CMR
INSTITUTE OF
TECHNOLOGY

2nd Test Scheme of Evaluation – May 2017

Sub:	Smart Materials and Structures							**Code:**	14MST422
Date:	23/05/2017	Duration:	90 mins	Max Marks:	50	**Sem:**	4th M.Tech	**Section:**	-

Question No	Description	Marks Allotted	
1	Explain in detail about the Frahm Absorber with a sketch	10	
2	Explain the characteristics of Perissogyro Vibration Absorber	10	
3	Explain how “mistuning” affects circularly symmetric structures	10	
4	Explain in details about Extrinsic Fabry-Perot Fibre Optic Sensors	10	
5	Explain in details about Brag Grating Fibre Optic Sensors	10	
6	Explain in detail about SMA controlled cantilever beam structure	10	
7	Explain in detail about Bingham Plastic model for ER/MR fluids	10	

Attempt any 5 questions.

CI CCI HOD

where X_{1st} is the static displacement f_0/k, of the main mass. from (3a), it is clear that the vibratory amplitude of the main mass reaches zero if the natural frequency ω_2 of the absorber mass is tuned to be equal to the frequency of the forcing function at $\omega = \omega_1$ (i.e $\omega_2 = \omega = \omega_1$)

Thus, the vibratory motion of main structure is "absorbed" at its natural frequency, resulting in a null. However, the absorber mass itself vibrates with the amplitude given by eq (3b).

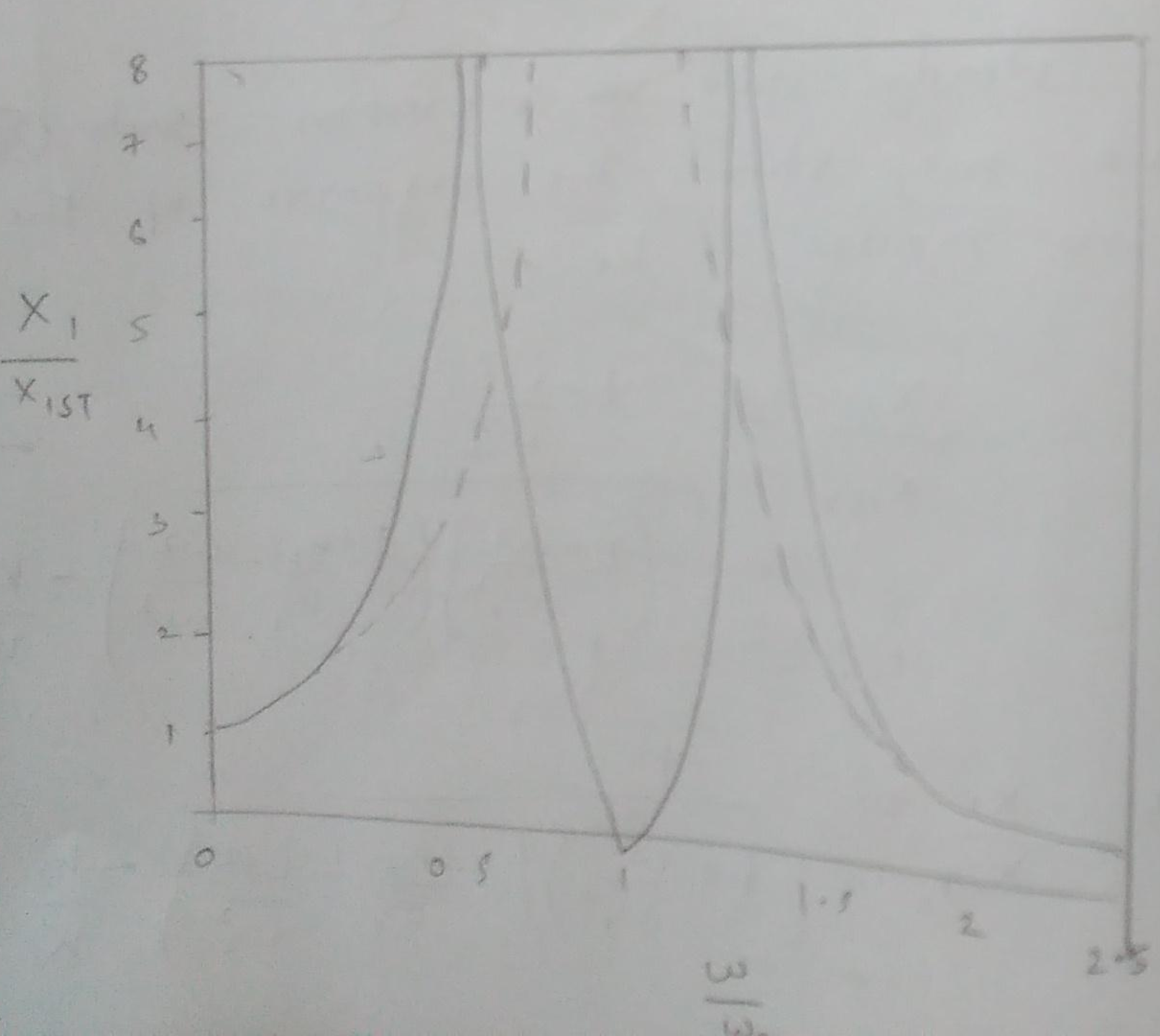


fig.2 response of the undamped main mass with no absorber and with an undamped conventional vibration absorber.

fig 2 ~~show~~ clearly shows two peaks corresponding to the two degrees of freedom and a null.

3Ans) Circularly symmetric structures

Consider a circular plate or disk, as sh in fig (1) vibrating in a 2 nodal diameter pattern. This may represent a spinning turbine wheel around which blades may mounted when a forcing function acts the plate in such a way that it matches natural mode both in space and time, then vibratory amplitudes reach a peak at the na frequency (ω_n) corresponding to the $n=2$ m However, in the presence of any asymmetry, t well defined $n=2$ mode splits into two dis but closely spaced frequencies (ω_{-2} and ω_{+2}) The spread between these frequencies depen upon the level of mistuning. The split mode are orthogonal to each other

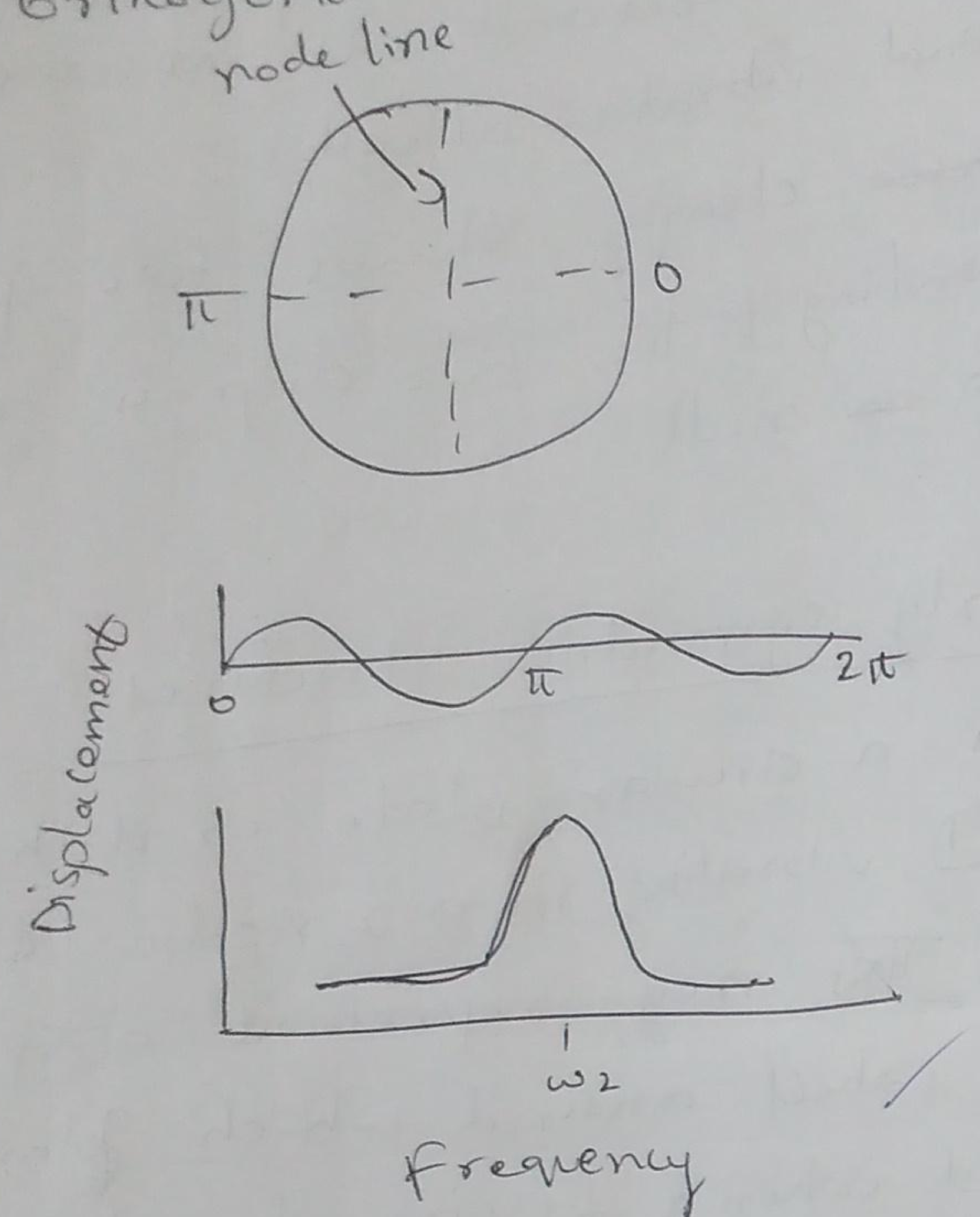


Fig ① A circular symmetric plate vibrating in a 2 nodal diameter pattern

and share the same simple sinusiodal circumferential distribution but are displaced by a quarter wave. Thus every such pair represents legitimate modes of the system and contributes to the dynamic response of the structure, much as the individual nodes of the corresponding tuned system would ~~we~~ have.

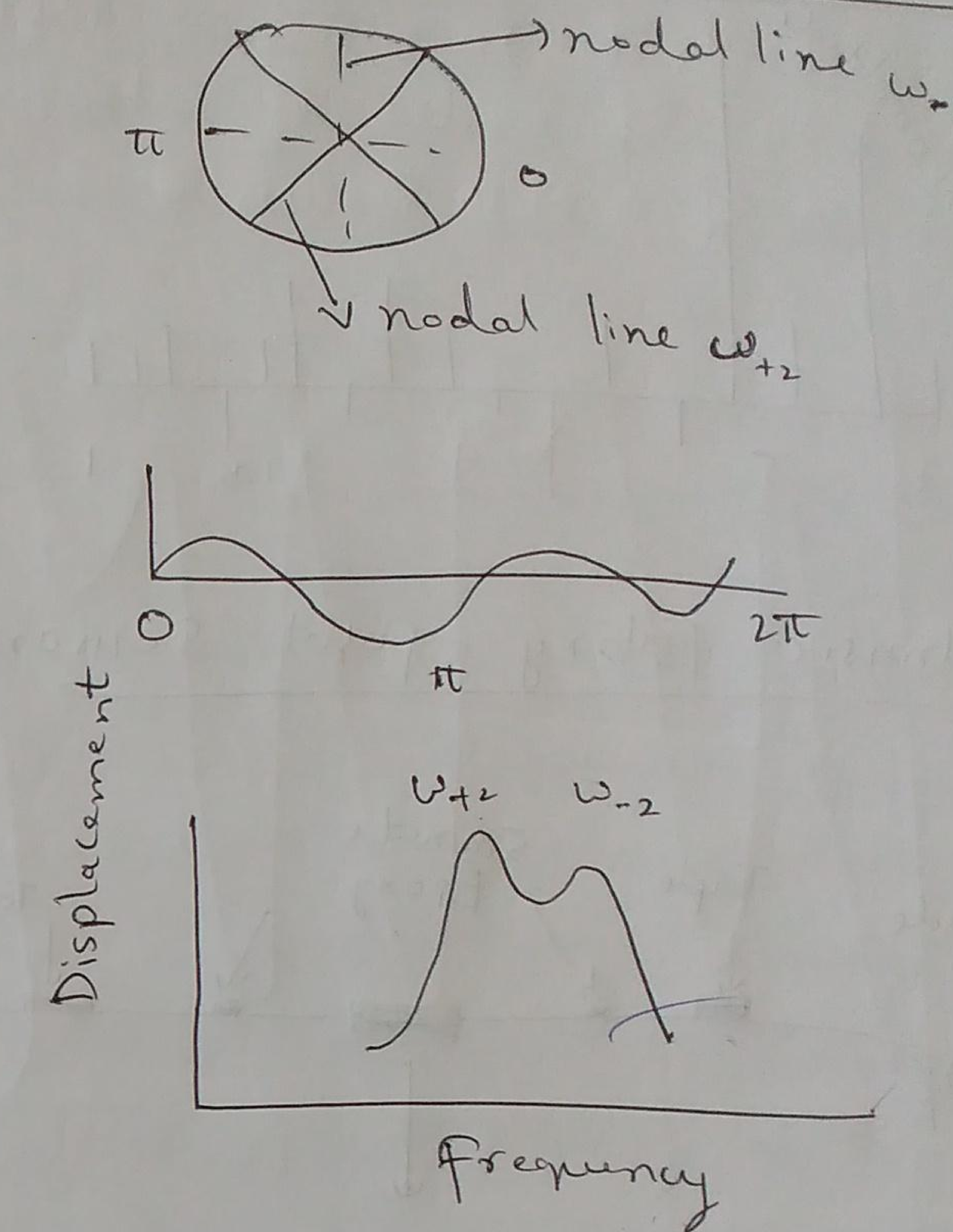


Fig ② An asymmetric circular plate vibrating i[n] a 2 nodal diameter pattern.

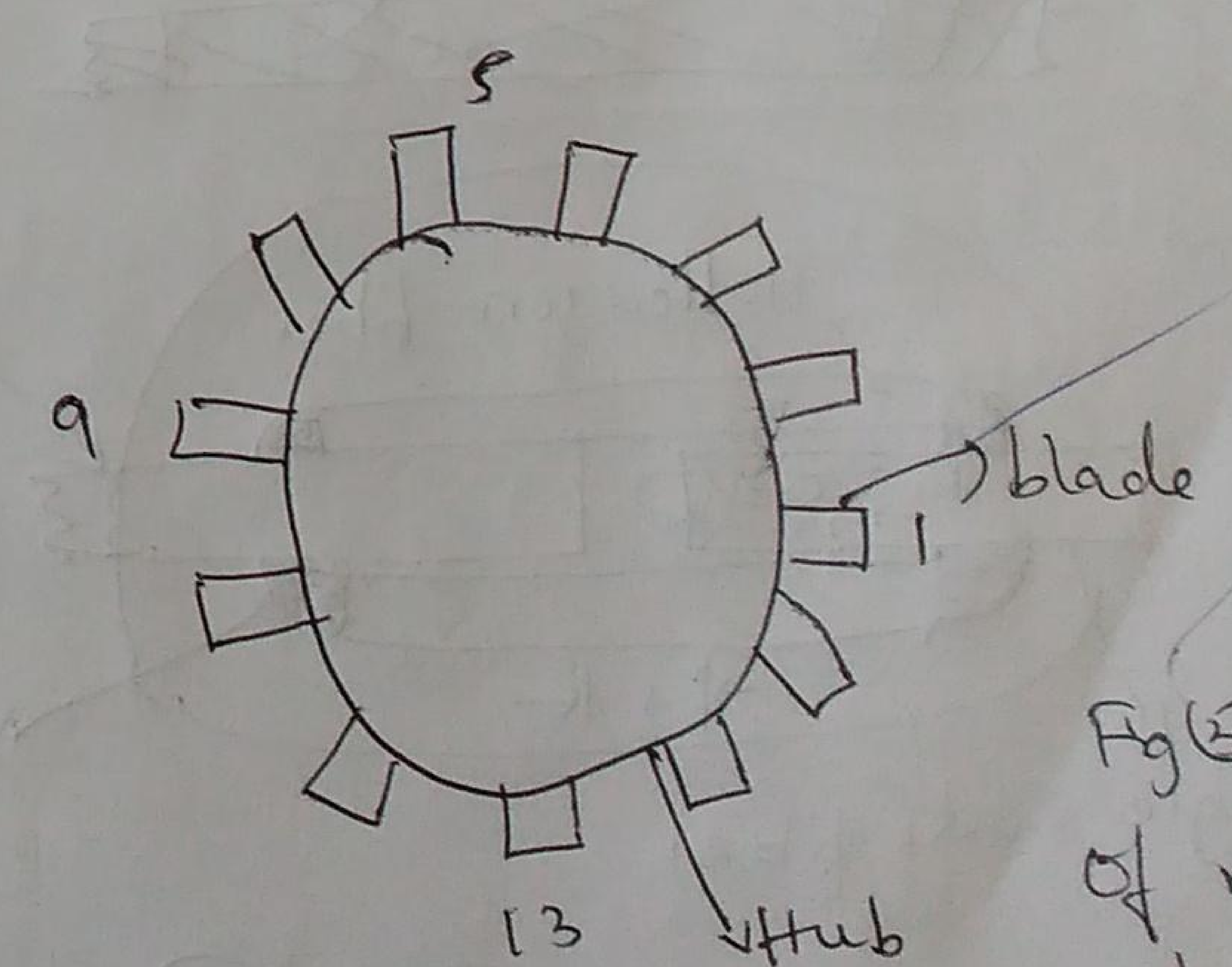
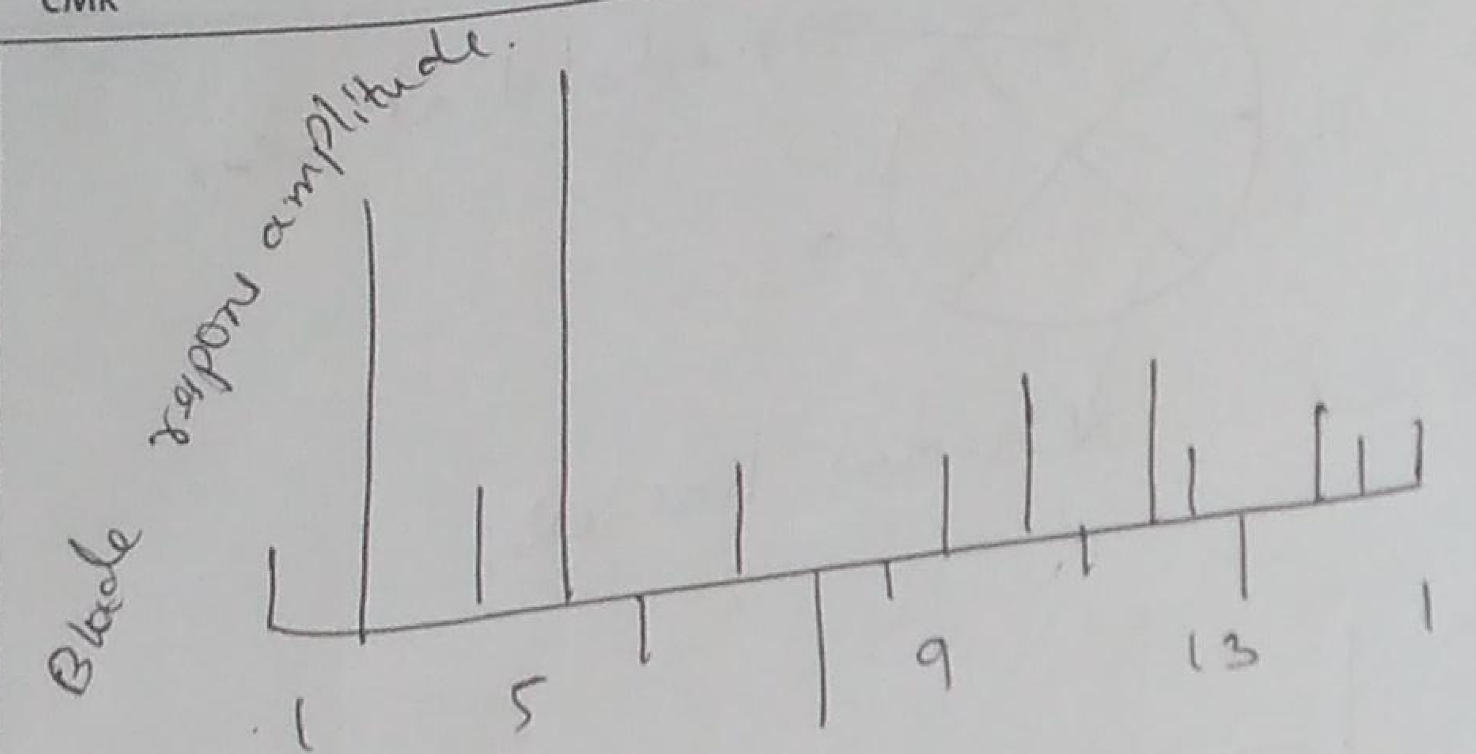


Fig ③ Amplitu[de] of vibration o[f] mistuned blad[ed] disk assemb[ly]



4 Ans.) Extrinsic fabry-perot sensors

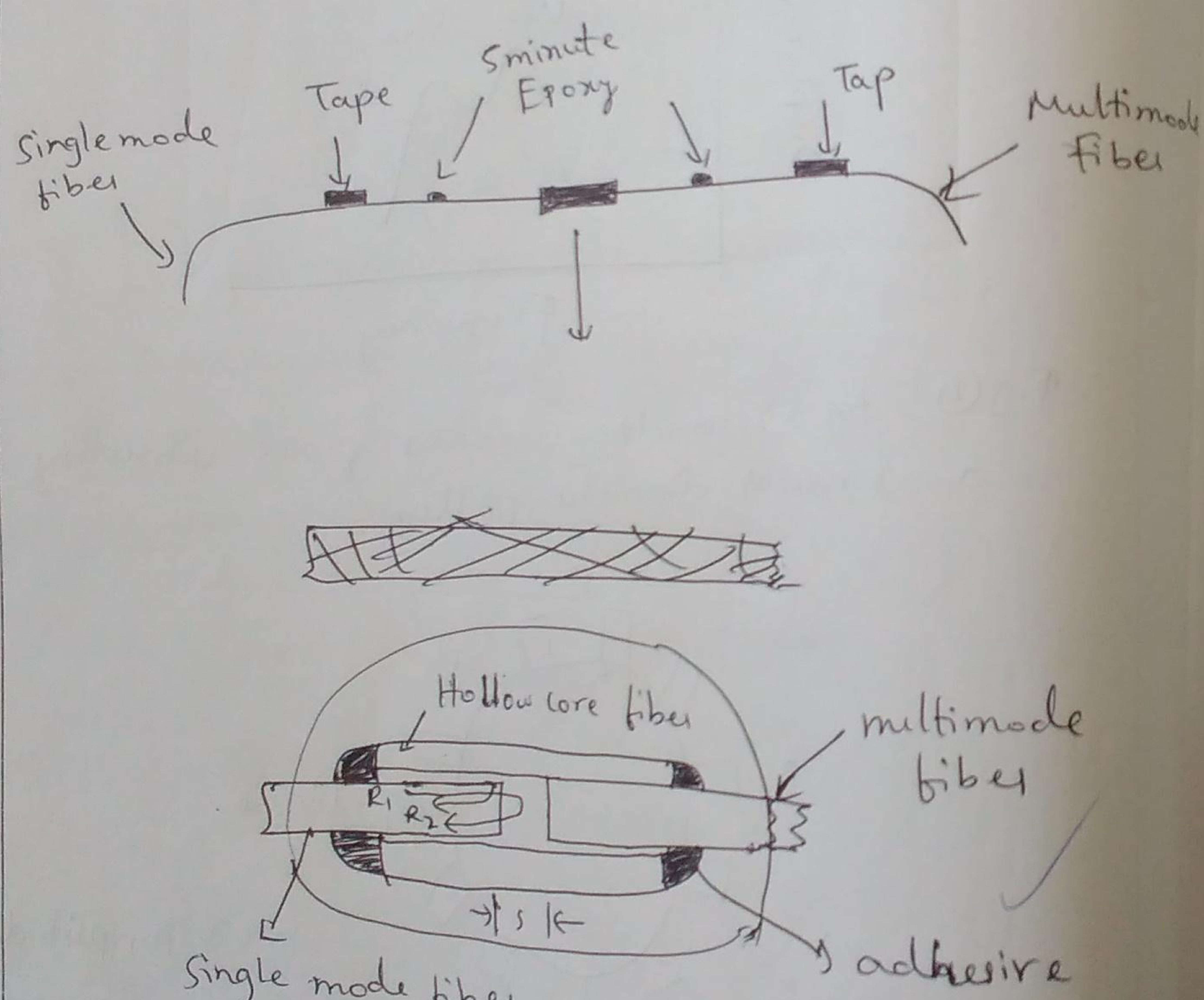
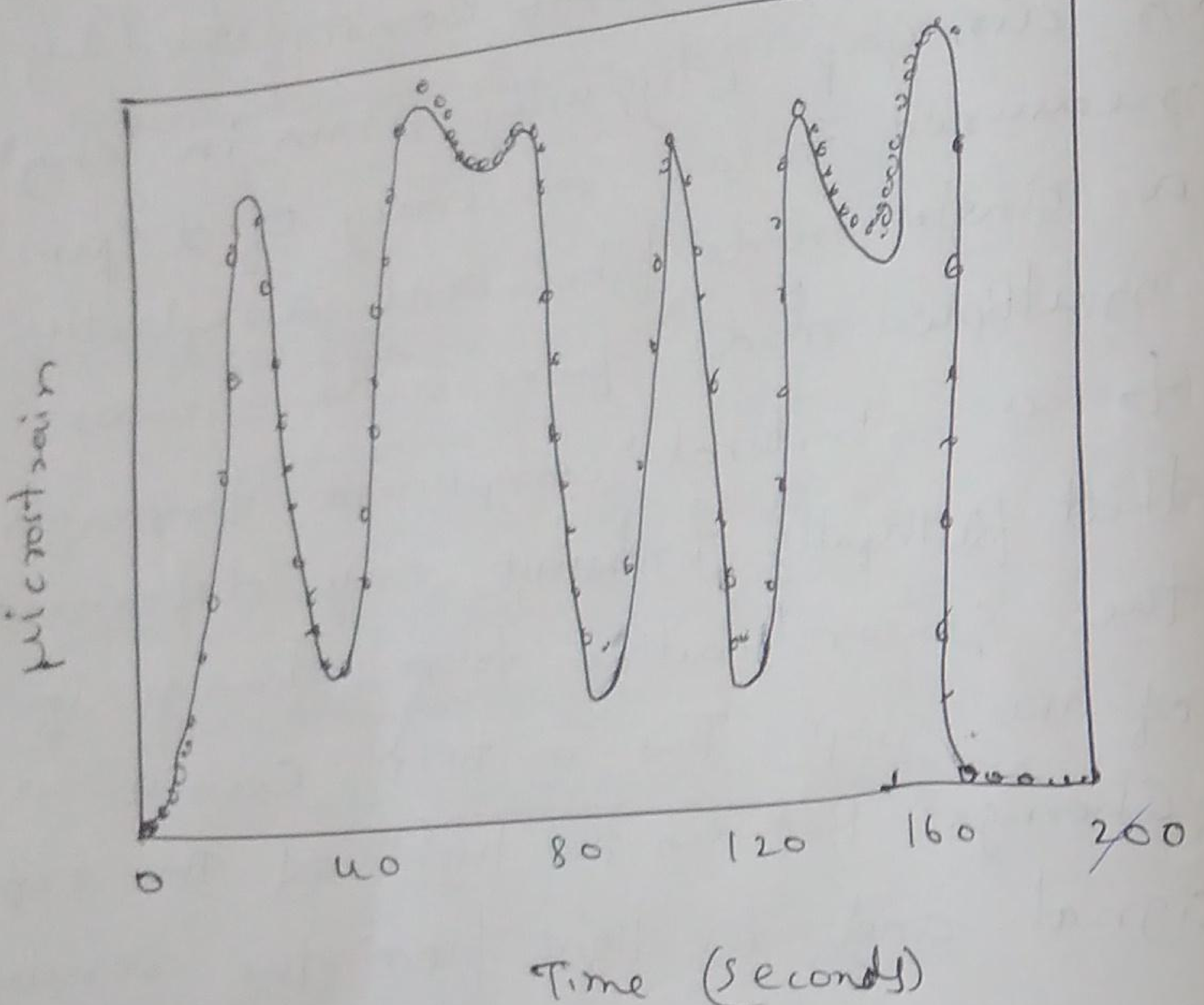


Fig ①

The basic principle that governs the operatio
of fabry perot sensors can be understo
with reference figure ①. The
instrument is constructed by prov
an air gap (typically 4mm in length an
measured to an accuracy of ± 5μm) be
a single mode fiber and a reflection fro
multiple mode fibre. The sensor is at
to a structural component through ad
that faithfully transmit any deformation
the sensor leading to a change in the
of the gap. This in turn, cause a pha
change between the light of the refrere
signal. and the light from the sensing si
because of interference between the two re
This phase change is a measure of moti
at the gap location and serves as
the basis for an accurate measurem
of strain. An excellent example of t
application of this instrument to mea
strains in an F-15 airframe during
log load fatigue test is described by
murphy et al. (1991). The results are
depicted in fig ② Fabry-perot sen

demonstrated minimum detectable motion of order of 0.1mm and a Strain of 0.01 μ strain.



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5Ans.) Bragg grating sensor

Bragg gratings are extremely close parallel lines "written" onto a small length (1 to 20mm) of the core of a fibre so as to Create a systematic perturbation of the cores refractive index This spatially periodic variation of the index of refraction acts as a filter by reflecting certain wavelengths while allowing others to pass through. Typical gratings have resonant wavelengths of 400 to 2000nm when broadband light traveling in the optical fiber encounters the grating, light at a wavelength proportional to the bragg spacing is reflected back. This may be observed as a gap in the spectrum of the transmitted light, or as a peak in that of the reflected light. when the grating is strained, the bragg spacing and thus the reflected wavelength change accordingly; the resulting change in spectrum is used as a measure of strain, This is robust sensing scheme because of light wavelength does not change as it passes through other fibers or connectors.

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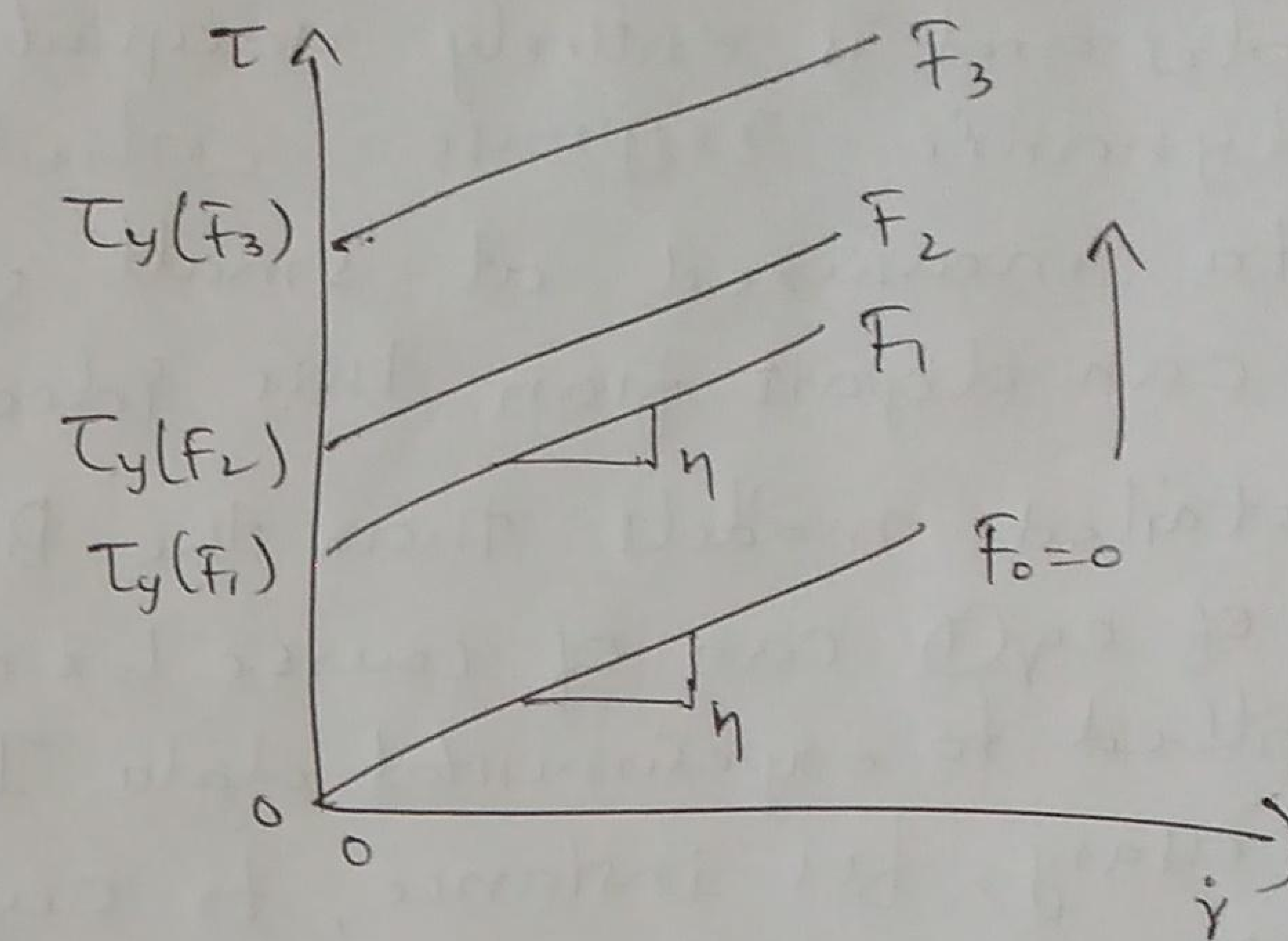
7 Ans) Bingham plastic model for ER/MR fluids

One might expect the formation of fibrils within an ER or MR fluid would increase the fluid viscosity, changes little if at all. The effect of the fibrils is instead to produce a shear stress that is largely independent of the strain rate. This is commonly referred to as the yield stress and denoted τ_y. Adding this term to the newtonian model results in the Bingham plastic model which has the stress-strain rate relation.

$$\tau = \tau_y(f) + \eta\dot{\gamma},$$

where in a given application f is the strength of the applied electric or magnetic field (i.e E or H). The response predicted by this model is plotted in fig 1 which depicts the strong dependence of the yield stress on the field strength.



Fig(1) shear stress versus shear strain rate for the Bingham plastic material model.

This model or extensions of it that predict similar overall response, is by fa the most popular for use in the design of devices that depend on the post yield shear resistance of an ER or MR fl

In practice, the dynamic viscosity is determined by a linear regression fit of a line to experimental data, and the intersection of this line with the shear stress axis is taken as the va of the yield stress τ_y.

Although this is a good approximation at strain value and is entirely adequate for small dynamic response calculations, the data measured at small strain value can depart from this idealization. More detailed models than the Bingham plastic of eq(3) can of course be devised and fitted to experimental data. It may be necessary, for instance, to capture the dynamics associated with the momentum of the fluid, or to represent the finite compliance of the container.

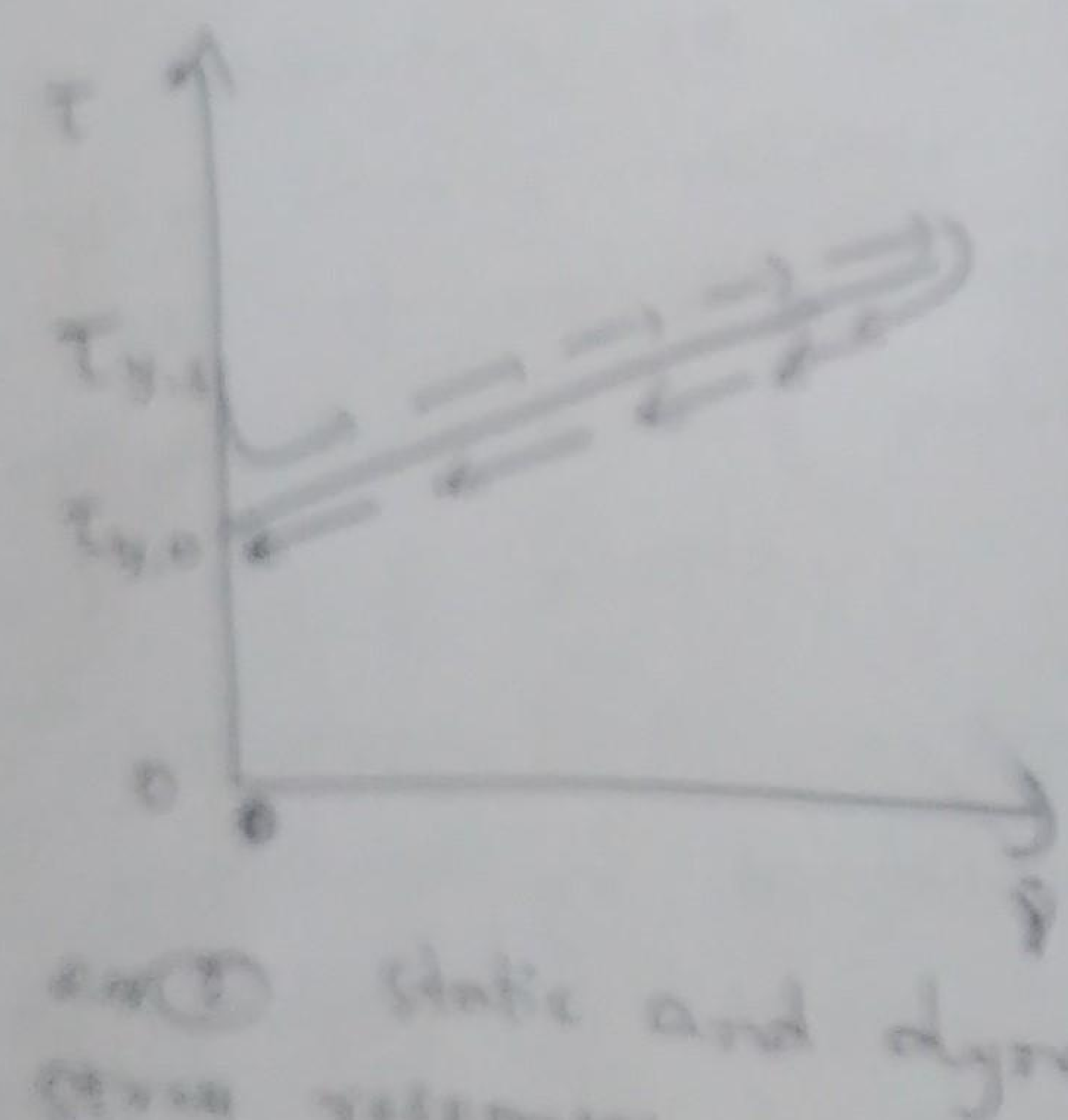


Fig ex(7) static and dynamic shear stress responses

An example of this extension of the bingham model to the case of an MR fluid damper is presented below