CE 103: Surveying

Lecture 16: Tachometry

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Outline

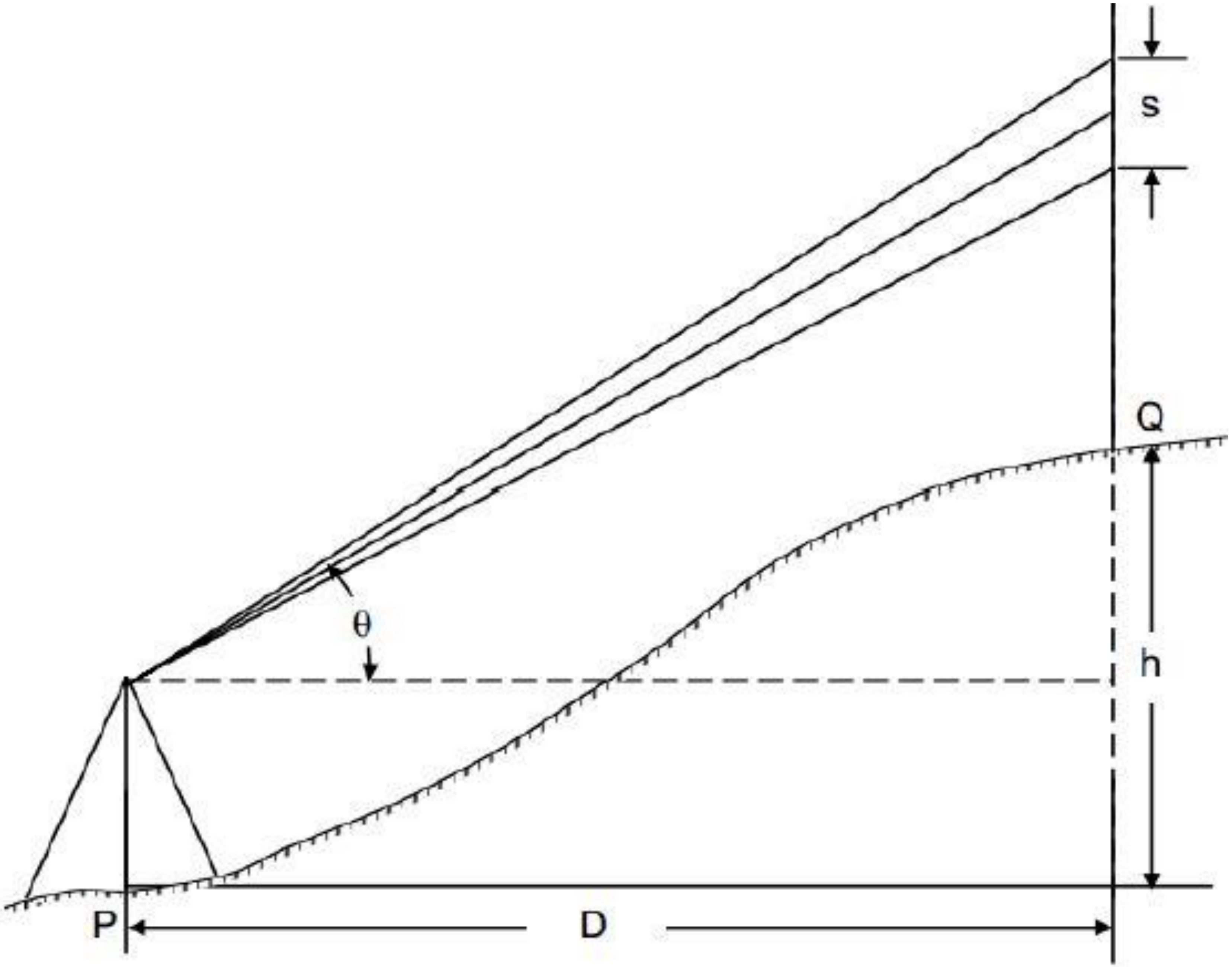
- Tachometry
- Stadia system
- Tachometry related math problem

TACHEOMETRY

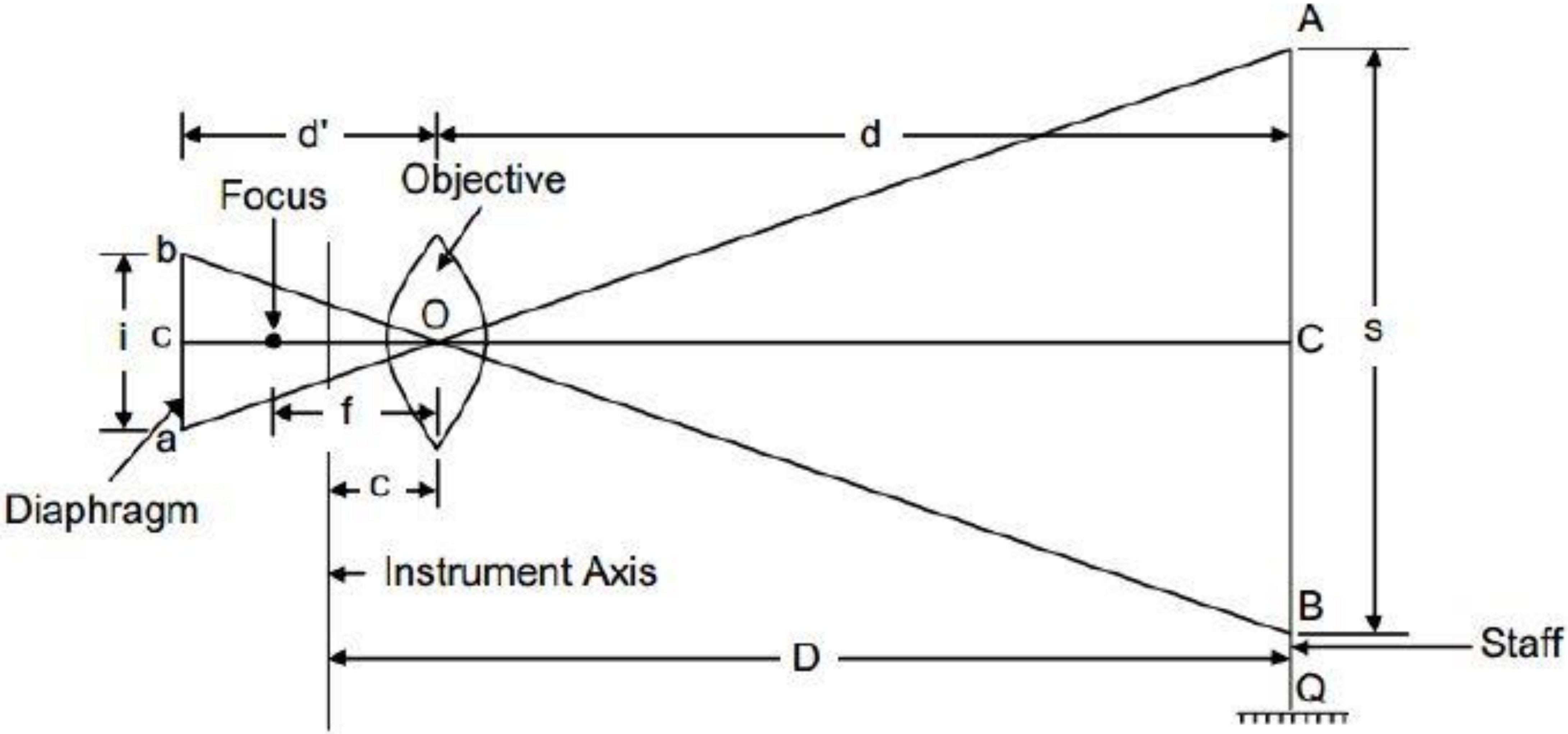
- A branch of angular surveying.
- Horizontal distances and heights/vertical distances are determined form instrument readings. Tape or chain is not required.
- Rapid and convenient method.
- Very useful where obstacles such as stretches of water or swamp roads, steep ground, ravines, crops etc. occur.
- Widely used in preparing contour maps of large scale.
- Accuracy is not very high, varying from about 1 in 10000 for more accurate subtense systems.

Stadia System

This is the more extensively used system of tacheometry particularly for detailed work, such as those required in engineering surveys. In this system, a tacheometer is first set up at a station, say *P*, and a staff is held at station *Q*, as shown in Figure. The difference of upper hair reading and lower hair reading is called staff intercept *s*. All the three hairs including central cross hair are read, and *s* is determined. Vertical angle, θ, corresponding to the central hair is also measured. These measurements enable determination of horizontal distance between *P* and *Q* and their Difference in elevation.



s
Q
θ
h
P
D


A
d'
d
Objective
Focus
b
i
c
O
C
s
f
a
c
Diaphragm
Instrument Axis
B
Staff
D
Q

f= focal length of the object glass,

i= stadia hair interval = ab,

s = staff intercept = AB,

c = distance from O to the vertical axis of the instrument,

d = distance from O to the staff,

d' = distance from O to the plane of the diaphragm, and

D = horizontal distance from the vertical axis to the staff.

From similar Δ^s, AOB and aOb, we get

$$\frac{d}{d'} = \frac{s}{i}$$

And from lens formula,

$$\frac{1}{f} = \frac{1}{d'} + \frac{1}{d}$$

Combining the two equations, we get

$$d = \frac{fs}{i} + f$$

Adding c to both the sides

$$D = \frac{fs}{i} + (f + c)$$

or $$D = Ks + C.$$

where the constant K is equal to (f/i). It is called **multiplying constant** of the tacheometer and is generally kept as 100. The constant C is equal to $(f + c)$. It is called **additive constant** whose value ranges from 30 cm to 50 cm for external focusing telescopes and 10 cm to 20 cm for internal focusing telescopes. For telescopes fitted with anallactic lens, C equals zero.

- A tacheometer fitted with an anallatic lens was set up at A. The following observations were made on a vertically held staff:

Instrument Station	Staff Point	Whole Circle Bearing	Vertical Angle, Θ	Reading		
A	X	45°30'	0	3.77	4.02	4.27
A	P	32°30'	-2 °30'	2.45	4.21	5.97
A	Q	212°30'	+ 3°15'	1.22	2.82	4.42

R.L. of X is 36 ft.
AX = 50 ft.(horizontal distance)

Determine the following:

1.Tacheometric constants.
2.R.L. of P & Q.
3.Determine horizontal distance between P & Q.

Solution:

c=0

AX=50=ks+c =k(4.27-3.77)+0

⇒k= 50/0.5 =100

When Instrument at A and staff at P:

$$D_{AP} = ks\cos^2\theta = 100(5.97 - 2.45)\{\cos(-2.5°)\}^2 = 351.33\,ft$$

$$H_{AP} = ks\frac{\sin 2\theta}{2} = 100(5.97 - 2.45)\frac{\sin(-5°)}{2} = -15.34\,ft$$

R.L. of instrument centre = 36 +4.02 = 40.02 ft

R.L. of P = 40.02-15.34-4.21=20.47 ft

When Instrument at A and staff at Q:

$$D_{AQ} = ks\cos^2\theta = 100(4.42 - 1.22)\{\cos(3.25°)\}^2 = 318.97\,ft$$

$$H_{AQ} = ks\frac{\sin 2\theta}{2} = 100(3.2)\frac{\sin(6.5°)}{2} = 18.11\,ft$$

R.L. of P = 40.02+18.11-2.82=55.31 ft

PQ = 351.33 + 318.97 = 670.30 ft