Homework 3
Answer all the questions
Project proposals should be ready

ME297

SJSU Eradat

Due Tuesday Oct. 11

No class on Oct. 4

3.1) Rules of thumb

- Decisions are made by efficiently applying "rules of thumb" to make quick approximations. Throughout your career, you should make sure to collect these and know how and when to use them (Jime Burge). As part of your homework assignments, **you should review the relevant notes and find at least 4 useful rules of thumb from the last week's lecture notes L5 & L6**. Report them in the following format.

Name for Rule	Small Angle Approximation
The Rule of Thumb	$\sin\theta \cong \theta$ (in radians)
When is this used?	This is used for small angles (< 0.2 radians or 11.5^0) Application of this approximation greatly simplifies analysis and calculation
Limitations	The percent error in the approximation is roughly $\theta^2/6$ x 100% so the approximation is valid to < 1% for angles < 0.24 radians (14°) and is valid to 0.01% (100ppm) for angles < 1.4. (you find this by calculating $(\sin\theta - \theta)*100$ for a range of angles and arguing when if you use it is a situation what kind of error you are signing up for)

3.2) rotation of a plane mirror

a) Find a rule for motion of the image produced by a plane mirror when the mirror is tilted by an angle theta?
b) Prove the claim.

3.3 Motion of a spherical mirror

- Derive a relationship for motion of the image as a function of the
  a) Axial
  b) lateral

motion of a spherical mirror.

3.4) Image stability I

- Consider a simple two-channel fiber coupler shown on next page. The incident beams are 3 mm in diameter, and come to focus on the end of the fiber with 0.1 NA. The back focal distance, as shown from the focusing lens (which is a multi-element lens) to the fiber is 8 mm. Coupling efficiency requires the position and rotation of the optics to be maintained so that both focused spots (one from beam 1 and the other from beam 2) are maintained on the fiber to ±0.3 µm

a) Determine the focal length of the lens and find its nodal point.

Calculate the following sources of error, consider the effects for both inputs 1 and 2

b) Lateral translation of beam splitter cube 20 µm

c) Rotation of the beam splitter cube about point A of 3 µrad

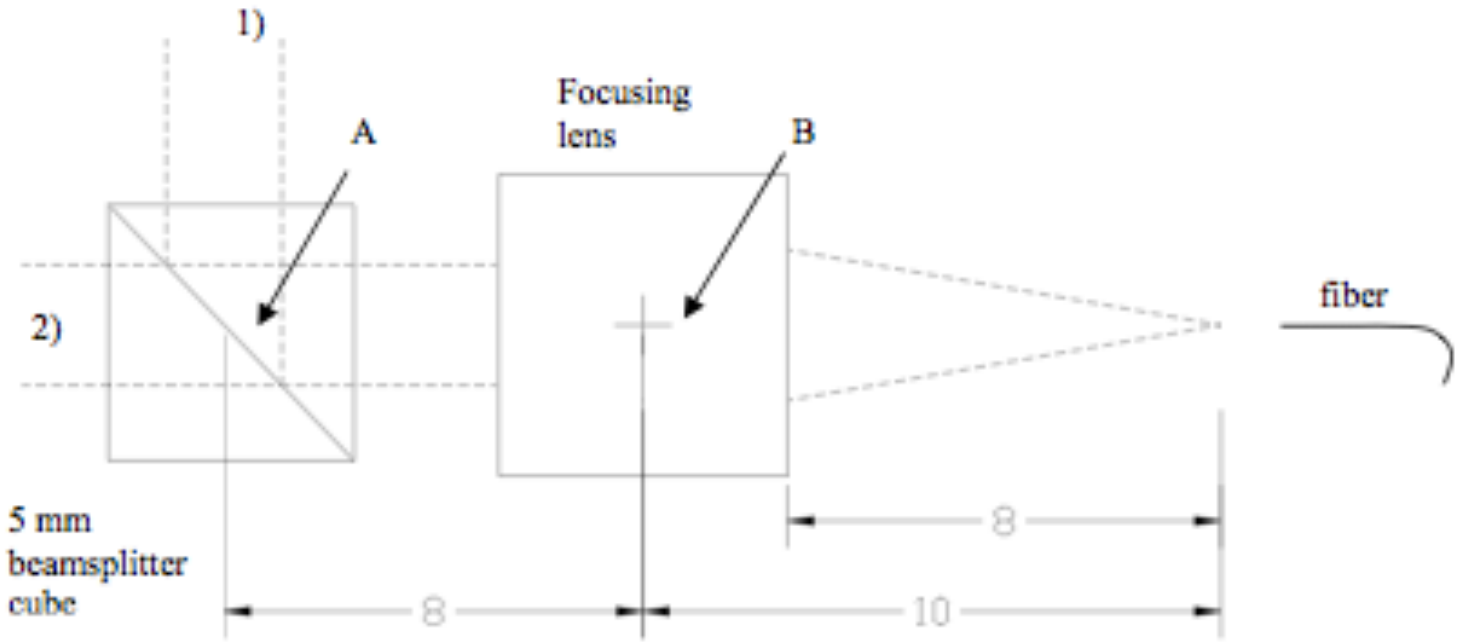
d) Lateral translation of the focusing lens of 0.1 µm

e) Rotation of focusing lens about point B of 20 µrad (decompose motion into rotation about nodal point + translation of nodal point.)

f) Lateral translation of the fiber of 0.1 µm

g) Calculate the combined effect of all of the above and summarize in a table like the one shown on the next page,

h) How does this compare to the requirement?



3.4) Image stability II

Motion	Beam 1	Beam 2	Combined for 2 beams
b)			
c)			
…			
Combined effect			