Homework 6
Answer all the questions

ME297

SJSU Eradat

Due Thursday Nov. 10

6.1) 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 (Jim Burge). As part of your homework assignments, **you should review the relevant notes and find at least 6 useful rules of thumb from the last week's lecture notes LN14 – LN15**. 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)

6.2 Mirror mount

This part is not due on Nov. 1st. It is to get started with cad design.

Understand the definition of a datum on a drawing. Make a CAD drawing for the 1” flat mirror mount that use ANSI Y14.5 conventions for dimensioning and tolerancing.

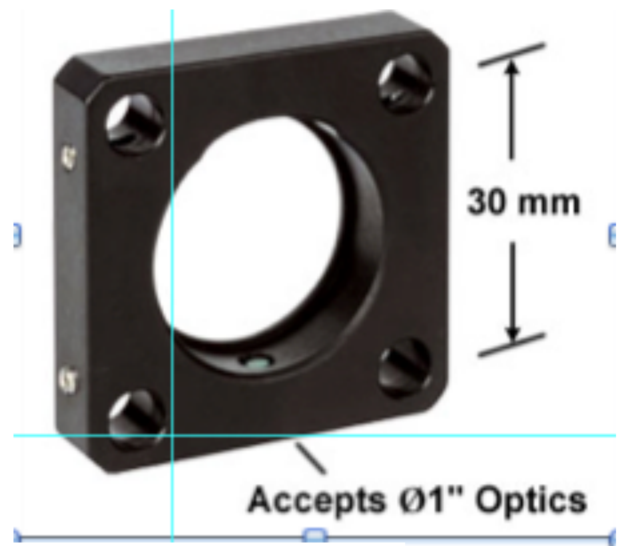
Correctly show dimensions for linear size, diameter, and radii. Make up the numbers and tolerances based on the following most important issues:

a) Diameter of the optics is 1”

b) center-to center of the holes is 30mm

c) Specs of the mirror to be mounted is given in the table. We want to preserve the mirror’s functionality and specs.

Use feature control frames to specify tolerances for straightness, flatness, roundness, profile, perpendicularity, parallelism, concentricity, position, and runout. Define datum references as necessary.



Backside Polished Mirrors			
Item #	**BB1-E02P**	**BB1-E03P**	**PF10-03-P01P**
Diameter	Ø1"		
Diameter Tolerance	+0.00 mm / -0.10 mm		
Thickness	6 mm		
Thickness Tolerance	±0.2 mm		
Substrate	Standard Grade Fused Silica		
Wedge	<5 arcmin		
Front Surface			
Coating	Broadband Dielectric 400-750 nm	Broadband Dielectric 750-1100 nm	Protected Silver
Flatness	λ/10		
Surface Quality	10-5 (Scratch-Dig)		
Clear Aperture	>90% of Diameter		
Reflectivity	>99% for S and P Polarization for Angles of Incidence from 0° to 45°		R_{avg} >96% from 400 nm - 700 nm R_{avg} >97.5% from 700 nm - 2000 nm
Damage Threshold	0.25 J/cm2 (532 nm, 10 ns, 10 Hz, Ø0.803 mm)	1 J/cm2 (810 nm, 10 ns, 10 Hz, Ø0.133 mm) 0.5 J/cm2 (1064 nm, 10 ns, 10 Hz, Ø0.433 mm)	3 J/cm2 (1064 nm, 10 ns, 10 Hz, Ø1.000 mm)
Back Surface			
Flatness	λ/4		
Surface Quality	20-10 (Scratch-Dig)		

6.3 Kinematic design

a) What is a kinematic design? Count advantages and disadvantages of it.
b) Under what condition a design is considered to be kinematic?
c) Is it possible for a kinematic design to act like a semi-kinematic or no kinematic at all? How?
d) What is the difference of kinematic and semi-kinematic design
e) Find an optomechanical product or design that uses a kinematic interface. Provide a drawing of this and a brief description. Discuss the features that make this kinematic. Provide the benefits and limitations of using this particular kinematic constraint. (Any place that sells optomechanical hardware will have numerous kinematic mounts and stages to choose from. You only need one. Hardware for optical design are preferred for this class)

6.4 Solid mechanics

Provide definition of the concepts listed in the next window. Proper drawing would be useful.

Find the SI and common engineering units for each and their relationship. Provide a data table for the common material used in optomechanical design for the cases that apply. Mention the source.

a) Normal stress, strain and give their relationship.
b) Shear stress and shear strain. Give their relationship
c) Poisson ratio
d) Bulk modulus, and its relationship to E and G
e) Show the stress – strain curve for a metal
f) Yield strength
g) Precision Elastic Limit (microyield strength)
h) Contact stress and its relations to stiffness and stress