Practical Manual

on

Geo-informatics, Nano-technology and Precision Farming

APA 304 2(1+1)

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2020

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Rani Lakshmi Bai Central Agricultural University
Jhansi-284003

Syllabus APA 304 2 (1+1):

Introduction to GIS software, spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS. Creation of productivity and management zones. Fertilizers recommendations based of VRT and STCR techniques. Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of GPS for agricultural survey. Formulation, characterization and applications of nanoparticles in agriculture. Projects formulation and execution related to precision farming.

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Roll No. .....

Batch.....

Session.....

Semester.....

Course Name: .....

Course No. : .....

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Date: Course Teacher

INDEX

Practical No. 1

Objective: Introduction to ERDAS Imagine software.

Material Required: ……………………………………………………………………………………………

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Description:……………………………………………………………………………………………

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Conclusion:

Practical No. 2

Objective: To download various satellite data from open source web link.

Material Required: ……

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Procedure:………

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Practical No. 3

Objective: To study of visual and digital interpretation of optical imagery.

Material Required: ………………………………………………………………………………………………

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Procedure:……………………………………………………………………………………………………

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Practical No. 4

Objective: To display various band combination of satellite imagery.

Material Required: ……

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Procedure:……

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Observations:……

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Satellite	FCC Band combination	NCC Band combination	Pseudo combination
Landsat			
LISS-III			
Sentinel-2A			
MODIS			

SPOT			

Practical No. 5

Objective: To stack/de-stack satellite data.

Material Required: ……………………………………………………………………………………

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Procedure:………………………………………………………………………………………

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Observations:……

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Discussion and Conclusion:…….....

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Practical No. 6

Objective: To supervise classification and accuracy assessment of satellite data.

Material Required: ……

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Procedure:……

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Observations:……

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LU/LC type	LAT/Long-1	LAT/Long-2	LAT/Long-3	LAT/Long-4	LAT/Long-5	LAT/Long-6
Water bodies						
Fallow land						
Settlement						
Forest						
Barren land						

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Accuracy Assessment.……

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LU/LC type	Water bodies	Fallow land	Settlement	Forest	Barren land
Water bodies					
Fallow land					
Settlement					
Forest					
Barren land					

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User Accuracy: …..…….....……

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Producer Accuracy: ……

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Overall Accuracy:……

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Discussion and Conclusion:……

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Practical No. 7

Objective: To unsupervise classification of satellite data.

Material Required: ……………………………………………………………………………………………………

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Procedure:……………………………………………………………………………………………………

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Observations:……

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Class	Recode value	New value

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Histograms equalization:…….

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Discussion and Conclusion:

Practical No. 8

Objective: To generate spectral profiles of different object.

Material Required: ………

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Procedure:……

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LU/LC type	DN Value-1	DN Value-2	DN Value-3	DN Value-4	DN Value-5	DN Value-6
Water bodies						
Fallow land						
Settlement						
Forest						
Barren land						

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Spectral Profile:……

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Discussion and Conclusion:……

Practical No. 9

Objective: To study the soil mapping through multispectral satellite data.

Material Required: ……

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Procedure:……

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Observations:……

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Particulates	GPS (LAT/LONG)
Location -1	
Location -2	
Location -3	
Location -4	
Location -5	
Location -6	

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Methodology Chart:……

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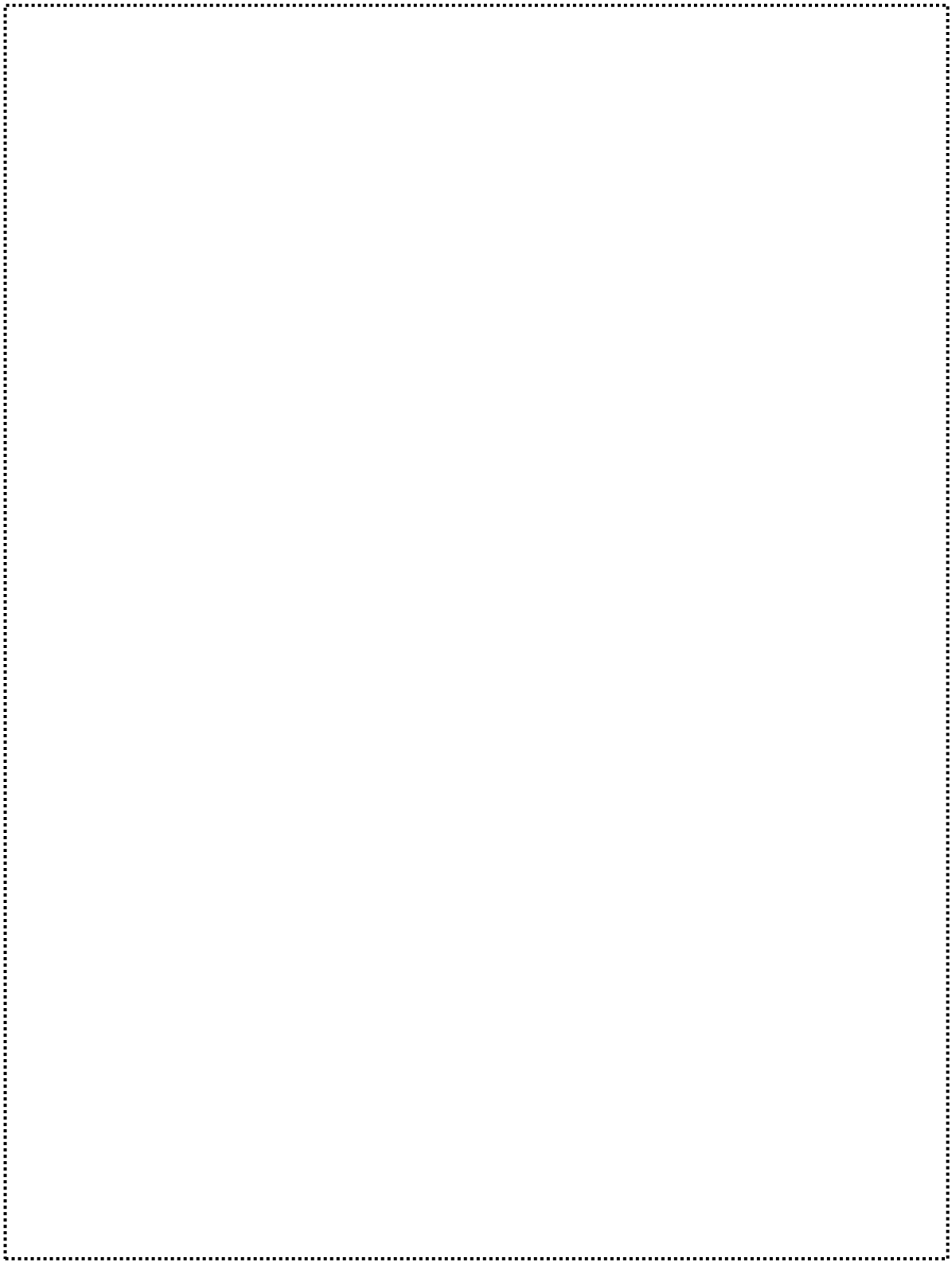

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Modelling:……

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Discussion:…………………………………………………………………………………………

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Practical No. 10

Objective: Familiarization with GIS Software Installation, sample data, starting and stopping Arc GIS.

Material Required: ……

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Procedure:……

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Observations:……

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Practical No. 11

Objective: To create various shape file using Arc GIS.

Material Required: ……………………………………………………………………………………………

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Procedure:……………………………………………………………………………………………

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Observations:……

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Practical No. 12

Objective: To view, edit, overlay using Arc GIS.

Material Required: ……………………………………………………………………………………………

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Procedure:……………………………………………………………………………………………

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Practical No. 13

Objective: To map composition of various feature class using Arc GIS.

Material Required: ……………………………………………………………………………………………

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Procedure:…………………………………………………………………………………………………

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Observations:……………………………………………………………………………………………
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Practical No. 14

Objective: To study biotic/abiotic stress crop monitoring using geospatial technology.

Material Required: ……………………………………………………………………………………………

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Procedure:…………………………………………………………………………………………………

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Methodology Chart:……

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Modelling:……

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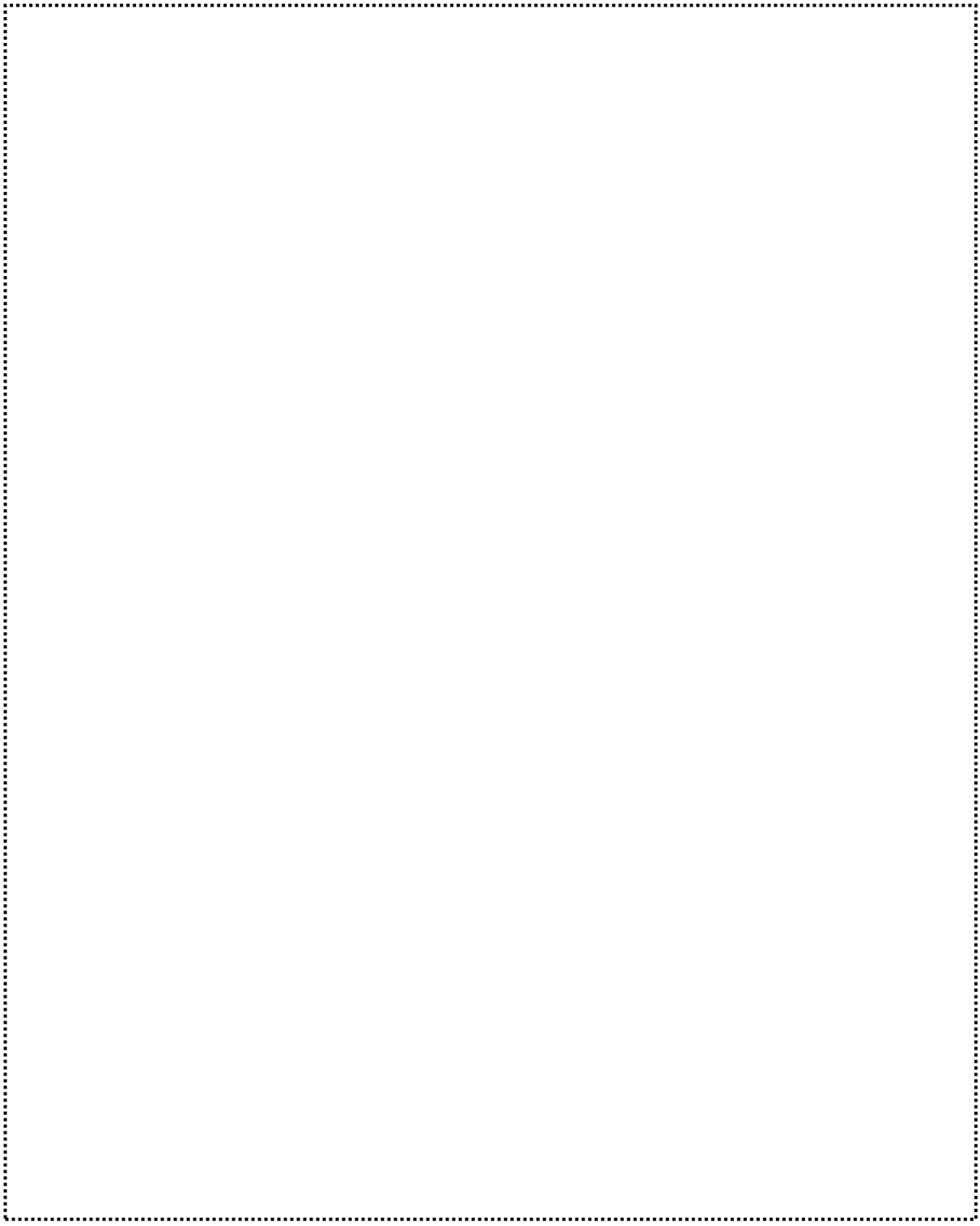

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Discussion:

Practical No. 15

Objective: To demonstrate of use of GPS for agricultural survey.

Material Required: ……………………………………………………………………………………………………

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Procedure:……………………………………………………………………………………………………

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Observations:……

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Class	**LAT/LONG**
Sample data 1	
Sample data 2	
Sample data 3	
Sample data 4	
Sample data 5	
Sample data 6	

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Discussion:……

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Practical No. 16

Objective: To view handheld GPS and their function.

Material Required: …………………………………………………………………………………………………

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Procedure:…………………………………………………………………………………………………

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Observations:……

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Class	**LAT/LONG**
Location 1	
Location 2	
Location 3	
Location 4	
Location 5	
Location 6	

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Discussion:……

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Practical No. 17

Objective: To study creation of productivity and management zones.

Material Required: ……

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Procedure:……

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Observation:……

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Discussion:……

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Practical No. 18

Objective: To study fertilizer recommendations based of VRT techniques.

Material Required: ……

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Procedure:……

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Observation:……

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Discussion:……

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Practical No. 19

Objective: To study the formulation of nanoparticles.

Material Required: ……

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Procedure:……

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Observation:……

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Discussion:……

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Practical No. 20

Objective: To study the characterization of nanoparticles.

Material Required: ……

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Procedure:……

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Observation:……

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Discussion:……

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Practical No. 21

Objective: To study applications of nanoparticles in agriculture.

Material Required: ……

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Procedure:……

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Observation:……

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Discussion:……

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Notational Conventions

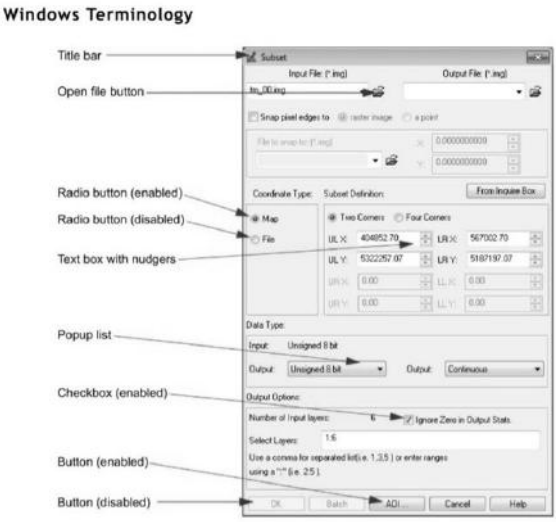
Bold Italicized Text: Any text, which is bold, indicates a ***file name***, or **parameter** to be changed or selected.

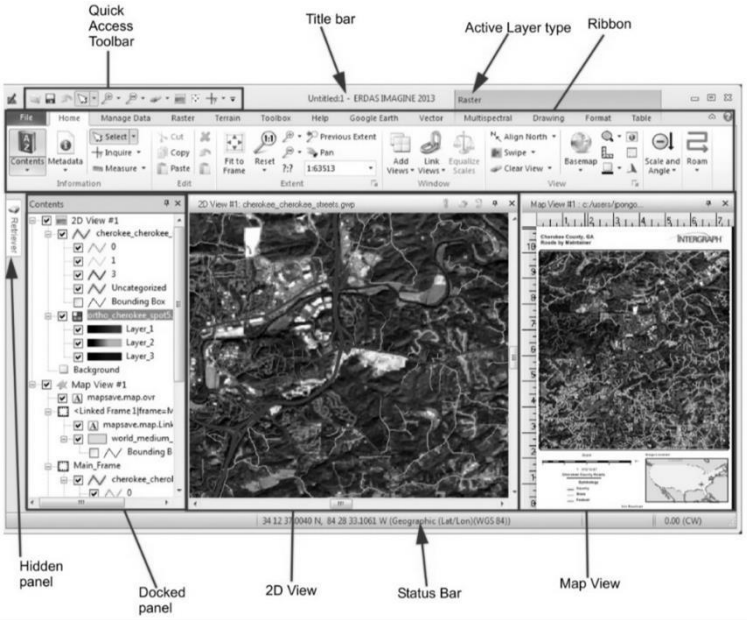
Graphics: To help you locate icons and objects used in the exercises, the icons will be next to the icon name in the text.

Insets: These italicized captions will appear in the outside margin of the page. They define terms or explain theory behind the steps you are being asked to perform.

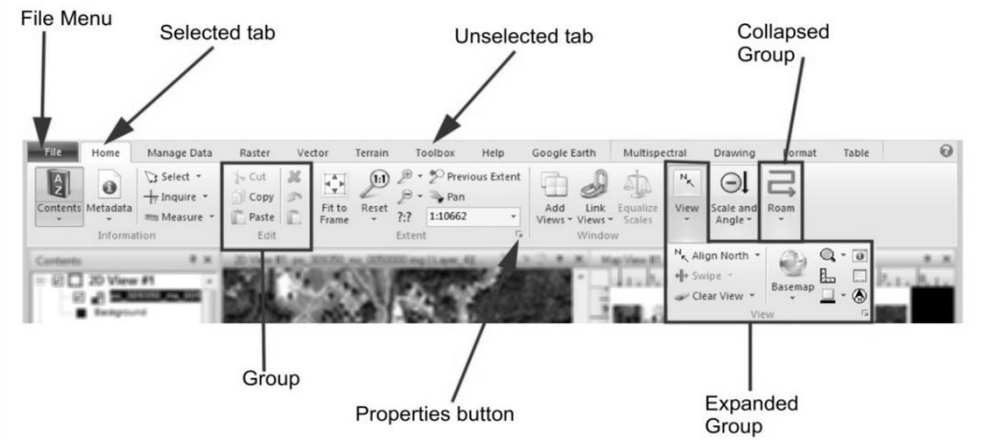
Diagrams: These are an optional means to direct you in the usage of some of the application's tools.

The following graphics are also used for particular purposes:





The Ribbon Explained



GENERAL LAB SAFETY RULES

Following rules are very important as for as concern to works in the any laboratory as mention below:

1. Before entering the lab bears the lab coat, gloves, mask and goggle etc.
2. Be sure you are aware of all safety rules instructions, procedures and fully aware of your facilities.
3. You should know about first aid kit, fire extinguishers and emergency phone numbers,
4. Keep proper distance while working in the lab and work in properly-ventilated areas.
5. Be sure after finishing your experiment, keep everything as it is
6. Never use lab equipment that you are not aware of the same.
7. End of your work switch off all electric appliances of the lab
8. Never leave an ongoing experiment without completions.
9. Never smell or taste chemicals even do not pipette by mouth.
10. If you notice any unsafe conditions in the lab, immediately inform to senior authority
11. Always keep your work area(s) tidy and clean.
12. Before leaving the lab or eating, always wash your hands.
13. Before stating experiment keep all requirements on workings bench

CHEMICAL SAFETY RULES

1. Do not allow any solvent to come into contact with your skin.
2. All chemicals should always be clearly labelled with the name and receiving date
3. Before removing any of the contents from a chemical bottle, read the instructions twice.
4. Do not put unused chemicals back into their original container.
5. New glassware items are slightly alkaline in reaction, so it should be soaked for several hours in acid water
6. Clean all glassware before use and dry in heat.
7. After cleaning, rinse the glassware with running tap water and then with distilled water.
8. After rinsing dry the glassware at 60°C to 65°C for 2 day inside the hot oven.
9. Do not blow into the pipettes as it causes moisture to condense on the inside of the pipettes.
10. Slides should be washed, placed in glacial acetic acid for 10 minutes, rinsed with distilled water, and wiped dry with clean paper towels or cloth.

SOLUTION PREPARATION

The concentration of a particular substance in the media can be expressed in various units that are as follows:

Units in weight

It is represented as milligram per litre (mg/l)

10-6 = 1.0 mg/l or 1 part per million (ppm)

10-7 = 0.1 mg/l.

10-8 = 0.001 mg/l or 1 µg/l

Molar concentration

A molar solution (M) contains the same number of grams of substance as is given by molecular weight in total volume of one litre.

1 molar (M) = the molecular weight in g/l

1 mM = the molecular weight in mg/l or 10-3 M

1 µM = the molecular weight in µg/l or 10-6 M or 10-3 mM.

Conversion from mg/l to mM

The molecular weight of $CaCl_2$ - $2H_2O$

= 40.08 + 2 x 35.453 + 4 x 1.008 + 2 x 16 = 147.018

(the atomic weights of Ca, Cl, H and O being 40.08, 35.453, 1.008 and 16.0 respectively).

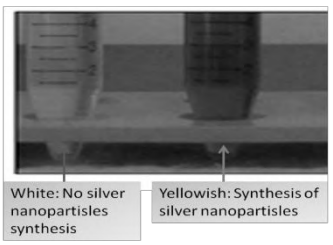
If, 440 mg/l of $CaCl_2$ - $2H_2O$ is to be converted into mM; then

The number of mM $CaCl_2$. $2H_2O$

= No. of mg $CaCl_2$ - $2H_2O$/Molecular weight of $CaCl_2$. $2H_2O$ =440/ 147.019 =2.99 mM Thus, 440 mg/l $CaCl_2$ - $2H_2O$ = 2.99 mM.

STEPS INVOLVED IN SYNTHESIS OF SILVER NANOPARTICLES

1. The plant leaves (*Arabidopsis thaliana)* were washed properly and dried the sample.
2. Nearly 1g of dried plant tissue was powdered using mortar and pestle and re-suspended in 10 mL Milli-Q water.
3. The resultant mixture was autoclaved at 121°C for 20 min and filtered the mixture using Whatman filter paper.



4. The filtrate was centrifuged at 10,000 x g for 5 min and the cell-free supernatant was taken.
5. 5 ml of plant extract was mixed with 2.5 ml of 10 mM silver nitrate aqueous solution and the volume was made up to 25 mL with Milli-Q water.
6. The mixture was incubated at room temperature (RT) (25 °C) and formation of AgNPs was monitored as indicated by a color change to yellowish brown from white solution were observed as given below in figure.

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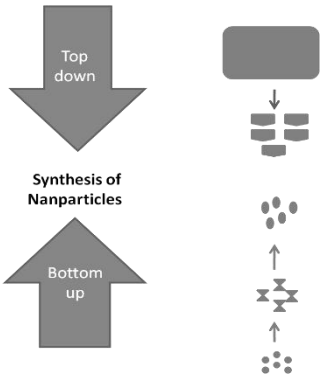
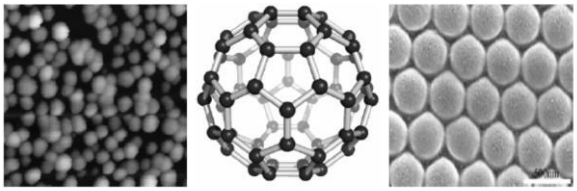
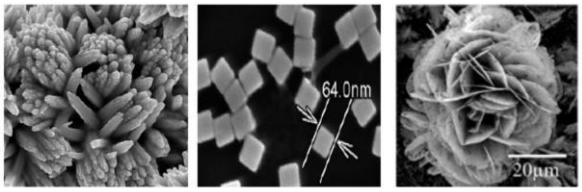
PICTORIAL REPRESENTATIONS OF SYNTHESIS OF NANOPARTICLES



MORPHOLOGIES OF NONMATERIAL

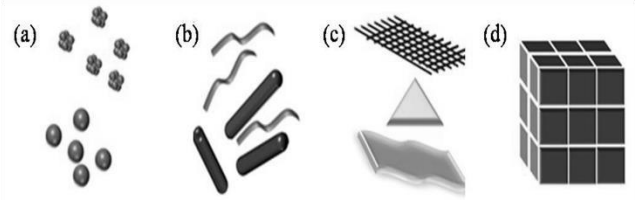


Au nanoparticle Buckminsterfullerene FePt nanosphere



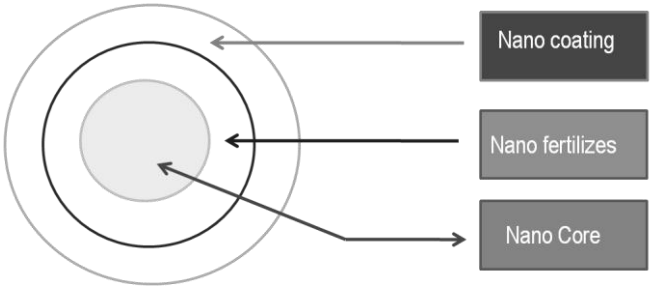
Titanium nanoflower Silver nanocubes SnO2 nanoflower

CLASSIFICATION OF NANOMATERIALS

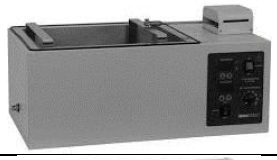
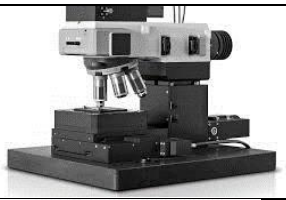


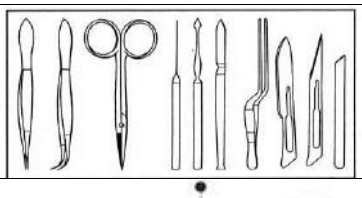
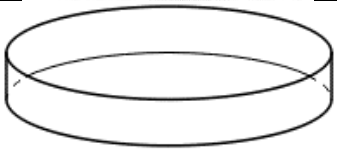
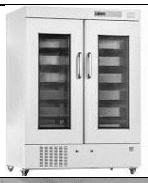
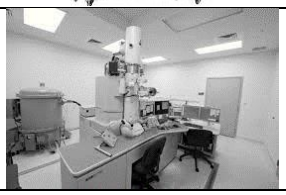
(a) 0D Spheres and clusters (b) 1D Nano fibers, wires, and rods (c) 2D Films, plates, and network (d)3D Nanomaterials

DIAGRAMMATIC REPRESENTATION 0F PREPARED NANO FERTILIZER



ESSENTIALS EQUIPMENT

1.Morter and Pestle **Use:** Crushing the samples	
2.Water bath **Use:** Heating the samples	
3.Centrifuge **Use:** Separation of biological materials	
4.pH meter **Use:** Measures the pH of solutions	
5.Micro-pipette **Use:** Measurement of small volume of solution	
6.Atomic Force Microscope **Use:** Visualizing, imaging, and manipulating the objects that are in nanometre scale	
7.Tip-box **Use:** Helps in measures the small to small volume of biological solutions	
8.Analytical Balance **Use:** Measurements of chemicals and the biological samples	
9.Conical flask **Use:** Used calibration of solution	
10. Scanning Electron Microscope **Use:** Imaging surfaces at the atomic level	

11.Spectrophotometer **Use:** Quantification of biological samples based on specific absorption	
12.Scizzers, forceps, scalpel, needle **Use:** Cutting and handling of tissue culture materials	
13. Heating block **Use:** Heating the small tube at desired temperature	
14. Blotting paper **Use:** Removing of excessive water and moistening the culture materials	
15. Plate **Use:** Culture of plant tissue materials	
16. Shakes **Use:** Provide proper aeration of culturing materials	
17.Micro-wave oven **Use:** Heating the samples	
18.Vortex shaker **Use:** Proper mixing of culturing materials	
19. Refrigerator **Use:** Store the nanoparticles	
20. Transmission Electron Microscope **Use:** Characterization and visualization of nanoparticles	

TERMINOLOGY

Artificial nanomaterials: second ones are artificial/synthetic e.g. carbon-based nanomaterials fullerene, carbon nanotubes, graphene, graphene oxide, graphene quantum dots etc.

Green synthesis: It is a field of bio-nanotechnology in which eco-friendly, nontoxic and biosafe synthesis of nano-particles from plant extracts on the basis of economic manner is called green synthesis.

Zero dimensional nonmaterial (0 D): which have all the 3 dimensions in nano scale range e.g., Spheres and clusters. (0D nonmaterial means all the dimensions are measured within the nanoscale range i.e., within 100 nm range)

One dimensional nonmaterial (1 D): which has any 1 out of 3 dimensions in nano scale range e.g., Surface films.

2 dimensional nonmaterial (2 D): which have any 2 out of 3 dimensions in nano scale range (eg. strands or fibres).

Three dimensional nonmaterial (3 D): Formed by arrangement of multiple 0D, 1D or 2D materials forming 3D structure.

Natural nanomaterials: These include nanomaterials that exist in biological systems; e.g., viruses (capsid), substances in our bone matrix, butterfly wing scales,

Nano-fertilizers: It is nutrient carrier of nano dimension range, capable of holding of large amount of nutrient ion and slowly and steady release of nutrient accordingly to the crop demand called nano-fertilizers e.g., rich vita flora, N-fertilizers etc.

Nanoparticles: A nanoparticle (or nano-powder or nanocluster or nanocrystal) is a microscopic particle with at least one dimension less than 100 nm. Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale this is often not the case.

Nano-pesticides: It is branch of nanotechnology in which small engineered structure or formulation of active ingredient created which provides pesticidal properties in nano form range is called nano-pesticides.

Nano-sciences: It is a study of basic fundamental understanding of manipulation of materials at atomic, molecular and macromolecular scale is called nanoscience.

Nanotechnology: It is a branch of technology that deals with design, production, characterizations, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanoscale dimensions to produce desired product for human welfare is called nanotechnology. For examples carbon nanotube, titanium nano flower and silver nano tube etc.

IMPORTANT QUESTIONS

1. Who has given modern concept of nanotechnology?

The Richard Feynman as the founding father of the nanotechnology. Through his famous lecture, there's plenty of room at the bottom.

2. Who was given the term of nanotechnology?

The term of nanotechnology was coined by Norio Tanguchi and according to him Nanotechnology is ability to engineer materials precisely at the scale of nanometre.

3. What is standard size range of nanoparticles?

It is from 1 nm to 100 nm

4. What is method of preparation of nanoparticles?

There are two methods, the first method is top down method and second is bottom up method.

5. What are the properties of nanoparticles?

1. Nanomaterials have a relatively larger surface area when compared to the same mass of material produced in a larger form. This can make materials more chemically reactive.
2. It exhibits quantum effects: can begin to dominate the behaviour of matter at the nanoscale particularly at the lower end – affecting the optical, electrical and magnetic behaviour of materials.
3. It shows high range of free movability
4. It has high surface energy,

6**. What are the applications of nanotechnology in agriculture?**

1. In preserving fruit and vegetables, and it helps in transporting the vegetables
2. In pesticide delivery systems through bioactive nano encapsulation
3. To detect and quantify pathogens on disease plants
4. Increasing the shelf life of vegetables and fruits and to detect herbicides doses for the field crops

7. What are the natural occurring non-materials?

Aerosol, fogs, virus and DNA diameter etc. all are coming in nano range scale.