UNIVERSITY OF ILORIN

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING

FACULTY OF ENGINEERING AND TECHNOLOGY







LABORATORY MANUAL (UNDERGRADUATE)

(ABE COURSES)

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2020-2024

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
FACULTY OF ENGINEERING AND TECHNOLOGY

LIST OF LABORATORY EXPERIMENTS

a) **ABE 206:Introduction to Agricultural Engineering Discipline**

Laboratory 1: Identification and specification of agricultural tractors
Laboratory 2: Identification and specification of agricultural implements and equipment
Laboratory 3-5: Tractor driving
Laboratory 6-7: Maintenance and trouble shooting
Laboratory 8: Coupling and uncoupling of implements for field use and transportation
Laboratory 9: Tillage operations
Laboratory 10-11: Planting, fertilizer and chemical applications
Laboratory 12: Some tractive parameters of selected agricultural tractors
Laboratory 13: Field efficiency determinations: Tillage operations.

b) **ABE 308: Agricultural and Biosystems Hydrology**

Laboratory 1: Visit and study of a standard meteorological station
Laboratory 2: Development of computer programmes to estimate evapotranspiration
Laboratory 3: Determination of hydraulic conductivity of soils by the auger hole method.
Laboratory 4: Determination of empirical synthetic hydrograph parameters for a watershed.

c) **ABE 314: Agricultural Power & Machinery**

Laboratory 1: Study of engine models and designs
Laboratory 2: Study of engine accessories
Laboratory 3: Fuel systems- Operation and Maintenance
Laboratory 4: Lubrication & Cooling systems - Operation and Maintenance.
Laboratory 5: Determination of soil properties related to tractive performance of Agricultural tractors
Laboratory 6: Analytical determination of the draw bar pull of a given prime mover.
Laboratory 7: Performance appraisal of a 2-wheel drive tractor
Laboratory 8: Performance evaluation of nozzle sprayers.

d) **ABE 411: Irrigation and Drainage Engineering**

Laboratory 1: Staking an irrigation channel
Laboratory 2: Irrigation Water Measurement using weirs, Parshali flume and float
Laboratory 3: Determination of the conveyance efficiency of an irrigation head ditch
Laboratory 4: Field calibration of siphon tubes used for conveying irrigation water from the field channel to the plot.

(e) **ABE 417: Agricultural Structures and Environmental Control**

Laboratory 1: Concrete slump test
Laboratory 2: Bar shrinkage test
Laboratory 3: Estimation of Heal loss/Gain from a building
Laboratory 4: Visit to Livestock Farms In and Around Ilorin.

f) **ABE 415: Agricultural Land Surveying**

Laboratory 1: Chain surveying
Laboratory 2: Closed compass traversing
Laboratory 3: Leveling - Longitudinal section
Laboratory 4: Leveling - Cross section; earth work computation
Laboratory 5: Contour mapping
Laboratory 6: Theodolite traversing
Laboratory 7 Tacheometric mapping

g) **ABE 423: Design of Agricultural Machinery**

Laboratory 1: Mechanism illustration study
Laboratory 2: Schematics and calculations of Working Parts of (Grass crop) cutting machine
Laboratory 3: Cam layout problem
Laboratory 4: Trajectory experiment

h) **ABE 503: Transportation Systems for Agricultural and Rural Development**

Laboratory 1: Farm transport Productivity studies
Laboratory 2: Farm transport productivity studies
Laboratory 3: Determination of a farm road-waytrafficability
Laboratory 4: Analysis and design problem of a farm transport device.

i) **ABE 504: Agricultural Land Clearing and Development**

Laboratory 1: Taking tree counts
Laboratory 2: Measurement of tree diameter
Laboratory 3: Measurement of soil resistance to penetration
Laboratory 4: Machinery and equipment selection for agricultural land clearing and development

j) **ABE 507: Application of Electricity to Agricultural and Biological Systems**

Laboratory 1: Power Generation
Laboratory 2: Power Distribution
Laboratory 3: Specification and maintenance of electric motors
Laboratory 4: Electrical controls - Time switch

k) **ABE 514: Agricultural Power**

Laboratory 1: Measurement of slippage of traction devices in soils during farm operation
Laboratory 2: Tractor repair - bleeding of the fuel system
Laboratory 3: Laboratory study of the farm tractor
Laboratory 4: Identification and use of hydraulic controls.

l) **ABE 516: Agricultural Machinery**

Laboratory 1: Field performance evaluation of Implements and equipment I: Field capacity
Laboratory 2: Field performance evaluation of implements and equipment II: Field efficiency
Laboratory 3: Calibration of row crop planter
Laboratory 4: Measurement of soil compaction.

m) **ABE 522: Agricultural Land Drainage**

Laboratory 1: Design of drainage filter
Laboratory 2: Design of a drainage project

n) **ABE 524: Advanced Irrigation Engineering**

Laboratory 1: Determination of Irrigation water quality
Laboratory 2: Determination of soil Intake (Infiltration) characteristics using a double ring infiltrometer
Laboratory 3: Determination of soil intake characteristics by the inflow-outflow method.
Laboratory 4: Evaluation of a sprinkler irrigation system

o) **ABE 523: Rural Water Supply and Sanitation**

Laboratory 1: Determination of turbidity and odour of water
Laboratory 2: Measurement of solids in water
Laboratory 3: Determination of dissolved oxygen in water
Laboratory 4: Determination of Biochemical Oxygen Demand (B.O.D.) of sewage Effluent

p) **ABE 527: Advanced Hydraulic Engineering**

Laboratory 1: Study of turbulent flow in rough pipes
Laboratory 2: Determination of roughness coefficient for an open channel
Laboratory 3: Determination of the characteristic curves of a centrifugal pump
Laboratory 4: Development of computer programme for computing and plotting gradually varied flow in open channels.
Design project I: Design of gully control structures
Design project II: Irrigation project design

q) **ABE 528: Soil and Water Conservation Engineering**

Laboratory 1: Determination of the kinetic energy and erosivity indices of rainfall
Laboratory 2: Tour of an erosion site
Laboratory 3: Survey of a soil erosion site
Laboratory 4: Staking of a contour in the field.

r) **ABE 533: Engineering Properties of Agricultural and Biological Materials**

Laboratory 1: Physical properties of agricultural products I: shape and size
Laboratory 2: Physical properties of agricultural products II: volume, density and surface area.
Laboratory 3: Physical properties of agricultural products III: Angle of repose and angle of internal fiction
Laboratory 4: The planimeter
Laboratory 5: Using the planimeter for area measurements.

s) **ABE 535: Handling of Agricultural and Biological Materials**

Laboratory: Site visits and presentation of results
Design project I: Design of belt conveyors
Design project II: Design of screw conveyors
Design project III: Design of bucket elevators
Design project IV: Design of pneumatic conveyors

t) **ABE 536: Processing of Agricultural and Biological Materials**

Laboratory 1: Determination of finess modulusand modulus of uniformity for feed.
Laboratory 2: Air screen cleaner
Laboratory 3: Efficiency of shelling

u) **ABE 537: Bioprocess Engineering**

Laboratory: Site visits and presentation of results
Design project: Design of biogas digesters

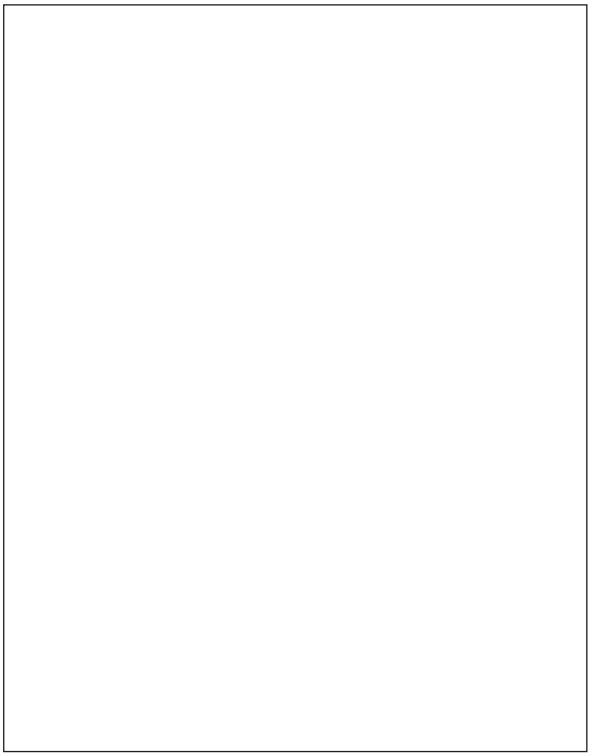
v) **ABE 538: Storage of Agricultural and Biological Materials**

Laboratory: Site visits and presentation of results
Design project: Design of silos

w) **ABE 554: Bioenvironmental Engineering**

Laboratory: Site visits and presentation of reports.
Design project: Design of waste treatment plants

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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INFORMATION ABOUT THE STUDENT

Name: _____

Matric No: _____

Level: _____

Phone Number: _____

Email Address: _____

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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PROCEDURE FOR THE CONDUCT OF EXPERIMENTS

ABE 206: Introduction to Agricultural Engineering Discipline

PRACTICAL 1
Title: Identification and specification of agricultural tractors.
Objectives:
To acquaint students with methods of

a) Identifying and categorizing agricultural tractors and machinery.
b) Accessing information from agricultural engineering handbook manuals
c) Specifying and selecting agricultural tractors

Theory: Agricultural tractors are designed for different purposes; land clearing and development, farm layout and operations etc.

Agricultural implements are units designed to perform specific agricultural operations: They are either self-propelled or by tractors or a combination of both. .

There is need for Students to be familiar with the different categories of farm tractors and implements, the: power ratings and how they are matched with various sizes of attachments (implements)or power units (tractors)

Agricultural Tractors
Equipment

1. Agricultural tractor
2. Agricultural Engineering handbooks
3. Tractor manuals and catalogues

Procedure

(1) Identifying and classify tractors (as supplied) in terms of:
- i) Make
- ii) Model
- iii) Year of manufacture (if known)
- iv) Power rating – drawbar power and brake power
- v) Ignition system
- vi) Total static (and dynamic) weight
- vii) Number of gears – forward and reverse
- viii) Wheels – front, drive, track type
- ix) Tyre sizes – front, rear
- x) Tyre inflation pressure
- xi) Location of engine
- xii) Power outlets – P.T.O., Belt, Drawbar, Traction wheels
- xiii) Implement hitch location: front of tractor, rear of tractor, Hitch category – cat. I, II, III, etc.
- xiv) Implement hitch type: 3-point, drawbar, 3-points and drawbar, others
- xv) Fuel system – diesel, petrol

xvi) Steering system – mechanical, hydrostatic/power steering
xvii) Wheel base
xviii) Treat

(2) Make reference to agricultural engineering handbooks, ASAE standards, tractor manuals and catalogues.

Results: Tabulate the above information for each category of tractors: wheeled (2-WD and single axle), track type

Discussions and conclusions

1. Comment on the design of traction device and use for each tractor
2. Relate the tractor weights totyre sizes and engine ratings.
3. Make other reasonable deductions on your observations,

PRACTICAL 2

Identification and specification of agricultural implements and equipment

Equipment

1. A disk plough (3 disks)
2. An offset disk harrow
3. A two-row planter
4. A two-row fertilizer applicator

Procedure

Identify and classify the implements and equipment in terms of

i) Make
ii) Model
iii) Year of manufacture
iv) Number of disks
v) Diameter of disk
vi) Gang components
vii) Number of units on tool bar
viii) Capacity
ix) Size or width covered per pass
x) Type of metering device
xi) Number of possible metering rates
xii) Quantity delivered from opening per pass
xiii) Gauge wheel size and pressure
xiv) Hitch type (3-point, drawbar etc.)
Hitch category (cat. I, II, III etc.)
xv) Prime mover type
xvi) Results: Tabulate the above information for each implement/equipment
xvii) Discussions and conclusion
xviii) Discuss method of adjusting each equipment/implement prior to and during field operations
xix) What are the special requirements for each?
xx) How is the rate of work influenced by selection of each equipment or implement

PRACTICAL 3 - 5
Title: Tractor driving

Objectives:
1. To acquaint students with all safety rules (and highway codes) governing the operation of tractors.
2. To train students on the operation of the agricultural tractor

Theory:
The success of a field operation is governed by the appropriate use of tractor and other prime movers. Tractors are mainly operated in the field but are sometimes driven on the highways. There is need to be familiar with and obey all the highway codes. This laboratory attempts to highlight guidelines for operating agricultural tractors and the accompanying safety rules.

Equipment
1. Agricultural tractor
2. Tractor manual
3. Highway code
4. Agricultural Engineering handbooks

Procedure
1. Make initial checks before operating tractor
   a) check engine oil level
   b) check water level in radiator
   c) check battery water level
   d) checkfuel

2. Take necessary pre-starting precautions like:
   a) Making sure the gears (main and auxiliary) are in the neutral position before starting engine
   b) Making sure there is no obstacle in front of tractor.

3. After starting the engine allow it to run briefly and check the indicator lights on the panel to see if there isany warning light on. If there is any warning (oil, battery, temperature etc.) Switch off engine and rectify asappropriate.

4. a) Engage the gears, startingwithlow speed and high torque gears,
   a) Release the hand brake
   b) Ease off the clutch pedal gradually until tractor starts off.
   c) Make sure you do NOT release the clutch pedal in a single swift motion else the tractor will jerk
   and stall.

5. Drive and maneuver around thefield at low speeds. DO **NOT** ACCELERATE EXCESSIVELY.

6. Stop the tractor by applying the brakes.
7. Shift the main gear lever to the reverse position
8. Gradually ease off the clutch pedal until the tractor moves backwards.
9. Stop the tractor by applying the brakes
10. Return the gears to the neutral positions
11. Apply the hand brake
12. Cut off the engine.

I SAFETY PRECAUTIONS

1. If you acquired a new tractor, keep it on light work for the first 25- 48 hours. Avoid labouring the engine.
2. Don't operate the **independent foot-brake** when travelling at high speed.
3. Don't run on the highway without locking the foot-brake pedals together.
4. Don't wear loose doming near moving partsof a tractor, engine or implements.
5. Do not attemtp to start the engine in gear.
6. Do not run the P.T.O. or belt pulley (if any) without a guard.
7. Do not leave the starter key in the tractor unattended.
8. Do not swerve to turn sharply on high speed.
9. Do not press the clutch pedal suddenly on a slope or brake fiercely while running down hill.
10. Do not use differential lock on the public highway
11. Do not make a sharp turn unless the differential lock is out of engagement.
12. Do not operate the tractor on dangerously steep ground. Be cautious on steep slopes, slopes, realizing that thesudden swing of a heavy implement or the pull of a tractor can cause trouble. Use clutch brakes, throttleand steering cautiously.
13. Do not carry passengers on the tractor or linkages.
14. Do not turn with a projecting implement without making sure there is enough room for it.
15. Do not hitch trailed implements above the **centerline** of the rear-axle.

MORE HINTS ON STARTING AND STOPPING

	Procedure	Explanation
1.	Pre-starting checks	Check water, fuel and Crankcase oil levels. Disengage clutch, set brakes. Put gears inneutral, make visual observations on the tractor.
2.	Switch on the engine	This controls the starting circuits. Some diesel tractors do not use a switch in the starting circuit.
3.	Fuel cut-off in	The T-handte or choke button type control shuts off fuel when pulled out
4,	Set the throttle halfway	
5.	Start the engine	The starter control may be on the switch, a burton or a push-pull control.

6.	Check oil pressure Engage the clutch	If the oil pressure does not come up to ' normal, stop the engine and locate the trouble. :
7.	Warm up the engine	Load should not be applied until the engine is warm.
8.	Release brakes before moving	Control tractor speed by gear selector and operate the engine at full throttle
9.	Stop engine by closing the throttle and pulling fuel cut-off	
10.	Switch off the engine (if necessary).	

ATTRIBUTES OF A GOOD DRIVER

A good driver:

1. Keeps his tractor clean
2. Completes the daily service at close of work
3. Enters up the log-book daily at close of work
4. Checks oil pressure and ammeter reading when starting the engine
5. Listens for any unusual noise from the engine
6. Reportsimmediately any defect(s) he cannot correct himself
7. Does NOT allow ANYONE to ride on his tractor or implement
8. Does not pull anything by the TOP LINK
9. Does not, wear long, loose clothing
10. Keeps his fuel and containers clean
11. Allows no lights or smoking near his tractor when refueling
12. Knows the correct hours to change engine oil, filters, etc.
13. Knows when to service the air cleaner
14. Uses, the right grade of oil for his services
15. Keep the tyres at correct pressures
16. Does not allow unauthorized persons to make adjustments on the tractor
17. Does not touch the diesel fuel injection pump or the injectors
18. Keeps spare filters, fan belts and hoses
19. Obeys the Highway Code at all times
20. Takes pride in his work.

Results and Discussions

1. Describe step by step procedures of starting a tractor
2. Describe the procedure in (1) for the automobile
3. Compare and contrast the procedures in (1) and (2)
4. List and explain the precautions to take in starting and stopping a tractor
5. Discuss the highway codes as relevant to tractor operation.

PRACTICAL 6-7

Title: Tractor maintenance and trouble shooting

Objectives

1. To acquaint students with maintenance methods
2. Fault finding and minor repairs
3. To acquaint student with the tractor maintenance kit and charts.

Equipment

1. Agricultural tractor
2. Maintenance kits
3. Maintenance charts
4. Tractor manuals

Theory: Tractor Trouble shooting

To manage your tractor well, you must know it well. You should be able to find the cause of any operating trouble quickly and remedy the trouble promptly.
Look first for the most probable cause of the trouble. You will be a better operator if you learn the causes of trouble and know how to remedy them. Here is a list of such troubles. The usual causes for the first two ire given and the remedy is obvious.
Through class discussions, from your own experience and by conferring with tractor users, complete the list, stating the common causes of each trouble.

a) Engine is difficult to start or fails to start
   - i) Ignition switch off
   - ii) Lack of fuel in tank or carburetor
   - iii) Poor fuel-water in fuel-distillate left in carburetor
   - iv) Poor or weak part
   - v) Spark plugs dirty or out of adjustment
   - vi) Defective insulation on spark plug cables
   - vii) Poor compression-valves not seating well
   - viii) Excessive choking
   - ix) Throttle closed

b) Engine misses or runs irregularly
   - i) Carburetor adjustment wrong
   - ii) Irregular or weak spark
   - iii) Spark plugs dirty or out of adjustment
   - iv) Ignition wiring and spark plugs-cables defective
   - v) Leaks in manifold gasket – or carburetor outlet gasket
   - vi) Valves not operating properly
   - vii) Poor fuel or water in fuel

c) Engine stops
   i) ……..
d) Engine backfires through the carburetor
   i) ……..
e) Engine overheats
   i) ……..
f) There is firing in exhaust pipe or muffler
g) Engine knocks
h) There is rapid oil dilution
i) There is smoke at exhause pipe
j) Clutch slips
k) Clutch does not disengage properly
l) Gears are difficult to shift
m) Brakes do not hold well

Procedure

Tractor maintenance: Turning on the tractor

Your tractor is probably your largest investment in equipment and most other machines depend on it forpower. So throughout the year it must be ready to go. This requires good maintenance. The following are somemaintenance methods:

a) Get specifications, measurements and manufacturer's recommendations such as, spade plug gaps, type,size; valve stem clearance measurement; location of ignition timing marks; free play for brake pedal; fuelsrecommended; oils and lubricants recommended lubrication chart and instructions; fen belt tension: ratedrevolutions per minute for engine crankshaft, belt pulley and P.T.O.

b) Test compression

Warm up engine and test compression of each cylinder separately. Remove all spark plugs from cylinders except the one being tested. Crank engine by hand and note resistance (compression). You will get a better result with a compression gauge.

c) Adjust the valve clearance
d) Inspect and adjust ignition system
e) Lubricate the tractor thoroughly
f) Service the fuel and carburetion system
g) Service the electrical equipment
h) Service the cooling system
i) Service the hydraulic system
j) Check tyre pressures

Results and discussions

1. Complete the trouble-shooting list based on experience gained during the laboratory session
2. List the procedures involved in all tests carried out during the laboratory session
3. List and sketch all items in a standard tractor repair kit.
4. Discuss the layout of the tractor maintenance chart supplied

PRACTICAL 8

Title: Coupling and uncoupling of implements for field use and transportation.

Objectives

1. To acquaint students with procedures for coupling and uncoupling farm implement for field use andtransportation
2. To acquaint students with the precautions to be taken when using the tractor hydraulic three point hitch.

Theory

The tractor as a main power source on the farm is not used independently most of the time.

A wide range of agricultural implements are coupled with, the tractor to carry out several different operations on the farm.

Examples of implements that can be coupled with the tractor are ploughs, ridgers, harrows, harvesters, planters and fertilizer applicators which are mainly coupled through the tractor three point linkage. However some very heavy machines (mostly trailing types) are coupled through a single drawbar point on flic tractor.

Equipment

1. Agricultural tractor
2. Plough, harrow or any implement with three point links
3. Tractor operation manual

Procedure

1. Start tractor away from the implement
2. Reverse tractor slowly to the point where implement is located. Make sure you align tractor hitch pointswith those on the implement.
3. Stop tractor when the hitch points on tractor and implement coincide or approximatelycoincide. (DONOT CRUSH IMPLEMENT WITH TRACTOR)
4. Get down and couple the implement in the order left-right-top link or right-left-top link as appropriate. It isadvisable to start with the link that is not adjustable, for obvious reasons.
5. Uncouple implement

Results and discussions

1 Discuss the order of coupling for the implement supplied

2. List precautions to be taken when coupling implements.

PRACTICAL 9

Title: Tillage operations

Objectives

1. To use the tractor coupled with tillage implements for tillage operation.
2. To acquaint students with various implement controls on the tractor.

Theory

A very important field operation on the farm is soil tillage. There are a wide range of tillage machines most of which are coupled with the tractor in order to cover more area and save time. Ploughs and harrows arc popular tillage implement:

1. Agricultural tractor
2. Plough harrow as supplied

Procedure

1. Couple plough to the tractor (Mow procedures in Practical 8)
2. Raise implement and drive tractor into the field
3. Drop the implement at the starting point with the aid of the controls on tractor
4. Move off and visually observe as you plough along
5. Lift or drop implement as appropriate in order to plough deep enough or not too shallow
6. Raise implement at the end of field and turn
7. Repeat (3) to (6)

Results and Discussions

1. Describe your experience when you drive the tractor with the implement
   a) Raise
   b) Engaged in the soil
2. Explain the forces felt at the steering wheel
3. Describe the use and operation of the Draft and position controls.

PRACTICAL 10 - 11

Title: Planting, fertilizer and chemical applications.

Objectives

1. To use the tractor coupled with a planter far planting and with a fertilizer applicator for the application of fertilizer.
   A planter will be used in the first session (Practical 10) while a fertilizer applicator will be used in fee nextsession (Practical 11). The procedures remain the same.

Theory

A tractorised planter and fertilizer application increases the rate at which the seeds or fertilizer are applied into the soil, it also reduces the drudgery associated with manual planting and fertilizer application. There are several types of these planters and fertilizer applicators. There are several types of these planters and fertilizer applicators. There is also a combination of planter and fertilizer applicator as a single machine. Many of these machines are manufactured with the standard three-point hitch to facilitate coupling with agricultural tractors.

Equipment

1. Agricultural tractor
2. Planter
3. Fertilizer applicator

Procedure

1. Fill the hopper with seeds or fertilizer according to manufacturer specifications.
2. Couple implement to tractor (follow procedures in Practical 8)
3. Raise implement and drive tractor into field
4. Drop the implement at the starting point using tractor hydraulic controls
   Move off and visually observe as you apply the seeds or fertilize.
5. If rate or mode of application is not satisfactory, make necessary adjustments on planter (fertilizer
   applicator).
6. Continue work lifting or dropping the implement to required depth for planting or fertilizer application
7. Raise implement at the end of field and turn

Results and discussions

1. Explain the differences in using a planter (or fertilizer applicator) and a plough with the tractor for field operations
2. Explain the observations made on the planter each time it is raised
3. Explain why the implement must be raised when turning at the end of the field.

PRACTICAL 12

Title: Some tractive parameters of cited agricultural tractors.

Objectives

1. To identify some parameter is that influence tractive performance of selected agricultural tractors.
2. To understudy their definitions and applications.
3. To determine the parameters by measurement and by calculation.

Theory:

Ability of a tractor to perform its function efficiently is governed by the amount of (engine) power it isdesigned to supply and the amount mat can be made available at the point of use. There is need foragricultural tractors to overcome power losses (at the traction wheels) at soil-wheel interface. These include drive wheel or track slippage, travel reduction, belt slippage stability factor rolling resistance, travel ratio, to mention a few.

Equipment

1. A 2-WD agricultural tractor
2. A single-axle agricultural tractor
3. Measuring tape
4. Known weights/loads
5. Agricultural implements

Procedure

Define the following terms as used in traction studies

i) Rolling circumference
ii) Rotting radius
iii) Travel ratio
iv) Known reduction (slippage)
v) Stability factor
vi) Belt slippage

Results:

1. Determine the following experimentallyor empirically:
2. Rolling circumference
3. Rolling radius specified zero conditions,
4. Travelratio
5. Travel reduction
6. Stability factor
7. Belt slippage

Discussion and Conclusion

1. Comment on the problems encountered in the determination of each item under Results.
2. How can these problems be remedied?
3. What logical deductions can you make from your determinations that could improve the tractive
performance of agricultural tractors?

PRACTICAL 13

Title: Field efficiency determinations; Tillage operations Objectives:

Objectives:

1. To determine time losses during tillage operation
2. To determine field efficiency of tillage operation

Theory

Time studies have been made by a number of investigators to determine field efficiencies.Detailed time studies involve the continuous observation and timing of each activity involved in the field operation.
Field efficiency has been defined as the ratio of the actual time utilized in doing the weak to the total timespend on the field.

$$i.e\ E_f = \frac{time\ spenton\ actual\ job}{total\ time\ spent} \times 100\% \qquad \ldots\ldots\ldots\ldots\ (1)$$

$$= \frac{time\ spenton\ ob}{time\ spenton\ actual\ job + time\ losses} \times 100\% \qquad \ldots\ldots\ldots\ldots\ldots(2)$$

Time losses that could be recorded for a tillage implement are:

(i) Turn at row ends
(ii) Idle travel
(iii) Cleaning of blades
(iv) Other down time

These losses reduce field efficiency.
Typical field efficiencies already analyzed by investigators are:

Most tillage operations	-	75-90%
Drilling (planting) row crops	-	60-80%
Combine harvesting	-	65-80%
Picking com	-	55-70%
Cottonpicking	-	60-75%
Spraying	-	55-65%

(Source: Principles of Farm Machinery by Kepner, Bainer and Beiger.)

Equipment

1) Agricultural tractor
2) Disk plough
3) Stop watch
4) Surveyor's tape

Procedure

1) Measure out a hectare of land on the field
2) Choose a definite pattern of ploughing the field
3) Drop implement at the start of ploughing and time the following activities:

i) Timing at row ends
ii) Idle time (e.g. stops in between ploughing)
iii) Declogging of blades (if necessary)
iv) Adjustments
v) Other clown time.

Results Discussions

1. Complete the following
   Name of tillage implement……..
   Areaof field (ha) ……
   Average speed of tractor during actual ploughing …….
   Width ofmachine (in) ……
   Actual width used on field……..

2. Complete the table

Activity	Time spent (minutes)
Idle time	
Cleaning or delogging	
Adjustments	
Other down time	
Actual ploughing	
Total	

i) Determine the total time spent on field per hectare
ii) Determine the timelosses per hectare
iii) determine field efficiency using equation (1) or (2)

ABE 308: Agricultural and Biosystems Hydrology
PRACTICAL I

Title: Visit and study of a standard meteorological station

Objectives:

1. To familiarize the students with a typical meteorological station and the equipment for gathering meteorological data,
2. To acquaint the students with the procedures for gathering, processing, and recording of routine meteorological data.

Procedure

1. A study tour of the meteorological station at Ilorin airport shall be undertaken.
2. Students are expected to submit written reports on the tour, describing the layout of the equipment in thestation. The procedures for data generation, processing and recording shall also be described for eachequipment,

PRACTICAL 2

Title: Development of computer programmes to estimate evapotranspiration

Objectives

1. To acquaint the students with the various methods used for estimating potential evapotranspiration
2. To re-inforce their ability to use the computer

Procedure

1. Review the theory and other details involved in about 25-30 methods used for estimating potentialevapotranspiration.
2. Assemble the climatic data required for each of the methods.
3. Write a computer programme to compute ET from all the equations.

ResultsDiscussion and Conclusion

1. Discuss the results in general and compare the results of the various methods.
2. Draw .your conclusions and make some recommendations.

PRACTICAL 3

Title: Determination of hydraulic conductivity of soils by the auger hole method.

1. To became familiar with at least one field method of determining hydraulic conductivity.
2. To become familiar with the problems involved in field measurements of hydraulic conductivity.

Equipment

1. Soil auger
2. Measuring tape with float
3. Small cup with which to remove water from the auger hole
4. Stopwatch

Procedure

1. Dig an auger hole as shown in the diagram.
2. Fix a datum above the soil surface from which the changes in the water level in the auger hole can be measured.
3. Measure the initial depth of water table below the soil surface.
4. Withdraw some water from the auger hole and measure the change in the depth of the water table with ton
5. Make all the measurements indicated in the figure.

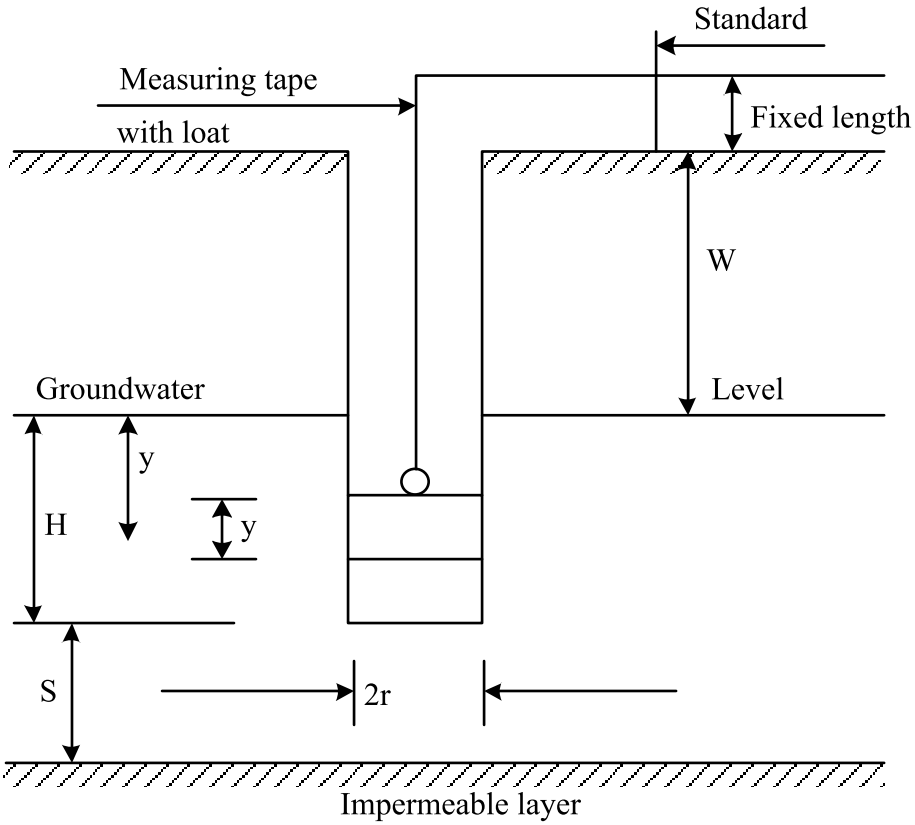
Calculation of hydraulic conductivity (k)

(i) If the bottom of the auger hole is not on the impermeable layer.

$$k = \frac{400r}{(H + 20r)(2 - (1/H))} \frac{\Delta y}{\Delta t}$$

(ii) If the bottom of the hole is on the impermeable layer:

$$k = \frac{3600r}{(H + 10r)\frac{(2 - y)}{H}} \frac{\Delta y}{\Delta t}$$


Standard
Measuring tape
with loat
Fixed length
W
Groundwater
Level
y
H
y
S
2r
Impermeable layer

Practical 4

Title: Determination of empirical synthetic hydrograph parameters for a watershed;

Objective:

To defeats a watershed and obtain the synder's synthetic hydrograph parameters.

Equipment

1. Planimeter
2. Scale rule
3. String
4. Topographical map

Procedure:

1. On the given topographical map, delineate the watershed
2. a) Measure
   b) The area of the watershed
   c) The length of the major and longest channel extended to the watershed boundary.
   d) The length of the channel between the outlet and a point opposite the center of the watershed.
   e) Any other relevant dimension.
3. Calculate, q_p, t_p, t_{lng}, t_{rise} (Choosing suitable C_t from tables)
4. Draw the dimensionless unit hydrograph for the watershed. Comment on your results.

ABE 314: Agricultural Power & Machinery
LABORATORY NO. 1

STUDY OF ENGINE MODELS AND DESIGN

PART A: ENGINE MODELS

Objectives

At the end of this laboratory', you will able to do the following:

1. Understand the workings of a 4 stroke, spark ignition internal combustion engine.
2. Understand the workings of a 2 stroke spark ignition internal combustion engine,
3. Understand the workings of a 4 stroke compression ignition internal combustion engine.

Notes When an internal combustion engine is cranked (i.e. when the engine is turned by battery powered sources), many things happen within few seconds. Fuel air mixture moves in, cams operate valves, mixture ignites or is ignited, pistons moves etc. It is necessary to understand how these operations occur in order to be able to appreciate this indispensable medium system - the internal combustion engine.

Procedure:

The class win divide into three groups with each group operating one of the three models for 30 minutes. The groups then change over to other models.

A. Four-stroke, spark-ignition engine model
   This group will operate die model by hand. Observe and fist the sequence of operations of:
   1. Inlet and outlet valves
   2. Introduction of spark
   3. Piston movement
   4. Any other moving part
   5. Trace the md line from tank to cylinder and exhaust with a drawing.

B. Two-stroke, spark-ignition engine model.
   Operate model by hand.
   Observe and list the sequence of operations as in A, keeping it in mind that inlet ports replace the valves in this system.
   Trace the fuel line as in A.

C. Four-stroke, compression-ignition engine model
   Operate model by hand.
   Observe and list the sequence of operations as in A. Trace the fuel pump, the fuel injector and the filter.

D. Answer the following questions.
   1. What are the major differences between a compression ignition and a spark ignition engine?
   2. How are sparks generated in a spark ignition engine?
   3. Compare a 4-stroke to a 2-stroke engine.

PART B: ENGINE DESIGN

Objectives:

At the end of this laboratory, you will be able to do the following:

1. Dismantle a petrol engine especially the piston, cylinder and valves.
2. Re-assemble the engine
3. Identify the various parts of the engine.

Notes An internal combustion engine converts thermal energy into mechanical energy. Both petrol engines anddiesel fuelled engines have cylinders, pistons, inlet valves and exhaust Valves irrespective of whether they are four-stroke or two stroke. It is important to be able to identify these parts and understand their functions.

Procedure

A. Dis -assembling of Engine.
   1. An engine block is provided. With the aid of the instructor, dismantle the engine to its barest form.
   2. Identity and draw the following parts
      i) The piston
      ii) valve system (with springs)
      iii) the cylinder
   3. Measure and record
      i) cylinder bore
      ii) cylinder stroke
      iii) piston diameter
      iv) pistonlength
      v) calculate the stroke-bore ratio (stroke-bore ratio for tractor is now about 1:16).

B. Assembly of Engine
   1. Without the aid of the instructor, assemble the engine back to its normal form.
   2. Get the overall dimensions of engine-length, breadth and height.
   3. Sketch the engine block -as much as possible to scale

C. Answer the following questions.
   1. What is the effect of a large stroke-bore ratio on (a) engine efficiency and (b) friction power?
   2. What material do you think was used to make the piston and
   3. How does one obtain a perfect seal between the piston and cylinder wall? Why is a perfect sealneeded?

LABORATORY NO. 2
STUDY OF ENGINE ACCESSORIES

Objectives

At the end of this laboratory, students will be able to do the following

1. Identify various engine accessories as given
2. Know the functions of these accessories in relation to the engine as well as to each other.

Notes The engine cannot function properly without the presence of certain engine accessories. Some of these accessories include:

1. Cams - ensure opening and closing of valves at the correct time.
2. Flywheels - reduce speed variations in the engine to an acceptable level
3. Crankshaft -transfers power to the flywheels,
4. Silencers or mufflers - exit port for exhaust gases. Without silencers, engine noise will be intolerable.

Procedure

A. Identification of some engine accessories.

i) The instructor will show you a cam system model and explain the operations of a cam system.
Sketch & well-labeled cam system showing the camshaft, the cam, the spring and valve.

ii) Flywheels:The instructor will explain the functions of a flywheel.
List the functions.
Sketch a flywheel connected to title crankshaft.

iii) The crankshaft:
The crankshaft connects all the pistons to the flywheel. Draw the picture of a four-cylinder engine crankshaft as shown in the laboratory indicating the piston rod positions.

iv) The muffler or silencer
Sketch the picture of silencer shown

B. Answer the following questions.

1. The cam opens the inlet and exhaust valves.How are these valves closed?
2. Derive an expression for the force on a cam using the spring constant and displacement.
3. List the advantages of a silencer.

LABORATORY NO. 3
FUEL SYSTEMS - OPERATION AND MAINTENANCE

Objectives

At the end of this laboratory, the student will be able to do the following:

1. Identity and draw (or sketch) a spark ignition fuel system
2. Identify and draw (or sketch) a compression ignition fuel system.
3. Be conversant with routine maintenance procedures of a fuel system.
4. Differentiate between diesel fuel and petrol.

Notes The function ofthe fuel system is to store and supply the engine with clean fuel; in the correct ratio, wide range of engine speeds and loads. The fuel system on spark ignition engines differs from the fuel systems of compression ignition (diesel)engines. The most importantmechanism in the former is flu carburetor while in the latter is the fuel injection pump.

A. Spark ignition fuel system.
The laboratory instructor will identify and explain the functions of the following:
1. Fuel tank and fuel line
2. Air lineand air cleaner
3. Float chamber
4. Throttle valve.

For your report, draw the system, identify the parts listed above and explain their functions one by one.

B. Compression ignition
The instructor will identify and explain the functions ofthe following:
1. Fuel tank and lines
2. Fuel filter
3. Fuel pump
4. Fuel injectors

As in A, draw and, explain these parts.

C. Differences in gasoline and diesel fuels.
Two samples of fuel are supplied. One is labeled ‘petrol’ and the other ‘diesel fuel’.
Explain the visible difference between the two in terms of
1. Colour
2. Specific gravity (use the hygrometer given to measure specific gravity)
3. Texture dip a finger into each sample
4. Any other characteristics

D. Maintenance of the fuel system.
The instructor will show you how an air cleaner can be dismantled and cleaned. Go through this procedure yourself, change the oil in the bowl and clean the filter Write a report on what you did.

E. Answer the following questions

1. State the dairy regular maintenance procedure for the fuel system
2. State the periodic regular procedure.
3. Why is diesel fuel used more on farm engine than gasoline engine?

LABORATORY NO. 4
LUBRICATION/COOLING SYSTEMS - OPERATION AND MAINTENANCE

Objectives:

At the end of this laboratory, you will be able to do the following:

1. Identify the path of lubricants in the engine block
2. Identify the components of an air-cooled engine.
3. Identify the components of a water-cooled engine.

Notes The heat generated in the engine is tremendous. This is as a result of hot gases and also friction. Heat is transferred by conduction, convection and radiation heat transfer. The cooling system reduces engine heat while the lubricating system principally reduces friction between moving parts in addition to reducing heat and moving away small particles.

Procedue:

A. Lubricating system

The instructor will show you the paths of lubricants in an engine block

1. Draw the top view of the block showing the entrance of lubricants
2. How does the piston get rid of the lubricants that go into the cylinder during its upward journey?

B. The cooling system:

1. Identify and draw the air-cooling system
2. The water cooled system consists of the fan, fee radiator and the water pump. Draw the fan and theradiator.
3. How does the engine move the fen pulley?

C. Answer the following questions.

1. What would you check in a vehicle that shows signs of overheating?
2. Explain the differences between air cooled and water cooled engines.
3. What kind of oil is used for lubricating tractor engines?

LABORATORY NO. 5

Title: Determination of soil properties related to tractive performance of agricultural tractors.

Objectives: To acquaint students with procedures for determining soil properties for the tractive performanceassessment of prime movers.

Theory: Wheeled and crawler type traction devices are commonly employed in agriculture. For wheeled-type, these could be 2-wheel drive or single-axle tractors. Power availability at the drawbar depends on the rolling resistance, coefficient of traction and soil properties (cohesion, c, and soil angle of internal friction, ϕ). There is need to determine these parameters for a good estimate of the drawbar pull of traction devices where direct measurements are not possible.

Equipment

1. Soil shear apparatus (direct shear or cohron shear)
2. Soil cone penetrometer
3. Soil bulk density measuring apparatus

Procedure

1. Select sites and describe soil surface (grassy, ploughed, etc.)
2. Obtain soil samples for moisture content and soil bulk density determinations (specify depth).
3. Probe cone penetrometer from soil surface to 30 cm, soil depth and record readings at 5cm interval.
4. Take shear data with Cohron shear graph or obtain soil samples for direct shear test.

Notes Cohron shear graph is capable of giving soil values: c and ϕ for soil-soil, robber-soil and steel-soil interface respectively. Direct shear apparatus is only capable of giving soil shear values for soil-soil interface).

Results:

1. Obtain per cent moisture content (wet basis and dry basis) for all sites.
2. Obtain soil bulk density values for the sites
3. i) Graph results of shear tests for so0-soil, rubber-soil, steel-soil interferes as the case may be.
   ii) Use method of Least squares to run a regression equation for establishing:

   $F = C + P\tan\phi$

   $= AC + W\tan\phi$

   F = shear force
   A = kb.l
   K = constant
   W = normal load
4. Graph the results of penetrometer pressure versus soil depth.

Discussion and Conclusion:

1. Discuss the usefulness of the regression equation, F * AC + Wtanϕ in tractive performance studies of agricultural prime movers.
2. Comment on the results of cone penetrometer pressures and its relevance to this experiment.

LABORATORY NO 6

Title: Analytical determination of the drawbar pull of a given prime mover.

Objectives:

1. To acquaint students with procedures for determining machine parameters of prime movers.
2. To determine, by analytical method, the drawbar pull of prime movers, using soil property and machines parameters values.

Theory: Wheeled and track-type traction devices are commonly used in agriculture. For wheeled- type, these include 2-wheeled drive and single-axle tractors. Power availability at the drawbar is governed by the roffing resistance, coefficient of traction and soil property values (cohesion, c, and soil angle of internal friction, ϕ). There is, therefore, the need to determine these parameters and property for a good estimate of the drawbar pull when direct measurements are not possible.

Equipment

1. Two tractor models
   a) 2-WD, 45kW tractor
   b) Single-axle, 6kW tractor
2. Measuring tape
3. Weighing scale
4. Pressure gauge

1. **Tractor specification**
   State all specifications for each tractor:
   a) Wheel base
   b) Tread width
   c) Drawbar height
   d) Wheel circumference (loaded and unloaded)
   e) Drawbar power
   f) Brake power
   g) Tyre size and inflation pressures

2. **Results**
   a) Obtain static weight distribution on traction wheels (Note: dynamic weight is attained only under dynamicstate):
      i) Right front wheel ……... kg; left front wheel ……. Kg
      ii) Right rear wheel …….. kg; left rear wheel ……..kg

   b) Obtain tyre inflation pressure
      i) Front tyres …….. kPa
      ii) rear tyres …….kPa

c) Recall soil property values from practical 5:
   i) Percent soil moisture content ……. d.b
   ii) Soil bulk density …….w.b
   iii) Soil cohesion (c) …….Gkm3
   iv) Soil angle of internal friction (ϕ)

d) Tractive surface parameters:
   n = ……
   K_c = ……..
   K_ϕ = ……..

Calculations

1. Rolling resistance, R_c, due to compaction:
   i) front wheels,

$$R_{cf} = \frac{2}{(n+1)(K_c + bK\phi)^{1/n}\left(\frac{W}{2l}\right)\frac{n+1}{n}}$$

   ii) Rear wheels

$$R_{cr} = \frac{2}{(n+1)(K_c + bK\phi)^{1/n}}\left(\frac{W}{2l}\right)\frac{n+1}{n}$$

   (b = width of tyre impression, l = length of tyre impression)
2. Rolling resistance due to stiffness (carcass material on tyres)
   i) $R_{tf} = W_u/Pi_a$
   ii) $R_{tr} = Wu/Pi^a$ u, a = constant

3. Unit motion resistance
   $M_r = u/Pi^g$

4. Ground pressure,
   Pg = W/A, A = 0.78bl
   Pgf = 2W/A = Pgr

5. Maximum drawbar pull, P_{max}:
   i) Smooth tyres
      $P_{max} = F - R$
      $R = R_{cf} + R_{cr}$
      $F = A_c + W\tan\phi$

   ii) Lugged tyres
      $P_{max} = F - R$
      $R = R_{cf} + R_{cr}$

$$F = blc\left(l + \frac{2h}{b}\right) + W\tan\phi l + 0.64\frac{h}{b}\cot - l\left(\frac{h}{b}\right)$$

6. Coefficient of traction, C_r:
   i) Smooth tyres
   $C_t = P_{max}$/Wt of tractive device

   ii) Lugged tyres
   $C_t = P_{max}$/Wt device

7. What is the expected increase in drawbar power when 2000kg is added to the rear wheels?
   i) Smooth tyres
   ii) Lugged tyres

Discussions and Conclusion

1. What is the relevance of all calculated values to the determination of P_{max} and expected Pull (P expected)?
2. What other conclusions can you draw to anther justify the relevance of experiments 1 and 2 to the study of tractive performance of prime movers? What are the limitations?

LABORATORY NO. 7

Title: Performance appraisal of a 2-WD tractor

Objective To make a complete field performance evaluation of a 2-WD tractor in terms of

i) Tractor specifications and selection
ii) Implement(s) specification and selection based on (i) for different field operation.

Theory. Tractors ore used under varying soil and climatic conditions. It is, therefore, necessary to make variouspower and functional measurements with a view to determine power efficiencies for the different fieldoperations. Such determinations would improve the tractive performance of agricultural tractors if the right size of implements are matched with appropriate size of tractors and if such machinery are used in conducive environments.

Equipment:

i) a 45 kW diesel tractor (2-WD)
ii) a hydraulic/spring type dynamometer
iii) fuel meter/graduated cylinder
iv) stop watch
v) measuring tape

Procedure:

i) Select appropriate size of diesel tractor and state specifications
ii) Select field implement(s) and state specification
iii) Perform different field operations with the implement(s) coupled to the tractor over a period of time.
   a) Ploughing
   b) Disking (disk harrowing)

iv) Perform drawbar test and tabulate your results in terms of:
   a) gear in use
   b) additional load
   c) time to move a prescribed distance
   d) pull
   e) speed
   f) drawbar power

Results:

Tractor specifications
Make .....size .....
Engine model.. .....
Engine power, max. ..... kW at ..... RPM
Engine governed to operate at ..... RPM..... %Eff

Engine max torque .....at ..... RPM
Engine weight. ..... .kg
Engine ignition system .....
Tractor wheel base ..... on Tread ..... cm
Tractor wheel circumference (rear) ....,...at .... .kPa (I.P.)
Travel speeds
1st gear: gear ratio (wheel; transmission) = …….
2nd gear: gear ratio = …….
3rd gear: gear ratio = …….
Othergear(s) = …….
Tractor engine bore., ... cm
Tractor engine stroke …….. cm at STP
Tractor engine displacement …….. Cm
Field performance tests in tabulated form:
Operation: Ploughing with a disk plough
Operation: disking with offset disk harrows:
Diameter of disk = ……. Cm
Hitching system = ……
Area ploughed = …… Ha
Time taken (including stops) …….. hr
Fuel consumed …….. 1/hr …….. 1/ha
Field capacity ……. ha/hr

Tabulate drawbar tests data

Calculations

From your results, calculate:

i) Power efficiency %

a. Plough $= \dfrac{Max\,DB\,Pull}{Full\ load\ power} \times 100$

b. Disking $= \dfrac{Max\,DB\,Full}{full\ load\ power} \times 100$

$$\frac{Indicating\,pull,\ X_i \qquad Actual\,pull,\ Y_i}{Regression\ line\ \ equation\ \ Y_i = a + bX_i}$$

(a, b = constants)

Maximum Power Plot engine RPM versus engine power (kW) to obtain maximum power

Discussions and Conclusions

1. Comment on gear selections for the two operations
2. Comment on the fuel consumption by the tractor during experimentation..
3. Why do we conduct drawbar Pull tests at low speeds
4. What is the effect of engine size on power development?
5. What criteria are employed by different categories of fanners in selecting tractors for various jobs?

LABORATORY NO. 8

Title:Performance evaluation of Nozzle Sprayers.
Objectives:
To test run nozzle sprayers under laboratory set up.
To analiyze data from (1)
To arrive at some logical conclusions from the results

Theory: Sprayers are extensively used for the application of chemical pesticides, herbicides and fungicides. There are different sprayers and nozzle designs. Design of nozzles is governed by the expected particle sizes, droplet. size distribution and uniformity of deposition.
The composition of the chemicals (ingredients) and method of agitation have also been found to influence performance of sprayers and nozzles.

Equipment

1. Sprayer of different nozzles sizes
2. Pump with pressure regulator
3. Measuring cylinders (graduated)
4. Corrugated iron sheets
5. Measuring scale
6. Conical flasks

Procedure:

1. Make complete identification of the sprayer
2. Fill and agitate the sprayer, attaining the required pressure(s) for each observation.
3. Discharge the liquid at selected pressure(s) and collect the spray from the nozzle(s) at …… (specified) cm away from the tip for ……..sees, into cortical flasks.
4. Make a further discharge, having four runs with each nm corresponding to a pie-selected pressure and achosen nozzle type.
   Note time for each run unto the corrugated iron sheets with the discharge running into the test tubes.
5. Tabulate results.

Measurements

Discharge rate of nozzles (cm/sec or cm/min) into conical flasks. Discharge rate collected as runoff from the corrugated iron sheets grooves (into test tubes)

Results:

Sprayers:
Sprayer type…… Make …….
Sprayer model and size …… liquid used……
Pump (if any) …….

Discharge into conical flasks

Application rate (1/ha) from …… (nozzle) tip at specified speed and pressure.

Speed km/hr		*Pressure, kPa*		

Calculations

$$l/ha = \frac{L/\min}{ha/\min} = \frac{X(l/\min)}{a(m) \times S(km/hi) x \frac{cm/\min}{km/hr}} \times d\frac{m^2}{ha}$$

Plot amount of discharge versus test tube number

Test tube Number ……..
Plot rate of discharge (l/min) versus gauge pressure (kPa) for …… nozzles)
Plot rate of application (1/ha) versus ground speed (km/hr)

Discussions and Conclusion
Show that increase in pressure leads to higher rate of discharge
Show the effect of nozzle type(s) on discharge and efficiency of distribution (equalness of discharge into the testtubes) show the usefulness of computed results.
Make any logical deductions from the practical.

ABE 411: IRRIGATION AND DRAINAGE

PRACTICAL 1

Title: Staking an irrigation channel

Objectives
To stake an irrigation channel such that water can be transported, without eroding the channel, from the source to the farm.

Equipment
1. Engineer's level and staff
2. Stakes
3. Measuring Tape
4. Cutlass,

Procedure
1. Collect all necessary information, estimate n, and select Z and S
2. With the given Q, determine the dimensions of the channel
3. Stake out the centre line of the channel bearing in mind the channel slope
4. Indicate, the curves and where drop structures are required.
5. Draw the plan arid layout

PRACTICAL 2

Title: Irrigation water measurement using weirs, Parshall flume and float

Objective:

1. To learn to use weirs, Parshall flume and afloat for irrigation water measurement
2. To establish the problems associated with each method of measurement
3. To compare measurements by the different methods.

Equipment

1. Triangular weir
2. Rectangular weir
3. Parshall flume
4. Float
5. Measuring tape
6. Stop watch and regular watch

Procedure:

1. Using a section of an irrigation channel measure the flow in the channel by the float method.
2. Set up a triangular weir, a rectangular weir, and a Parshall flume, respectively, in the same channel and measure the flow in the channel.
3. Analyze the flows by the different methods, explaining the theories involved.
4. Compare the level of accuracy obtained by each method.

PRACTICAL 3

Title: Determination of the conveyance efficiency of an Irrigation head ditch.

Objective
To measure the conveyance efficiency of a head ditch

Equipment
1. Flow measurement device selected from practical No. 2
2. Stopwatch and regular watch.

Procedure
1. Based on the results of practical No. 2, select an appropriate flow measuring device for the head ditch.
2. With all diversions closed and the measuring devices properly installed, measure the inflow and outflow rates, noting the time of measurement. Ensure that flow in the ditch is stable during measurements. Obtainat least 5 concurrent inflow-outflow measurements.
3. Analyze your result and find the conveyance efficiency
4. Compare the allowance that must be made (in water delivery) for seepage per unit length of the ditch, from the relation:

$$Seepage(l/s/km) = \frac{inflow(l/s)) - outflow(l/s)}{lengthof\ testditch(km)}$$

5. Comment on your results .

PRACTICAL 4

Title: Field calibration of siphon tubes used for conveying irrigation water from the field channel to the plot

Objectives:

1. To become familiar with the use of siphon tubes commonly used for irrigation
2. To calibrate the siphon tubes

Equipment

1. Siphon tubes
2. Engineers level and staff
3. Measuring tape and spade
4. Calibrated container for volumetric water measurement
5. Stopwatch

Procedure

1. Measure length, inside and outside diameters of the siphon tubes to be used.
2. Measure A, Q, and h of the discharge equation
3. Evaluate C
4. Plot Q vs h
5. Explain the theory involved

ABE 417: Agricultural Structures and Environmental Control
Laboratory 1: Concrete Slump Test
Aim: To determine the suitability of a concrete mix for various agricultural use.
Materials Cement, sand, gravel, water, open ended cone.

Background
Concrete is made by mixing a fine aggregates (sand), coarse aggregate (gravel), cement and water. The cement and water forms a paste during mixing and the paste coats the aggregates. Concrete is widdy used in agricultural construction due to its plasticity, durability and esistance to termites and rodents. The concrete-slum test gives an indication of the workability (ease withwhich the concrete mix can be compacted) of a concrete mix.

Procedure
1. Prepare concrete in 3 mixes namely (1:2: \ 1:2:3: and 1:3- 3).
2. Set the open ended cone (305mm high, 102mm diameter at the top and 203mm diameter at the bottom) on a flat surface and fill with a given mix of concrete.
3. Use a rod to ensure that the concrete poured inside the cone is well compacted.
4. After compacting very well, lift off the cone and set it next to concrete. Lay the rod across the top of thecone and measure the distance down to the concrete.
5. Repeat steps 2-4 for the two other mixes you are expected to prepare.
6. Using the table below classify the mixes you used.

Concrete stump for various Uses		
Consistency	Slump (mm)	Use
HighWorkability	100-150	Constructions involving complex shapes and heavily reinforced concrete
Medium workability	50-100	All normal construction work which may (cr may not) involve the use reinforcements.
Plastic	25-50	Floors and pavings
Stiff	0-25	Concrete blocks, mechanically vibrated floors and pavings.

Adapted from "Farm Structures in Tropical Climates" by L. P. Bengtsson and J H. Whitaker (Ed.)

Laboratory 2. Bar Shrinkage Test

Aim: To determine the minimum mixing ratio of soil-cement for cement stabilized earth blocks.

Materials Cement , 3 samples of earth, 9 rectangular boxes (each with the following dimensions, 600 x 50mm)

Background

Earth (i.e. Subsoil) has, for long, been used for building construction in the rural areas. This is probably because it is relatively cheap, readily available and easy to work using? simple tools and skills. In spite of the nice attributes of earth, it has low resistance to water. When it is wet, it swells and shrinks when dry thus causing it to crack. This weakness can be remedied by stabilizing the earth material. In deciding to stabilize, it is important to use the correct type and amount of stabilizers. The bar shrinkage test can be used in selecting the right amount of stabilizers to be used on a given earth material Some stabilizers that can be used are clay, cement, lime, gypsum natural fibres (sawdust, grass, straw and sisal).

Procedure

1. Mix a given soil (earth) sample with water to such a consistency that whena "V" shaped groove is cut in the mix, it win close up after the box has been tapped about 5 times.
2. Oil the inside of 3 rectangular boxes, fill them with the mix prepared in 1 above and compact very well. Pay special attention to the comers of the boxes by compacting them very well.
3. Measure the length of each of the wet soil bar and find the average length of the wet soil bar.
4. Dry the 3 boxes at room temperature for 24 hours and then in an oven at 110°C until they are dry.
5. When the samples are completely dry, measure the length of each of the dried bar and find the average length of the dried soil bar.
6. Repeat steps 1 - 5 for each of the 3 samples of earth that was collected.

Calculation

$$\text{Shrinkage ration} = 100\left[\frac{(\text{average length of wetbbar}-)(\text{average length of dried bar})}{\text{Length of wet bar}}\right]$$

Use the table below to determine the suitable cement-soil ratio for each of the 3 samples tested.

Shrinkage	Cement to soil ratio
0 – 2.5%	1:18
2.5 – 5%	1:16
5 – 7.5%	1:14
7.5 – 10%	1:12

Adapted from "Farm structures in Tropical Climates" by L. P. Bengtsson, and J. H. Whitaker (Eds).

Note that when shrinkage ratio exceeds 10% the soil is not suitable for stabilization.

Laboratory 3 Estimation of heat loss/gain from a building

Aim: To estimate the quantity of heat that is lost from or gained by a building
Materials: Measuring tape, thermometer (dry and wet bulb).

Procedure

1. Measure the following building dimension, length, width, wall height.
2. Calculate the total surface area of the ceiling, window, door, wall (minus window and door area) and perimeter.
3. Observe the materials of which the ceiling, window, door, wall and perimeter are made and obtain thethermal conductivity of these materials from literature.
4. Take the ambient and wet bulb temperatures inside and outside the building.
5. Calculate the heat loss/gain from each component of the building using the equation below:

$$q = AU (t_t - t_o)$$

where

q = rate of heat loss (W), A = surface area (m^2)
U = thermal conductivity of a given material (W/m^2 K)
t_i = inside temperature (^{0}K), t_0 = outside temperature (^{0}K)
$\Delta t = t_i - t_0$
Ceiling, $q_c = \Delta t$x ceiling a area xU ceiling material.
Window, $q_w = \Delta t$ x total window area x U window material
Doors, $q_d = \Delta t$ x total door area xU door material
Wall, q_{wa}, = Δt x total wall area x U wall material
Perimeter, $q_p = \Delta t$ x perimeter xU perimeter

6. Estimate of heat loss from or gained by the building, $q_b = q_c + q_w + q_d + q_{wa} + q_p$. Comment on the usefulness of the above exercise in environment control. Using a psychrometric chart find the properties of the air inside and outside the building.

LABORATORY 4: VISIT TO LIVESTOCK FARMS IN AND AROUND I LORIN

Aim: To assess the various structures used for livestock housing in and around florin.

Procedure During the visit students are expected to make the following observations on each structure visited

1. Environmental control systems installed in each structure (i.e . ventilation and temperature moderationsystems, sunshades, lighting system, vapour barriers, feeding and watering facilities)
2. Space and production (breeding) facilities (like pre-nurseries, nurseries, growing and farrowing pens, mud bath in each structure).
3. Materials of construction of each structure
4. Type(s) of animals housed in each structure
5. Safety precautions taken against pests, predators and fire.
6. Estimate the Population density (animals/m^2) of the animals in each structure.

Requirements

Based on your observations, write a report on the visit, commenting on the adequacy (or otherwise) of the structure visited in terms of meeting the optimum:

1. Environmental control requirements,
2. Space requirements
3. Production (breeding) facilities and,
4. Safety requirements, of the animals they house.

Recommend possible solution(s) to any defects observed

ABE 415: Agricultural Land Surveying

Practical 1: Chain Surveying

Introduction: Chain or linear surveying is that method of surveying in which only linear, measurementare made in the field. It is a method well adapted to survey of small areas with simple details, and its use can be extended to larger areas of open country if control points are previously established by triangular, traverse or other instruments surveys. The technique is established upon the fact that by measuring the lengths of the sides of well conditionedtriangles set out on the ground, it is possible to plot them in the office to any desired scale.

Organization

The field work is to be carried out by groups of about five cooperating students. Each group is to be given a specified project area.

Aim: To produce the plan of a given project area applying the techniques of chainsurveying.

Equipment: Chain, tape, ranging poles, arrows, prismatic compass, optical square, pegs.

Procedure:

a) Reconnoitre the ground and select points for stations in accordance with governing rules.
Establish station with pegs and fix flags to station poles if necessary.
Sketch an 'index map' of the area on the first page of the field work and insert the survey fines.

b) Proceed to measure lines and offsets to the adjacent boundaries, selecting the order most suitable to the prevailing condition.

c) Concurrently with the measurement of the lines, take offsets and tie lines to important features,

d) Continue the work on these lines until all the tines are measured taking care that no important triangle is unchecked and that no important detail is omitted.

e) Describe all the stations by referencing them to nearby features.

f) Take the magnetic bearing of the base line and finally remove the station pegs.

Plotting

The final plan of the surveyed area will be drawn to a scale to be supplied. Black Indian ink and white cartridge paper are to be used The area of the project area is to be computed

Each person is to produce a plan while each group will submit one field book.

Practical 2: Closed Traversing

Introduction: A traverse is a continuous framework of lines connecting a number of points, the lengths of thelines and their angular relationship to each other being measured. The lines are known as legs and the points asstations. When the framework forms a closed figure or when the traverse connects two stations whose positions areknown, it is known as a closed traverse.

Aim: To obtain the closed traverse of a specified project area.

Equipment: Prismatic compass, tape, pegs, ranging poles.

Method:Compass Traversing:

a) Select the stations that enable delineation of the boundary of the project area
b) Identify the stations using letters.
c) Reference all stations
d) Measure the length and forward bearing of each leg of the traverse.
e) Check the effect of local attraction
f) Record measurement using appropriate format

Plotting Plot the traverse using a scale to be supplied. Effect the necessary closing error correction using Bowditch's rule. Find area enclosed.

Practical 3: Levelling is the process of determining the difference in elevation between two or more points on the earth's surface. The main uses of levelling include:

1. Taking oflongitudinal sections
2. CrossSections
3. Contouring
4. Setting out of levels.

Aim: To run and plot the longitudinal profile of a given line e,g. the centre line of a given road

Equipment: The level, arrows, ranging poles, tapes and umbrella and levelling staff.

Procedure:

a) Select a suitable TBM near the starting point of the given line whose longitudinal section is to be run.
b) Divide the lines at 20m intervals and put pegs or nails at those points.
c) Runlevel lover the pegs (bottom of) and close back at theTBM by a series of fly back levels.
d) Select a suitable vertical interval depending upon the highest and lowest points and draw the longitudinal section of the line.
e) Find the- elevation difference between the first and last point on the line

Practical 4: Levelling - Cross Section: Earthwork Commutation

Aim: To obtain cross-sections along a given longitudinal section and to compute the volume of earth within denned boundaries

Equipment: As in Practical 3

Procedure:

a) Using the line established in Practical 3 as thecentre, establish a parallel grid line at 1.5m distance from this centre line on either side.
b) At the beginning of each 20m interval and end of the centre line, obtain spot heights at 5m intervals along a cross-section bounded by the two grid lines (Note that both the chain man and the staff man shouldtraverse the grids from left to right consistently; mistakes in booking are like to occur if this consistency is lacking)
c) Reduce the levels using the sameTBM as in Practical 3.
d) Draw all the cross-sections obtained using equal vertical and horizontal scales, and the datum you are to be supplied.
e) Determine the area of earth at each of the cross-sections.
f) Compute the volume of earth between the beginning and end sections using any suitable formula.

Practical 5: Contour Mapping

Introduction: A contour line or contour may be denned as the line in which the surface of the ground is interacted by a level surface. This implies that every point on a contour has the same elevation - that of the assumed intersecting surface.

Aim: To produce the contour map of the specified project areas.

Equipment: The level, arrows, ranging poles, tapes, prismatic compass, pegs and levelling staff

Method: The Grid system

a) Select the longest line(baseline) and divide it at 20m intervals.
b) Mark out fines parallel to the base line which are at 20m intervals.
c) Run levels over the points mapped out by the grid lines.
d) Reduce the levels using TBM 100m
e) Select a suitable vertical interval depending on the highest and lowest points,
f) Interpolate where necessary and plot the contour of the project area.

Practical 6: Theodolite traversing

Introduction Traverse surveys are used where sight conditions makes the chain triangulation method impossible. Theodolite traverse is more accurate than the compass traverse. In large area surveys, extensive theodolite traverses are required for the establishment of control points from which subsidiary surveys for mapping of detail may proceed.

Aim: To traverse the boundary of the specified project area.

Equipment: The Theodolite, poles, umbrella, chains, tapes pegs, prismatic compass.

Procedure

a) Recommoitre the given area.
b) Locate stations with wooden pegs and reference the station. Consecutive stations should be inter-visible
c) Measure the angles at each station and chain each leg. Measure the angles on both faces.
d) Use the prismatic compass to take the bearing of the first line.
e) Compute the traverse and produce the survey plan on a scale to be given,
f) Check that misclosure is tolerable using the appropriate formula.

Practical 7: Tacheometric mapping

Introduction: Tacheometry is a branch of angular surveying in which both the horizontal and verticposition of points are determined from instrumental observations, thelabour of chaining being entirely eliminate is being increasingly used for preliminary surveys of roads, railways, canal route and for contouring.
The usual instrument employed is called a tacheometer and is basically a theodolite adapted for distancemeasurement by the provision of special fittings

Aim: To map the details on both sides of survey route.

Equipment: The theodolite or tacheometer, compass, levelling staff and umbrella.

Procedure

a) Locate the stations in the given route ascertaining that consecutive stations are inter-visible.
b) Set up the instrument over the first station (A, say) and sight on a field staff held on a TBM.
c) Determine the instrument height by measuring down from trunnion axis to the top of the peg and to theground. Hence find the reduced level of the ground at A.
d) With the horizontal circle clamped at zero, sight a reference object (R)
e) Proceeding in clockwise manner, take side shots on staff held at points of importance (e.g. comers ofbuildings, centre line of roads etc.) Noting the stadia, vertical circle and horizontal circle readings, (Notealso the readings on the reduction curves if using a tacheometer).
f) When all the side shots have been taken from A, sight the next station (B, say), note the angle RAB, thestadia and vertical angle readings. Set up the instrument at B, clamp the horizontal circle at zero and sightback to A before taking side shots. When the observations at B are finished move to the next station;continue to the last
g) Find the magnetic bearing of the first line (AB)
h) Compute and plot the survey. Find also the elevation difference between the first and last stations. Each student is to hand-in his field book along with his map.

ABE 528: Soil and Water Conservation Engineering
LABORATORY EXERCISES

Laboratory 1 Determination of the Kinetic Energy and Erosivity Indices of rainfall.

Aim

i) To calculate kinetic energy of rainfall using the formula of Wischmeier and Smith and Hudson.
ii) To calculate the Wischmeier Index (EITO) and Hudson index (K.E. > 25);

Materials: Recording rain gauge charts-pencil, eraser, calculator.

Background:

Evidence abound mat the kinetic energy of rainfall is directly related to the erosive power of rainfall. There arevarious .instrumentation techniques for direct measurement of kinetic energy in literature. It is also possible toestimate kinetic energy indirectly through the use of a recording rain gauge chart This is possible because severalauthors (Wischmeier and Smith., Hudson, Mihara and Kowal and Kassam) have derived empirical relationshipsbetween kinetic energy and rainfall density (I).

The erosivity of rainfall is usually expressed in terms of its erosivity index (R). Depending on the index adopted, R, can either be a product of the total K.E. (E) of rainfall and the maximum 30 - minutes intensity (I_{30}) (Wishmeier Index) or total K.E. for all rainfall intensities greater than or equal to 25rnm/hr (Hudson Index).

Procedure

I. Determination of Kinetic Energy of a storm
   1. Divide the trace of rainfall on the automatic recording rain gauge chart into small time increments(Δt) of uniform intensity.
   2. Determine the depth of rainfall (D)that fell during each of the small time increments.
   3. Compute intensity of rainfall during each time increment. Intensity = $D/\Delta t$
   4. Compute the kinetic energy of rainfall for each time period using the:
      i. equation of Wischemeier and Smith
      ii. equation of Hudson.
   5. Find the product of the depth of rainfall and the kinetic energy (computed in 4 above) for eachtime period (Δt). This product is the total kinetic energy during the time period (Δt).
   6. Summation of the total K.E. for all the time periods equals the total kinetic energy of the storm

II. Determination of Erosivitv Index
   i) From the raingauge chart, find the 30-minute period with the greatest amount of rain, D_m. Therefore, I_{30}=2 D_m (rnm/hr).
   ii) Compute theWischmeier index.
   iii) Compute the Hudson index by summing the total kinetic energy of all the component storms whose intensities are greater than or equal to 25rnrn/hr.

Laboratory 2: Tour of an Erosion site

Aim:

i) To assess the nature and extent of the erosion on the site in question.
ii) To make recommendations for rehabilitation/reclamation of the land.

Procedure:

Write a report, detailing your observations and recommendation.

Laboratory 3: Survey of a soil Erosion site

Aim: In this laboratory exercise we shall attempt to lay the basis for the implementation of some of the recommendations you may have made in laboratory exercise 2. To this end, we shall:

i) produce a map of the site, showing all Gullies on the site.
ii) produce a topographic map of the site and,
iii) draw a profile of the gully(-ies) on the site.

Materials: Automatic level, tape, staff, ranging poles, pegs.

Procedure

Use a grid spacing of 20m for the topographic map.
During profile levelling, take the elevation of the gully bed at 20m interval.

Laboratory4: Staking of a contour in the field

Aim: To layout a contour in the field.

Materials/Equipment

Level, levelling staff stakes, Topographic map of the area, paint and waiting brush.

Procedure

1. From the topographic map, determine a suitable elevation (DE) for the contour you want to set out in the field.
2. Using the level and staff determine the ground elevation at the point(s) at which the desired contour is to be set out
3. Determine the height of instrument (HI) with reference to a known bench mark elevation.
4. To obtain your desired elevation (DE); the staff reading (SR) at the top of the stake at each point must be ascalculated below:

$$SR = HI - DE$$

5. To obtain the staff reading (SR) calculated in No, 4 above, at a given point, a stake is partially driven into theground at that point and a rod reading is. taken on top of the stake. If the reading does not coincide with thevalue of SR (as calculated in No. 4 above), then adjust the stake until the desired value is obtained.
6. Repeat procedure 5 for all the points at which the desired contour is to be set out.
7. You will observe that all points staked out in No. 6 above are at the same elevation.

ABE 503: Transportation Systems for Agricultural and Rural Development
LABORATORY 1 & 2

Title: Farm transport Productivity studies

Objectives:
1. To determine the various methods of (local) transportation to and from a farm in the vicinity of Unilorin,
2. To develop cost-per-tonne-kilometer for the various carriages using farm transportproductivity concept.

Theory:
Farm transportation, being an index of a nation's well-being, entails different transportation systems, some of which are compatible with traditional agriculture while some are not It involves different devices, some of which are:

i) head and shoulder carriage on foot
ii) bicycle and motorcycle carriages and carts
iii) animal drawn carts and trailers
iv) tractor-powered trailer
v) trucks and lorries

Commodity movements are place utility as well as time utility based. Place utility is the movement ofcommodities to where they are needed. Time utility is the movement of commodities when they are needed. Agricultural engineers must ensure the realisation of commodity movements to and from the farming communities.

Equipment:
1. Stopwatch
2. Weighing scale
3. Distance measuring devices
4. Transport devices - man, bicycle, motorcycle and tractor-drawn trailers

Procedure
1. Select a farm road of interest
2. Survey the terrain, types and intensity of use by different transport devices
3. For a predetermined distance obtain the following:
   a) Number of road users with head carriage, recording average weight being carried (specifydirection) and the rate, of walk
   b) Repeat as in (a) for bicycle carriage, motorcycle carriage and, possibly tractor-drawn trailers.

Results
Tabulate your results as outlined m table 1 and Table 2

Table 1: General specification/characteristics of transport devices

Parameter	Transport Devices			
i) Type: Size:				
ii) Type tread: - Primemover - Carriage				
iii) Wheel base: - Prime mover - Carriage				
iv) Other specifications				
v) Ht. of axle				
vi) Average speed				
vii) No. of similar device in transit for period				

Table 2. Farm transport Productivity determination (for 5-kilometer distance)

Type of carriage	Output per maa-tonne-km-day	Value of : Vehicular Equipment (N)	Accessories used	Cost/day a) Accessories b) Operating c) Interest d) Wages (N)	Cost per day (N)	Cost per tonne (N)
1. Head (state weight)						
2. Bicycle (weight)						
3. Motorcycle						
4. Tractor-trailer (weight)						

Calculations

For the above computations, use the following information where possible

i) Interest on investment of 2.5% of capital
ii) Equipment salvage value of 10% original cost
iii) Useful life of about 5 years for all equipment

Assume reasonable initial value for each equipment.

Discussion of Results

1. With the aid of sketches, illustrate design differences in the transport devices observed
2. Comment and justify the carrying capacity limitations for each device under study.
3. Prepare schematics of (i) gear train/transmission and (u) steering mechanisms to amplify point No. 2 above.
4. Make any logical deduction which may lead to improvement on each device.

Laboratory 3

Title: Determination of Farm Road-Way Traficability

Objective To determine the general (terrain) characteristics of a farm road that may influence trafficability of a farm transport system.

Theory: Farm roads are generally influenced by two parameters of vehicle way system.

These are:

i) Macro-roughness and
ii) Micro-roughness

Macro-roughness is the natural surface of the earth crust including climatic factors.
Micro-roughness defines the qualities of materials used in construction that forms the basis for roadway stability andtraction.
Attempt to satisfy the above often result in either winding or straight roadways. This, in turn, limits the types and sizes offarm transport devices mat can trafficate such farm roads.

Equipment

1. Farm level and its accessories
2. Measuring tape
3. Farm road

Procedure:

1. Select a farm road as used for Labs I and II
2. Range with your farm level from a reference point to a distance of 1000m, noting variations at the right side, left side and center of the road.
3. Determine the angles of deviation such that you can quantify road bends.

Results and Discussions

1. Tabulate your leveling results as B.S., I.S. F.S., H.I., R.L, S, Remarks
2. Plot for the Profile, using 20m spacing
3. Plot the horizontal grids, indicating the angles of deviation at every deviating point.
   (Notes: you may wish to average readings for the corresponding coordinates (i.e. road center reading + right side readingleftside reading + 3)
4. What other **extraneous** factors affect or influence the use of the farm-road under consideration
5. Makeall logical deductions as may be relevant to this laboratory.

Prepare a concise report, ensuring mat your plots are illustrative and clear

LABORATORY 4

Title: Analysis and Design Problem of a Farm Transport Device

Objective

1. To guide students on identifying typical farm transport needs/problems
2. To infuse the design concept of a component, part or a whole farm transport device.

Procedure Group of students to be assigned with design problems and to be solutions based on social, economic and technological/technical considerations. Outcome of eachdesign project is to be critically discussed by all the students to further establish the practicality ofsuch design.

ABE 504: Agricultural Land clearing and Development
Laboratory 1

Title: Taking Tree count

Objective To characterize the tree density on an undeveloped land meant for land clearing.

Equipment and facilities:
Undeveloped land within the University land area will be used as case studies. Simple surveying equipment and tools will be required: Compass, ranging pole, measuring tape and cutlass.

Background:
Knowledge of the tree density on an area of land meant for agricultural farm land is desirable to enable the engineer or farm manager budget for time, size and type of equipment for the job.

Procedure:
Students will be divided into groups and assigned plots of land (about 1 hectare per group). They will:

a) carry out an approximate traversing of the site to estimate the land area.
b) mark out sample plots of about 10m x 10m in about 3 to 4 locations.
c) count the number of trees on the plots.

Results
a) Show by a sketch of the land area and calculation, the area of the land in hectare.
b) Tree count

	Plot Sample				

c) What is the average tree density on the plot? Show by calculation.

LABORATORY 2

Title: Measurement of Tree diameter

Objective: To enable students assess sizes of trees on an undeveloped land and the type of machinery accessories that win be required for land clearing.

Equipment and Facilities: As in Lab. 1.

Background: The girth of tree trunks can be used to estimate fee spread and depth of the root system. Knowledge of tree sizes on a piece of land will guide the operator in his choice of machinery and land clearing implements.

Procedure: Students groupings win be as in Laboratory 1

1. Use the plots marked out in Lab. 1.
2. Measure the breast height diameters of the trees on the sample plots.

Results:

a) Show records of your measurement

b) Divide the data in 6(a) into groups such that the tree diameters fall within ranges. Compute theaverage diameter of the plot

Diameter range e.g. (0-30)mm	*Plot Sample*			
Average				
Gross average				

Show calculation for the mean.

c) Recommend machinery and implements for stumping., packing and primary tillage on the plot

LABORATORY 3

Title: Measurement of soil resistance to penetration

Objectives:

a) To enable students classify soils as a function of soil resistance to toolpenetration.
b) To enable students gain an insight into the selection of soil opening4ools during primary tillage.

Equipment and facilities: The same plot of land as used in Labs 1 and 2, Soil Cone penetrometer.

Background: Measurement of soil resistance to penetration by the soil Cone Penetrometer wasdeveloped by the ASAE as a standard method of expressing general soil mechanicalconditions for comparative purposes. The method does riot provide information on soilproperties as cohesion, angle of faction or coefficient of soil-metal friction.

Procedure: Student groupings is as in Labs 1 and 2.

a) The instructor will demonstrate the use and reading of the penetrometer for the students.
b) One test site shall be chosen per plot of 10x10m^2.
c) For each measuring spot, take 5-7 readings of the penetrometer at about 50mm depth.

Results

a) Report readings in the Table below

b) Plot the average penetrometer readings as ordinate against soft dearth as abscissa on a graph.
c) How will you describe the soil on the plot
d) Recommend primary tillage machinery for the soil

LABORATORY 4

Title: Machinery and Equipment selection for agricultural land clearing and development

Objectives

a) To familiarize students with the sequential chain of operations involved in land clearing and development.
b) To familiarize students with different range of machinery and equipment use in agricultural land clearing and farmland preparation.

Facilities This exercise is to be carried out as an exercise by students on visits) to sites of land clearing and development operations in the locality. Operations of interest are: (i) bush stumping (ii) packing of the brush and felled trees (iii) crushing of the branches of felled trees (iv) plot demarcation (v) deep tillage of virgin lands (vi) land preparation for surface irrigation (vii) ditching (viii) dam construction and (ix) construction of fish ponds.

Background Agricultural land clearing operations usually involve almost all of the operations listed in 3(i-iv). Operations 3(viii&ix) are civil works often found on the farm. Machinery for the various operations varies with the capability of the firm carrying out the works. Generally, crawler tractors are used as the prime mover to carry the various equipment or implements. Stumping is usually done with a front mounted blade and/or a tree pusher. Packing may be carried out with the blade but there are special rakes for the operation. Rippers or subsoilers or disc ploughs may be used for deep tillage on fresh soils. Other special equipment may be found such as ditching equipment, basin tillage etc.

Procedure: Visit to the farm site

Report

a) List the sequence of operations earned out to turn a virgin forest into crop field.
b) For the operations in 6(a), make a tabular list of alternative machinery and their accessory
equipment.
c) How many operators woe attached to each field machinery?
d) For each of the operations in 6(a), make a table of machine, operation and output (ha/day)
e) Collect information (data) on fuel/machine/operation characteristics of the whole operation.

Make recommendations for budgeting a 400 ha land preparation work.

Table 1. Results sheet

Operation (sequential)	Name	Machine Power rating (kW)	Implement Name	Alternatives to(3&4)	Output (Ha/day)	Fuel Consum pt (D

*Give number of machine working hours ( ) d

Describe the size of trees, for example, as shrub or trees
Recommend machinery for the stumping of the bush.

ABE 507: Application of Electricity to Agricultural and Biological Systems
Laboratory No. 1
Power Generation

Objectives:

a) To understand how power is generated in a magnetic field
b) To understand the principles of standby power generation systems.

Notes Electric power is generated when a coil moves inside a magnetic field. The coil movement is usually caused by hydraulic power or thermal energy. Power is generated nationwide by a National Institution called the National Electric Power Authority NEPA), Sometimes when NEPA power fails, farms resort to using standby electric power generator.

Procedure:

1. The generator
   a) You will be shown the electric power generator that is driven by the mains supply.
   b) Connect the rotor to the starter and switch on the system
   c) Observe and write a report on what you see.

2. Standby generator
   a) You will be shown a 1 -cylinder, single phase standby electric power generator
   b) Identify the engine parts and the shaft that serves as rotor.
   c) Describe how the machine operates
   d) Using the total load and the critical load systems, design a standby generator for the Agric.Engineering block. (Use the procedures taught in class).

3. Answer the following questions
   a) Explain the differences and similarities between a hydro- and thermo- electric power station.
   b) List the advantages of having a standby generating plant.

Laboratory No. 2
Power Distribution

Objectives

1. To be able to identify one-way and two-way switches and socket outlets.
2. To be able to connect the fusebox to the various switches and outlets

Notes

When electricity is generated, it is transmitted through cables and transformers until it finally arrives at the farm. The farm will have a switch that connects it to the transformer serving that area. It is from this main, switch mat electricity is distributed throughout the entire farmstead,

Procedure

A. Fixing of fuse box
   1. You are provided with a distribution board. Following the instructor's irruptions, connect the fuse box with a cable (assumed to be coming directly from the meter).
   2. Connect outlet cables to each of the fuses.
   3. Draw your connections on paper

B. Outletpoints
   1. Connect the outlet cables to individual socket outlets and fighting points
   2. Draw your connections showing live, neutral and ground (earth).
   3. Put on the switch and check to see that your connections are right.

C. Answer the following questions
   1. Describe the types of fuses in use for electrical installation and distribution.
   2. What sort of care is necessary to avoid electric shock while connecting or disconnecting cables?

Laboratory 3

Title: Specification and Maintenance of Electric Motors

Objectives

1. Understanding of electric motor maintenance procedures.
2. Understanding the information on motor name plate.

Notes:
Electric motors do not break down very often especially when they are property maintained. Cleaning of motor can be achieved by using solvent and brush on ports wife no windings.

Procedure

A. Name plate information
Observe and record the following information if available on motor.

Manufacturer	-	Insulation	-
Serial Number	-	Temperature rise	-
HP	-	Service factor	-
RPM	-	Phase	-
Voltage	-	Cycles	-
Amps	-	Code	-
Frame	-	Overload protector	-
Model	-	Any other information	-

B. Disassembly
1. Disassemble and clean the motor following the directions of instructor.
2. Draw a schematic of the circuitry in the motor and assemble

C. Answer the following questions
1. What are the differences between single-phase and three-phase motors and under what circumstances are the latter used?
2. Explain with diagrams, how the power factor of an induction motor can be corrected.

Laboratory No. 4
Electrical Controls-Time Switch

Objective
To understand circuits control using tone switch.

Notes: While it is possible to control electricpowerby manual switch, it is sometimes necessary to use automaticon-off devices. Example of these include, thermostat, time switch and humidstat. Theyare used when equipment is to be switched on and off without operator assistance. Examples of suchequipment include,automatic milking machines and automatic feeders for livestock.

Procedure:
A. Switch-on timer
   1. Connect a bulb to the switch-on tinier
   2. Set the timer to 5 minutes
   3. Observe the tight come on
   4. Draw the circuit diagram

B. Switch off timer
   Repeat as in A

C. Switch on and off
   1. Combine the two times and watch the light go on and off.
   2. Sketch the circuit diagram

D. Answer the following questions
   1. List 6 equipment where the use of automatic switches may be necessary
   2. Explain the operation of a thermostat.

ABE 514: Agricultural Power

Laboratory I

Title: Measurement of slippage of Traction Devices in Soils during farm operations.

Procedure:

i) To acquaint students with the phenomenon of slippage of tractor wheels and tracks in soils duringfarm field operations.
ii) To monitor the effects of slippage on field capacities of tractors during primary and secondary tillage operations.
iii) To monitor the effects of slippage on farm input operations like drilling, row crop planting, spraying and dusting and fertilizer application.

Equipment

Ploughs (disc, moldboard); harrows (off-set, tandem, rotavators), cultivators; slashers (rotary, shear);(mounted implements).

Machinery: Tractors (single axle; 2-wheel drive, 4-wheel drive, tracklayer), other Traction aids.

Facilities:

i) Floor surfaces (concrete; compacted floor, soil baths)
ii) Farm land with varying vegetative covers.

Measuring instruments:

Farm layout equipment - compass, Theodolite, ranging poles, measuring tapes; metal rule, plumb line; stop watch; staking pins and flags.

Background:

This experiment is complementary to the laboratory exercise on "Determination of soilproperties related to tractive performance of agricultural tractors". The student is advised to revise elementary soil mechanics and surveying.

Procedure:

The experiments may be carried out on model land surfaces simulating field conditions,or carried out as selected case studies in actual field operations.

a) (i) Select a land surface in addition to concrete or compacted soil surface.
(ii) Compare the measured speed with the rated speed of the machinery chosen in (4) by taking measurements on laid out plots. Record any differences observed. Record any reduction in the diameter and lug size of the Tractor wheel (if used). Describe Tractive aids on the Tractor (Tyre lugs, tracks etc). Record actual sinkage of the wheels or tracks into the soil. Describe the soil in terms of appearance, texture etc.

b) Groups' work. Case studies.
i) Select a bid out field (6); primary or secondary tillage equipment from (3) and appropriatemachinery in (4). Different soil textures and vegetative covers (or none) to be selected by different groups.

ii) Soil characteristics must be described; sinkage of Tractive devices recorded; Any previous tillage operation must be described (if any) in terms of machinery, implement, time and vegetation.
iii) Observe the Tractor rated forward speed and the effective speed of operation. Assume fieldlengths of about 100 mete wad neglecting human factor in the time consumed during operation, estimate the effect of slippage on the efficiency of the operation of the machinery-equipment combination in unto or time. Record any observation.
iv) Discuss your observation and results and suggest means of improvement in theoperation(vis-à-vis tractive device)

Note: Wheel slippage may be measured by measuring the distance travelled in 10 revolutions of thewheel when implement is in working position and when implement is raised: Percentage slippage is calculated from the difference observed.

Group work: Case study
Follow instructions in 8(b) for tertiary operations etc. by selecting planters, Harvesters, sprayers or Duster.

i) Discuss the economic or agronomic implications of soil slippage on these operations.
ii) What are the implications of soil slippage on trailing implements e.g. drills, fertilizer applicator of spreaders; and row crop planters (e.g. maize)?
iii) What ate the implications of slippage on self-propelled equipment like harvesters?

References

1. Agric. Engineers Year Book. ASAE standard:ASAE 313.1
2. Farm Machinery by Kepner et al.
3. Manufacturer's manuals for Agric. Tractors and implements.
4. Liljedahl et al tractors and their power units.

Results

i) Tractor (without implement)
Tractor: Make; Model……; Wt.....r...(kg).
Soil-describe as: Hard, Firm, Tilled or soft (sandy)
With C_a=50,30,20, 15 respective.
Tyre (Front and Rear):
Front Size:……..; Inflation Pressure.....
Rear Size:……..; Inflation Pressure……
Ballast (If added):…….(kg)

Computations:

1. What rear wheel ballast will give 10-15% slippage (optimum operation of tractor drawbar putt)?

$$R = W\left[\frac{1.2}{Cn} + 0.04\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

2. Compute rolling resistance, R,from

3. Compute Gross Tractive Pull, P, from

$$P = 0.75W\left[1 - e^{-0.3C_n^3}\right] \quad \text{..... (2)}$$

where s = slippage (for measured, 10% and 15%)

4. Compute Net pull F from

F = P – R

from equations(1 and 2)……..(3)

5. Compute tractive efficiency TE from

$$TE = (1 - s)1 - \left[\frac{\frac{1.2}{C_n} + 0.04}{0.75\left(1 - e^{-0.3C_n^3}\right)}\right] \quad \text{.....(4)}$$

Tractor with Implement in working position?
Implement: Name:……; Make……., Model……..
Size……..
Slippage …….
Compute TE (as in equation 4).
Answer questions in section A8.

Laboratory 2

Title: Tractor repair - bleeding of the fuel system

Objective: To introduce students to some of the trouble shooting procedures on the tractor.

Machinery: Tractor - Fiat 666,2WD.

Preamble: It is necessary for one to be familiar with some of the trouble shooting procedures on thefarm tractor. This familiarity with the tractor can save a lot of time on the field. One of the commonest problems encountered on Diesel engines is failure of the fuel line. It occurs frequently on the field due to the dusty working environment, and it also happens on stationary engines. Students are advised to form the habit of studying the service manuals of any machinery they have to work with at all times.

Procedure:

i) The class will be led by a tractor mechanic and an operator (driver). A discussion will be held on common problems of the engine and some quick trouble shooting that may be carried out. Topics to be discussed are:
(a)Engine hard to start, (b) engine knock
(c) engine overheating and (d) engine emitting black or grey smoke.

ii) The fuel line from the tank to the engine cylinder via the injector and nozzle will be identified. The different components from tank, filters, injector, nozzle and bleeding outlets will be dismantled and cleaned. The mechanic will lead the students through the motions of loosening pipes, loosening and cleaning filters and bleeding of the injector.

Reports

a) No written report is required
b) Students should endeavour to interact with the mechanic and operator through questions and
answers.
c) What may be responsible for problems listed in 5(i) (a -d). Discuss.

Laboratory 3

Title: Laboratory Study of the Farm Tractor.

Objectives

i) To enable students identify the various parts of the farm tractor and their functions.
ii) To help students understand the various adjustments possible on the farm tractor for differentconditions.

Equipment:

Sectioned full size tractor; parts of the tractor (in the store from scraps) put on display tables in the workshop.

Machinery: Full size tractor in working condition. (Wheel and crawler Tractors).

Facilities:

Charts of tractors (full size in various views); charts of various farm implement normally operated by the tractor; (see A3).

Background:

Operator's manual on different makes and models of farm tractors provide informationand guides to the identification, functions and manipulation of the various parts of the tractor. Also contained in the manuals are safety rules for operation, tractor specifications like tyres and pressure gauges, power (drawbar, PTO) etc, stability during operation to allow good steering, soil penetration of implements etc, specifications on fuel and lubricants; and various other adjustments.

The student is to be led through charts and live equipment and actual operation to identify the tractor parts and their uses.

Procedure:

i) The student is to be led through safety rules in operating the tractor.
   a) To prevent rearing backward during starting and m operation. (List factors that may cause rearing backward).
   b) To prevent engine knock. (List the factors that may lead to the knocking of the engine)
   c) To prevent capsizing sideways on a slope. (Describe ways of improving lateral stability).
ii) The student is to be led to identify the outlets for utilization of the Tractor power - viz PTO,
iii) hydraulic system). What is the importance of depth and load controls on the hydraulic system especially during primary and secondary tillage operations?
iv) The student should identify the various parts of the tractor engine that may cause common breakdown during field operations, e,g. on the fuel line, hydraulic, electrical, air supply, lubricants,cooling system.

List routine/periodic checks that should be carried out on these systems on the tractor. What are the advantages of using a log book for the tractor?

Note: Give model and make of Tractor References:

References

1. Tractor operator's manual (Always available with each Tractor),
2. ASAE YearBook
3. Liljedahal et al. Tractors and their Power Units.

Results

i) Tractor. Make ; Model…….. ; Power Rating.....
Weight……(kg) Minimum;……kg (Maximum);……
2WD/4WD; Steering Type ……..
Tyre sizes ……(front);……. Rear,
Throttle location.,…….. ; Gear…….
Engine compression ratio ……

ii) Outline the power transmission from the engine to the wheels or tracks, PTO and hydraulics in a block diagram. What problems may cause failure of any or all of the power outlets?

iii) Outline the fuel distribution system. How may fuel fail to reach the engine cylinder and what are symptoms of such failure.

iv) Outline the electrical distribution system from the battery to the kick-starter/flywheel. Describe any alternative to a failure in the electrical system.

v) The logbook is important to the tractor and operator.What entries might we logged in thelogbook? Discuss the importance of the information.

vi) Make an outline of the cooling system of the tractor. Discuss factors mat may cause overheating of the tractor engine.

vii) Answer 7(i).

viii) How may ballasting be used to improve traction on a soil with low bearing capacity? The front weights (detachable) can be used to improve steering, discuss.

Laboratory 4

Title: Identification and use of Hydraulic controls.

Objectives:

i) To familiarise students with the hydraulic system on Tractors.
ii) To enhance students' understanding and uses of the Tractor hydraulic system.

Facilities:

Machinery and implement: A 4W Tractor in operational condition (Rat 666) , 3-point hitch Implement (e,g. plough, planter) trailer with tipping jack.
Personnel: Tractor mechanic/operator.

Background

The hydraulic system of the farm tractor c»n1ributesmimeriselytoitsntirqeroususeson the farm apart from the drawbar hitch point. Automatic position and draft controls are made possible with the use of the hydraulics. Transportation and field uses of mountedimplements are carried out with the use of the hydraulic system. Other uses are in power steering and operation of front mounted implements.

Procedure

The operator will guide students on the identification and location of controls for the various hydraulic appliances on the tractor. Students will be shown the use of thecontrols. Demonstrations of the operation of the hydraulic system will be carried out. Students are required to make the Mowing observations:

i) The mode of operation of the different circuits - level, push button, pedal etc.
ii) The response of the tractor or implements to the operation of the controls,
iii) The general placement of the controls relative to the operator's seat.
iv) The hydraulic components in the circuit for the control system - activators, valves, type of fluid lines, etc.
v) Common problems of the hydraulic system. (With the aid of the operator - Noise, leakage etc).

Report

i) How many points of control can you identify on the tractor? Give the tractor name, make, type and power rating; and the functions of the, controls.
ii) What controls can the operator use while driving on the field? (Operations that may require the operator to watch the implement while working).
iii) Using hydraulic symbols, sketch the hydraulic circuits from an input point to the output point anto the output point from the control points in 6(1). E.g. Tipping of the Trailer, steering, lifting and lowering of hitch links, etc.
iv) Explain the following:
a) Nudging (b) Automatic position controlc) Automatic draft control
What type of direction control valves are used in each case and the type of hydraulic circuit system.
v) a) Briefly describe the response of the tractor operation to the use of the controls inploughing, ridging and planting?
b) What type of control system should the operator use during such operations.

ABE 516: Agricultural Machinery Laboratory I

Title: Field performance Evaluation of Implements and Equipment I: Field Capacity.

Objectives:

i) To enable students develop an appreciation of factors relating tp field capacity of equipment
ii) To prepare students for equipment budgeting in carrying out field operations - timeliness andequipment requirements.

Equipment

Ploughs, harrows, cultivators, slashers, planters, harvesters, ridgers, rakes etc.

Machinery: Tractor - Fiat 666/766 (4-wheel)

Facilities:

The operations can be organised as case studies in conjunction with a mechanised tarnoperation involving the faculty of Agriculture and the Department of Agricultural Engineering. Commercial farm enterprises can also serve for organising the studies. Activities can range from stumping, packing, planting, spraying to harvesting on the field

Measuring instruments: Measuring tape, stop watch

Background: The effective field capacity ,C, of a farm implement is expressed as:

$C = SWE/10$ ……... (1)

C,ha/hr, S(Speed) 5km/hr; W(Width of implement),m; E (efficiency)

The efficiency, E, is a function of various factors ranging from soil, crop, to implement and prime mover, and farm lay out The efficiency can be measured in terms of time losses due to turning at field ends, interruptions due to dogging, checks on equipment or machine breakdown.

Procedure:

a) Select a field operation (e.g. as in 5)
b) Give a description of the operation, implement, prime mover, soil, vegetation and weather whichwould also affect the machine and operator performance. Find out the following: operating speedrecommended for the operation, the designed width of implement, layout of the plot, time losses(accountable) on the operation, and overlap (where applicable).
c) From your findings, estimate the effective field capacity of the implement for the operation
(chosen).
d) On close examination, identify parts of the implement that can be expected to breakdown on thefield. Find out the reliability factors of these machine parts.

Compute an expected over all
reliability for the machine/implement Use the result to adjust results in (8.c).

e) Compare your results with previous results of other workers (if any).

Results:

1. Tillage operations -Ploughing,Harrowing, Ridging,
   - i) Implement: Name…….. : Make…….. Model..... .....
   - ii) Recommended forward speed :…….. km/hr
   - iii) Width of implement ……. (m)
   - iv) Effective width of cut ……(m)
   - v) Measured forward speed of operation.....
   - vi) Length of field (L) …… (m); width of field (W) ……. (m)
   - vii) Average time spent turning at row ends. T_a = ……. (minute) (Tabulate)
   - viii) Average time spent due to breakdowns)…… T_h……..... (minute)(Tabulate)

Calculations:

Compute $E_f = \frac{T_0}{T_e + T_h + T_a} \times 100\%$ .....,..(2)

where T_0 = Theoretical time per hectare
T_e = Effective operating time
K = Percentage of implement width actually utilized
T_h = Time lost per hectare due to interruptions
T_a = Time lost per hectare turning at row ends

2. Using result in equation (2) compute C in equation (1)
3. Compares the ratios

$$\frac{T_a}{T_e + T_h + T_a} \; and \; \frac{w}{2L + w}$$

and comment

4. How does a(v) affect the result in (2)? Explain.

*Show at least tern measurements of row end turnings; and indicate the nature of breakdown or interruption

b) Planting; spraying/Dusting; Harvesting

Equipment: Name: ..... Make: ..... Model:..., ...,
Recommended speed of operation: ..... , (krn/hr)
Operating width. No. Of rows of equipment: ....
Effective width coverage: ....
Length of field: ..... ; width of field: ....
Average time spent turning at row ends (T_a)..... ....
Average time spent due to interruptions:..... ....
Measured speed of operation: ....

Calculations:
Compute as in steps 9a (1-3) and answer the question 9a (4) accordingly.
*List the nature of interruptions.
Give reasons for reduction in width coverage (if any).

References:
Kepner et al. Principle of Farm Machinery
ASAE Standard. ASAE S290.1
Manufacturers' catalogue

Laboratory 2

Title: Field performance Evaluation of Implements and Equipment II: field Efficiency

Objectives:

i) To familiarize students with the efficiency of performance of field implements on intended operations.
ii) To acquaint students with the implications of quality of performance of field equipment
iii) To introduce students to testing of new and existing farm implements.

Equipment: As in LAB 1(3)

Machinery: Tractor (4 - wheel)

Facilities:
The exercise involves actual field operations. This implies that farmland should be available under cultivation.

Measuring instruments: Steel rate; spirit level bar, measuring tape; weighing balance etc.

Background:
Performanceevaluation of equipment refers to efficiency with which it performs itsintended function. Examples are stumping, slashing, weeding, ploughing, ridging, harrowing, planting, harvesting, spraying and dusting etc. The quality efficiency will be applicable to such operations where economic losses are easily directly quantified. Examples abound in harvesting like grain and cereal harvesting. Left-overs can be estimated and attributed to performance efficiency while damages resulting in lower market values can be attributed to quality efficiency. The overall efficiency of the operation can be estimated as a product of Field Performance and quality performance efficiencies.

Procedures:

i) For selected field operations, equipment and machineries to match (Lab. 1,3 and 4), the performance and quality efficiency of the equipment/operation can be measured.
ii) For the selected field operation, list the objectives in terms of measurable quantities. (Refer to equipment manuals and farmers'guides).

Examples:

i) Ploughing - depth, soil inversion etc.
ii) Harrowing - weeding or soil pulverization, bulk density or soil particle size distribution etc.
iii) Ridging/bedding - cross -section geometry
iv) Slashing - Height of cut

v) Root harvester-misses and damages
vi) Grain/Cereal combine - field misses, machine losses etc.

iii) Describe the mechanics of operation of the equipment
iv) Suggest ways of improving the efficiency of the implement for example, additional weight can allow betterpenetration on trailed implementslike ploughs and harrows.
v) Compare differences between your observation and results with rated efficiencies of the machines.

References:

ASAE Year Book
Kepneret at, Principles of Farm

Results

a) Tillage; ploughing, Harrowing
   i) Implement: Name: ……Make:…… ; Model:……
   ii) Requirement: Depth of cut Soil particle size, soil bulk density; (underlined for ploughing)
   iii) Measured depth of cut below ground surface (D_c)…….
   iv) Comment on soil inversion
   v) Bulk density of the undisturbed soil in locality of the farm (y) bulk density oi the soilon the field after harrowing γ_h ……..
   vi) List alternative implement/equipment that may be used for the operation
   vii) Calculate performance efficiency for plough:

$$\frac{D_c}{D} \times 100\%$$

   viii) Performance index for harrowing:

$$\frac{\gamma_h}{\gamma - \gamma_h} \quad \ldots\ldots\ldots\ldots\ldots\ldots$$

b) Planting (Rowcrop); Drill, Fertilizer application.
   i) Equipment: Name…….Make……..
   Model……..,
   ii) Required: Planting distance..... ....(crop);
   Drop per stand……
   Or Dropper hectare ……..fertilizer, Grain Drill).
   iii) Recommended forward speed for operation. …….
   iv) Measured forward speed of operation. ....
   v) Observe Anting distance. ..... ;Drop per stand…….or No of misses
   vi) Calculate performance efficiency as
   1. Planting(Row)

$$E_1 = \frac{actual\ planting\ distance}{designed\ planting\ distance} \times \frac{No.\ of\ droppings}{\text{Re}qd.\ No.\ of\ droppings} \times \frac{100\%}{1}.$$

(1)

2. Grain Drill or fertilizer applicator

$$E_2 = \frac{dropping\ per\ hectare}{reqdd\ dropping\ per\ hectare} \times \frac{100\%}{1} \quad \ldots\ldots\ldots\ldots\ldots\ldots$$

(2)

3. Fertilizer applicator combined with planting:
   E_3 = Planting efficiency x Fertilizer application efficiency ……
   (3)

c) Root crop harvesters (e.g. groundnut)
   i) Equipment Name .....Make .....Model .....
   ii) Find the weight of material harvested W_1: .....
   iii) Find the weight of material missed W_2 .....
   iv) Find the weight of material damaged W_3 .....
   v) Calculate efficiency as:

$$E = \frac{W_1}{W_1 + W_2} = \frac{W_2 - W_3}{W_2} \times \frac{100\%}{1}$$

   vi) What is the significance of the following?

$$1.\ \frac{W_1}{W_1 + W_2} \quad 2.\ \frac{W_2 - W_3}{W_2}$$

   vii) Wheel slippage is an advantage to improve the efficiency, E, but leads to reduced field capacity.

d) Discuss problems of field losses on a grain combine harvester.

Laboratory 3

Title: Calibration of row crop planter

Objectives
To teach students the procedures necessary for the calibration of farm input equipmentlike row crop planters and grain drills.

Equipment and measuring instruments:
A 2-row crop planter (maize); measuring tape or ruler, beaker and weighing balance.

Background:
Correct use of farm input equipment depends on the knowledge of the factors influencingthe performance of such equipment. The allowable forward speed of the prime mover is limited by the rate of the discharge of the input material through the metering device. The rate of discharge depends on the metering device and the flow of the material. Planting density and spacing may also be regulated through the mechanism of the metering device.

Procedure:
(a) The student will be given a 2-row maize planter. The operator will describe the machine.
(b) Study the equipment noting:
(i) The hitch system (ii) type of hopper (iii) metering place (iv) discharge chute
(v) drive mechanism of the metering device (vi) any other attachment.

Report: Equipment Name……..;Make…….Model:…….

a) Make a sketch of the planter and label the important parts.
b) Describe the mechanism of transfer of the material from the hopper to the soil.
c) Sketch and give dimensions of the metering plate.
d) Sketch the drive mechanism of the metering device. (Note number of sprocket or gear teeth,diameter of land wheel), etc.
e) Show what the planting distance will be by calculation. How may the planting distance bechanged, and the mil drop?
f) (i) Fill the hopper with grain. Raise equipment land wheels above ground. Turn the wheelthrough 1,2,3……10 revolutions and record the weight of grain discharged.

	Planting density			
No. of rev.				
No. of grain				

Compute the average weight of droppings per wheel revolution. Then calculate the planting density of the grain.

(ii) What will be the field capacity of the equipment when the prime mover is moving at 2,3,4,5 km/hr?

Laboratory 4

Title: Measurement of soil Compaction

Objectives:

i) To acquaint students with the phenomenon of soil compaction resulting from the use of agricultural machinery on farm lands.
ii) To be able to estimate soil compaction
iii) To be familiar with the effects of soil compaction on machine operation and crop growth.
iv) To be able to reduce the effects of soil compaction by good sequencing of operations and selection of machinery and implements.

Implements:

Machine Crawler tractor (40, 100kW)
2 WD&4WD conventional Tractors.

Implements: Scrapper blade, Rome Plough, Rippers, Subsoiler, Harrow.

Measuring instruments:

Soil cone penetrometer, measuring cylinders and weighing balance, oven.
Farm land (University land area).

Background:

Soil compaction is undesirable disturbance of the soil, especially, with, respect to root development It is often affected by the moisture content of soil, the soil type and the pressure applied to the soil. A quick indicator of soil compaction would be its change in bulls: density.

Procedure:

i) Given facilities as in 3 (a,b,c), find the name, make and type of tractor and implement. Note the weights of the tractor-implement and the pressure distribution on the soil.
ii) Note the type of soil on the chosen site, (farm land). (Clayey, Sandy, sand/clayey loamy, etc). Make sure the chosen site for the work has uniform slope across the breadth,
iii) Measure the bulk density, moisture content and porosityof the soil along a 10m x 100m stretch at 0, 50, 100, 150, 200, 250, 300, 400, 500, 600mm.
iv) Divide the plot into ten parts of 10m length each. Allow the tractor or tractor-implementcombination to make one pass on first plot, two passes on second plot and so on so that there are ten passes on the tenth plot.
v) Repeat measurements in 5 (iii) on the each of the ten plots.
vi) Cone penetrometer measurements may be carried out as for 5 (iii and v).
vii) Allow a tillage implement to work through the soil e.g. Ripper, Rome plough etc).
viii) Repeat 5 (iii and v).

Report:

i) Machinery:
Name: …….. Make …….. Type……... Weight……....

ii) Implement- Name:…….Make……Weight…….. Working depth……...

Vertical section of the soil

iii) Soil Description:
Scope ……..; Type: ……..
Tillage (describe) ……..

iv) Results of measurements

Depth	Before traffic				After traffic				After tillage			

γ_b= bulk density (kg/m^3); m_c = moisture content (%);P=porosity %;
Cl= Cone index (N/cm^2).
Take two readings for Yb, p and CI and use ttae average.

v) Plot the results in Table 6(iv) on a graph using the plot number/depth as abscissa.
vi) Record any other observation. (E.g. sinkage of tractive device etc).
vii) Show by calculation, the pressure exerted on the soil by the tractive device.
viii) Comment on the results shown in the graph of o (v)
ix) What are the implications of soil compaction on roof development and ordering field operations in landpreparation?

ABE 423 - DESIGN OF AGRICULTURAL MACHINERY LABORATORY 1

Title: Mechanism illustration study

Objectives:

1. To develop an understanding and proficiency in the interpretation of engineering assembly drawings.
2. To develop necessary proficiency in the detailing of machine elements.

Theory: Engineering drawings or illustrations are usually in the form of:

a) Orthographic projections
b) Assembly drawings
c) Perspective drawings, and
d) Cross sectioning

a) **Orthographic projection**: is an accurate measurement of the mechanism taken directly from an accurately scaled drawing. It is essential to the fabricator but not necessarily to those who need to understand its functions. The views of interest are front, side (right and/or left), top and, sometimes, back or bottom.

b) **Assembly drawing**: is an orthographic projection or several pans drawn in their intended working positions. Such drawings are important for:

i) showing how the parts are assembled
ii) determine the overall dimensions of the assembly
iii) determining the motion relations between parts.

c) **Perspective drawing** (of a part, an assembly or a machine) indicates in a single view, all the 3 dimensions -height width and depth. It is very difficult to prepare, usually not to scale and is of little value in fabrication, It, however, conveys a rapid general understanding of the nature of the part, assembly or machine. Exploded views are perspective drawings of an assembly. Parts are drawn at an appropriate distance from each other.

d) **Cross sectioning** is a particular type of assembly drawing suited for symmetrical assemblies which aid:

i) identification of different materials by their separate cross-hatching;
ii) positions of such components bearings, seals, springs, fastens.
iii) lubrication provisions, if any, and
iv) working action of the mechanism

Equipment

1. Drafting sheet
2. Drawing sets/instruments

Procedure:

1. Carefully study the drawings provided and understand the techniques used in presenting the technicalinformation.
2. Try to discover a pattern in the arrangement of parts and in the detailing.
3. Examine reference materials as may be supplied which can give added meaning.
4. Prepare drawings of parts of a machine/assembly as may be instructed.

Assignments:

Identity the labeled parts of a (cross) sectioned tractor P.T.O. clutch Assembly as shown in Figure 1

Make a proper orthographic projection of the block for the 19mm rod clamp assembly shown. Indicate the true dimensions needed to fabricate the clamp as required.

Draw logical conclusions from, the identified parts and from the drawings prepared on a summary sheet.

LABORATORY 2

Title: Schematics and calculations of Working Parts of a (grass crop) cutting machine.

Objectives:
To have a working knowledge of a cutting machine as provided
To come up with some calculations based on the various mechanisms of the machine.

Theory: There are different methods of removing grass crop materials from the field. This ranges from manual cutting and the use of motorized harvesters to the use of combine harvesters. The mechanisms involved the cutting process consist of the following:

a) power Source
b) drive urfcits
c) cutter bar
d) knife guards
e) reel
f) conveyor
g) collection unit

A definite relationship exists between the crank wheel (crankshaft), ground wheel, various gears, shears, other rotating or reciprocating parts and the power source r.p.m. which could be transmitted through the crank wheel and the Pitman.

There are two types of cutting mechanism:

i) The rotary cutter, and
ii) The reciprocating cutter

The rotary cutter has different types of cutting:- cutting by a pair of circular saw cutter or of circular grinding stone cutter or by one rotating circular saw cutter or straight blade and ledger plate.

The reciprocating cutter is a blade with the same shape (Pitch of about 50) as used for rice, wheat or cowpea reaping. The material and the resulting thickness are such that will ensure durability.

Procedure: For the cutting machine provided, proceed to:

1. Identify Reworking or moving parts
2. Determine the various proportions and ratios (of speeds) of moving parts.
3. Prepare the schematics of the moving parts.
4. Use the details of moving parts in the various calculations.

Calculations:

1. Determine the type and size of the engine used to power this unit.
2. Determine the forward speed at - rpm.
3. Determine the average forward speed

4. Determine the cutter stroke per minute
5. Determine the conveyor pulley speed in r.p.m.
6. Determine the conveyor teed rate
7. Determine the ratio of the peripheral speed to average forward speed.
8. Determine the ratio of the conveyor feed rate to average forward speed

Calculations:

1. Type and size of engine (prime mover)
   Make:
   Model:
   Engine rated r.p,m.;
   Engine Power rating (kW):

2. Forward speed range:
   a) at low r.p.m. of the engine and wheel r.p.m., determine the translational and (forward) velocity
   b) at mid-range engine r.p.m., determine the forward speed
   c) at high r.p.rn.determine the forward speed.

3. Compute the average forward speed.
4. Determine the cutter (knife) stroke per minute.

$$= RPM_{engine} \times \frac{engine pulley dia(x)}{first\ working pulley dia(A)} \times \frac{pulley connecting A(B)}{pulley with\ belt\ from B(C))} \times \frac{pulley connecting\ belt\ from C(D)}{pulley linking belt D\ and connecting\ to\ cutter bar\ linkage(E)} = strokes/\min$$

5. Conveyor Pulley speed (r.p.m.)

$$= RPM_{engine} \times \frac{X}{A} \times \frac{B}{C} \times \frac{pulley dia\ drawing\ conveyor(P)}{pulley dia\ actually engaging platform(G)} \times \frac{any other\ pulley linking\ F\ to\ G(H)}{any other\ pulley with\ bet\ from H(I)} = RPM$$

6. Conveyor teed rate

$$= RPM_{engine} \times \frac{X}{A} \times \frac{B}{C} \times \frac{ratio\ of\ \ pulley J}{ratio\ of\ \ pulley k} \times dia\ \ pulley K$$

7. Ratio of conveyor feed rate/ave forward speed

$$= (2\pi)\frac{dia\ of\ \ final\ \ pulley to\ conveyor}{ave\ \ forward\ speed}$$

Draw logical conclusions from the exercise in your write-up summary sheet.

References:

1. Principle of farm Machinery, 3rd Ed AVI, Publishers, Co.
2. ASAE Standards.

LABORATORY 3

Title- Cam Layout Problem

Objectives:

1. To have an enhanced understanding of cam mechanisms in relationship with
2. To develop some proficiency in cam design
3. To enable students plot the displacement diagrams under varying engine conditions

Theory:

Cams are curved surface mechanism that rotate to drive; (a spring-loaded)cam follower. Cain mechanisms are widely used in farm machinery to.

i) open valves in engines, controlling ignition of fuel in each cylinder.
ii) tie bales
iii) control hydraulic systems.

The transformation of any one of the simple motions, such as uniform rotation into any other arbitrarily determined irregular motion, is most conveniently accomplished by means of a Cam mechanism.

By its rotation, a Cam gives pre-determined motion to another element called the follower.In the layout of a cam mechanism it is frequently desirable to make use of a displacement diagram. The curves in the displacement diagrams are called Base Curves (modified straight-fine base curve, harmonic base curve or the parabolic base curve).

a) For a Cam layout problem, the following exercise must be accomplished:
Size of Cam determination
b) Cam profile determination
c) Off-set follower diagram instruments

Equipment:

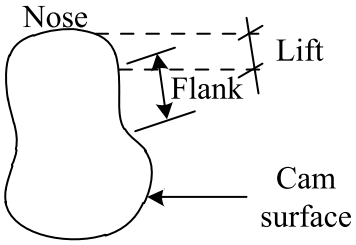
1. Drafting sheet
2. Drawing instruments

Procedure/Design problem:

This intake valve of a four-cylinder tractor engine starts to open for cylinder No. 1 at T.D.C. and closes when the crank angle is 215 degrees.

1. Design a Cam for this engine and
2. Plot the displacement diagram when the following conditions apply:
   a) Draw the Cam to three times actual size
   b) Let the radius of the base circle be 20mm
   c) Let the flanks be straight times and determine the nose radius necessary to give a lift of 12.5mm.
   d) Neglecting tappet clearance, determine graphically the lift for each 5 degree of Cam rotation. Plot the displacement diagram on cross section paper.

Keep in mind that degrees of valve openings are measured by crank angle and that the camshaft turns only one-half as fast as the crankshaft.
The following diagram will illustrate the problem



Show all calculations for obtaining the required radius for the Nose.

References

1. Principles of Farm Machinery, 3rd Edition AVI Publishers Inc.
2. Schaura's Outline Series of Machine Design.

LABORATORY 4

Title: Trajectory Experiment

Objectives:
To measure acceleration
To predict the path of a freely failing body

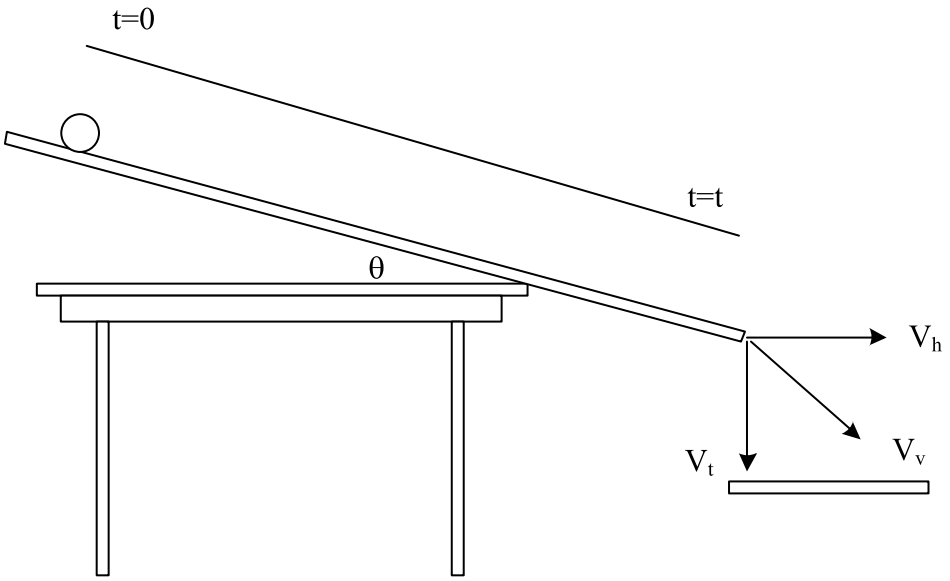
Theory:
The acceleration motions of mechanisms are important because a force is required to produce them. Newton's second law says that a force is required to cause either an acceleration or deceleration of a mass.

In farm mechanics it is more convenient to use weight in the relationship:
Where $F = w/g\ a$
F = force required
w = weight of the body being accelerated
g = acceleration due to gravity., 9.81 m/sec^2
a = acceleration experienced by the body (m/sec^2)

When a body is accelerating, it is not in a static condition.

Equipment:
1. A solid (steel) ball
2. A smooth steel surface adjustable to various angles of inclinations
3. Stop watches
4. Rules or measuring tapes .

Procedure:
1. Place the steel surface (track) on a table and adjust so that the bail will strike in a shallow sand box
2. By turning the passage of the bail along the steel track, determine the velocity V_t
3. Compute the theoretical striking position of the ball in the sandbox.
4. Ran the experiment for several angles of inclination
5. Compare the actual results with the theoretical
6. Account for any discrepancies.



Result
Prepare vow results and tabulate the resulting data as shown below

Datasheet
Test Number

Distance to track end, m (L)	1	2	3	4
Tangent of track incline				
Angle, degrees				
Height of track from sand box, m(H).				

Calculated values

Theoretical acceleration, m/sec^2 (A_t)				
Velocity at end of track, m/sec (V_t)				
Vertical component of velocity, end of track, m/sec (V_v)				
Horizontal component of velocity, end of track, m/sec (V_h)				
Time for free fall sec (t_f)				
Theoretical striking position (X_t)				.

Experimental Values

Time to track end, sees (t)				
Trial 1				
Trial 2				
Trial 3				
Average				
Actual acceleration, m/sec (A_a)				
Actual sinking position, m (X_a)				

% Error, X_a/X_t

Show all your calculations/determinations very clearly. Present your summary on summary page

ABE 527: Advanced Hydraulic Engineering

PRACTICAL I

Title: Study of Turbulent flow in Rough pipes.

Objectives: To investigate die relationship between:

1. the hydraulic gradient h_f/L and the velocity in turbulent now
2. the Darcy friction factor and Reynolds number (R,) forturbulent flow,

Equipment:

1. Test rig with pump, flow control valves, flow mster and manometers
2. Stopwatch
3. Thermometer
4. Linear measuring scale
5. Rough galvanised steel pipe section 18mm in diameter

Procedure

1. Install the rough pipe in the rig
2. Start pump and expel air from the system. The difference in manometer readings should be zero at thisstage.
3. Adjust the flow rate, Q, to the maximum possible. Allow the system to steady before taking the manometer readings, h_1 and h_2.
4. Obtain a series of Q, h_1 and h_2 readings by reduction of Q in equal steps.
5. Measure the water temperature and obtain the dynamic viscosity.
6. Plot h_f/L versus the flow velocity, V, on a log-log scale
7. Plot $\lambda$and Re on another sheet on log-log scale
8. Comment on your results.

PRACTICAL 2

Title: Determination of Roughness coefficients for an open channel

Objective:

To establish uniform flow conditions and to obtain the values of Chezy, C, and Manning's, n, for a rectangular channel.

Apparatus

1. Adjustable bed flow channel apparatus with downstream control weir
2. Constant water surety with flow regulating valve
3. Volumetric bucket
4. Depth gauge.
5. Optical level and staff
6. Stopwatch.

Procedure:

1. Note the shape of the channel cross section and measure the dimensions
2. Adjust the channel bed slope such that the flow would be subcritical i.e. $y_n > y_c$
3. For a particular maximum flow rate expected adjust the height of the downstream control weir to give aconstant depth of flow along the channel. ,
4. Allow conditions to steady and measure the flow rate, Q
5. Reduce Q, in equal stages and record the corresponding y_n values. Ensure that readings are only taken after uniform conditions have been establishe for each Q.
6. Measure the channel slope S
7. For each flow, compute the average velocity V, the hydraulic radius R, - Manning's n, and Chezy's C.
8. Plot V against $(R_{s0})^{½}$and also V against $R^{2/3}S_0^{½}$. Comment on youi1 results.

PRACTICAL 3

Title: Determination of the characteristic curves of a centrifugal pump

Objective: To establish the relationship between head, discharge, speed, power and efficiency for a single-stage centrifugal pump.

Apparatus:

1. Test rig with necessary pipework system and control valves
2. Flow meter
3. Pressure gauges
4. Variable speed motor with tacheometer
5. Dynamometer.

Procedure

1. Set the speed control of the motor to minimum and switch on the pump with the discharge isolating valve closed.
2. Open the isolating valve slowly and establish flow.
3. Hold the motor speed steady at the lowest of the speed range and reduce flow in stages using the flow control valve. For this valve position obtain readings for
   Flow rate Q
   Pump inlet head
   Pump discharge head and
   Brake load.
4. Repeat procedure No. 3 for 3 other higher speeds. Use equal incremental values such that the speed range of the motor is covered.
5. Note the pump impeller diameter
6. Plot the:
   a. Head/discharge characteristics and isoefficiency curves
   b. Brake power/discharge curves
   c. Efficiency/discharge curves
   d. The general dimensionless characteristic curver.

PRACTICAL 4

Title: Development of computer program for computing and plotting gradually varied flow in open channels.

Objectives:

1. To review the various methods for computing, and plotting gradually varied flow in open channels.
2. To develop a computer program and use it to solve an assigned problem (N. B. The problem shall be given).

ABE 522: Agricultural Lad Drainage

PRACTICAL 1

Title: Design of Drainage filter

Objective: To design sand filter for tile drains.

Equipment:

1. Sade
2. Containers for bulk soil samples
3. Set of sieves
4. Mechanical sieve shaker
5. Weighing scale

Procedure:

1. Within a specified problem area, locate 8 random points to cover the area.
2. At each point, obtain soil samples at 20cm interval to 1.2m depth. Bulk the samples obtained into a composite sample for the point.
3. Air-dry the composite samples. Perform the sieve analysis and plot the gradation curves.
4. Obtain the mean gradation curve of the 8 composite samples.
5. Design the filter material using any set of criteria you know.

PRACTICAL 2

Title: Design of a Drainage project

Objective: To design an appropriate drainage system for a given problem area.

Procedure:

1. Reconnoitre the area
2. Assess the drainage problem
3. Determine the site data required for the assignment if not already provided.
4. Propose,justify and design a drainage system for the area

NB: Students are to be divided into working groups. Information that would enable the students to complete the assignment within the available time would be provided.

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
FACULTY OF ENGINEERING AND TECHNOLOGY

ABE 524: Advanced Irrigation Engineering

PRACTICAL I

Title: Determination of Irrigation water Quality

Objectives: To determine the salinisation and sodification potentials of an irrigation water source by themeasurement of the electrical conductivity (Ec_i-value) and the concentration of some anions and cations.

Equipment

1. Conductivity meter
2. Photospectrometer
3. PH meter
4. Chemicals
5. Plastic containers for water samples

Procedure

1. Collect water samples from the water source (stream or borehole)
2. Consult the manual of the Ec_i meter and measure the Ec_i-value of the sample
3. Consult the manual of the photospectrorneter and determine the concentration of the following in thesample:Na^{+}, Mg^{2+}, Ca^{2+}, CO_3^{2-}, HCO^{3-}
4. Measure the pH of the sample Calculate:
    a. the sodium absorption ratio (SAR)
    b. the residual sodramcarbonate (RSC)
5. Classify the irrigation water using the US salinity laboratory criteria
6. Discuss the suitability of the water source for irrigation.

PRACTICAL 2

Title: Determination of soil intake (infiltration) characteristics using a double-ring infiltrometer.

Objectives:

1. To familiarize the students with the double-ring infiltrometer method of determining intake ratecharacteristics of soil.
2. To determine the parameters of the intake function of a soil.

Equipment:

1. Double ring infiltrometer
2. Metallic rule with attachment frame
3. Stopwatch
4. Calibrated container for volumetric water measurement
5. Core sampler with rammer and driving dotty
6. Jute bag matting.

Procedure

1. Drive the infiltrometer rings about 10cm into the soil. Place the jute bag matting in the inner ring.
2. Obtain a core sample of soil near theinfiitrometer for determining initial moisture content.
3. Rapidly pond both rings to about 1 2cm depth and remove the matting (The volume of water for thispurpose must be known).
4. With the stopwatch, monitor the rate of drop of water level in the inner ring; Refill the infiltrometer to about12cm depth whenever the water level drops by about 5cm. Continue the experiment until a constant infiltration rate is achieved.
5. On the same log-log paper, plot cumulative depth infiltered (cm) against time(min) and infiltration rate (cm/min) against time (min).
6. Obtain:
    a. the soil basic intake rate
    b. the parameters of the intake function

    $I = aT^b + C$

    where I is the cummulative depth infiltered (cm), t is time (min, and a, b and c are the parameters.

PRACTICAL 3

Title: Determination of soil intake characteristics by the inflow-outflow method.

Objective:

1. To familiarize the students with the Siphon tube, Volumetric bucket Parshall flumes and Steel band tape for determining soil intake characteristics of soil.
2. To determine the parameters of the intake function of a soil.

Equipment:

Siphon tube
Volumetric bucket
Parshall flumes
Steel band tape,

Procedure

1. Select the test furrow
2. Measure furrow spacing
3. Head up water in the supply ditch
4. Select test reach and install parshall flumes at the beginning and end of the reach. Measure the length of the reach.
5. Discharge non-erosive stream into the furrow using the sihpon. Measure the siphon discharge using thevolumetric bucket and stopwatch.
6. Measure the reach inflow and outflow periodically noting the times of measurements. Continue themeasurements until infiltration rate nearly attains steady state.
7. Analyse the date and evaluate the parameters of the extended Kostiakov infiltration equation

$$Z = KT + MT$$

Where Z is the infiltrated depth (cm), T is opportunity time.
K, a and M are to be evaluated.

PRACTICAL 4

Title: Evaluation of a sprinkler Irrigation System.

Objective: To evaluate the uniformity of water distribution under a sprinkler system,

Equipment

1. Centrifugal pump with inlet and outlet connection hoses and couplings
2. Sprinkler heads, risers, mains and lateral
3. Stopwatch
4. Collector cans
5. Ranging poles, tapes and optical square
6. Pressure gauge with pitot tube
7. Calibrated container for volumetric measurement.

Procedure

1. Set up the system
2. Start the pump, open the discharge gate and measure the throw of the sprinkler head to be tested.
3. Measure the sprinkler discharge rate and operating pressure. Stop pump.
4. Delineate 2 x 2m grids around the sprinkler with the riser at the centre and in such a manner as to cover theentire area of throw of the sprinkler.
5. Place the collector cans in the middle of each square formed by the grids.
6. Operate the pump and allow the sprinkler to work for about 45 minutes. Measure the sprinkler dischargerate and operating pressure again and also the catch of each collector can. Express the catch in units ofdepth (mm).
7. Calculate the coefficient of uniformity from the expression.

$$Cu = 100\left[1.0 - \frac{\sum x}{MN}\right]$$

Where M is the average value of all the catches, N is the total number of observation points and x is the numerical deviation of individual observations from the average. Comment on your result.

(b) Plot the distribution pattern (I) normal to the lateral (ii) along the lateral.

8. Assigning that the sprinklers are to be spaced 12m x 14m and mat the distribution pattern you obtained forthe single sprinkler would apply toothers:
    a. Plot as in 7(b) the (superimposed) distribution pattern for 4 overlapping sprinklers.
    b. Compare the result obtained in 8fa) and 7(b).

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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ABE 523: Rural Water Supply and Sanitation
LABORATORY EXERCISES

Laboratory 1

Title: Determination of turbidity and Odour of water

Objectives:

i) To determine the turbidity of raw and treated water samples.
ii) To determine the level of odour of a water sample.

Materials: Samples, Jackson Candle turbidirneter and stand, candle or burner. ,

Background:

Water that is not clear and which has a dirty appearance is known as turbid water. Turbidity in water is caused by suspended matter such as clay, silt; fine organic matter, planktons, colloids and microscopic organisms. Turbidity expresses the optical properties of a water sample in the sense that it causes light to be scattered arid/or absorbed while passing through the sample.Turbidity of water can be measured based on its ability to allow the passage of light through it as in the visual method employing Jackson's candle turbidimeter or its ability to scatter light (as in the instrument method e.g. use of Nephlometers).

1 standard turbidity unit = lmg/1 SiO_2

Turbidity is significant in the treatment of water for drinking purposes for aestheticconsiderations and the fact that pathogens in water can hide on the suspended matter that cause turbidity. World Health Organisation international standards for drinking water recommends that treated tap water should not have more than 5 turbidity its, while, untreated water, that will be used for drinking should not have more than 25 turbidity units.

Procedure:

Collect at least two litres each of water samples from the following sources (i) Kunrun stream (behind Agric.Engrg. Biding) (ii) the second borehole for the irrigation (Field) laboratory and (iii) the water mains in the laboratory.
Set up the Jackson candle Turbidimeter
Light the candle (or burner) and pour the water sample into the glass tube while observing the outlines of the flame beneath the glass tube. Continue pouring the sample (into the glass tube) until the outline of the flame is no longer visible.
Read the turbidity unit of the sample off the side of the turbidirneter (i.e. the glass tube).
Carry out steps 3 and 4, at least 3 times for each sample and then find an average of the turbidity valuesobtained for each sample.
Threshold odour test Materials
2 Jars each of 1 lire capacity, distilled water and 3 "innocent students, "Innocent" students refer to students with fractioning of factory (smell) senses.

Background

Water which has a distinct smell is said to be odourous. Odour in water is usually due to the presence of excessive amounts of organic and inorganic substances, like phenols and chlorides. The type of odour in water will vary with the type of substances) present in water. Odour in water can be broadly described as either objectionable or unobjectionable. Odour is measured quantitatively by the threshold odour test. The level of odour from a water sample is quantified by the threshold odour number, which is the number of times a water sample has been diluted before it loses its odour. Odour is significant in water treatment for aesthetic reasons.

Procedure

1. Give the 3 "innocent" students one sheet of paper each and ask them to copy out the short questionnaire below:
   Did you detect any odour after smelling the:
   i) Undiluted (Raw) sample YES ( )NO ( )
      Description of the nature of the odour……..
   ii) Diluted sample (1st dilution) YES( ) NO ( )
      Description of the odour……
   iii) Diluted sample (nth dilution) YES ( ) NO ( )
      Description of the odour……

2. Put 1 litre of the water sample in a jar and pass the jar round to each of the 3 "innocent? students. Then askthem to fill their response on the questionnaire they had copied earlier on.
   Note: All the 3 "innocent"students should be advised to signify as soon as they can no longer detect any odour in the sample being passed around.

3. Dilute the sample by 50% (with distilled water) and pass it round for smelling and ask them to fill theirresponse in the questionnaire. All dilutions should be announced to the students.

4. Repeat step 3 until at least two of the 3 "innocent* students stops detecting any odour. The number ofdilutions after which this happens is known as the threshold odour number of the water sample in question.

LABORATORY 2
Measurement of solids in Water

Objectives: To measure the concentration of total solids, dissolved solids and suspended solids in a water sample.

Materials: Samples, glass dish, weighing balance, hot water bath, measuring cylinder, Gooch crucible, filter paper, desiccator, conical flask.

Background
Solids are significant in water and wastewater treatment. Solids in water cause turbidity, colour,odour and taste. While solids complicate the wastewater treatment process they have a significant effect on the efficiency of wastewater treatment plants. Solids are either dissolved or suspended in water. The aggregate of both types of solids is known as total solids.

Procedure
Determination of Total Solids
1. Weigh a glass dish (W_1) g.
2. Shake the water sample thoroughly, measure 50ml of sample into a measuring cylinder and pour into theweighed glass dish. Rinse the measuring cylinder with distilled water and pour into the glass dish.
3. Evaporate, completely, the liquid content of the glass dish by boiling over a water bath.
4. Dry the residue in 3 above in an oven at 104^0C for 30 minutes, then cool in the desiccator.
5. Weigh dish + residue (W_2g).
6. Repeat steps 1 -5 at least 2 times for the sample and average your results.

Determination of Dissolved Solids
1. Filter the water sample using a Gooch crucible
2. Weigh a glass dish (W_3) g.
3. Measure 50ml of filterate into the glass dish and evaporate the liquid over a hot water bath.
4. Dry the residue in 3 above in an oven at 104^0C for 30 minutes, then cool in the desiccator.
5. Weigh the dish + residue (W_4) g.
6. Repeat steps 2-5 at least 2 times for the sample and find the average of the results.

Calculations
A. Total solids (T.S.) $= \dfrac{W_2 - W_1}{volume of\ sample evaporated} \times 10^3 (g/l)$

B. Dissolved solids (D.S.) $= \dfrac{W_4 - W_3}{volume of\ sample evaporated} \times 10^3 (g/l)$

LABORATORY 3
Determination of dissolved Oxygen in Water

Aim: To Determine the amount of free dissolved oxygen in a water sample, using the Winlder dissolved oxygentest.

Materials:
Burrete, Pipette, Manganese sulphate solution, Alkaline potassium Iodide solution, concentrated H_2SO_4, standard sodiumthiosulphate solution, starch indicator, measuring Cylinder, conical flask, stirrer, 250ml B.CX, bottle.

Background
Dissolved oxygen (P.O.) Content of water is probably one of the most important measure of water quality. This is because oxygen is fundamental to aquatic life and microorganisms mat carry out biodegradation of organic wastes in water.
The amount of dissolved oxygen in water can be measured either by an oxygen probe or by the standard wet technique known as the Winkler Dissolved Oxygen test. Chemical reactions that take place in the Winkler test are as follows:

Reaction 1: $Mn^{2+} + O_2$ MnO_2
Dissolved white precipitate

The manganese ion added to the sample combines with the dissolved oxygen in the sample to form a white precipitate, under alkaline conditions.

Reaction 2: $MnO_2 + 2I^- + 4H^+ \; Mn^{2+} + I_2 + 2H_2O$

The addition of iodide ions causes manganous oxide to react with iodide ions to form iodine, under acidic conditions.

Reaction 3: $2S_2O_3^{2-} + I_2 \xrightarrow[indicator]{starch} S_4O_6^{2-} + 2I$

The quantity of iodine liberated in reaction 2 (which is proportional to the amount of dissolved oxygen) is measured by titrating with standard sodium thiosulphate solution.

Procedure
Fill a 250 ml B.O. D, bottle with the water sample, by using a rubber hose. The spout of the hose mustalways be below the water level in the bottle to prevent aeration of the water sample. When the bottle isfilled, allow it to overflow for about 3-4 minutes, before corking it. Then check for the presence of airbubbles by inverting the bottle over and over.

Using a pipette, introduce 2ml of Manganese sulphate ($MnSO_4$) into the bottle. The end of the pipette mustbe below the water level when introducing the MnS04. Shake to ensure proper mixing.
Introduce 2ml of alkaline potassium iodide following the same procedure as in step 2 above.
Add 2ml concentrated sulphuric acid (H2S04) following the same procedure as in step 2 above.
Transfer 100ml of the sample from the B.O.D. bottle into a conical flask and titrate against sodiumthiosulphate solution, using a starch indicator, until there is a colour change to pale yellow, then add drops of starch indicator to the sample in the conical flask. Continue the titration to the end point. At the end point, there is a colour change to blue. Then record the titre value. Repeat this process again to obtain another titre value and find the average of the two values.

Calculation: Dissolved Oxygen (D.O.) Concentration in sample =

$$\frac{average\ titre\ value \times 0.2 \times 10^3}{volume\ of\ sample\ taken\ for\ titration}(Mg.\ of\ D.O/litre)$$

LABORATORY 4
Determination of Biochemical Oxygen Demand (B.O.D) of sewage Effluent

Objectives: To determine the B.O.D. of Sewage effluent on Unilorin Campus.

Materials: Incubator, 6 B.O.D, bottles, synthetic dilution water (distilled water + Nutrient solution).

Background

Biochemical oxygen demand is the rate at which dissolved oxygen (D.O.) is used up. B.O.D. is a measure matter of the amount of oxygen required by bacteria and other microorganisms during the biodegradation of organicmatter. Because different factors like light time and temperature affect the uptake of D.O. from water it is therefore necessary to standardize B.O.D. tests. It should therefore be carried out in the dark, at 20^0C for 5 days. The result oftests socarried out in the referred to as 5-day B.O.D. or B.O.D, 20^0C. B.O.D. determination helps to determine the pollution potential of any organic liquid waste material.

Procedure

1. Put the mark "XA" on 3 B.O.D. bottles and" YB" on the remaining 3 B.O.D. bottles. The letter "A" implies:after incubation. "B" implies before incubation. X and Y denotes the letters assigned to the bottles foridentification purposes.
2. Measure a given quantity, V mi, of sewage into each of the six bottles and then top the bottle up withsynthetic dilution water and mix properly.
3. Measure the D.O. concentration (D.O.) of all the bottles marked "B" by the Winkler test and put all thebottles marked "A" in a dark incubator set at 20°c for 5 days. After 5 days remove all the bottles anddetermine D.O. Concentration of the samples ($D.O._f$) using the Winkler test

Calculations

1. D.O. Concentration = Average titre value x 0.2x 103/ Volume of sample taken for titration (Mg. Of D.O./litre)
2. B.O.D. ($5,20^0$C) = D.O.i - $D.O._f$/Dilution factor, P.
   P = Volume of sample in B.O.D. bottle/ Total volume of B.O.B. bottle
   D.O.i =initial dissolved oxygen (mg/1)
   D.O.f =final dissolved oxygen (mg/1)
   Note: D.O.i and D.O.f are average values of the D.O. measured in the 3 bottles labelled "XA" and "X3"

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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ABE 544: Bioenvironmental Engineering

LABORATORY 1

Title: Design of gully control structures

Objective To design grade stabilisation structures for a gully.

Procedure

1. Using the gully map produced in Laboratory 3 ofAGE542, propose and justify the grade stabilization structures required and their location along the gully.
2. From your knowledge of the hydrology of the area, estimate the design discharge rate for the proposedstructures where applicable.
3. Produce the hydraulic and structural designs of all the proposed structures. (NB: Each working group shall be assigned different gully segment).

LABORATORY 2

Title: Irrigation Project design

Objective: To design an irrigation system for a given location.

Procedure

1. Reconnoiter the location, if possible
2. Obtain all information relevant to the project if not already provided.
3. Design an irrigation system for the area. State and justify all assumptions made.

N.B.

1. Students are to be provided
    a. The topographical map of the location
    b. Crops to be grown.
2. Students are to be divided into working groups. A working group may be restricted to the design of aparticular irrigation system or specific system component within a project

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ABE 533: Engineering Properties of Agricultural and Biological Materials

LABORATORY 1
Title: Physical Properties of Agricultural Products I: Shape and Size

Objectives: At the end of this laboratory, you will be able to do the following:

1. Measure the principal dimensions of some fruits and vegetables
2. Determine the roundness and sphericity of the products
3. Determine surface area of the products
4. Determine the overall shape of the products.

Notes: Physical characteristics of agricultural products are very important in handling the products and in the design of machinery for drying, handling, processing and storage.

Procedure

A. Roundness and Sphericity

You are supplied with

a) Garden egg
b) Tomato
c) Orange
d) Any other product

1. Draw the projection of each of the product in the natural rest position.
2. Draw the smallest circumscribing circle on the projection drawn in 1.
3. Calculate Roundness using the relationship A_p/A_c.
4. Repeat procedure Al, draw an inscribed circle and calculate roundness using the relationship E_T/NR asgiven in class
5. Repeat procedure Al and calculate roundness using the relationship r/R as given in class.
6. Compare the three results for all the products.

B. Sphericity

1. Measure the three major diameter a, b and c (as given in class) of all the products given.

$$\frac{(abc)^{1/3}}{a}$$

2. Determine sphericity using the relationship.
3. Draw the projections of the products in their natural rest position.
4. Draw the largest inscribed circle and the smallest circumscribed circle.
5. Determine sphericity with the relationship d_i/d_c (as in class)
6. Compare your results in 2 and 5.

C. Answer the following questions

1. Why do you think Roundness and Sphericity are important in handling and processing?
2. Which is easier to handle - a large sized product or a small - sized product? Why?
3. Describe the shape of each product.

LABORATORY 2:
Title: Physical Characteristics of Agricultural Products II –Volume, Density and Surface Area

Objectives: At the end of this laboratory, you will be able to do the following:

1. Determine the volume and density of product that is heavier than water,
2. Determine the volume and density of a product that is lighter than water.
3. Determine the surface area of some products.

Requirements: Fruits, vegetables, graph paper, scale , container sinker and water.

Notes: Volume, density and surface area are important parameters in the design of soils and storage bins,separation of products from undesirable materials, mechanical compression of material, grading and sorting.

A. **Procedure**

Volume and Density of heavy product.
You are supplied with 4 agricultural products that will readily sink in water, for all four products.

1. Determine the weight of product in air - W_a
2. Determine wt of container + water - W_w
3. Determine weight of container + water + product - W_T
4. Find volume of product Also find density and specific gravity of product.

B. Volumeand density of light product

You are supplied with 3 products that are lighter than water.

1. Determine weight of product in air -W_{pa}
2. Determine weight of product in water W_{pw}
3. Determine weight of sinker + product in air - W_{sa}
4. Determine weight of sinker + product in water –W_{sw}
5. Find the wt of water supplied, volume of solid and density of solid

C. Surface area

You are supplied with 3 kinds of leaves

1. Project the surface area on paper
2. Find the area of the leaves using graph paper.

D. Questions

1. In What area do you think surface area of objects are particularly useful?
2. How do you suppose you can find the volume of products that will dissolve in water?

LABORATORY 3
Physical Property of Agricultural Crops - angle of repose and angle of Internal Friction

Objectives: At the end of this laboratory, you will be able to:

1. Determine the Dynamic angle of repose of an agricultural produce.
2. Determine the static coefficient of friction for agricultural produce.

Notes: factional characteristics of agricultural crops play a big role in the design of handling and processingequipment Angle of repose and static coefficient of faction are two indices that can be used to indicate the fictional properties of crops and their definitions have been given in the class. Revise these definitions in order to get a clear distinction between these two properties.

Procedure

A. Dynamic Angle of Repose

i) You are supplied with two types of agricultural crops. Follow the instructions of 1he laboratory supervisor and use the runnel system to determine the angle of repose.

ii) You are also supplied with an emptying angle box. Use this method in obtaining the angle of repose.

iii) Compare your results. Which of these values is closest to standard values for these crops?

B. Static Coefficient of Friction

i) You are suppliedwith an incline plane method apparatus. Following the instructions of thelaboratory supervisor, determine the static coefficient of friction on
   a. plywood (along the grain)
   b. plywood (across the grain)
   c. galvanized iron sheet

C. Answer the Following Questions

i) Under what real-life situations would you think angle of repose and angle of internal friction areuseful?

ii) Under what situations do you think:
   a. a high angle of repose is an advantage?
   b a high angle of repose is a disadvantage?

LABORATORY 4

Title: The Planimeter

Objectives: At the end of tins laboratory, each student will be able to do the Mowing:

1. Identify the various parts of a planimeter
2. Test the planimeterfor reliability
3. Use the planimeterto determine area of given shapes

Apparatus: planimeter, plain paper, pencil and ruler.

Notes: A planimeter is an instrument for measuring the area of all shapes of plane figure. The area is obtained by tracing their perimeters. Area of plans and maps to any scale, sectional areas of machine drawings as well as the mean heights of line diagrams can also be obtained with the planimeter.

Procedure

A. Getting Familiar with the Planimeter

The laboratory instructor will explain to you how the planimeter is used.

1. Sketch and label the various parts of the planimeter
2. Explain in your own words how the planimeter is set up and used.

B. Test-Running the Planimeter

1. Attach the test rule as described to you. Set the planimeter as directed and determined
   area described in mm^2.
2. Find the percent difference between your measurement and the area on the test rule.
3. Draw a square of 1 x 1 cm and use the planimeter to determine the area of the square.
   Repeat for a circle of 1cm diameter.
4. Find the percentage error.

C. Answer the Following Questions

1. What are the advantages and disadvantages of using aplanimeter for area determinators
2. In what disciplines do you think the planimeter can be very useful,

LABORATORY 5
Using the Planimeterfor Area Measurements

Objectives: At the end of this laboratory, you will be able to do the following:

1. Use the planimeter to measure the projected area of some crops
2. Use the planimeter to measure the surface area of leaves.
3. Compare the effectiveness of planimeter to graph sheet method.

Apparatus: Planimeter, graph paper, pencil, fruits and leaves.

Notes: Roundness and surface area of crops and leaves are often needed. The planimeter is one instrument that can be used to quickly determine these characteristics especially where there are no other means of measurement. However, the use of the planimeter requires care because a small error of judgement can result in a larger error of measurement.

Procedure

A. **Areas of Leaves**:

1. You are supplied with three kinds of leaves with different surface areas
2. Trace the areas of the leaves on graph paper,
3. Use the planimeter to determine the area of each leaf
4. Use the graph paper to determine the area of each leaf
5. Compare your results

B. **Roundness**

1. You are supplied with three fruits.
2. On a graph paper, draw the projection of each fruit in the natural rest position.
3. Draw the smallest circumscribing circle on the projection drawn in (1)
4. Use both planimeter and graph sheet method to determine the projected area A_f. And thecircumscribing circle A_c.
5. Determine Roundness (A_p/A_c) with both methods
6. Compare your answers for the three products.

C. Surface Area of Fruits

1. You are supplied with two kinds of fruits/seeds.
2. Coat each fruit/seed with the ink supplied
3. Cover the entire fruit/seed with graph paper (You may fold the graph paper)
4. Use the graph paper squares to determine the surface area of each fruit/seed.
5. Use the parameter to determine the surface area of the fruit/seed.
6. Compare your results.

D. Answer the following questions:

1. What specific advantages do you think
    a. the planimeter has over the graph paper method?
    b. the graph paper method has over the planimeter?
2. Which method will you choose and why if:
    a. you are in the field?
    b. you are in the office?

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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ABE 535: Handling of Agricultural and Biological Materials

DESIGN PROJECT I

Title: Design of belt conveyors

Objective: To design a simple belt conveyor.

Procedure

1. Using the standard procedure, design a simple belt conveyor for handling agricultural and biological materials.
2. From your knowledge of machine design and engineering properties of agricultural and biological materials, estimate the design capacity, power requirements and prime mover selection for the proposed device where applicable.
   Produce the engineering drawing and detailed design computations of all the proposed devices.
   (NB: Each working group shall be assigned different aspect of the design).

DESIGN PROJECT II

Title: Design of screw conveyors

Objective: To design a horizontal screw conveyor.

Procedure

1. Using the standard procedure, design a horizontal screw conveyor for handling agricultural and biological materials.
2. From your knowledge of machine design and engineering properties of agricultural and biological materials, estimate the design capacity, power requirements and prime mover selection for the proposed device where applicable.
   Produce the engineering drawing and detailed design computations of all the proposed devices.
   (NB: Each working group shall be assigned different aspect of the design).

DESIGN PROJECT III

Title: Design of bucket elevators

Objective: To design a bucket elevator.

Procedure

1. Using the standard procedure, design a bucket elevator for conveying agricultural and biological materials.
2. From your knowledge of machine design and engineering properties of agricultural and biological materials, estimate the design capacity, power requirements and prime mover selection for the proposed device where applicable.
   Produce the engineering drawing and detailed design computations of all the proposed devices.
   (NB: Each working group shall be assigned different aspect of the design).

DESIGN PROJECT IV

Title: Design of pneumatic conveyors

Objective: To design a pneumatic conveyor.

Procedure

1. Using the standard procedure, design a pneumatic conveyor for handling agricultural and biological materials.
2. From your knowledge of machine design and engineering properties of agricultural and biological materials, estimate the design capacity, power requirements and prime mover selection for the proposed device where applicable.
   Produce the engineering drawing and detailed design computations of all the proposed devices.
   (NB: Each working group shall be assigned different aspect of the design).

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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ABE 536: Procesingof Agricultural and Biological Materials

LABORATORY 1
Determination of Fineness modulus and Modulus of Uniformity for feed

Objectives: At the end of this laboratory, students will be able to:
Identify a set of Tyler's sieve and a Ro-tap machine
Determine the Fineness modulus of a given ground feed
Determine the Modulus of Uniformity of ground feed.

Notes: Screening is a method used for classifying small grains or granular materials. Tyler's sieve's, which arecommonly used originated in the United states in 1910. Sieve sizes (size of opening) vary from 3.75mm to 0.07mm with a pan at the bottom. However, a standard set of seven sieves is used to classify ground feed.

Fineness modulus and modulus of uniformity are two indices that are used to classify ground feed. Theseindices have been explained to you in the classroom.

Procedure:

A. **Screening**

You have been supplied with two samples

a. Grains
b. Ground feed

i) Weigh 250g of each sample
ii) Arrange the seven standard sieves (3/8", 4,8,14,28,48,100) and the pan on the Ro-tap, pour the sample from the top and vibrate for 5 minutes.
iii) Find the percentage on each sieve

B. Calculations

i) Using an appropriate table, calculate tile fineness modulus (fm)
ii) Calculate the average size of grain (D) in inches.

$$D = 0.0041 \times 2^{fm}$$

iii) Determine the modulus of elasticity
iv) Draw a graph of screen opening versus per cent finer than screen

C. Answer the Following Questions

i) In what category will you place your two samples in terms of coarse, medium and finer in relationto:
   a. Fineness Modulus
   b. Modulus of uniformity
ii) What do you mink about this statement:
   "The tagger the animal, the coarser the feed should be"
iii) Describe how a completeTyler's sieve set look like (with the aid of diagrams)

LABORATORY 2
The Air-Screen Cleaner

Objectives: At the end of this laboratory, you will be able to do the following:
Identify a 2-screen air cleaner and its parts
Determine the percentage of separated fractions.

Notes: The air-screen cleaner is the most versatile and the most commonly used for cleaning, grading and sorting of grains and seeds. It separates on the basis of shape, size and density. The air-screen cleaner varies from small single fen, single screen types to automatic two-fan, six-screen systems,but the principle of operation is the same. The system in tins lab is a single fen, 2-screen cleaner which can be used for any of the grains depending on the type of sieves used.

Procedure:

D. Identification

i) Sketch the air-screen cleaner and label all its important parts
ii) Identify the type of screen on it and determine the size of sieve opening.
iii) Identify the type of fen used and state whether the fen system is suction or pressure.

E. Operation

i) Run the shelled maize supplied through fee machine (Note the total tome of operation). Collect the various separated fractions in different containers,
ii) Weigh each fraction and calculate the percentage weight.
iii) Describe each fraction e.g. Good seeds, split seeds, shriveled seeds, chaff; stone e.tc.

F. Answer the Following Questions

i) If a farmer decides to buy an air-screen cleaner, what manual operations do you think he will eliminate?
ii) What advantages and disadvantages would accrue to a farmer if he abandons manual cleaning for air-scree; cleaner?

LABORATORY 3
Efficiency of Shelling Systems

Objectives: At the end of this laboratory, students will be able to:

i) Compare various shelling methods
ii) Calculate the efficiencies of a shelling machine

Notes: Shelling/threshing is an important procedure in processing. It usually involves the detachment of seeds from the cob or pod.

Most small farmers shell or thresh their crops by hand. They use several systems including direct hand shelling, stick and sack method, mortar and pestle, and so on. A few farmers use hand shellers while fewer still use machines ran by electric motors or petrol/diesel engines. These machines combine shelling and pre-cleaning. In this laboratory, we are going to use three systems: manual, handsheller and motorized sheller.

Procedure:

A. Manual

i) Let a few members of the group pick some ears of maize and shell by hand. Record time of shelling. Total time of shelling is sum of individual shelling time.
ii) Weigh the amount shelled and find the "capacity" of manual shelling i.e. amount shelled per hour or pc: minute or per second.

B. Handsheller

i) Each group will be supplied with a handsheller. Repeat the experiment in A(i).
ii) Calculate the "capacity" in the same units as A(ii) lii)
iii) Find percentage difference in "capacity" relative to manual shelling.

C. Motorized Sheller

i) The motorized sheller will be used to shell a given quantity of maize. Record the time spent to finish the job.
ii) Record the following weights
   a. Total weight of shelled maize collected in pan
   b. Shelled losses - grains that are detached from the cobs but fall outside the collecting pan
   c. Unshelled losses - grains that remain on the cob (detach these manually)
iii) From (ii), calculate machine capacity and percentage losses, also find the shelling efficiency.

D. Answer the Following Questions

i) List the advantages and disadvantages of
   a. manual shelling
   b. the hand sheller
   c. the motorized Sheller
ii) Give reasons why you think local farmers might prefer any system rather than the other.

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ABE 537: Bioprocess Engineering

DESIGN PROJECT

Title: Design of biogas digesters

Objective: To design an anaerobic digestion tank for biogas production.

Procedure

1. Using the standard procedure, design a simple biogas digester.
2. From your knowledge of machine and process design, estimate the design capacity for the proposed device where applicable.
   Produce the engineering drawing and detailed design computations of all the

   proposed devices.

   (NB: Each working group shall be assigned different aspect of the design).

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ABE 538: Storage of Agricultural and Biological Materials

DESIGN PROJECT

Title: Design of silos

Objective To design metal silo for grain storage.

Procedure

1. Using the standard procedure, design a grain silo.
2. From your knowledge of structural, estimate the design capacity for the proposed device where applicable.

Produce the engineering drawing and detailed design computations of all the structural components.
(NB: Each working group shall be assigned different aspect of the design).