks and expansion waves created. This shock wave rushes into the driven section and pushes the driven gas towards the far-down stream end. This generated shock wave move along the length of the driver section, hence temperature & pressure of the gas increase.

Reflected shock wave from the downstream end again compresses the test gas & increase its temperature & pressure, This state of high value of temperature & pressure is maintained at downstream end & until the expansion wave are reflected from the upstream end from the driver tube to neutralize the compression partially. The time period over which high value of temp--erature & pressure condition is sustained at downstream end is of the order of millisecond. this time period changes, depends on the dimension of the shock tube, nature of the driver gas & test gas.

the pressure sensor S_1 & S_2 are piezo electric transducers which senses the signal of primary shock waves produced by the increase of pressure & temperature by refle--cted shock wave. These signals are recorded in the digital CRO. The oscilloscope of bandwidth 1MHz or more is used for mea--surement of time-based calculation for sustained state one milli second time interval.

Applications of shock waves

(*) Following are the applications of the shock waves.

Shock waves are used in

1. wood preservation.
2. Cell information.
3. Kidney stone treatment.
4. Treatment of dry bore wells.
5. Pencil industry.
6. Gas dynamics study.

Q.1

(c) A car has a spring system that support the in-built mass 1000 kg. When a person with a weight 980 N sits at the centre of gravity, the spring system sinks by 2.8 cm. When the car hits a bump, it starts oscillating vertically. Find the period & frequency of oscillation.

Soln:- Given $x = -0.028\,m$, $m = 1000\,kg$.
$W = 980\,N$.

When the person sits, the weight acting is 980 N.

we have $F_x = -kx$ & $k = -\frac{F_x}{x} = \frac{-980}{-0.028}$

$k = 3.5 \times 10^4\ N m^{-1}$.

$$mass = \frac{F}{g} = \frac{980}{9.8} = 100\,kg.$$

$\therefore$ Total mass $= 1000 + 100 = 1100\,kg$.

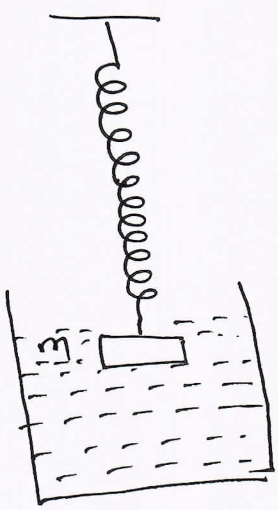
$$\therefore T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1100}{3.5\times10^4}} \cong 1.11\,s$$

$$f = \frac{1}{T} = \frac{1}{1.11} \cong 0.90\,Hz$$

Q.2 (a) Explain various forces acting on a system under oscillations. Set up differential equation and assuming the solution, mention the variation of amplitude with respect to time — (8M)

Soln:- For a body executing vibrations, the amplitude keeps on decreasing because of frictional resistance to the motion and hence the vibrations die out after some time. The motion is said to be damped by friction & is called damped oscillations.

Ex:-



Consider an object of mass 'm' moving through a liquid medium. It is clear that the damping force is more, when the mass is in liquid.

The damped system is subjected to

(i) A restoring force proportional to displacement but oppositely directed. ($-ky$)

(2) A frictional force proportional to velocity but oppositely directed ($-r\frac{dy}{dt}$).

where $r \to$ coefficient of frictional force (damping coefficient)

Since $F = ma$

$$F = m\frac{d^2y}{dt^2} \quad \text{---- (1)}$$

$\therefore$ Equation of motion of the particle is given by.

$$m\frac{d^2y}{dt^2} = -ky - r\frac{dy}{dt} \quad ----- \quad (2)$$

$$m\frac{d^2y}{dt^2} + ky + r\frac{dy}{dt} = 0$$

$$\frac{d^2y}{dt^2} + \frac{r}{m}\frac{dy}{dt} + \frac{k}{m}y = 0$$

$$\frac{d^2y}{dt^2} + 2b\frac{dy}{dt} + \omega^2 y = 0 \quad ---- \quad (3).$$

Note: $\frac{r}{m} = 2b$ and $\frac{k}{m} = \omega^2$

The solution of equation (3) is

$$y = A e^{\alpha t} \quad ---- \quad (4)$$

where A & α are arbitrary constants.

Differentiating eqn (4) w.r.t. 't', we get

$$\frac{dy}{dt} = A\alpha e^{\alpha t} \quad \text{and}$$

$$\frac{d^2y}{dt^2} = A\alpha^2 e^{\alpha t}$$

Substituting above relations in equation (3) we get

$$A\alpha^2 e^{\alpha t} + A\alpha e^{\alpha t} \cdot 2b + \omega^2 A e^{\alpha t} = 0$$

$$A e^{\alpha t}\left[\alpha^2 + 2b\alpha + \omega^2\right] = 0$$

As $A e^{\alpha t} \neq 0$

$$\alpha^2 + 2b\alpha + \omega^2 = 0$$

This gives

$$\alpha = -b \pm \sqrt{(b^2 - \omega^2)}.$$

The general solution of equation (3) is given by

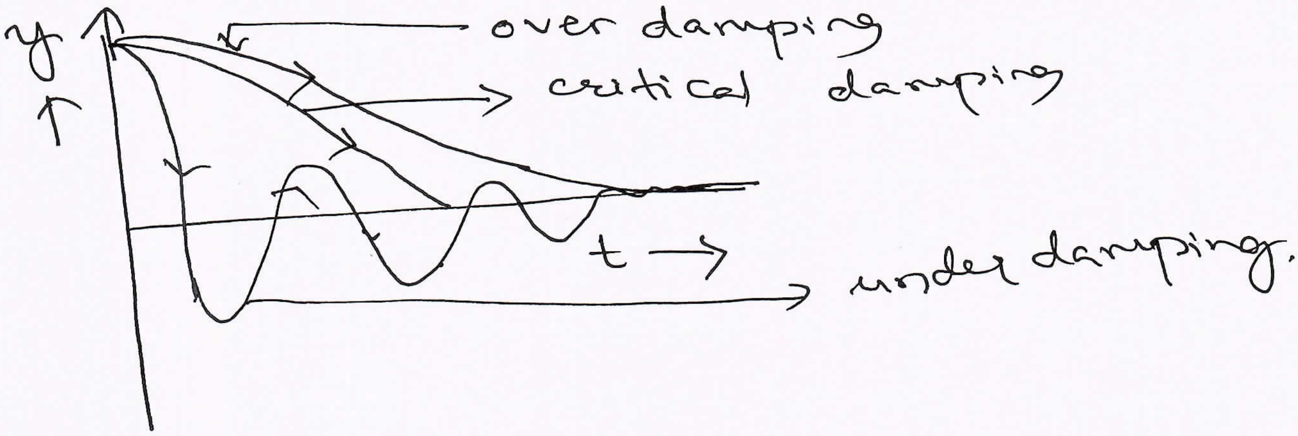
$$y = A_1 \exp\left[-b+\sqrt{b^2-\omega^2}\right]t + A_2 \exp\left[-b-\sqrt{b^2-\omega^2}\right]t \quad \text{---} (5)$$

where A_1 and A_2 are arbitrary constants. Depending upon the relative values of 'b' & 'ω', the following three cases are possible.

(i) Under damping :- Oscillations are said to be under damped, if the retarding force is weaker than the restoring force. The amplitude of oscillations decreases with respect to time. The condition is $b^2 < \omega^2$.

(ii) Over damping :- Oscillations are said to be over damped when the system attains equi-librium state quite slowly without making oscillations. The condition is $b^2 > \omega^2$.

(iii) Critical damping :- When the system approaches equilibrium state quite quickly without making any oscillations, is called critical damping. The condition is $b^2 = \omega^2$.



Q. 2 (b) Explain Mach number, Mach angle, Resonance and Sharpness of resonance. — (7M).

Sol:-

Mach number:- It is defined as the ratio of speed of the object (V_o) to the speed of sound (V_s) in the surrounding medium. It is a dimensionless quantity. It is given by

$$\text{Mach nor}(M) = \frac{V_o}{V_s}$$

$M = 0.5$ represents half the speed of sound.
$M = 2$ " twice " speed of sound.

Mach Angle:- Mach angle is half of the vertex angle of a Mach cone whose sine is the ratio of the speed of sound to the speed of a moving body.

$$\sin\theta = \frac{V_s}{V_o} = \frac{1}{M}.$$

The Mach angle depends upon the speed of the object. For transonic speeds, Mach angle is 90° & for supersonic speeds, Mach angle will be <90°.

Resonance:- Consider a system under forced oscillations in which the frequency of the applied periodic force is varied (tuning).
During the course of tuning, if the frequency of the applied periodic force 'ω' matches with the natural frequency 'ω_0' of oscillations of the system then the amplitude of the oscillations will be maximum and the condition is called Resonance.

Examples of Resonance:

(i) In Sonometer, when the natural frequency of the stretched string is equal to the frequency of the tuning fork, the amplitude of oscillation is maximum.

(ii) Helmholtz Resonator

(iii) Resonance in LCR circuits

(iv) Resonance in air column

Sharpness of Resonance:-

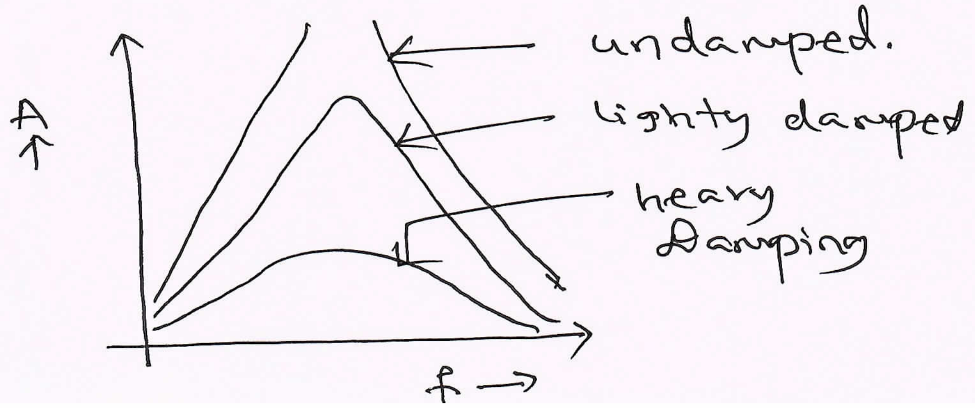
During the tuning of oscillating system, the rate at which the amplitude varies near resonance depends on damping.

The sharpness of resonance is the rate of change of amplitude with respect to a small change in frequency of the applied external periodic force, at resonance.

Mathematically,

$$\text{Sharpness of resonance} = \frac{\Delta A}{\Delta \omega}$$

Here ΔA is the change in amplitude with respect to change in frequency ($\Delta\omega$) at resonance.



Q. No. 2

(c) A mass of 0.5 kg causes an extension 0.03 m in a spring & the system is set for oscillations. Find

(i) Force constant (k) of the spring.

(ii) Angular frequency (ω).

(iii) Period (T) of the resulting oscillation

Soln.

$x = -0.03\ m \qquad m = 0.5\ kg$

Force acting $F = mg$

$= 0.5 \times 9.8$

$\therefore$ Restoring force $= -4.9\ N$

$\therefore\ k = -\frac{F}{x} = \frac{-4.9}{-0.03}$

(i) $k = 163.3\ N\,m^{-1}$

(ii) $\omega = \sqrt{\frac{k}{m}}$

$= \sqrt{\frac{163.3}{0.5}}$

$\omega = 18.1\ rad/s$

(iii) $f = \frac{\omega}{2\pi} = \frac{18.1}{2\pi}$

$= 2.877\ Hz$

$T = \frac{1}{f}$

$T = 0.35 s.$

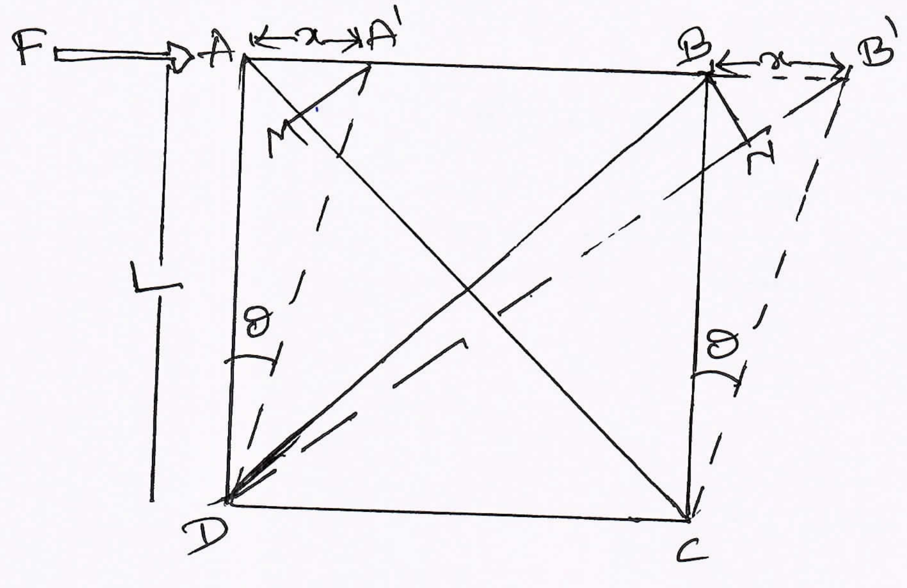
Q.3
ⓐ Define Poisson's ratio. Derive the relation between Young's modulus, Rigidity modulus & Poisson's ratio. (8M)

Soln: Poisson's ratio :- Within elastic limits, Poisson's ratio is defined as the ratio of lateral strain to the longitudinal strain

$$\sigma = \frac{\beta}{\alpha}$$

The theoretical limit of 'σ' lies between 1 to 0.5,

Relation between Young's modulus, Rigidity modulus & Poisson ratio.



$AA' = BB' = x$

$AB = BC = CD = AD = L$

$AC = BD = DN$

The diagonal element BD is elongated to B'D.

The strain produced along the diagonal is equal to $T(\alpha + \beta)$ ------ (1)

Along the DB is

$$\text{strain} = \frac{B'N}{BD} \quad \text{———} (2)$$

From (1) and (2)

$$T(\alpha+\beta) = \frac{B'N}{BD} \quad \text{.... (3)}$$

The value of diagonal length is determined by using Pythagoras theorem

$$DB^2 = BC^2 + DC^2$$

$$DB^2 = L^2 + L^2$$

$$BB^2 = 2L^2$$

$$DB = \sqrt{2}\,L \quad \text{..... (4)}$$

~~After~~ the stress, the two isosceles right-angle triangles is formed $\angle AMA'$ & $\angle BNB'$

$$NB' = BB' \cos 45^\circ$$

$$NB' = x \cdot (1/\sqrt{2}) \quad \text{..... (5)}$$

Substituting (4) & (5) in (3)

$$T(\alpha+\beta) = \frac{x \cdot (1/\sqrt{2})}{\sqrt{2}\,L}$$

$$T(\alpha+\beta) = \frac{\theta}{2}$$

$$\frac{T}{\theta} = \frac{1}{2(\alpha+\beta)}$$

$$\eta = \frac{1}{2(\alpha+\beta)}$$

$$\eta = \frac{1}{2\alpha\left(1+\frac{\beta}{\alpha}\right)} = \frac{1/\alpha}{2(1+\beta/\alpha)}$$

$$\boxed{\eta = \frac{Y}{2(1+\sigma)}} \quad \text{or} \quad \boxed{Y = 2\eta(1+\sigma)}$$

Q. 3

(b) Define 3 types of moduli and discuss stress- strain curve. (8M)

Soln :- Moduli of Elasticity :

(i) Young's modulus :- It is defined as the ratio of longitudinal stress to longitudinal strain,

$$Y = \frac{\text{Longitudinal stress}}{\text{Longitudinal strain}} = \frac{F/A}{x/L}$$

$$Y = \frac{FL}{xA}$$; F → Force applied, A → Area, x → new length, L → original length

(ii) Rigidity modulus (η) :- It is defined as the ratio of shearing stress to shearing strain.

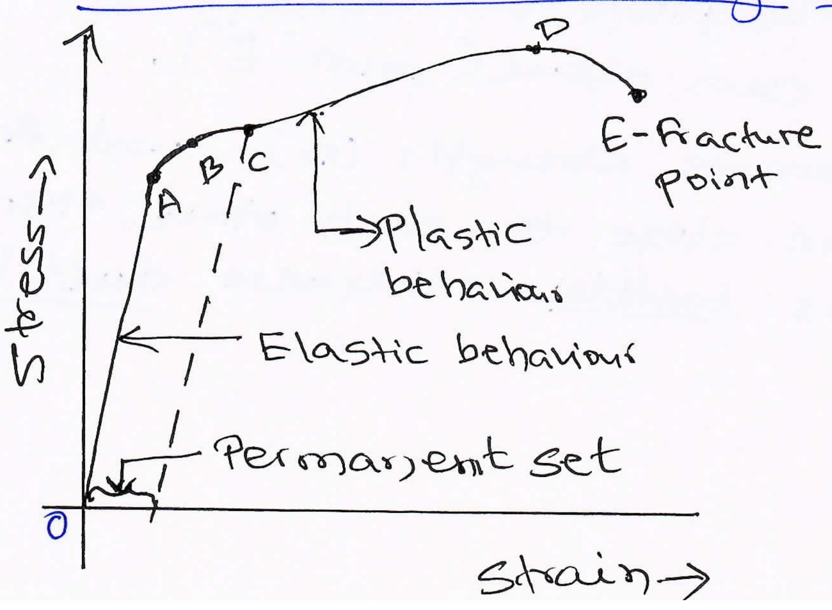
$$\eta = \frac{\text{shearing stress}}{\text{shearing strain}} = \frac{FL}{xA}$$

(iii) Bulk modulus (K) :- It is defined as the ratio of volume stress to volume strain.

$$K = \frac{\text{Volume stress}}{\text{Volume strain}} = \frac{F/A}{v/V} = \frac{PV}{v}$$

v → change in volume
V → original volume
P → Pressure.

Stress - strain Diagram.



OA → Proportionality range
A → Proportionality limit
B → Yield point
C → Plastic limit
D → ultimate strength
E → Fracture point

From stress and strain figure

(i) we can see that in the region between 'O' and 'A', the curve is linear. Hence Hooke's law obeys in this region. In the region from A to B, the stress & strain are not proportional. However if we remove the load, the body returns to its original dimension.

(2) the point 'B' in the curve is the Yield point or the elastic point, & the corresponding stress is the Yield strength of the material.

(3) Further, Stress is increased, exceeding the Yield strength, the strain increases rapidly even for a small change in the stress.

(4) If the load is removed at, say a point 'C' between 'B & D', the body does not regain its original dimension. Hence, even when the stress is zero, the strain is not zero & the deformation is called plastic deformation. This is a permanent set.

(5) Further, the point 'D' is the ultimate tensile strength of the material. Hence, if any additional strain is produced beyond this point, a fracture can occur (point 'E').

(6) If the ultimate strength (D) and fracture points (E) are close to each other, then the material is brittle otherwise ductile.

Calculate the extension produced in a wire of length 2m and radius 0.013×10^{-2} m due to a force of 14.7 N applied along its length. Given Young's modulus of the material is $Y = 2.1 \times 10^{11} \, Nm^{-2}$. — (4M)

Soln: Given, $L = 2m$, $F = 14.7 \, N$, $A \rightarrow$ Area

$Y = 2.1 \times 10^{11} \, Nm^{-2}$, $R = 0.013 \times 10^{-2} \, m$

$x = ?$

$$Y = \frac{FL}{Ax} = \frac{FL}{\pi R^2 x}$$

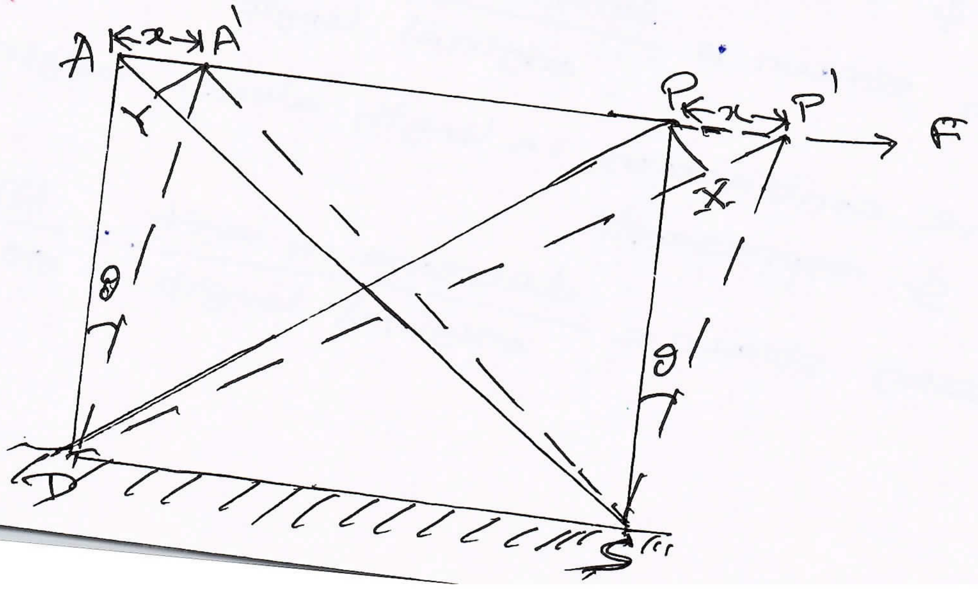
$$x = \frac{FL}{\pi R^2 Y}$$

$$= \frac{14.7 \times 2}{3.142 \times (0.013 \times 10^{-2})^2 \times 2.1 \times 10^{11}}$$

$$\boxed{x = 2.6 \times 10^{-3} \, m}$$

Q. 4 (a): Explain elongation, compression strain & Poisson's ratio & also arrive at the relation between them and explain limiting values of Poisson's ratio. — (8M)

Soln:



First let us derive the relation between shearing strain, Elongation strain & compress-ion strain.

[to show, shear strain = Elongation strain + compression strain]

Consider a cube of length 'L' whose lower surface is fixed and a tangential force 'F' is applied at the upper surface.

Let APSD be the one of the face of the cube having diagonals 'AS' and 'DP'. When deforming force F is applied on upper surface AP then point 'A' slides to A' and point P slides to point P'.

Let 'θ' be the angle of the shear and 'x' is the displacement of the points. The diagonal AS contracts to A'S & diagonal DP elongates to DP' by a distance 'x'.

Let a perpendicular PX drawn to diagonal DP' and A'Y to diagonal AS

$\therefore DP = DX$ & $A'S = YS$.

Hence P'X is the extension length along original length PD & represents

$$\text{Elongation strain} = \frac{\text{increase in length}}{\text{original length}} = \frac{P'X}{PD} \quad \text{—(1)}$$

AY is the contraction in length along original length AS & represents

$$\text{Compression strain} = \frac{\text{decrease in length}}{\text{original length}} = \frac{AY}{AS} \quad \text{—(2)}$$

Sum of equations (1) & (2) gives shear strain (θ)

Pythogoras theorem applied to triangles ADS & PSD

$\Rightarrow AS^2 = AD^2 + DS^2$

$= L^2 + L^2$

$= 2L^2$

$\Rightarrow AS^2 = \sqrt{2}L = PD$ ------ (3)

From $\Delta PXP'$,

$\cos \angle PP'X = \frac{P'X}{PP'}$

$\Rightarrow P'X = PP' \cos \angle PP'X$ ---- (4)

Since ΔAPD is isosceles triangle

$\angle APD = 45^\circ$

If θ is small, then $\angle AP'D = \angle APD = 45^\circ$

$\therefore$ Equation (4) becomes,

$P'X = PP' \cos(45^\circ) = \frac{PP'}{\sqrt{2}}$

$\Rightarrow P'X = \frac{x}{\sqrt{2}}$ -------- (5)

From $\Delta PP'S$, $\tan\theta = \frac{PP'}{PS}$

For small angles, $\tan\theta \approx \theta$

$\therefore \theta = \frac{x}{L}$ ------ (6)

Substituting Eqs (3) & (5) in (1)

Eqn (1) $\Rightarrow$ Elongation strain $= \frac{\frac{x}{\sqrt{2}}}{\sqrt{2}L} = \frac{x}{2L} = \theta\left(\frac{1}{2}\right)$

$\therefore$ Elongation strain $= \frac{\theta}{2}$

$|||^{ly}$ we can show

Compression strain $= \frac{\theta}{2}$

$\therefore$ Elongation strain + Compression strain $= \frac{\theta}{2} + \frac{\theta}{2} = \theta$ --- (7)

Limiting value of 'σ' (Poisson's ratio)

Consider the relation

$$Y = 2n(1+\sigma) \quad \text{---- (8)}$$

$$Y = 3K(1-2\sigma) \quad \text{—— (9)}$$

Equating (8) & (9) we get

$$2n(1+\sigma) = 3K(1-2\sigma) \quad \text{--- (10)}$$

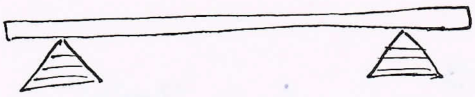
- If 'σ' > 0.5, then LHS will be +ve and RHS will be −ve.
- If σ < −1 then LHS will be −ve & RHS will be +ve.
- Since both sides represent Young's modulus they must result in the same positive value.
- Hence for both sides to be +ve, the 'σ' can take values in the range $-1 < \sigma < 0.5$
- Since σ cannot take negative values $0 < \sigma < 0.5$
- Thus the value of 'σ' ranges from 0 to 0.5.

Q.4 (b). Explain Beam, Types of beams, bending moment, ductile fracture and brittle fracture — (8M).

Sol^n: Beam is a homogeneous body having uniform cross section, whose length is large compared to other dimensions like breadth, thickness etc.

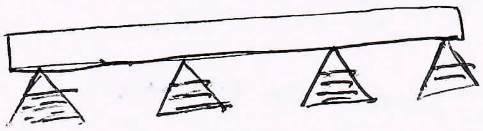
Types of beams:-

(i) Simple beam:- is a bar resting on

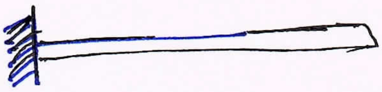


two supports at its end. It is the most commonly used beam.

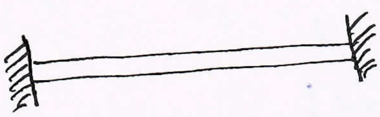
(ii) Continuous beam:- is a bar resting on more than two supports.



(iii) Cantilever beam:- is a bar or beam whose one end is fixed & other end is free.



(iv) Fixed beam:- A beam which is fixed at its both ends is called fixed beam.



Brittle fracture:- means fracture of material without or with very small plastic deformation before fracture.

Eg:- Rock, concrete blocks, and cast iron.

Ductile fracture:- is a type of failure seen in readily deformable (malleable) materials & is characterised by extensive plastic deformation that occurs before the material finally cracks or breaks apart.

Eg: Aluminium, Copper...

Such materials are called ductile materials

Q.4 (c) Calculate the force required to produce an extension of 1mm in steel wire of length 2m & diameter 1mm.

Given $Y = 2.1 \times 10^{11}\ N m^{-2}$.

Soln:- $x = 1mm = 10^{-3} m$, $L = 2m$

$d = 1mm = 10^{-3} m$ $\quad Y = 2.1 \times 10^{11}\ N m^{-2}$.

$F = ?$, $a = \pi R^2$

Radius of the wire $R = \frac{d}{2} = \frac{10^{-3}}{2}$

$R = 0.5 \times 10^{-3} m$.

Young's modulus

$$Y = \frac{FL}{ax} = \frac{FL}{\pi R^2 x}$$

$$F = \frac{\pi R^2 x Y}{L}$$

$$= \frac{3.14 \times (0.5 \times 10^{-3})^2 \times 10^{-3} \times 2.1 \times 10^{11}}{2}$$

$$\boxed{F = 78.54 N}$$

Module - 3

Q.5 (a) With some relevant points define and explain Lambert's cosine law and Inverse square law. — (8M)

Soln :- The basic idea to study "illumination" in engineering is to thoroughly understand the principle of illumination for interior light design which include domestic & industry lighting. Further, it is also important to gain insights into highway lighting, sports ground lighting and airport lighting.

Illumination is the luminous flux received by a surface per unit area. It is measured in Lux (lx).

Law of Illumination :-

(1) Lambert's Cosine Law :- The law states that the radient intensity observed from an ideal diffusely reflecting surface (Lambertian surface) is directly proportional to the cosine of the angle 'θ' between the direction of the incident light and the surface normal.

Explanation :-

(i) Diffuse Reflection :- Lambertian surfaces reflect light uniformly in all directions, regardless of the angle of incidence.

(ii) Radient Intensity :- This refers to the amount of light energy reflected per unit solid angle. According to the law, the intensity diminishes as the angle of observation increases from the normal to the surface.

If I_0 is the radient intensity when $\theta=0$, the observed intensity I at an angle θ is given by

$$I = I_0 \cos\theta$$

Application:- This law is fundamental in Computer graphics for realistic rendering, in photography for understanding lighting and in remote sensing for interpreting surface reflect

(2) Inverse Square law:-

The law states that the intensity of a physical quantity (Like light, sound or gravity) from a point source is inversely proportional to the Square of the distance from the source.

Explanation:

(1) Point source:- This law applies to idealized point sources where the source dimensions are negligible compared to the distance from the source.

(2) Intensity & distance:- As the distance from the source increases, the same amount of energy is spread over a larger area. Thus, the intensity decreases.

If I_0 is the intensity at a reference distance r_0, the intensity I at a distance 'r' is given by

$$I = I_0 \left(\frac{r_0}{r}\right)^2$$

Applications:- This law is crucial in Physics for understanding electromagnetic radiation, gravitational fields & acoustics.

Q.5(b) Define Reverberation and Reverberation time. Discuss reverberation time optimum value for good auditorium. (8M) 25

Sol ✓:- The persistence or prolongation of audible sound even after the source has ceased to produce sound is called reverberation.

The time interval, after the source of sound is cut off, in which the intensity of a sustained note falls to one millionth (10^{-6}) of its original value is called reverberation time (T)

Importance of Reverberation time (T)

'T' should not be too large or too small. If T is too large the resulting sound persists for a long time & results into confusion due to overlapping of sounds. On the other hand, if T is too small, the sound produced ends abruptly & becomes unpleasant to hear.

Optimum value for Reverberation time (T)

The optimum reverberation time (T) of a room or space is defined as the time it takes for sound to decay by 60 dB.

Sabine found that the time of reverberation depends upon the size of the hall, loudness of sound & the kind of music or sound for which hall is to be used.

It was found that, for a sound of frequency 512 Hz, the 'T' is 1 to 1.5 seconds for a capacity of 4500 m^2 hall. To avoide longer 'T' materials such as Porous tiles, asbestos for plastering can be used.

Q.5

(C) A hall having volume of 1500 m^3 has total absorption equivalent to 100 m^2 Sabine. calculate the reverberation time of the hall. – (4M)

Sol^n:-

$$RT = \frac{0.161 \times V}{A}$$

V = volume of the hall in m^3

A = total absorption in m^2 Sabine.

$$\text{Reverberation Time (RT)} = \frac{0.161 \times 1500}{100}$$

$$RT = 2.42 \ s.$$

Q.6 (a) Define photometry & Radiometry and also define 4 photometric and 4 radiometric quantities.

Sol^n:- Radiometry deals with the detection and measurement of electromagnetic radiation across the total spectrum.

Radiometry is divided according to various regions of the electromagnetic spectrum like UV-radiometry, IR-radiometry, microwave radiometry, however in all these division similar measurement techniques are applied.

Photometry :- is the subdivision of radiometry that deals with the measurement of electromagnetic radiation in the visible range and near-visible part of the electromagnetic spectrum.

Radiometric and Photometric Quantities

Radiometric	Photometric
(1) Radiant flux	(1) Luminous flux
(2) Radiant intensity	(2) luminous intensity
(3) Irradiance	(3) Illuminance
(4) Radiance	(4) Luminance.

(1) Radiant flux and luminous flux

Radiant flux is the energy (Q) radiated by a source per unit time, expressed as $\Phi = \frac{dQ}{dt}$. The unit is Watt (J/s).

Luminous flux (Φ_v) is the time rate of flow of light as weighted by $V(\lambda)$. The unit of luminous flux is the Lumen (lm).

(2) Radiant intensity and luminous intensity

Radiant intensity is the radiant flux from a point source emitted per unit solid angle in a given direction.

Its unit is W/sr

Luminous intensity is the luminous ~~int~~ flux from a point source emitted per unit solid angle in a given direction.

Its unit is candela (cd = lm/sr)

(3) Irradiance and Illuminance.

Irradiance is defined as the radiant flux per unit area. It is measured in W/m^2.

Illuminance :- is the luminous flux per unit area. It is measured in lux (lx = lm/

④ Radiance and luminance

Radiance is the radiant flux per unit solid angle emitted from a surface element in a given direction, per unit projected area of the surface element perpendicular to the direction.

It is measured in $W\,sr^{-1}\,m^{-2}$.

Luminance is photometrically weighted radiance. It is an approximate measure of how bright a surface appears when we view it from a given direction.

It is measured in $lm\,m^{-2}\,sr^{-1}$.

Q.6.(b) Explain impact of Noise in Multi-storied buildings.

Soln:- Noise as the name suggests is an unwanted sound which produces displeasing effect on the ear.

Impact of noise in multi-storied buildings

① speech privacy :- will get affected.

② Background noise (Eg - fan, a.c, generator, printer - etc) It can adversly affect the work space.

③ orientation of building :- The noise impact may also be great for rooms perpendicular to roadways because

(a) a noise pattern can be more annoying

(b) windows on perpendicular walls don't reduce noise.

Apartment dwellers are often annoyed by noise in their homes, especially when building is not well designed.

Q. 6 (c) The volume of room is 1500 m^3. The wall area of the room is 260 m^2, the floor area is 140 m^2, & the ceiling area is 140 m^2. The average sound absorption coefficient for wall is 0.03, for the ceiling is 0.8 & for the floor is 0.06. Calculate the average absorption co-efficient & the reverberation time. — (5M)

Soln Given :

$V = 1500\ m^3$ $\quad S_1 = 260\ m^2$ $\quad S_2 = 140\ m^2$ $\quad S_3 = 140\ m^2$

$a_1 = 0.03$ $\quad a_2 = 0.8$ $\quad a_3 = 0.06$

Reverberation time $(T) = \frac{0.167V}{\Sigma as}$

$= \frac{0.167 \times 1500}{(0.03 \times 260) + (0.8 \times 140) + (0.06 \times 140)}$

$= \frac{250.5}{128.2}$

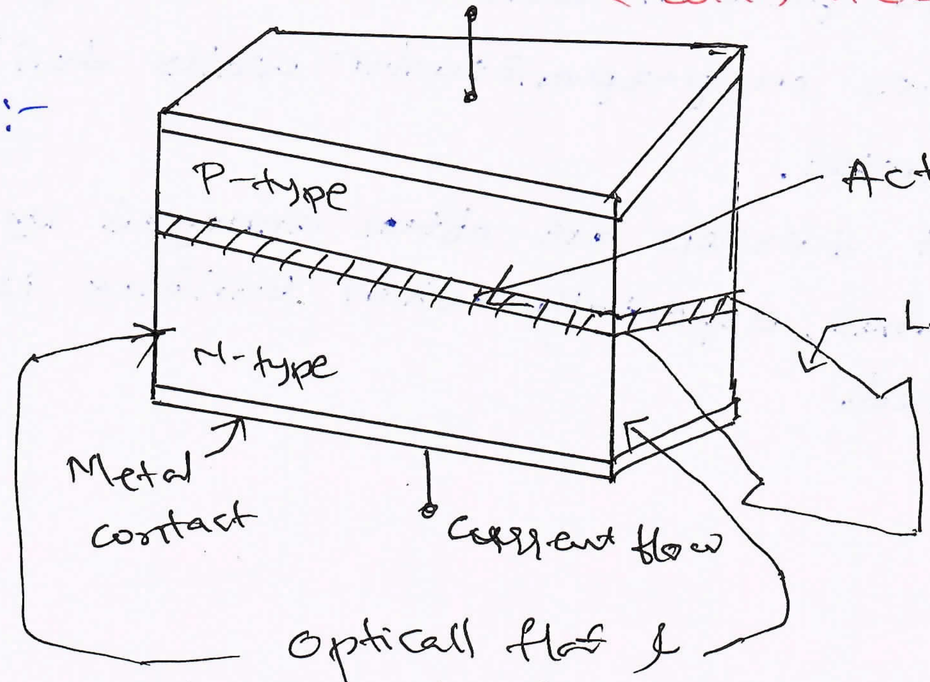
$T = 1.9539s$

average abs. coefficient $(\alpha) = \frac{0.167}{\Sigma ST} = \frac{0.167}{(260+140+140) \times 1.95}$

$= 0.2374s$

Q.4(a) Explain the construction & working of Semiconductor LASER with necessary diagram →(8M)

Soln:-



Working:-

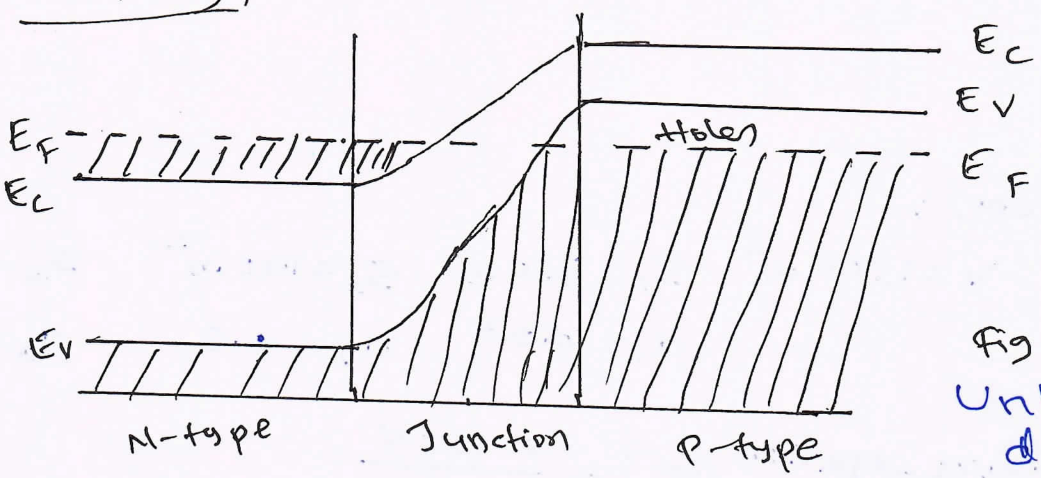
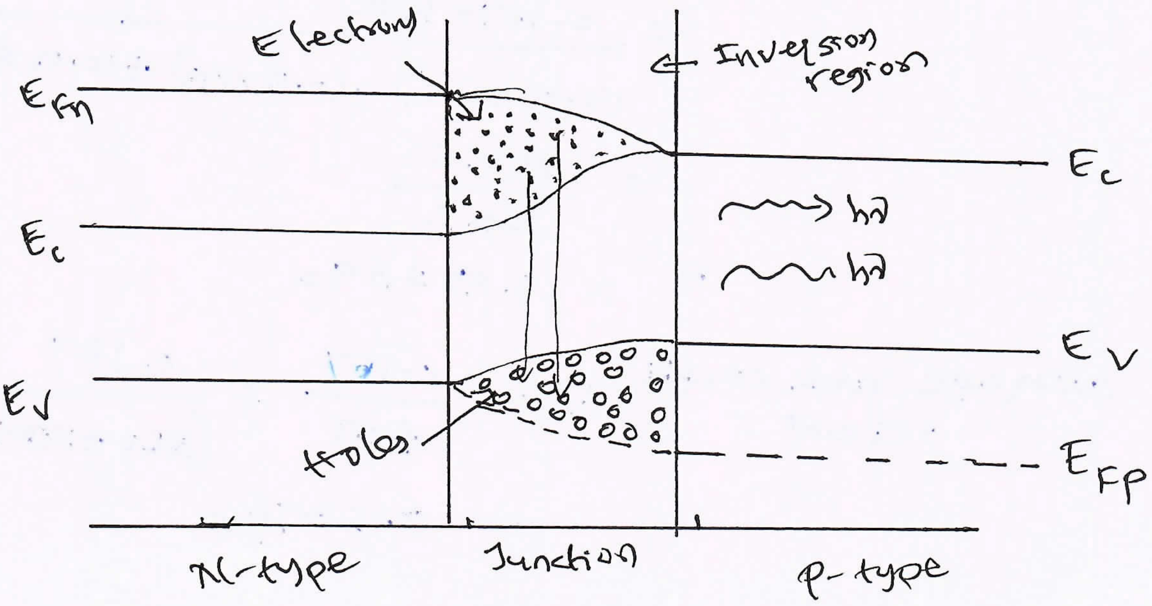


Fig (a) Unbiased diode



fig(b) After biasing

Construction :- A schematic diagram of semiconductor laser is as shown in the first figure. The diode is very small size with sides of the order of 1mm. The junction lies in a horizontal plane. The top and bottom surfaces are metalized and ohmic contacts are provided for external connection. The front & rear faces are polished. The other two faces are roughened to prevent lasing action in that direction. The active region consists of about 1μm thickness.

The emitted photon stimulates the recombina-tion of other carriers.

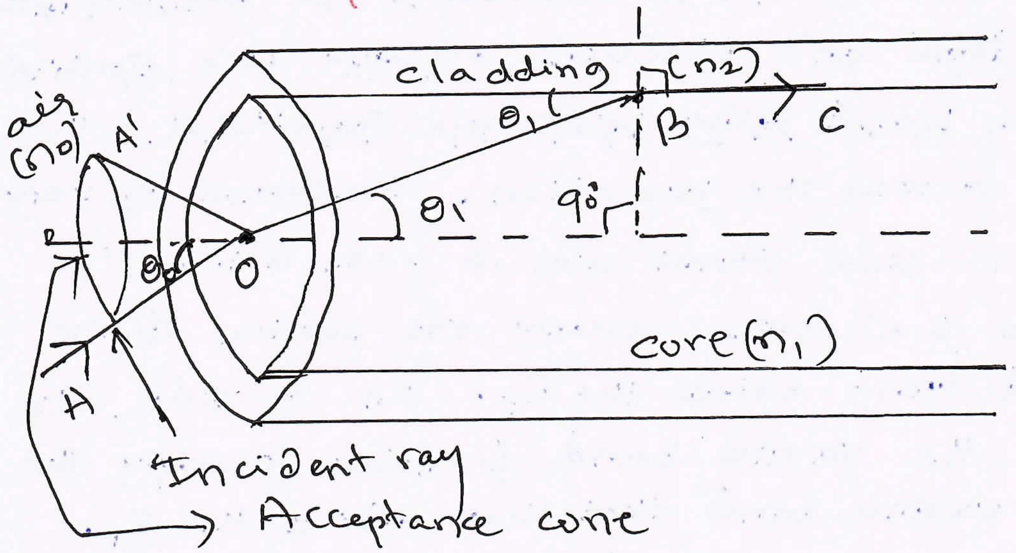
Working :- The energy band diagram of heavily doped pn-junction is as shown in fig.(a); unbiased condition. At thermal equillibrium, ~~the fermilevel is pushed into the conduction band and electrons occupy the portion of the conduction band lying below the fermilevel~~. The E_F is uniform across the junction. Because of very high doping on N-side fermi level is pushed into the conduction band & electrons occupy the portion of the Conduction band lying below the E_F. On P-side, the E_F lies within the valence band & holes occupy the portion of the valence band that lies above the E_F.

When the junction is forward biased electrons and holes are injected into the junction region in high concentrations. At low forward current, the electron-holes recombination results in spontaneous emission of photons & the junction acts as a LED. As the forward current is increased gradually and when it reaches a threshold value the carrier concentration in the junction region there will be large concentrations of electrons within the band.

As a result, condition of population inversion is attained in the narrow region. This narrow zone in which population inversion occurs is called as an active region, at that stage, a photon emitted spontaneously triggers stimulated emission. This stimulated electron-hole recombination produces coherent radiation.

Semiconductor LASER exhibits high efficiency, operated with lesser voltage & produces continuous wave output.

Q.7(b) With necessary diagram, explain propagation of light through optical fibre and obtain expression for Numerical aperture and angle of acceptance. — (8M)



Consider a ray of light AO incident at an angle θ_0 enters into the fibre. Let θ_1 be the angle of refraction for the ray OB. The refracted ray OB incident at a critical angle $(90° - \theta_1)$ at B, grazes the interface between core and cladding along BC. If the angle of incidence is greater than the critical angle, it undergoes total internal reflection. Thus θ_0 is called the waveguide acceptance angle and

$\sin\theta_0$ is called the numerical aperture. Let n_0, n_1 & n_2 be the refractive index of air, core & cladding respectively.

From Snell's law,

$$n_0 \sin\theta_0 = n_1 \sin\theta_1 \quad \text{------(1)}$$

At B the angle of incidence is $(90-\theta_1)$

From Snell's law

$$n_1 \sin(90-\theta_1) = n_2 \sin 90^\circ \quad \text{----(2)}$$

$$n_1 \cos\theta_1 = n_2 \qquad [\because \sin(90-\theta_1) = \cos\theta_1]$$

$$\cos\theta_1 = \frac{n_2}{n_1} \quad \text{-----(3)}$$

From Eqn (1)

$$\sin\theta_0 = \frac{n_1}{n_0} \sin\theta_0$$

$$\sin\theta_0 = \frac{n_1}{n_0}\sqrt{1-\cos^2\theta_1}$$

using Eqn (3)

$$\sin\theta_0 = \frac{n_1}{n_0}\sqrt{1-\frac{n_2^2}{n_1^2}}$$

$$\sin\theta_0 = \frac{\sqrt{n_1^2-n_2^2}}{n_0}$$

If the surrounding medium is air, then $n_0 = 1$

$$\therefore \sin\theta_0 = \sqrt{n_1^2-n_2^2}$$

where $\sin\theta_0$ is called numerical aperture (NA)

$$\therefore NA = \sqrt{n_1^2-n_2^2}$$

$\therefore$ for any angle of incidence θ_i equal to or less than θ_0, the incident ray is able to propagate.

$\theta_i < \theta_0$; $\sin\theta_i < \sin\theta_0$

$\sin\theta_i < NA$ is the condition for propagation.

Q. 7(c) The average output power of LASER source emitting a laser beam of wavelength 6328 Å is 5mW. Find the number of photons emitted per second by the laser source.

Soln:- $P = 5mW = 5\times10^{-3}\,W$, $t = 1s$, $c = 3\times10^{8}\,ms^{-1}$

$h = 6.634\times10^{-34}\,Js$, $\lambda = 6328\,Å = 6328\times10^{-10}\,m$

nos. of photons, $n = ?$

W.K.T

$E = P\times t$ &

$E = \frac{nhc}{\lambda}$

using both the above Eqn

$$\frac{nhc}{\lambda} = P\times t$$

$$n = \frac{Pt\lambda}{hc}$$

$$= \frac{5\times10^{-3}\times1\times6328\times10^{-10}}{6.634\times10^{-34}\times3\times10^{8}}$$

$$= \frac{31640\times10^{-13}}{19.902\times10^{-26}}$$

$$= 1589\times10^{13}$$

$$n = 1.589\times10^{16}$$

Q. 8(a) What are optical fibers? Explain the principle of optical fiber with neat diagram, explain types of optical fibers. — (10M)

Soln: An optical fiber is a very thin strand of glass/plastic. In reality, it is very narrow. It is used to carry/guide light within it & the propagation of light in fiber is based on the principle of total internal reflection.

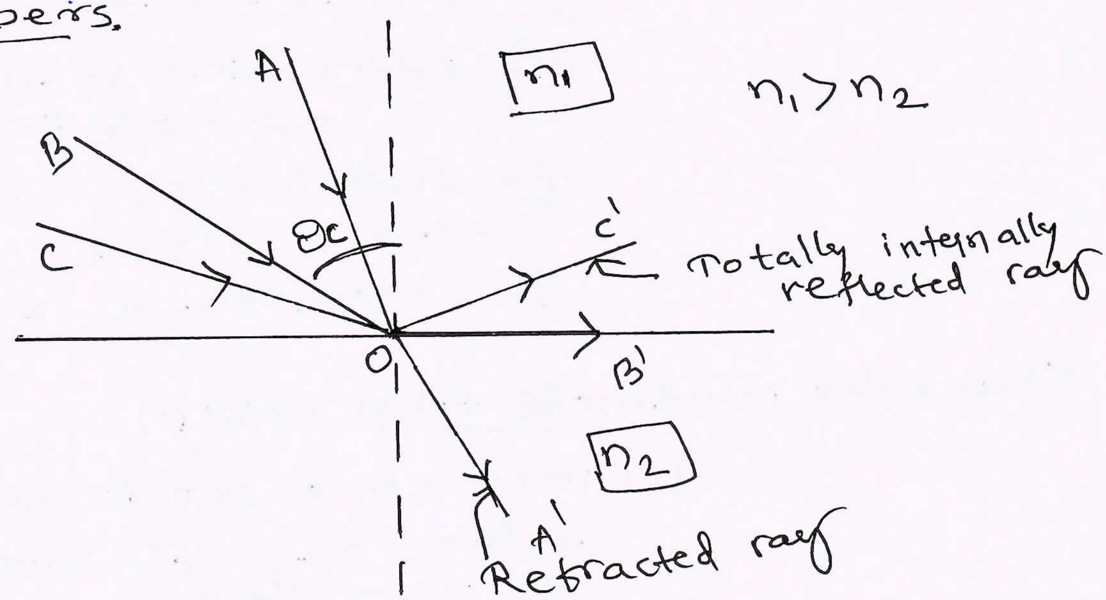
Two critical factors stand out in case of optical fibers.

(1) Very little light is lost in its journey along the fiber.

(2) Fiber can bend around corners & the light will stay within it & be guided around the corners.

An optical fiber consists of two parts: the core & the cladding.

Principle behind the working of an Optical fibers.



When a ray of light travels from denser to rarer medium it bends away from the normal. As the angle of incidence increases in the denser medium, the angle of refraction also increases. For a perticular angle of incidence called the critical angle, the refracted ray grazes the surface separating the media & the angle of refraction is equal to 90°. If the angle of incidence is greater than the critical angle, the light ray is reflected back to the same medium, This is called "Total internal reflection" (TIR)

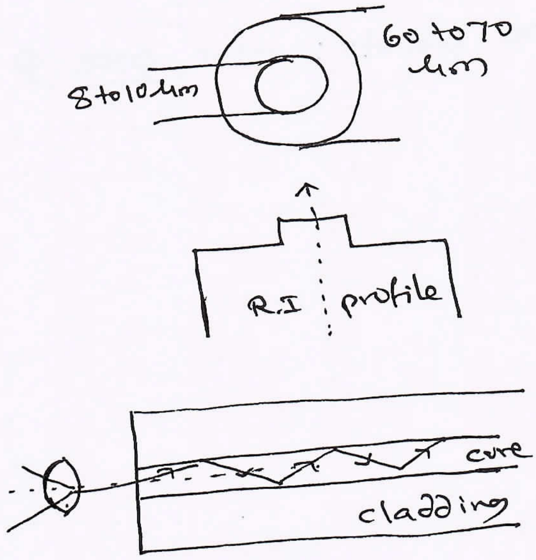
In TIR, there is no loss of energy. The entire incident ray is reflected back.

Total internal reflection (TIR) is the principle behind propagation of light through optical fiber.

Different types of optical fibers:-

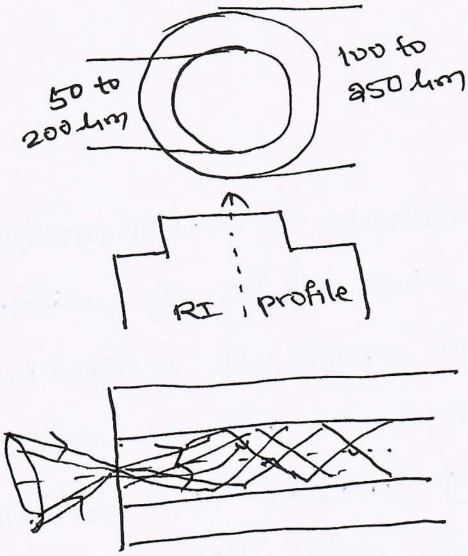
Following are the three types of optical fibers

① Step index single mode fiber:- (SMF)



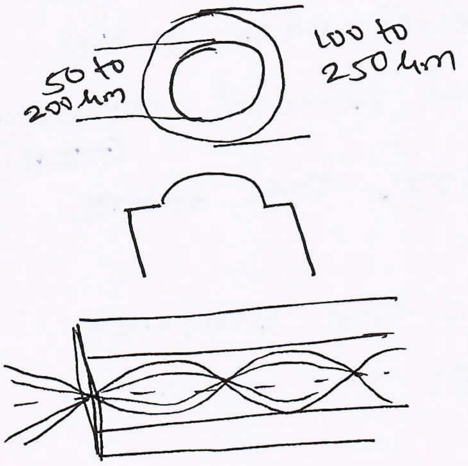
1. SMF core diameter = 8 to 10 μm & cladding diameter = 60-70 μm
2. V number is < 2.4
3. NA is < 0.12
4. Attenuation is in the range 0.25 – 0.5 dB/km
5. Information carrying capacity is large.
6. LASER source is used.

② Step index multimode fiber (MMF):-



1. MMF has a core diameter = 50 to 200 μm uniform RI, cladding diameter is 100 to 250 μm
2. V number < 2.4. NA is 0.2 to 0.3
3. Attenuation is in the range 0.5 to 4 dB/km
4. Information carrying capacity is small,
5. LED source is used.

③ Graded index multimode fiber (GRIN):-



1. GRIN core diameter = 50 to 200 μm, cladding " = 100 – 250 μm
2. V number > 2.4, NA is 0.2 to 0.3
3. Attenuation is 0.5 to 4 dB/km
4. Information carrying capacity is large
5. LASER / LED is used.

Q.8 (b) Define Attenuation co-efficient, induced absorption, spontaneous emission, stimulated emission, population inversion and metastable state. — (6M)

Soln:-

① Attenuation coefficient :- Attenuation is the loss of optical power as light travels through a fiber. It is expressed in dB/km.

$$\alpha = -\frac{10}{L}\log_{10}\left(\frac{P_{out}}{P_{in}}\right).$$

② Induced Absorption:- is the phenomenon in which an atom (A) in the lower energy state (E_1) absorb the incident photon of energy '$h\nu$' & excite to the higher energy state (E_2)

$$h\nu + A \rightarrow A^*$$

③ Spontaneous Emission:- is the phenomenon in which at atom in the excited state of energy (E_2) de-excite to the lower energy state (E_1) without any external influence by emitting a photon of energy ($h\nu$)

$$A^* \rightarrow A + h\nu$$

④. Stimulated Emission :- is the phenomenon in which an atom in the excited state of energy (E_2) de-excite to the lower energy state E_1 under the influence of an external photon ($h\nu$) by emitting an identicle photon of energy $h\nu = E_2 - E_1$

$$h\nu + A^* \rightarrow A + 2h\nu$$

⑤ Population inversion:- is the condition of a system in which the number of atoms in higher energy state exceeds the atoms in the lower state.

⑥ Metastable state:- is an intermediate state in which the average life of the atoms is 10^{-3} s.

Q.8 (c) An optical fiber has a core material with refractive index (RI) 1.55 & its cladding material has a RI of 1.5. The light is launched into it in air. Calculate NA, the acceptance angle & also the fractional index change — (4M)

Soln:- $n_1 = 1.55$ $n_0 = 1$.

$n_2 = 1.50$

$$NA = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}$$

$$= \frac{\sqrt{(1.55)^2 - (1.50)^2}}{1} = \frac{\sqrt{0.1525}}{1}$$

(Numerical Aperture) $NA = 0.390$

$$\sin\theta_0 = NA$$

$$\theta_0 = \sin^{-1}(NA)$$

Acceptance angle $(\theta_0) = 22.9°$

fractional index change $\Delta = \frac{(n_1 - n_2)}{n_1}$

$$= \frac{1.55 - 1.50}{1.55} = \frac{0.05}{1.55}$$

$$\Delta = 0.0322$$

Module - 5

Q.9 (a) Explain the classification of natural hazards & man made hazards with examples. — (10M)

Soln: Natural hazards are extreme events that occur naturally in the environment & have the potential to cause harm to humans, property and the environment.

Natural hazards - Examples.

(1) Earthquakes:-

Description:- Sudden shaking of the ground caused by the movement of the tectonic plates.

Effects:- Can cause buildings to collapse, tsunamis, landslides & loss of life

Example:- The 2011 Tohoku earthquake in Japan caused widespread destruction & a tsunami.

② Tsunami :-

Description: Large ocean waves usually caused by underwater earthquakes, volcanic eruptions or landslides

Effects:- Coastal floodings, destruction of buildings, loss of life.

Example:- The 2004 Indian ocean tsunami affected several countries & resulted in over 23,000 deaths.

③ Land slides:

Description:- The movement of rock, earth or debris down a slope due to gravity, often triggered by rain, earthquakes or volcanic activity.

Effects:- Buriel of homes, roads & people; disruption of transportation & infrastructure.

Example: The 2014 Oso landslide in Washington, USA caused significant fatalities & property damage.

④ Forest fires:

Description:- Uncontrolled fires occuring in forests or grasslands, often caused by lightning or human activity.

Effects:- Destruction of vegetation Loss of wildlife, air polution & damage to property.

Example:- The 2019-20 Australian bushfires destroyed vast areas of land causing significant ecological & economic impacts.

⑤ Floods:

Description:- Overflow of water onto normally dry land, often due to heavy rainfall, river overflow a dam breakage.

Effects:- Damage to homes and infrastructure, loss of crops & waterborne diseases.

Example:- The 2010 Pakistan floods affected over 20 million people.

⑥ Volcanic Eruptions:

Description:- The release of magma, ash & gases from volcano.

Effects:- Destruction of land, air travel disruptions, health issues due to ash.

Example:- The eruption of Mount Vesuvius in AD 79 buried the cities of Pompeii & Herculaneum

Man-made Hazards

Man-made hazards are caused by human activities that have the potential to cause harm to humans, property & the environment.

① Industrial Accidents:

Description:- Accidents occurring in Industrial settings such as chemical spills, explosions or machinery failures.

Effects:- Injuries, fatalities, environmental contamination & economic losses.

Example:- The Bhopal gas tragedy in 1984, where a gas leak at a pesticide plant in India resulted in thousand of deaths.

(2) Nuclear disasters:

Description :- Accidents involving the release of radioactive material.

Effects :- Radiation sickness, Long term health effects.

Example :- The chernobyl disaster in 1986 caused wide spred radioactive contamination.

(3) Pollution :

Description :- Contamination of air, water or soil by harmful substances.

Effects :- Health issues, environmental degradation.

Example :- The great smog of London in 1952 caused severe air pollution & respiratory problems.

(4) Deforestation :

Description :- The large scale clearing of forests for agriculture, Logging or development.

Effects :- Habitat loss, climate change.

Example :- Amazon rain forest has been heavily deforested, impacting bio diversity.

Q.9(b) Define earthquake & discuss four types of earthquakes. — (5M)

Soln :- An earthquake is a trembling of the ground that results from the sudden shifting of rock beneath the earth's crust. Earthquakes may cause land slides & rupture dams.

Earthquakes are caused by the collision of the tectonic plates.

4- Types of Earthquakes:-

① Tectonic Earthquakes:- The earth's crust is composed of loose, cracked fragments of land referred to as tectonic plates. These plates are capable of moving slowly & gradually. A huge tremor occurs when two moving tectonic plates slide over one another.

② Volcanic Earthquakes:

Compared to tectonic earthquakes, volcanic earthquakes are less prevalent. They typically takes place before & after the volcanic eruption

③ Explosion Earthquakes:

These are caused by nuclear explosions. These are essentially man triggered kind of earthquakes.

④. Collapse Earthquakes:

These kinds of earthquakes are generally smaller & commonly occur near underground mines.

Q.9 (c) A recent earthquake in San francisco measured 7.1 on the Richter scale. How many times more intense was the San francisco earthquake earlier registered 8.3 on the Richter scale?

Soln:- To determine how many times more intense an earthquake measuring 8.3 is compared to one measuring 7.1, we can use the formula for the Richter scale

$$I = 10^{(M_2 - M_1)}$$

where $I \rightarrow$ intensity ratio

$M_2 \rightarrow$ magnitude of larger earthquake

$M_1 \rightarrow$ magnitude of smaller earthquake.

$$I = 10^{(8.3 - 7.1)}$$

$$= 10^{1.2}$$

$$I = 15.85.$$

So the earthquake with a magnitude of 8.3 was approximately 15.82 times more intense than the one with a magnitude of 7.1.

Q 10 (a) Enumerate the causes and adverse effects of tsunami waves — (8M)

Soln :- The word "Tsunami" literally means "harbor wave". A tsunami is a catastrophic ocean wave, usually caused by a submarine earthquake, an underwater or coastal landslide or a volcanic eruption. Waves radiate outward from the generating impulse at speeds of upto 500 miles (800 km) per hour, reaching maximum heights of 100 feet (30 m) near coastal areas.

Causes of Tsunami waves

① Undersea Earthquakes :- Seafloor displacement due to tectonic activity..

② Volcanic Eruptions :- collapse of volcanic islands.

③ Landslides → Coastal landslides into the ocean.

(4) Mateorite Impacts :- Large mateorites impac-ting the ocean can displace a significant volume of water.

(5). Human Activities :- Rare, but possible causes include underwater nuclear tests.

Adverse Effects of Tsunami waves -

(1) Human Casualties (2) Property damage
(3) Economic Losses (4) Environmental damage
(5) Displacement of populations. (6) Health issues
(7) Ecological Impact (8) Disruption of services.

Q. 10 (b) Define landslide & describe the causes for landslide — (8M)

Soln :- A landslide is the movement of rock, earth or debris down a slope due to gravity. This movement can occur suddenly or without warning often triggered by natural events or human activities. Landslide can range from small slips of earth to massive collapses involving millions of cubic meters of material.

Causes of Landslides :

(1) Geological Factors :- Soils, rocks or other geological materials that are prone to failure.

(2) Morphological factors :- Steeper slopes are more prone to landslides.

(3) Hydrological factors :- Heavy rainfall increas water content in the soil, reducing its cohesion & increasing weight, which can lead to failure.

(4) Seismic Activity :- Shaking can dislodge rocks & soil, triggering landslides.

(5) Volcanic Activity :- The eruption of a volcano can trigger landslides due to the sudden depositio of volcanic material & the shaking of the ground.

Q. 10. (C) Early in the century the earthquake in San Francisco registered 8.3 on the Richter Scale. In the same year, another earthquake was recorded in South America that was 4 time stronger. What was the magnitude of the earthquake in South America? (4M)

Soln :- Let M_s be the magnitude of the South American Earthquake. The relation between the magnitudes & the intensity can be expressed as

$$10^{M_s} = 4 \times 10^{8.3}$$

$$M_s = \log_{10}(4 \times 10^{8.3})$$

$$M_s = \log_{10}(4) + \log_{10}(10^{8.3})$$

$$= 0.6 + 8.3$$

$$M_s = 8.9.$$

$\therefore$ The magnitude of the earthquake in South America was 8.9.

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