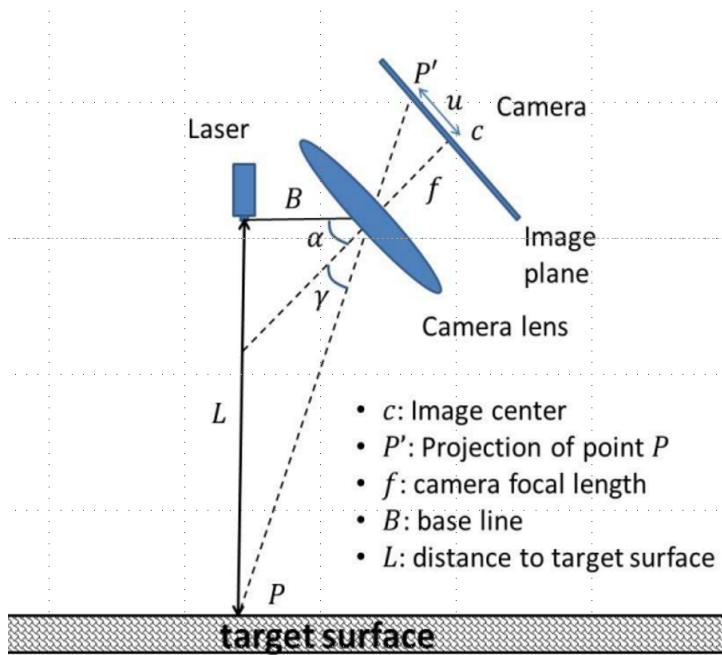
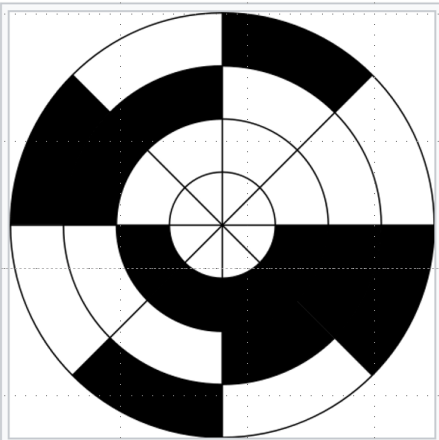


### Homework # 3

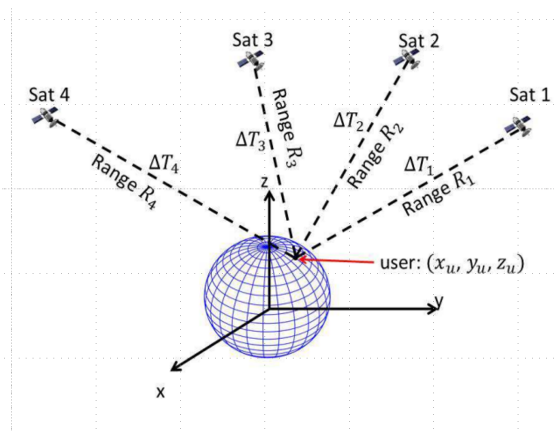


- 1) A surveyor uses a camera and a laser that are configured for optical triangulation to measure the distance to a goal post. The angle between the camera's optical axis and the laser beam is 30 degrees. The focal length of the camera is 10cm and the baseline ( $B$ ) is 15 cm. The image of the laser hitting the goal post appears 5 cm from the camera's optical axis. How far away is the goal post? (Hint: See slide 5 Lecture 4)



Rotary encoder for angle-measuring devices marked in 3-bit binary. The inner ring corresponds to Contact 1 in the table. Black sectors are "on". Zero degrees is on the right-hand side, with angle increasing counterclockwise.

- 2) Using 5 black/white sensors, into how many equally sized sectors can a circular encoder be divided? How many degrees will be contained within each equal sized sector? (Hint: See Slides 6-7 Lecture 4)
- 3) If the speed of sound is 343 m/sec and a sonar pulse can travel the distance to a tree and back in .01 sec, how far away is the tree?



4) Defining the Psuedo Range (distance) of each of four satellites from a user as

$$PSR_i = \text{SQRT}((x_i - x_u)^2 + (y_i - y_u)^2 + (z_i - z_u)^2) + c\Delta T_{0i} = c(\text{apparent measured time}) = c(\text{time on satellite clock} - \text{time on user clock})$$

$i = 1, \dots, 4$

where  $c = 299792458$  m/sec

	Apparent Measured Time (sec)	Time Delay at Receiver (sec)
Satellite #1	.0665	.0002
Satellite #2	.0666	.0002
Satellite #3	.0667	.0002
Satellite #4	.0668	.0002

What is the distance of each satellite from the user?

### 5) From slide 19

Assume that the modulating signal has a wavelength of  $\lambda = 60\text{m}$  ( $f = 5\text{MHz}$ ), what is the phase measurement for a range of:

- a range of 10m

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EEE187-01  
HOMEWORK 03

1. GIVEN:  $\alpha = 30^\circ$   
 $f = 10\text{ cm}$   
 $B = 15\text{ cm}$   
 $u = 5\text{ cm}$

$$\gamma = \arctan u/f$$
$$= \arctan (5/10)$$
$$L = B \tan (\alpha + \gamma)$$
$$= 15 \tan [\pi/6 + \arctan (5/10)]$$
$$= 22.72\text{ cm}$$

2.  $2^n = 2^5 = 32\text{ sectors}$   
 $360^\circ/32 = 11.25^\circ$

There are 32 equally size sectors  
and  $11.25^\circ$  contained in each sector.

3. GIVEN:  $v_s = 343\text{ m/s}$   
 $t_0 = 0.01\text{ s}$

$$r_0 = v_s t_0 / 2$$
$$= (343)(0.01)/2$$
$$= 1.715\text{ m}$$

4. satellite 1:  $299792458(0.0665 - 0.0002) = 19.87 \times 10^6\text{ m}$   
satellite 2:  $299792458(0.0666 - 0.0002) = 19.91 \times 10^6\text{ m}$   
satellite 3:  $299792458(0.0667 - 0.0002) = 19.94 \times 10^6\text{ m}$   
satellite 4:  $299792458(0.0668 - 0.0002) = 19.97 \times 10^6\text{ m}$

5.  $D = \lambda \theta / 4\pi$   
 $\theta = 4\pi(D/\lambda)$   
 $= 4\pi(10\text{ m} / 60\text{ m})$   
 $= 2\pi/3 \approx 2.0944$   
 $= 120^\circ$