Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20
Course Code: CIV 313
Course Name: ADVANCED SURVEYING
Program & Sem: B. Tech. (Civil) & V

Date: 27.09.2019
Time: 11:00AM to 12:00PM
Max Marks: 40
Weightage: 20%

Instructions:

(i) Use of non-programmable Scientific Calculator is permitted
(ii) Read all the questions carefully before answering them

Part A (Memory Recall Questions)

Answer all the Questions. Each Question carries four marks (3Qx4M=12M)

1. Discuss briefly the classification of triangulation system. (C.O.NO.1) [Knowledge]

2. Write the operations involved in routine of triangulation survey. (C.O.NO.1) [Knowledge]

3. Define accuracy and precision. (C.O.NO.1) [Knowledge]

Part B (Thought Provoking Question)

Answer both the Questions. Each Question carries eight marks. (2Qx8M=16M)

4. Identify which all parameters can be determined through principle of triangulation and prove it. (C.O.NO.1) [Comprehension]
5. Two triangulation stations A and B are 60 kilometres apart and have elevations 240 m and 280 m respectively. Find the minimum height of signal required at B so that tile line of sight may not pass near the ground than 2 metres. The intervening ground may be assumed to have a uniform elevation of 200 metres. (C.O.NO.1) [Comprehension]

Part C (Problem Solving Questions)

Answer the Question. The Question carries twelve marks **(1Qx12M=12M)**

6 a. Directions were observed from a satellite station S, 65m from C, with the following results:

A (0° 0' 0"), B (62° 40' 44") and C (276° 12' 0").

The approximate lengths of AC and BC are 14.5km and 21.35km respectively. Compute the angle ACB If satellite station is to the right of C, [8 M]

(C.O. NO.1) [Application]

b. If the probable error of direction measurement is 1.2 seconds, compute the maximum value of R for the desired maximum probable error of 1 in 10,000. [4 M]

(C.O.NO.1) [Comprehension]

SCHOOL OF ENGINEERING

Date: 27 September 2019

Semester: V

Time: 11am to 12 pm

Course Code: CIV 313

Max Marks: 40

Course Name: Advanced Surveying

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q. No.	C.O. No.	Unit/Module Number/ Unit/Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	CO 1	Module 1 Geodetic Surveying and Theory of Errors	4	--------	--------	4
2	CO 1		4	--------	--------	4
3	CO 1		4	--------	--------	4
4	CO 1		--------	8		8
5	CO 1		--------	8		8
6	CO 1		4		08	12
Total Marks			16	16	08	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Mr. Gopalakrishnan

Reviewers' Comments

SCHOOL OF ENGINEERING

SOLUTION

Semester: V | **Date**: 27 September 2019

Course Code: CIV 313 | **Time**: 11am to 12pm

Course Name: Advanced Surveying | **Max Marks**: 40 | **Weightage**: 20%

Part A (3Q x 04M = 12 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
1	Based on the extent and purpose of the survey, and consequently on the degree of accuracy desired, triangulation surveys are classified as 1) first-order or primary, 2) second-order or secondary, and 3) third-order or tertiary. First-order triangulation is used to determine the shape and size of the earth or to cover a vast area like a whole country with control points to which a second-order triangulation system can be connected. A second-order triangulation system consists of a network within a first-order triangulation. It is used to cover areas of the order of a region, small country, or province. A third-order triangulation is a framework fixed within and connected to a second-order triangulation system. It serves the purpose of furnishing the immediate control for detailed engineering and location surveys.	1 Mark for classification 1 Mark for description of each (03 x 01 Mark = 03 Marks)	05 Minutes
2	The routine of triangulation survey, broadly consists of (a) field work, and (b) computations. The field work of triangulation is divided into the following operations : (i) Reconnaissance (ii) Erection of signals and towers (iii) Measurement of base line (iv) Measurement of horizontal angles (v) Measurement of vertical angles (vi) Astronomical observations to determine the azimuth of the lines.	01 Mark 0.5 Mark each 6 x 0.5 Mark =03 Marks	05 Minutes
3	(1) Accuracy: The term accuracy is used to denote the closeness or a measurement to its true value. The measured value is said to be accurate if it is near to its true value. Thus, the accuracy reflects the degree of perfection of the measurement.	2 Marks for accuracy	05 Minutes

	(2) Precision: The term precision of a measurement is used to denote closeness or nearness to another measurement of the same quantity. If a quantity is measured several times and the values obtained are very close to one another, it is said that precision is high. It indicates degree of agreement between several measurements of same quantity and depends on degree of perfection used in observations, instruments and methods	2 Marks for Precision	

Part B (2Q x 08M = 16 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
1	Fig. 1 shows two interconnected triangles ABC and BCD. All the angles in both the triangles and the length L of the side AB, have been measured Also the azimuth θ of AB has been measured at the triangulation station A, whose coordinates (X_A, Y_A) are known The objective is to determine the coordinates of the triangulation stations B, C, and D by the method of triangulation. Let us first calculate the lengths of all the lines By sine rule in ΔABC, we have $\frac{AB}{\sin 3} = \frac{BC}{\sin 1} = \frac{CA}{\sin 2}$ We have $AB = L = l_{AB}$ or $BC = \frac{L \sin 1}{\sin 3} = l_{BC}$ and $CA = \frac{L \sin 2}{\sin 3} = l_{CA}$ Now the side BC being known in ΔBCD, by sine rule, we have $\frac{BC}{\sin 6} = \frac{CD}{\sin 4} = \frac{BD}{\sin 5}$ We have $BC = \frac{L \sin 1}{\sin 3} = l_{BC}$ or $CD = \left(\frac{L \sin 1}{\sin 3}\right)\frac{\sin 4}{\sin 6} = l_{CD}$ and $BC = \left(\frac{L \sin 1}{\sin 3}\right)\frac{\sin 5}{\sin 6} = l_{BD}$	1 Mark for figure 3 Mark for derivation	15 Minutes

Fig. 1 Principle of triangulation

Let us now calculate the azimuths of all the lines.

Azimuth of $AB = \theta = \theta_{AB}$

Azimuth of $AC = \theta + \angle 1 = \theta_{AC}$

Azimuth of $BC = \theta + 180^\circ - \angle 2 = \theta_{BC}$

Azimuth of $BD = \theta + 180^\circ - \angle 2 + \angle 4 = \theta_{BD}$

Azimuth of $CD = \theta - \angle 2 - \angle 5 = \theta_{CD}$

From the known lengths of the sides and the azimuths, the consecutive coordinates can be computed as below.

Latitude of $AB = l_{AB} \cos\theta_{AB} = L_{AB}$

Departure of $AB = l_{AB} \sin\theta_{AB} = D_{AB}$

Latitude of $AC = l_{AC} \cos\theta_{AC} = L_{AC}$

Departure of $AC = l_{AC} \sin\theta_{AC} = D_{AC}$

Latitude of $BD = l_{BD} \cos\theta_{BD} = L_{BD}$

Departure of $BD = l_{BD} \sin\theta_{BD} = L_{BD}$

2 Mark for Latitude and 2 Mark for Departure

Latitude of $CD = l_{CD} \cos\theta_{CD} = L_{CD}$

Departure of $CD = l_{CD} \sin\theta_{CD} = D_{CD}$

The desired coordinates of the triangulation stations B, C, and D are as follows

X-coordinate of B. $X_B = X_A + D_{AB}$

Y-coordinate of B. $Y_B = Y_B + L_{AB}$

X-coordinate of C. $X_C = X_A + D_{AC}$

Y-coordinate of C. $Y_C = Y_A + L_{AC}$

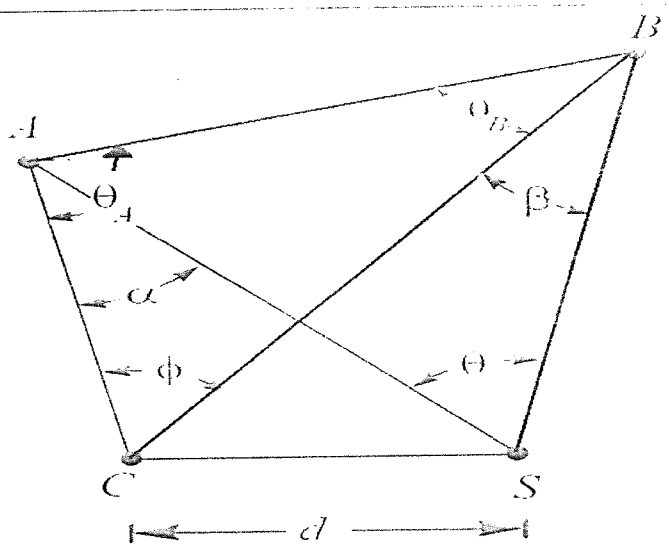
X-coordinate of D. $X_D = X_B + D_{BD}$

Y-coordinate of D. $Y_D = Y_B + L_{BD}$

It would be found that the length of side can be computed more than once following different routes, and therefore to achieve a better accuracy, the mean of the computed lengths of a side is to be considered.

2	[illegible]	Distance D_1 and D_2 – 04 Marks Elevation of Line of sight at B - 02 M Minimum height of signal at B – 02 M	15 Minutes

Part C (1Q x 12M = 12 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
1a.	 $\theta = 62°40' 44"$ CAS = $\gamma = 83° 48' 0"$ AC = b = 14.5km = 14500m BC = a = 21.35km = 21350m AS = d = 65m $\alpha = \frac{d \sin(\theta + \gamma)}{b} 206265$ $\alpha = \frac{65 \sin(62°40' 44" + 83° 48' 0")}{14500} * 206265$ $\alpha = 510.62$seconds = 0°8' 30.62" $\beta = \frac{d \sin \gamma}{b} 206265$ $\beta = \frac{65 \sin(83° 48' 0")}{21350} * 206265$ $\beta = 624.3$ seconds = 0°10' 24.3" $\phi = \theta - \alpha - \beta = 62°40' 44" - 0°8' 30.62" - 0°10' 24.3"$ Angle ACB, ϕ = **62°21' 49.08"**	1 Mark for diagram 3 Marks 3 Marks 1 Mark	15 Minutes

2	Given d = 1.25" ; Maximum probable error = 1 in 10,000 $L^2 = \frac{4}{3} d^2 R$ L being the probable error of a logarithm, it represents the logarithm of the ratio of the true value and a value containing the probable error. L = the 6th place in log of $\left(1 \pm \frac{1}{10000}\right)$ L = the 6th place in log ((1± 0.00001) log (1 + 0.00001) = 0.0000434 The 6th place in the log value = 43 Hence L = ± 43 It is given that d = 1.2" $L^2 = \frac{4}{3} d^2 R$ $R = \frac{3}{4} \frac{L^2}{d^2}$ $R = (3/4) (43^2/1.25^2)$ **R = 963.03**	Value of L = 2 Marks Value of R = 2 Marks	05 Minutes

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PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST - 2

Sem & AY: Odd Sem 2019-20
Course Code: CIV 313
Course Name: ADVANCED SURVEYING
Program & Sem: B.Tech. (Civil) & V Sem

Date: 16.11.2019
Time: 11:00 AM to 12:00 PM
Max Marks: 40
Weightage: 20%

Instructions:

(i) Read all the questions carefully before answering them
(ii) Use of non-programmable scientific calculator is permitted

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Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries four marks. (3Qx4M=12M)

1. Define: Zenith & Nadir (C.O.No.2) [Knowledge]
2. Describe Celestial Sphere and Celestial Horizon. (C.O.No.2) [Knowledge]
3. List the phenomena leading to changes in seasons. (C.O.No.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries eight marks. (2Qx8M=16M)

4. Find the difference of longitude between two places A and B from their following longitudes:
   (1) Longitude of A = 40° W
   Longitude of B = 73° W
   (2) Longitude of A = 20° E
   Longitude of B = 150° E
   (3) Longitude of A = 20° E
   Longitude of B = 50° W
   (4) Longitude of A = 40° E
   Longitude of B = 120° W
   (C.O.No.2) [Comprehension]
5. Discuss about spherical triangle and its properties. (C.O.No.2) [Comprehension]

Part C [Problem Solving Questions]

Answer the Question. The Question carries twelve marks. **(1Qx12M=12M)**

6. Compute the distance in nautical miles and kilometers between two points A and B along the parallel of latitude, given that

   (1) Lat. of A, 28° 42' N; longitude of A, 31° 12' W
   Lat. of B, 28° 42' N; longitude of B, 47° 24' W

   (2) Lat. of A, 12° 36' S; longitude of A, 15° 6' W
   Lat. of B, 12° 36' S; longitude of B, 120° 24' E

(C.O.No.2) [Application]

SCHOOL OF ENGINEERING

Sem & AY: Odd Sem 2019-20
Course Code: CIV 313
Course Name: Advanced Surveying
Program & Sem: B. Tech. (Civil) & V Sem

Date: 16.11.19
Time: 11:00AM to 12:00PM
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q. No.	C.O. No.	Unit/Module Number/ Unit/Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	C.O. No. 2	Module 2 Field Astronomy	4									4
2	C.O. No. 2		4									4
3	C.O. No. 2		4									4
4	C.O. No. 2					8						8
5	C.O. No. 2					8						8
6	C.O. No. 2								12			12
Total Marks			12			16			12			40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60% of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

[Mr. Bhavan Kumar M]

Reviewer's Comments:

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SOLUTION

Sem & AY: Odd Sem 2019-20
Course Code: CIV 313
Course Name: Advanced Surveying
Program & Sem: B. Tech. (Civil) & V Sem

Date: 16.11.19
Time: 11:00AM to 12:00PM
Max Marks: 40
Weightage: 20%

Part A (3Q x 04M = 12 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
1	**Zenith (Z)** is the point on the upper portion of the celestial sphere marked by plumb line above the observer. OR It is thus the point on the celestial sphere immediately above the observer's station. **Nadir (E)** is the point on the lower portion of the celestial sphere, marked by the plumb line below the observer. OR It is thus the point on the celestial sphere vertically below the observer's station.	2 Marks for Zenith 2 Marks for Nadir	05 Minutes
2	**Celestial Sphere** - The imaginary sphere on which all stars appear to lie or to be studded is known as the Celestial Sphere. **The Celestial Horizon** (also called True or Rational horizon or geocentric horizon) - It is the great circle traced upon the celestial sphere by that plane which is perpendicular to the Zenith—Nadir line, and which passes through the centre of the earth	2 Marks for Celestial Sphere 2 Marks for Celestial Horizon	05 Minutes
3	The following phenomena lead to changes in seasons: Equinox & Solstices 1. The Vernal Equinox or the First Point of Aries 2. Autumnal Equinox or the First Point of Libra 3. Summer solstice 4. Winter solstice	1 Mark for each phenomena 4 x 01 Mark = 04 Marks	05 Minutes

Part B (2Q x 08M = 16 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
4	(1) Longitude of A = 40° W; Longitude of B = 73° W Difference of longitude between two places A and B = 73° – 40° **Difference of longitude between two places A and B = 33°** (2) Longitude of A = 20° E; Longitude of B = 150° E Difference of longitude between two places A and B = 150° – 20° **Difference of longitude between two places A and B = 130°** (3) Longitude of A = 20° E; Longitude of B = 50° W Difference of longitude between two places A and B = 20° – (- 50°) **Difference of longitude between two places A and B = 70°** (4) Longitude of A = 40° E; Longitude of B = 120° W Difference of longitude between two places A and B = 40° – (- 120°) **Difference of longitude between two places A and B = 160°**	02 Marks 02 Marks 02 Marks 02 Marks	10 Minutes
5	A spherical triangle is a triangle formed by the intersection of three arcs of great circles of the sphere. The properties of a spherical triangle are summarised below: 1. The sum of any two sides of a spherical triangle is greater than the third. 2. The sum of the three sides of a spherical triangle is always less than the circumference of the great circle. 3. The sum of the three angles of a spherical triangle is greater than two right angles (>180⁰), but is less than six right angles (<540⁰). 4. If two angles are equal, the sides opposite to them are also equal. 5. The greater angle is opposite to the longer side and vice versa. 6. Any angle of the spherical triangle is less than two right angles (<180⁰). 7. If the sum of two sides is equal to two right angles (=180⁰), the sum of the angles opposite to them is also equal to two right angles (=180⁰). (Student is expected to write any 4 points)	Definition – 02 Mark 01.5 Mark for each property - 4 x 1.5 Mark = 06 Marks	10 Minutes

Part C (1Q x 12M = 12 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
6	(1) Lat. of A = 28° 42' N; Longitude of A = 31° 12' W Lat. of B = 28° 42' N; Longitude of B = 47° 24' W Distance in nautical miles between A and B along the parallel of latitude = difference of longitude x cos (Latitude) Difference of longitude = (47° 24' - 31°12') = 16° 12' Difference of longitude = 972' Distance in nautical miles between A and B = 972 x cos (28°42') **Distance in nautical miles between A and B = 852.59 nautical miles** Distance in km between A and B = 852.59 x 1.853 **Distance in km between A and B = 1579.84km**	Formula – 1M Distance AB in nautical miles – 03M Distance AB in km – 02M	25 Minutes
	(2) Lat. of A = 12° 36' S; Longitude of A = 15° 6' W Lat. of B = 12° 36' S; Longitude of B = 120° 24' E Distance in nautical miles between A and B along the parallel of latitude = difference of longitude x cos (Latitude) Difference of longitude = (15° 6' – [-120°24']) = 135° 30' Difference of longitude = 8130' Distance in nautical miles between A and B = 8130 x cos (12°36') **Distance in nautical miles between A and B = 7934.20 nautical miles** Distance in km between A and B = 7934.20 x 1.853 **Distance in km between A and B = 14702.07km**	Formula – 1M Distance AB in nautical miles – 03M Distance AB in km – 02M	

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GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20
Course Code: CIV 313
Course Name: ADVANCED SURVEYING
Program & Sem: B. Tech. (CIV) & V (OE-I)

Date: 20 December 2019
Time: 9:30 AM to 12:30 PM
Max Marks: 80
Weightage: 40%

Instructions:
(i) Read the all questions carefully and answer accordingly.
(ii) Use of non-programmable scientific calculator is permitted

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 06 marks. (5Qx6M=30M)

1. List out the objectives of triangulation survey (C.O.No.1) [Knowledge]
2. Define: i) Latitude ii) Longitude and iii) Prime Vertical (C.O.No.2) [Knowledge]
3. With a neat figure, explain vertical and oblique photograph (C.O.No.3) [Knowledge]
4. Bring out the differences between accuracy and precision (C.O.No.1) [Knowledge]
5. Determine the difference in longitude between two places A and B from the following longitudes:
   (i) Longitude of A = 79° E, Longitude of B = 32° W
   (ii) Longitude of A = 126° E, Longitude of B = 14° E
   (iii) Longitude of A = 43° W, Longitude of B = 25° W
   (C.O.No.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

6. Derive the expression for scale of a vertical photograph on:
   i) Flat terrain
   ii) Variable terrain.
   (C.O.No.3) [Comprehension]
7. Derive the expression for relief displacement. (C.O.No.3) [Comprehension]
8. A vertical photograph was taken at an altitude of 1800m from the datum using a camera having focal length of 15cm. Determine the scale of the photograph for a terrain lying at an elevation of i) 250m ii) 520m and iii) 870m (C.O.No.3) [Comprehension]

Part C [Problem Solving Questions]

Answer the Question. The Question carries 20 marks. **(1Qx20M=20M)**

9. The ground length of a line AB is known to be 545 m and the elevations of A and B are 500 m and 300 respectively above mean sea level. A vertical photograph taken with a camera having focal length of 20 cm include the images a and b of these points, and their photographic coordinates are

   (x_a = + 2.65 cm, y_a = + 1.36 cm); (x_b = -1.92 cm, y_b = + 3.65 cm)

   The distance ab scaled directly from the photograph is 5.112 cm. Compute the flying height above the mean sea level.

   (C.O.No.3) [Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q. No.	C.O. NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted] Bloom's Levels	Total Marks
			K	C	A	
1	C.O. NO. 1	Module 1 Geodetic Surveying and Theory of Errors	6			6
2	C.O. NO. 2	Module 2 Field Astronomy	6			6
3	C.O. NO. 3	Module 3 Aerial Photogrammetry	6			6
4	C.O. NO. 1	Module 1 Geodetic Surveying and Theory of Errors	6			6
5	C.O. NO. 2	Module 2 Field Astronomy	6			6
6	C.O. NO. 3	Module 3 Aerial Photogrammetry		10		10
7	C.O. NO. 3			10		10
8	C.O. NO. 3			10		10
9	C.O. NO. 3				20	20
Total Marks			30	30	20	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Comment:

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

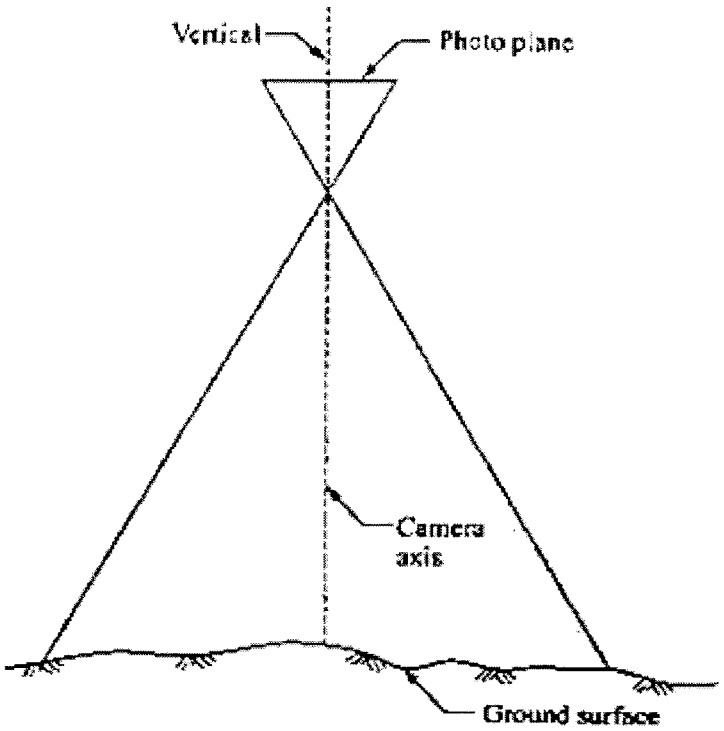
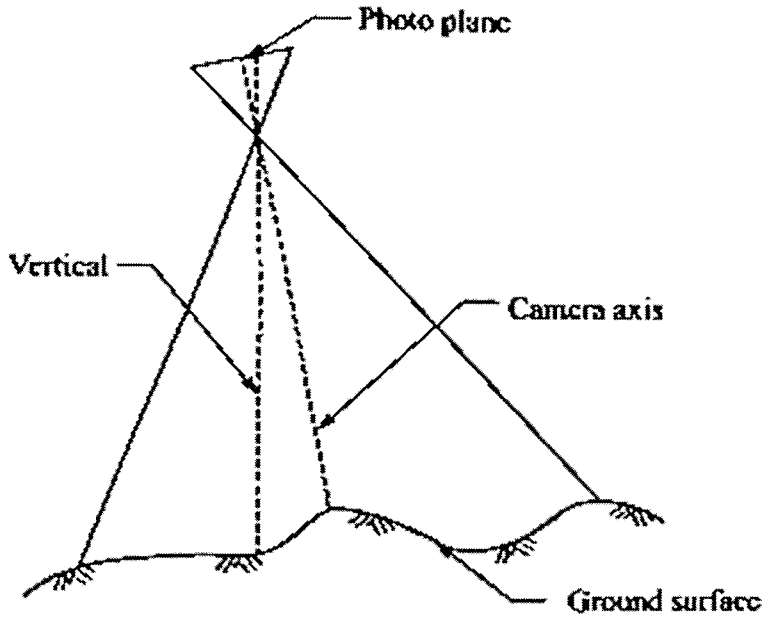
SOLUTION

Semester: Odd Sem. 2019-20
Course Code: CIV 313
Course Name: ADVANCED SURVEYING
Program & Sem: B.TECH. (CIVIL) & V SEM

Date: 20.12.2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

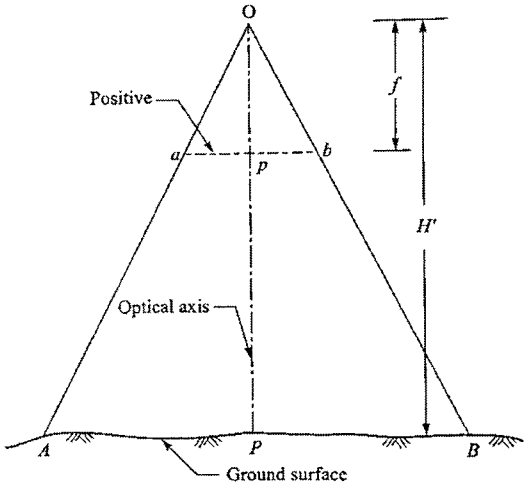
Part A (5Q x 6M = 30Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Questior
1	The primary objectives of triangulation surveys are (i) to establish accurate control for plane and geodetic surveys of large areas, by terrestrial methods, (ii) to establish accurate control for photogrammetric surveys of large areas, (iii) to assist in the determination of the size and shape of the earth by making observations for latitude, longitude and gravity (iv) to determine accurate locations of points in engineering works	**1.5 Marks for each objective** **(04 x 1.5M = 06M)**	**5 Minutes**
2	**i) Latitude -** It is the angular distance of any place on the earth's surface north or south of the equator and is measured on the meridian of the place. **ii) Longitude -** The longitude of a place is the angle between a fixed reference meridian called the prime or first meridian and the meridian of the place. The prime meridian universally adopted is that of Greenwich. The longitude of any place varies between 0° to 180°, and is reckoned as east or west of Greenwich. **iii) Prime Vertical -** It is that particular vertical circle which is at right angles to the observer's meridian, and which, therefore passes through the east and west points of the horizon.	**2 Marks for each definition**	**5 Minutes**

3	 Vertical photographs are those aerial photographs which are taken when the optical axis of the camera is vertical or nearly vertical. A truly vertical photograph closely resembles a map. These are utilized for the compilation of topographical and engineering surveys on various scales.  Oblique photographs Oblique photograph are obtained when the optical axis of the camera is intentionally inclined from the vertical. An oblique photograph covers larger area of the ground.	**Sketch of Vertical Photograph - 1M** **Explanation of vertical photograph – 2M** **Sketch of Oblique Photograph - 1M** **Explanation of oblique photograph – 2M**	**10 Minutes**

4	<table><tr><th>Accuracy</th><th>Precision</th></tr><tr><td>Accuracy is used to denote the closeness or nearness of a measurement to its true value.</td><td>Precision of a measurement is used to denote its closeness or nearness of to another measurement of the same quantity.</td></tr><tr><td>The measured value is said to be accurate if it is very near to its true value.</td><td>The precision is said to be high if a particular quantity is measured several times and the values obtained are very close to one another</td></tr><tr><td>Accuracy reflects the degree of perfection the measurement.</td><td>Precision reflects the degree of agreement between several measurements of the same quantity</td></tr></table>	**02 Marks for each difference** **(03 x 2M = 06M)**	**5 Minutes**
5	(i) Longitude of A = 79° E; Longitude of B = 32° W Difference of longitude between A and B = 79° – (– 32°) **Difference of longitude between A and B = 111°** (ii) Longitude of A = 126° E; Longitude of B = 14° E Difference of longitude between A and B = 126° – 14° **Difference of longitude between A and B = 112°** (iii) Longitude of A = 43° W; Longitude of B = 25° W Difference of longitude between A and B = 43° – 25° **Difference of longitude between A and B = 18°**	**02 Marks** **02 Marks** **02 Marks**	**10 Minutes**

Part B (3Q x 10M = 30 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
6	**i) Scale of a vertical photograph on Flat terrain**  The scale of a vertical photograph over the flat terrain is the ratio of the photo distance ab to the ground distance AB between the point A and B.	**Figure – 1 M**	**25 Minutes**

Thus, if scale is s then

$$s = \frac{ab}{AB}$$

From similar triangles Oab and OAB,

$$\frac{ab}{AB} = \frac{Op}{OP}$$

$$\frac{ab}{AB} = \frac{f}{H'}$$

or $$s = \frac{f}{H'}$$

Derivation of expression for scale – 3 M

where f = focal length of the aerial camera
H' = Flying height above the ground

ii) Scale of a vertical photograph on variable terrain

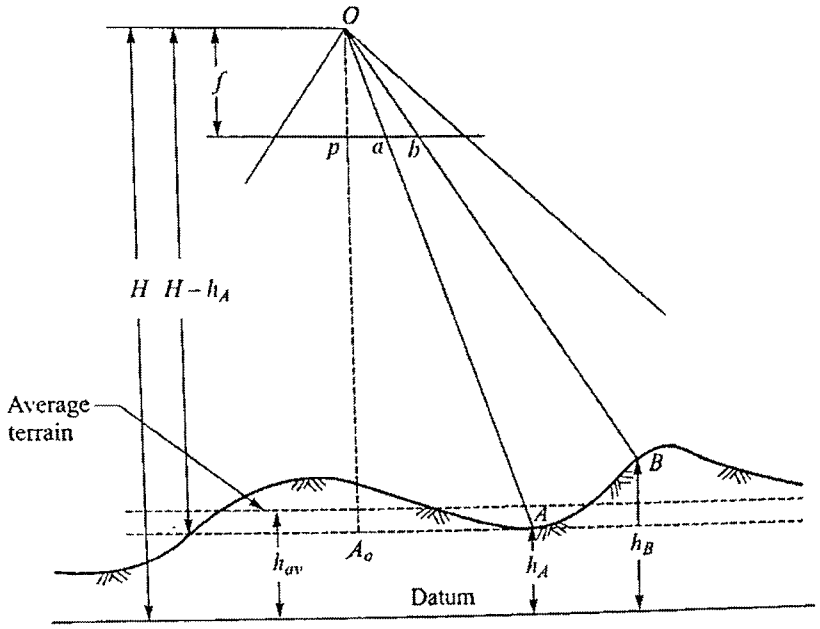


Figure – 2 M

If the terrain varies the object distance H' varies depending upon the elevation of the points. In the above figure, this distance for the point A, having elevation h_A, is (H - h_A), and for the point B having elevation h_B is (H - h_B).

The scale, therefore, varies from point-to-point depending upon the elevation of the points.

If the distance of image, a of A on the photograph from the principal point p is 'pa', the scale at the point A, is given by

Derivation of expression for scale – 4 M

$$s = \frac{pa}{A_O A}$$

From similar triangles Opa and OA_oA, we have

$$\frac{pa}{A_O A} = \frac{f}{H - h_A}$$

$$s_A = \frac{f}{H - h_A}$$

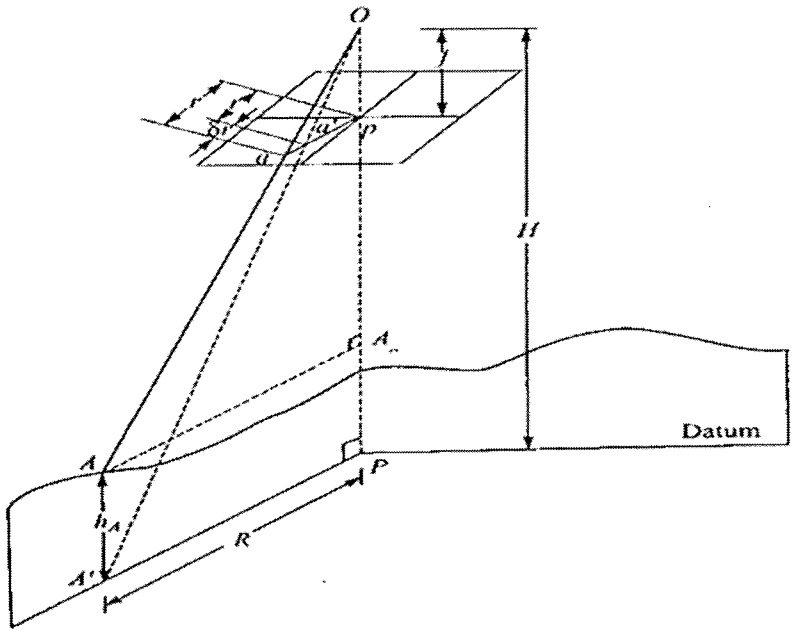
Similarly, at the point B, we have

$$s_B = \frac{f}{H - h_B}$$

In general, at any point having elevation h, the scale is given by

$$s = \frac{f}{H - h}$$

where H = the flying height above the datum.

7	 The shift or displacement in the photographic position of an image caused by the relief of the object, i.e. its elevation above or below a datum, is called relief displacement. The Fig. shows a vertical photograph taken from flying height H above datum. The focal length of the camera is f, and p is the principal point. The image of ground point A, which has elevation of h_A above datum, is located at 'a' on the photograph. An imaginary point A' is located vertically beneath A in the datum plane, and its corresponding, imaginary image point is at a'. Since the lines AA' and OP are the vertical lines, the plane, AaOPA' is a vertical plane, The plane A'a'OPA' is also a vertical plane which coincides with plane AaOPA'. These two planes intersect the photo plane along the lines pa' and pa, respectively. Since the lines pa and pa' are coincident, the line aa', which is relief displacement of point A due to its relief h_A is radial from the principal point. From similar triangles Oap and OAA_o $$\frac{r}{R} = \frac{f}{H - h_A}$$	**Figure – 4 M** **Derivation – 6 M**	**20 Minutes**

	or f. $R = r (H - h_A)$ Also, from similar triangles Oa'p and OA'P $$\frac{r'}{R} = \frac{f}{H}$$ or f. $R = r' H$		
8	Given data: Flying Height, H = 1800m Focal length, f = 15cm = 0.15m The scale at any height h is given by $$s_h = \frac{f}{H - h}$$ (i) Elevation, h = 250 m $$s_{250} = \frac{0.15}{1800 - 250} = \frac{1}{10333.33}$$ **1 : 10333.33** (ii) Elevation, h = 520m $$s_{520} = \frac{0.15}{1800 - 520} = \frac{1}{8533.33}$$ **1 : 8533.33** (iii) Elevation, h = 870m $$s_{520} = \frac{0.15}{1800 - 870} = \frac{1}{6200}$$ **1 : 6200**	**Formula – 1 M** **3 M** **3 M** **3 M**	**20 Minutes**

Part C (1Q x 20M = 20 Marks)

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
9	Ground length, AB = 545 m Elevation of A, h_A = 500m Elevation of B, h_B = 300m Focal length, f = 20 cm Photo distance, ab = 5.112cm x_a = + 2.65 cm, y_a = + 1.36 cm x_b = -1.92 cm, y_b = + 3.65 cm The approximate height can be calculated from $$\frac{f}{H_{approx.} - h_{ab}} = \frac{ab}{AB}$$ $$\frac{f}{H_{approx.} - h_{ab}} = \frac{ab}{AB}$$	**Data – 1 M**	**50 Minutes**

$$H_{approx.} - h_{ab} = \frac{f \times AB}{ab}$$

$$h_{AB} = \frac{500 + 300}{2}$$

$$h_{AB} = 400\ m$$

$$H_{approx.} - 400 = \frac{20\ cm \times 545\ m}{5.112\ cm}$$

$H_{approx.}$ - 400 = 2132.24m

$H_{approx.}$ = 2132.24 + 400

$H_{approx.}$ = 2532.24m

Calc. of approx. flying ht. – 3 M

Using this approximate height, ground coordinates of A and B are calculated

$$X_A = \frac{H - h_A}{f} . x_a$$

$$X_A = \frac{2532.24 - 500}{20\ cm} \times + 2.65cm = + 269.27m$$

$$Y_A = \frac{H - h_A}{f} . y_a$$

$$Y_A = \frac{2532.24 - 500}{20\ cm} \times + 1.36cm = + 138.19m$$

$$X_B = \frac{H - h_B}{f} . x_b$$

$$X_B = \frac{2532.24 - 300}{20\ cm} \times - 1.92cm = -214.3m$$

$$Y_B = \frac{H - h_B}{f} . y_b$$

$$Y_B = \frac{2532.24 - 300}{20\ cm} \times + 3.65cm = 407.38m$$

Det. of Ground coordinates – 4 M

Ground Length AB computed based on the approximate height and the ground coordinates determined using the approximate height is given by

Computed AB = $\sqrt{(X_A - X_B)^2 + (Y_A - Y_B)^2}$

Computed AB = $\sqrt{(269.27 - [-214.3])^2 + (138.19 - 407.38)^2}$

Computed AB = $\sqrt{(269.27 + 214.3)^2 + (138.19 - 407.38)^2}$

Computed AB = 553.45m

However, it is known that actual ground length AB = 545m

Det. of computed length AB – 2 M

	The second approximate height is calculated as follows: $$\frac{H - h_{ab}}{H_{approx} - h_{ab}} = \frac{Correct\ AB}{Computed\ AB}$$ $$\frac{H - 400}{2532.24 - 400} = \frac{545}{553.45}$$ H = 2099.69 + 400 = 2499.69m Using this value of H ground co-ordinates are again computed, $$X_A = \frac{2499.69 - 500}{20\ \text{cm}} \times +2.65cm = +264.96m$$ $$Y_A = \frac{2499.69 - 500}{20\ \text{cm}} \times +1.36cm = +135.98m$$ $$X_B = \frac{2499.69 - 300}{20\ \text{cm}} \times -1.92cm = -211.17m$$ $$Y_B = \frac{2499.69 - 300}{20\ \text{cm}} \times +3.65cm = 401.44m$$ AB = $\sqrt{(264.96 + 211.17)^2 + (135.98 - 401.44)^2}$ AB = 545.13m which agrees with correct length of AB **Therefore, Flying height above mean sea level = 2499.69m**	**Calc. of approx. flying ht. – 3 M** **Det. of Ground coordinates – 4 M** **Det. of computed length AB – 2 M** **Final answer for Flying ht. – 1 M**	