

## Example SURE 340 Exam Questions

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- Identify the individual associated with the following:
  - Made the first practical photograph
  - First to use terrestrial photographs for topographic mapping
  - Developed the first stereocomparator using x and y scales
  - The American Father of Photogrammetry who used direction cosines to solve space resection, orientation, etc.
  - The person who developed the first orthophoto production unit.
  - Derived the projective equations and their differentials
  - Developed approach to lens distortion by looking at the image with a telescope through the camera lens.
  - Developed the first analog plotter called the Autocartograph in 1921.
  - Invented the first analytical stereoplotter.
  - Manufactured an optical projection plotter that offered the private photogrammetrists an accurate mapping instrument without the expense of European stereoplotters
- What is the difference between metric photogrammetry and interpretative photogrammetry?
- What is an oblique photograph and describe the difference between a high and low oblique photo.
- What is the difference between frequency, amplitude and wavelength?
- An aerial camera makes an exposure at a shutter speed of  $1/1,000$  sec. If the aircraft speed is 500 miles per hour, how far will the aircraft travel during the exposure? Although FMC can enhance image detail, some image blurring could exist. Why? The Z/I Imaging DMC and Leica ADS 40 digital cameras were discussed in lab. Do these cameras employ FMC? If so, how? If not, why? An aerial camera with FMC is used to acquire photography at a flying height of 5200 m above ground. The focal length is 153.15 mm. The aircraft is flying at 325 km/hr and an exposure time of  $1/250$  second is used. How far across the focal plane must film travel during the exposure in order to obtain an image with no blurring?
- Describe coma. What is the difference between an aberration and a distortion?
- What is the optical axis of an individual lens element? Include a clear sketch in your answer. When looking at the affects of image distance on illuminance it was stated that this relationship adheres to the inverse square law. What does this mean and describe how it affects the image. Describe the effects of image distance on illuminance. What is depth of field and how can it be increased in a camera? What is the vignetting effect (falloff) and how is it compensated?

- What is the law of reflection? Define refraction. Describe the concept of lateral image displacement? What is it and how is it created? Compute the critical angle for a light ray given the following indices of refraction: glass = 1.550 and air = 1.000. Clearly state any assumptions used in your formulation. What is the significance of the critical angle? A light ray enters glass, whose refractive index is 1.535, from air, whose refractive index is 1.0005, at an angle of  $48^\circ 27'$ . What is the angle of refraction?
- How does the characteristic curve (D log E curve) describe the characteristics of emulsions? What is a digital number? What is the difference between spatial and spectral resolution? A 3-band digital image consists of 12,000 rows and columns. How many bytes of computer space are required to store the image if each pixel takes 1 byte? What is the difference between intensity, hue and saturation?
- What is the difference between the nominal focal length, equivalent focal length and calibrated focal length? A camera manufacturer is asked to develop a wide-angle camera for a special mapping application. The picture format is 230 mm x 230 mm. They take a lens with an angular field of view of  $122^\circ$  and attach it to the camera body. What is the focal length of the camera? If a camera has a format of 230 mm x 230 mm and a focal length of 153-mm, what is the angular field of view?
- A digital camera consists of a CCD area array of 4096 x 4096 pixels. Each pixel is 8  $\mu\text{m}$  in size. The focal length of the camera is 50 mm. What is the angular field of view for this camera?
- What is a non-metric camera? What is a multilens (multiband) frame camera? Describe how the flying spot scanner operates and explain why this type of image collection is not used for very accurate mapping. The geometry of a linear array sensor is called a line perspective. Explain what this means. Identify five (5) of the requirements for a precision aerial mapping camera.
- Describe and discuss the differences between component and system concepts of calibration. Describe the difference between the multi-collimator and goniometer methods of camera calibration.
- Given the following camera calibration values, compute the distortions based on the calibrated focal length:

Angular Value	Measured Value	Distortion
$7.5^\circ$	20.223 mm	0 mm
$15.0^\circ$	41.177 mm	+0.018 mm
$22.5^\circ$	63.663 mm	+0.036 mm
$30.0^\circ$	88.726 mm	+0.040 mm
$37.5^\circ$	117.866 mm	-0.002 mm
$45.0^\circ$	153.435 mm	-0.174 mm

- What are the causes of radial lens distortion and decentering lens distortion?
- What is the difference between the principal point of photogrammetry, principal point of autocollimation and principal point of symmetry (or calibrated principal point)? Use a diagram along with your explanation.
- What are the important functions of a filter? What is the difference between the shutter and the diaphragm? Describe how the rotating disk shutter operates. What is a focal plane shutter and why isn't it a good shutter for mapping purposes? What is the property of the nodal point? What is the focal plane and how is it defined on the aerial camera?
- Using the thin lens formula, what is the object distance (distance from the incident nodal point to the ground) if the focal length is 153.019 mm? Justify your solution. A thin lens has a focal length of 100.00 mm. What is the object distance that is perfectly focused at an image distance of 165 mm?
- Define crab. What is the cause of crab?
- Describe the photographic coordinate system.
- Explain the difference between the scale of a truly vertical photograph and a large-scale map. Describe the effects of scale variation when the plane maintains a constant height and steadily rising terrain height.
- What is the scale, expressed as a representative fraction, of a truly vertical photo taken with a 6.13" focal length camera if the flying height above datum is 3250' and the elevation of the point is 824'?
- A distance between 2 points on a map at a scale of 1:62,500 is 28.65 mm. The distance between the same points on a vertical photo taken with a 152.11 mm focal length camera is 46.19 mm. If both points lie at an elevation of 84 meters, compute the flying height above datum.
- How high above sea level must an aircraft fly in order that photographs at a scale of 1"=500' may be obtained if the focal length is 6.04" and the average elevation of the terrain is 800'?
- A vertical photo, with a scale of 1"=850', was taken over a flat area lying at an average elevation of 650' above the datum. The focal length is 8.250". A distance was taken from the bottom to the top of a tower and found to be 0.152" on the photo. The distance from the principal point to the image of the top of the tower is 2.845". What is the height of the tower?
- Given a focal length of 6.000", a ground distance between two points of 5,536', and a corresponding photo distance between the same two points of 4.92", calculate the expected error,  $dH'$ , caused by an error in the ground distance of  $\pm 1.0'$ .
- A point lying on the axis of tilt has auxiliary photo coordinates  $x' = -5.000$  mm and  $y' = 3.104$  mm. If the focal length of the camera is 152.35 mm, and the swing angle is  $150^\circ$ , what is the amount of tilt in the photograph?

- Define the following terms: Nadir point, swing, axis of tilt, principal line, tilt angle, azimuth, relief displacement, exposure station, photographic x-axis, principal plane, isocenter. Where on the photograph is there no relief displacement? Where is there no tilt displacement? What phenomenon affects the amount of relief displacement on a photograph? What causes an increase in relief displacement on a truly vertical photograph? Describe how tilt displacement distorts the position of an image point. Use a sketch with your explanation.
- Given the following data, compute the ground coordinates of the point:  $f = 152.4$  mm,  $x' = -4.358$  mm,  $y' = 3.531$ ",  $H = 8,200'$  above datum,  $h = 1,587'$ ,  $t = 2^\circ 10'$ ,  $s = 135^\circ 00'$ , and azimuth =  $212^\circ 30'$ .
- A tilted photograph recorded a tilt angle of  $2^\circ 15'$  and swing angle of  $220^\circ$ . The camera used for the photography had a focal length of  $6.00$ " and the photo was taken at an altitude of  $3,900'$  above the datum. If the measured coordinates are  $x = 2.130$ " and  $y = 3.855$ ", what are the auxiliary photo coordinates?
- Given the following information, compute the radial distance from the isocenter to point A: tilt =  $3^\circ 27'$ , swing =  $272^\circ 00'$ , azimuth =  $189^\circ 30'$ , flying height above the datum =  $7,850'$ , focal length =  $6.0$ ", elevation of A =  $160'$ , and the auxiliary coordinates of the image point being  $x' = +2.109$ " and  $y' = -2.432$ ".
- Define the following terms: cornea, pupil, central fovea, macula lutea, retina, iris, parallax angle, and parallax.
- Describe the primary clues in stereoscopic vision. Distance to objects can be monoscopically perceived. How is this done? What is the cause of vertical exaggeration and what is its contributing factor? What is the parallax angle and how is it employed in depth perception?
- What is the approximate vertical exaggeration within a stereomodel for photography obtained with 60% endlap from a camera with a  $152.0$  mm focal length and a 23-sm square format (assume a  $b_c/h$  ratio of 0.15)?
- Describe how the "flight line" axis system is created. What are the causes of y-parallax? Describe the principle of the floating mark.
- What is the stereoscopic parallax for a point whose measured coordinates are  $x$  (left photo) =  $68.05$  mm and  $x'$  (right photo) =  $-21.61$  mm?
- Parallax was measured between two points, one at the bottom of a hill and the second at the top, and the recorded values are, respectively,  $3.216$ " and  $3.307$ ". The elevation of the bottom of the hill is  $3511'$ . The focal length of the taking camera was  $5.99$ " and the photographs were taken at an altitude of  $6912'$  above datum. What is the elevation of the top of the hill?

- If the parallax at point a, which has a ground elevation of 1905', was found to be 92.71 mm and the difference in parallax between a and b was -0.87 mm, what is the elevation of B? (Assume a flying height of 4,057' above datum.)
- A pair of overlapping vertical photographs were taken from a flying height of 1233 m above sea level with a 152.4 mm focal length camera. The air base was 390 mm. If the parallax at a point was found to be 95.74 mm, what is the elevation of that point?
- The air base of a pair of overlapping vertical photographs was determined to be 1,838 feet. The focal length of the camera was 157.10mm. The image coordinates of point A, whose elevation is 865 feet above the datum, were determined on the left photo as  $x_a = 1.68$  mm and  $x'_a = -86.37$  mm on the right photo. What is the flying height above the datum for the stereopair?
- What is the difference between a mechanical projection stereoplotter and an analytical stereoplotter? Describe the three different types of viewing systems found in direct optical projection plotters. The lens formula for a direct optical projection plotter is

$$\frac{1}{f'} = \frac{1}{p} + \frac{1}{h}$$

Describe each of these variables.

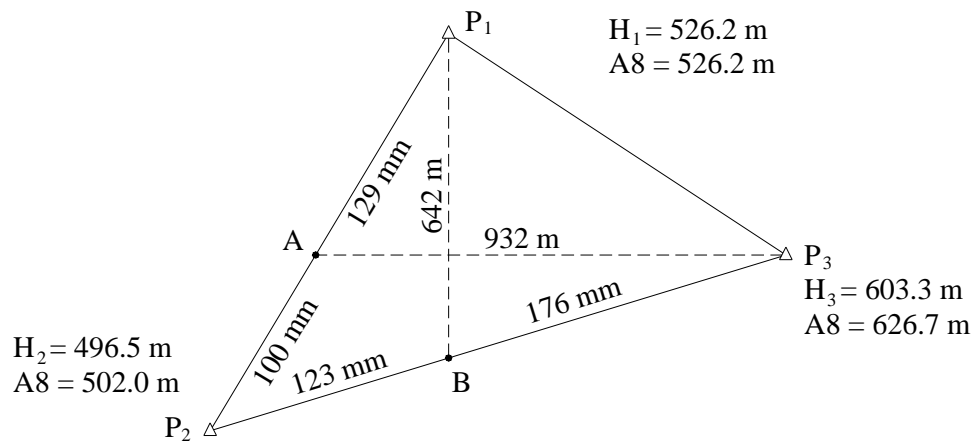
- What is the purpose of interior orientation? How is it achieved on a stereoplotter? The purpose of centering the diapositive in the projector is so that the principal is on the optical axis. How is this done and how is the projector optical axis defined physically?
- Define relative orientation. How is the model oriented (relative orientation) in dependent orientation? in independent orientation? The principle of relative orientation means that in a perfect stereoscopic model any point must lie in a plane containing the airbase. Explain. Use a sketch. Draw the six von Gruber points within the model. Then, assuming moving only projector #2 (the right projector), show the direction of the model point at each of the von Gruber points when a  $\kappa$ ",  $\phi$ ", and  $\omega$ " rotation is applied. It can be shown that the y-parallax at a point can be expressed as:

$$-p_y = \frac{XY}{Z} (d\phi_I - d\phi_{II}) - \left( Z + \frac{Y^2}{Z} \right) (d\omega_I - d\omega_{II}) - \frac{Y}{Z} (b \cdot bz_I - dbz_{II} - b \cdot d\phi_{II})$$

$$+ X (d\kappa_I - d\kappa_{II}) + (dby_I - dby_{II} + b \cdot d\kappa_{II})$$

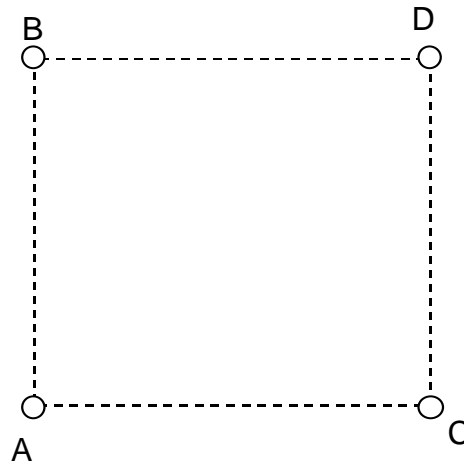
What is the significance of this relationship?

- Describe the coplanarity concept (use a sketch in the explanation).
- When scaling a stereomodel, the operator marks the two points A and B and measures a distance of 25.83" between them. This distance should scale at 26.38" (true distance at map scale). If the initial model base was set at 18.5", what length should the model base be adjusted to scale the model (Assume  $b_y$  and  $b_z$  components are zero)?
- The Kelsh plotter has a plotter projection distance of 760 mm. If the focal length of the taking camera is 152 mm and the scale of the photograph is 1" = 500', then the scale of the model is 1" = 3,000'. True or False? Explain your answer.
- Compute  $\Phi$  and  $\Omega$  given the data in the following diagram ( $H_i$  are the "true" survey elevations while A8 values represent the readings on the Wild A-8 stereoplotter).



- Describe the spatial accuracy requirements for a map to meet National Map Accuracy Standards. Describe how the root mean square (rms) error is determined in the ASPRS Large Scale Map Accuracy Standard. What is the difference between the ASPRS Accuracy Standard and the National Standard for Spatial Data Accuracy? Given a set of elevation data, compute the NSSDA.
- You have received a contract for 1:24,000-scale quadrangle mapping of two regions in the U.S.: Big Rapids, MI and Snowmass, CO (ski areas). Is the vertical accuracy the same for both maps when using the threshold defined by the National Map Accuracy Standards? What if the ASPRS threshold values are being used? Explain your answer.
- An analytical stereoplotter with a C-factor of 2700 is being used for topographic mapping with a 2' contour interval. What is the maximum flying height of the aerial camera above the ground?
- According to John Thorpe in his paper "CPS: Computed Photo Scale", under what conditions can the C-factor be used? Identify some of the common misconceptions in the application of the C-factor.

- Four vertical control points are identified in the corners of the stereomodel, thus forming a rectangle. The known ground elevations are shown in the following table. The ground distances between A and C and B and D was found to be 1015m, while the corresponding ground distance between A and B and C and D was determined to be 1995 m (see figure). The measuring mark is placed on the ground at point A and the stereoplotters Z-scale is set at the elevation of the ground control point. The table shows the instrument readings made at each of the four control points. What are the values of the angles  $\Phi$  and  $\Omega$ ?



Point	Height Control (m)	Instrument Height Reading (m)
A	325	325.0
B	412	464.2
C	361	374.3
D	470	535.5

- The airbase of a stereopair of vertical photos is 4,600' and a flying height above average ground is 8,000'. The camera has a 152.4 mm focal length and a 23 cm format. What is the percent endlap?
- A map will be compiled at a scale of 1:6,000 using a Kelsh plotter whose optimum enlargement ratio from photo scale to map scale is 5. What is the optimum photo scale?
- Why is it important to carefully plan the optimum map scale? Describe the limiting factors of the particular plotters in planning a photogrammetric project. Detail how season of the year is a limiting factor in the acquisition of photography for topographic mapping.

- Photogrammetric control must satisfy two requirements. Identify and describe them. What is the difference in criteria between a horizontal and vertical photogrammetric control point?

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*These sample questions are often taken from homework assignments. Therefore, I would like to acknowledge the problem sets from two photogrammetry texts authored by (a) Frank Moffitt and Edward Mikhail and (b) Paul Wolf. Any originality I may have in these questions is purely coincidental and an oversight.*

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*This page is maintained by Bob Burtch and was last updated on 27 March 2005.*