Model Answer

M.Sc. Forestry (First Semester)

Subject: Biometry, Surveying and Engineering

Department of Forestry, Wildlife and Environmental Sciences

Question 1: A. Choose the correct answer

i. The upper part of the tree stem corresponds to the following shape-

a. Cylinder

b**. Cone**

c. Neiloid

d. Paraboloid

ii. The girder theory of taper is explained by-

a. Mr. Chako

b. Mr. Watson

c. Mr. Schiffel

d**. Mr. Metzger**

iii. The basal area of vertically stacked logs are measured from-

a. **Lower portion of the log**

b. Middle portion of the log

c. Upper portion of log

d. Both lower, middle and upper portion of log

iv. When canopy density is between 0.75 to 1.0 than forest will be-

a. Closed

b. Open

c. **Dense**

d. Thin

v. The proportion of mixture of lime : sand : surkhi for foundations of bridge should be-

a. **1:1:1**

b. 1:2:3

c. 1:2:4

d. 2:1:1

B. Fill in the blanks

i. Hartig's formula for volume measurement for the group of trees **V=vXS/s**

ii. The intensity percent of sampling can be calculated by the formula **I= W/DX100**

iii. The Percent of silica in earth for good bricks should **50 to 75%**

iv. Circumference of circle = **2ΠIr**

v. Quarter girth formula= **V= (g/4)2XL**

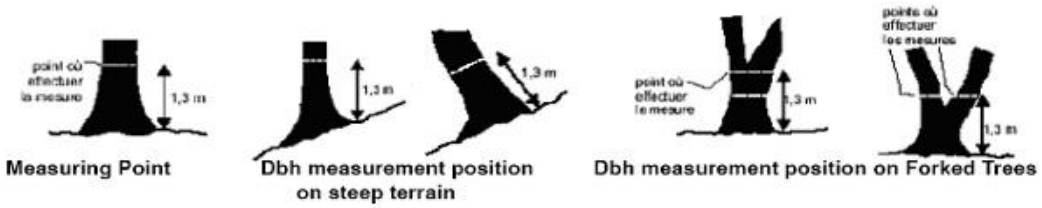
Question 2: What are the standard rules for taking breast height measurement in India? Why we have adopted 1.37m as DBH?

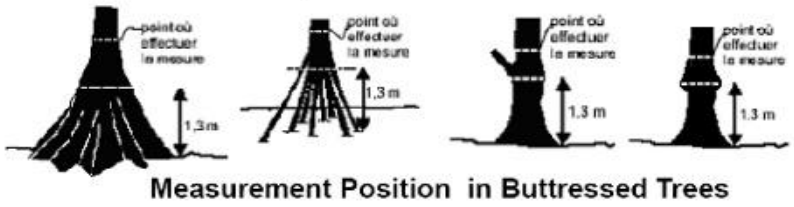
b. What is the advantage and disadvantages of Calliper and Wooden Scale?

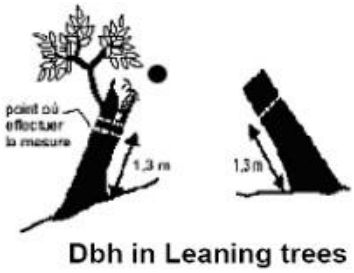
Answer:

Standard rules for DBH

1. Breast height point should be marked by intersecting vertical and horizontal lines 12 cm long, painted with white paint
2. Breast height should be marked by means of a measuring stick on standing tree at 1.37m or 4 ft 6 in above the ground level, but 1.3 (4'3") in case of FAO
3. On the sloppy ground, the diameter at breast height should be measured on the uphill side, after removing any dead leaves or needles lodged there
4. In the case of leaning tree, DBH is measured alone the tree stem and not vertically.
5. Breast height mark should be shifted up or down as little as possible to a more normal position of the stem and then diameter measured if stem is abnormal.
6. Buttress is formed due to edaphic factor so if buttress is seen, the DBH should be taken a little above the buttress formed.



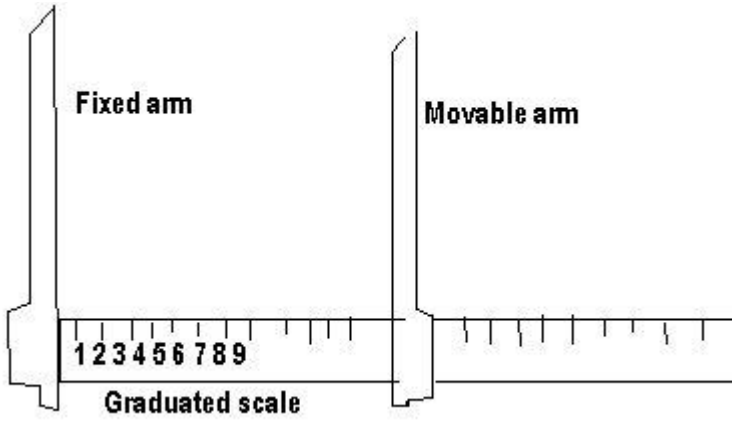




Reason for adapting DBH

1. Convenient height for taking measurement
2. Avoids the fatigue caused unnecessarily
3. Saves extra expenditure from not clearing the base
4. Abnormalities, eg. Root swell, disappear below breast-height
5. Standardizes diameter measurement giving a uniform point of measurement.

B. Advantage and disadvantages of Calliper and Wooden Scale



Advantages

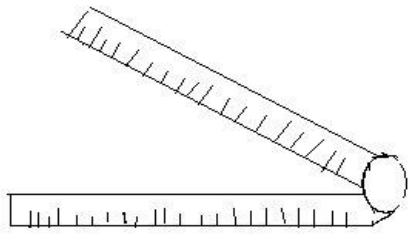
1. Diameters can be reading the directly in cm and mm thus making the instrument applicable for precise scientific work
2. The point's arms touching the tree are always in sight and irregularities if any can be avoided by firmly pressing the arms against the tree bole, the loose swollen bark is crushed out and irregularity from this source is avoided
3. It is adaptable for use by unskilled labor
4. The errors are both +ve and -ve and therefore the chances are that they may neutralize to give more accurate results than the tape which gives only +ve errors.

Disadvantages

1. They are not accurate when not in adjustment
2. Calipers sufficient in size to measure large trees are very awkward to carry and handle.
3. Two measurements have to be taken on every tree to get the correct diameter. In steep hilly terrain, measurement of second diameter in correct orientation is often very difficult
4. Movable arm often sticks when the scale is wet or dirty, thus wasting a lot of time.

Wooden Scale

Wooden scale is a flat wooden piece marked in centimeter and millimeters. It is available in two size 30cm and 60cm. The 30 cm scale is about 3 cm wide but the 60cm scale is about 1.5 cm wide and has folding arrangement at every 15 cm length. The scale is best used in diameter measurement of end sections of logs.



Advantages

1. It is very easy in use even unskilled labour can performed measurements of diameter of felled and standing trees. Direct measurement is taken in both the cross section of the stump.

2. Wooden scale is light weight hence easy to carry in forest area.

3. The diameter should be measured along the passing through pith. In case of eccentric stumps or logs, two diameters, one along major axis and other at right angles to it should be measured easily.

4. Large number of stumps and trees can be measured directly in less time without fatigue.

5. The reading of measurement is taken in front of the eye so there is less chances of error in diameter and height measurement.

Disadvantages

1. The end of the scale gets worn off by continuous use, the measurement may give error when not consider and execute properly.

2. Transport of wooden scale in forest area requires extra care because of chances of breakage especially in rainy season.

Question 3: a. What are the characteristics of good bricks and what field tests would you do to ascertain the soundness of a consignment of bricks delivered on site.

b. Give brief notes on the different types of wooden bridge constructed in forest area.

Answer: a.

Characteristics: Bricks constituted by sand, clay and remaining by lime, manganese, magnesia, oxides of Fe, Na and K. Sand in bricks increases the heat resistance, durability, preserves the shape and prevents shrinkage. Clay imports plasticity while molding and helps in maintain shape and size of the brick. Unwanted things in the bricks are iron pyrites, alkaline materials, pebbles, gravels, stone and straw. Iron pyrites causes splitting of bricks.

Testing of quality of bricks in field condition

1. A good brick should be uniform in size and colour.
2. No fissures, air bubbles and pebbles in bricks are preferable.
3. It should not be broken when fall from 2m height.
4. Bricks should have low porosity and adsorption capacity.
5. Metallic ringing sound can be produced when struck by another brick.
6. It should have plane, rectangular faces and parallel sides.

b. **Different Types of wooden bridge constructed in forest areas**:

1. **Simple wooden bridge:** The most common bridge in the interior forests where plenty of wood is available is wooden bridge. The maximum span of this bridge is up to 6m. Abutments are the masonry pillar or timber poles, which are erected in between the ends to hold the road bearers. Road bearers are the longitudinal beams that carry the load. Planks or round poles are laid side by side on the road bearer. A layer of branch wood or earth laid on this to obtain a smooth surface. Figures may be given.

2. **Super structure wooden bridge**: Super structure of the simple wooden bridge consists of road bearers, decking, wheel guides and haldrails. Road bearers are made of 35 X 35 cm cross section timber. Decking is made up of planks of 8cm, which are nailed and bolted to road bearers. Handrails are provided for preventing traffic, human being and cattle form being falling off.

3. **Trussed girder wooden bridge**:- This bridge is constructed by forming trusses. Wooden girders (Sleeper) are used for this purpose. The top and bottom trusses bear the compressive and tensile stresses of the bridge. Abutments are RCC constructed to give extra strength to the bridge. Timber beam and transom are used to cantilever the bridge from two side of the bank of river.

4. **Timber pole culvert:** It is made up of timber poles of 2m length and diameter of 15-20 cm. One end of the pole is sharpened and covered with iron cap to protect decay of wood. This end is driven in to ground at 1 to 1.2 m intervals in such a way that half of its remain above the road. The top of the culvert is made by placing poles along the direction of the road to rest above these projecting. This top layer is covered with earth or branch 30cm thick. A railing is also provided.

Question 4. a. Following are the observed fore -bearings of the lines AB, BC, CD and DE. Find out their respective back bearings.

$35^{o}.15'$, $151^{o}.35'$, $320^{o}.45'$, $217^{o}.50'$

b. Define chain survey and write about the instruments associated with chain surveying.

Answer :

a. Following are the back bearings of given fore-bearing of the line

Line	Fore bearing	Back bearing
AB	$35^{o}.15'$	215.15

BC	$151^{o}.35'$	331.35
CD	$320^{o}.45'$	140.45
DE	$217^{o}.50$	37.50

b. Chain survey is a linear measurement. In this method, the actual ground is set on a paper by a system of straight lines. These lines are called as chain lines which are prerequisite in chain surveying. This is a convenient method for surveying small areas and open ground with simple details. But it is not suitable where the area cannot be divided into triangles.

Instruments used in chain surveying

1. Chain :-The chain is composed of 100 or 150 pieces of galvanized mild steel wire 4mm in diameter called links. The end of each link are bent into a loop and connected together by means of three oval rings. The ends of the chain are provided with brass handles for dragging the chain on the ground. The length of link is the distance between the centers of the two consecutive middle rings. The end links includes the handles. Metallic tags or indicators are fixed at various distinctive of the chain to facilitate quick reading.

The following chains is used in surveying

a. Metric surveying chains:

The chains are made in lengths of 20 and 30 meters. To enable the reading of factious of a chain, tallies (tags) are fixed at every five meter length and small brass rings are provided at every meter length. To facilitate holding of the arrows in position with the handle, a groove is cut on the out side surface of the handle. The handle joints are flexible. the tallies used for marking the distances in a metric chain are marked with letters 'Me' and 'm'.

b. Steel Band Chain:-It consists of a ribbon of steel with bras handle at each end. It is 20 or 30 long and 16 mm wide. It is wound on an open steel cross or on the metal reel in a closed case. The graduations are etched as meters decimeters, centimeters on one side and 0.2 m links on the other. Brass tallies are fixed at every 5 m length of the band.

c. Günter's Chain:-It is 66 fit long and is divided into 100 links. Each link is 0.66 ft long. It is very convenient for measuring distance in miles and furlongs. Also for measuring area and when the units of area is an acre

d. Revenue Chain:-It is commonly used for measuring fields in cadastral survey. It is 33 ft long and divided into 16 links. Each link is 2.0625 ft long.

e. Engineer's chain:-It is 100 ft long and it is divided into 100 links. Each link is 1 ft in a length. Used in all Engineering surveys.

2. Arrows:-They are also called as marking or chaining pins and are used to mark the end of chain during the process of chaining. They are made up of good quality hardened and tempered steel wire of 4mm in diameter. The arrows are made 400 mm in length. They are pointed at one end of inserting in to the ground. The other end is in to a ring.

3. Tapes:-Used for taking subsidiary measurements, such as offset. It is very light and handy. Tape is available in 1, 2, 10, 30, and 50 meters. The tape is marked with a line at every five millimeters, centimeters, decimeters, and meter.

4. Wooden Pegs:-These are used to mark the positions. They are made of hard timber and tapered at one end. They are usually, 2.5 cm square and 15 cm long. But in soft ground 40 to 60 cm long and 4 to 5 cm square is suitable. They should be driven in the ground with about 4 cm lengths, projecting above the ground.

5. Ranging rods and pole:-Used for making the positions of stations and for ranging. They are made of seasoned timber or steel. They are circular or octagonal in cross section of 3 cm diameter. Lower shoe is 15 cm long. They are made in two sizes as 2 meters and 3 meters and are divided in equal parts each 0.2 m long. They are painted alternatively black and white or red and white. Ranging poles are 4m or more heighted hollow rods used in the case of very long chain lines.

Question 5: a. Classify Volume tables on the basis of outturn and write the steps of preparing local volume table.

b. How Remote sensing helps in resource analysis of forest.

Answer: Volume table is a table showing for a given species, the average contents of trees logs or sawn timber for one of more given dimensions.

Volume table is used to estimate the volume of a given crop. As per the use of volume table it is classified in different way. The outturn given by volume table is given following: -

1. **Standard Volume Table:** These tables give separately the estimated outturn in the form of standard timber, i.e from ground level to the limit of the portion of tree stem or branch where diameter is 20 cm. measured over bark.

2. **Commercial Volume Table:** Volume tables in which contents of round timber are given as volume measured down to a thin end diameter to which conversion is done, the stump volume being omitted. Market requirements decide the minimum limit of exploitation. Scope of applicability is limited.
3. **Sawn Outturn Tables:** Volume tables in which contents of sawn timber are given as volume measured down to a thin end diameter to which conversion is done, the stump volume being omitted.
4. **Assortment Tables:** Volume tables which give volume in round down to various stated thin diameters.
5. **Sawn Outturn Assortment Table:** Similar to assortment tables except they give sawn outturn in the number of standardized pieces instead of volume in round

Preparation of Local Volume Table

The volume table is compiled from the measurements of trees growing in restricted locality.
This is mainly based on one independent variable (dbh). These tables are either prepared directly from field data or derived from general volume table. This can be prepared either method by graphical or regression equation.

Steps for Local Volume Table from General Volume Table

- General VT gives volume of tree by diameter and height classes
- Figures of general volume table are plotted in a graph showing volumes against the middle of diameter classes for each height class separately
- So sufficiently large number of trees are measured and recorded by diameter class
- Diameters and height (measured) are then plotted on the same graph
- Volume derived from GVT against average dia and ht
- Table: dia class against volume prepared
- To prepare graph, a smooth curve is drawn through plotted points
- The curve is the desired local volume curve
- It represents the local relationship between diameter and height
- Based on this curve, volume for diameter classes can be calculated and tabulated as Local Volume Table.

b. How remote sensing helps in resource analysis in forest

The remote sensing technique is now become an important tool in the analysis of forest and other natural resources globally. In India this method is used in forestry in following ways:

1. **Location of forests, their distribution and area:** A map of forests in general and by functional classification in particular is required. In the productive forests, maps of forest areas by forest types, by productivity of sites and by maturity classes, etc are necessary to assess the yield of forests.
2. **Growing stock in the production forests:** Inventory of trees by species and by diameter classes is required. These aids in estimating volume by location so that management plans could be drawn or industrial plan may be prepared.
3. **Information about various factors affecting production:** The information on site, diameter and height, increment, age, timber quality and also about areas where new forests could be raised is necessary.
4. **Forest cover mapping:** It is carried out either by visual interpretation or digital interpretation method. In India Forest Survey of India monitors and map country's forest cover on biennial basis. The forest vegetation is further categorized into dense forest, open forest, mangrove, scrub etc. On the basis of use of satellite data different images are taken and all images are mosaiced and vegetation map at different level is prepared.
5. **Assessment of change in forest cover:**
6. Forest density determination
7. Detection of density change
8. Forest fire mapping
9. Habitat evaluation
10. Land degradation mapping
11. Soil resource mapping and land use cover
12. Watershed management

Question 6: Write Short notes on the following instrument used in biometry-

a.Site quality

b. Forest map

c. Abney's level

d. Random sampling

Answer a. Site quality: Site is complex of physical and biological factors of an area that determine what forest or other vegetation it may carry.

The productivity of a site for tree growth is usually evaluated on a stand basis. Site quality expresses the average productivity of a area for growing forest trees.

A common way of expressing relative site quality is to set up from three to five classes, or ordinal ranks, such as site I, II, III and IV.

Site Quality can be evaluated by following factors:

A. Determination by evaluation of site factors

B. Determination by evaluation of vegetation factors

Factors which affect site quality are:

i. Rainfall

ii. Humidity

iii. Climate

iv. Topography

Site quality can be calculated with the help of

CVP= TM/Ta X PXL/12 X E/100

b. Forest Map:- Forest map is a representation of the whole or part of the earths surface in miniature. Forest map are usually made in different scale depending upon its use.

Characterstics

1. All objects in the map are in the same relative position as on the ground.
2. All angles between the lines drawn on the map are equal to the angles between corresponding lines on the ground.
3. Each map has specific scale.
4. Information in the map is depicted in the form of signs or symbols.

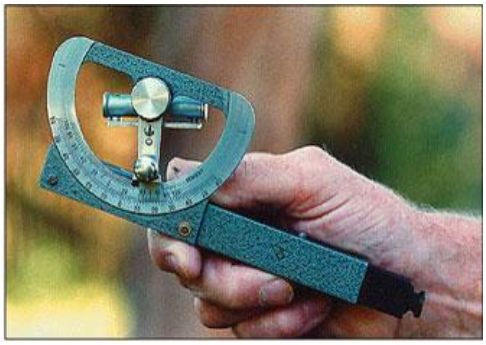
Utility

1. Map helps in the undertaking a forest survey.
2. It establishes a pattern of ground sampling.
3. It helps the field staff to locate the areas selected for sampling.
4. It act as a base map for many other map preparation.
5. It helps in laying out forest roads and other engineering works.

c. Abneys level: This is an instrument used in height and elevation measurement in forestry. It consist a hollow tube with an eye piece at one end and a short sighting tube fitted at the other.

Eye piece consists of 2 or 3 telescopic hollow tubes and a sighting tube is a small detachable tube fitted with a horizontal wire at the centre. A mirror behind the horizontal wire covering only half of the tube so fitted that it makes 45°. A spirit level is fitted to the main tube, which can be rotated by one screw. Wheel is for quicker movement and screw is for final adjustments.

An index arm is also attached to the spirit level. As the spirit level rotated, index arm moves on a graduated semi-circular arc. As the angles of elevation and depression are needed, graduation in degrees up to 90^0.



Advantages

- It gives accurate angle of elevation and depression.
- The instrument is small and light and can be used even in hills without difficulty.

Disadvantages

- Shaking of the hand makes the sighting of the top and bottom of the tree a little difficult and time-consuming.
- Sprit level needs adjustment , which is quite tiresome

d. **Random Sampling**: This is defined as process of partial enumeration that the sample units are selected in such a way that each and every unit of the population has an equal and independent chance of being selected in the sample.

Selection technique

1. Lottery method - Lotto
2. By random no. table method - Bingo

   Types of random sampling

i. Simple random sampling

ii Stratified random sampling

Merits

- Scientific method and no. bias
- Estimation methods are simple and easy

Demerits

- If sample chosen is widely spread, takes more time and cost
- A population frame or list is needed
- For a given precision, it usually requires larger sample size.

Question 7: a. What observations did Metgzer's reported for higher wood volume accumulation at the base of the tree.

b. What is the technique for the calculation of solid wood volume?

Answer a. **Metzger's or Girder Theory**

This theory explains the variation in taper from tree to tree. Metzger, a German Forester first proposed this theory. The salient feature of the theory is as follows:-

1. The tree stem works as cantilever beam of uniform size against the bending force of the wind
2. The stem of the tree is built in such a way with minimum of material, to offer uniformly the greatest resistance to the stress to which it is subjected.
3. The wind pressure acts on the crown and is conveyed to the lower part of the stem in an increasing pressure with the increasing length of the bole. Thus the greatest pressure is exerted at the base and there is a danger of tree snapping at the place.
4. To counteract this tendency, the tree reinforces along the tree stem so that it affords a uniform resistance all along its length to the pressure
5. As the pressure is in the upper part of the tree is less, due to smaller length of lever in that portion it is allocated lesser growth material than lower part where the pressure gets increased with increased length of bole.
6. The pressure of wind on crown keeps on changing as the tree is growing in open or crowded portion. Trees growing in complete isolation have larger crowns and so the pressure exerted on them is the greatest.

b. Technique for the calculation of solid wood volume: Stacked volume of wood is not the actual volume of solid volume of wood or fuel wood stacks. Therefore the value of fuel is based on the solid content. The solid volume of firewood depends upon the factors such as stacking, form of billets, length and diameter of the billets. The solid volume of wood can be assessed by any one of the following:

(i) Xylometric method: Xylometer is a graduated vessel and volume of wood is calculated by the principle of water displacement. The wood piece is submerged in the water in the vessel. The volume increment in the vessel gives the actual solid volume of wood. As the stack volume is huge, a sample portion is utilized and the results extrapolated for the whole log using the formula:

$$V = W \times v/w$$

Where W is the weight of whole stack, w- weight of submerged pieces, V- volume of the whole stack, v- volume of sample taken.

(ii) Specific gravity method: The fuel wood weight is calculated by using the relationship between the specific gravity and volume of wood.

Volume= weight /Specific gravity