MAHARSHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE

SEMESTER END THEORY EXAMINATION

B.Sc. (Hons.) Agriculture

MODEL ANSWER PAPER

Semester : **VI (New)** Term: **II** Academic Year: **2022-23**
Course No: **AGRO-3612** Title: **Geo-informatics and Nanotechnology and Precision Farming**
Credits : **2 (1 + 1)**
Day & Date: , / /2023 Time: Total Marks: **40**

Note: 1. Solve **ANY EIGHT** questions from **SECTION "A"**
2. All questions from **SECTION "B"** are compulsory.
3. All questions carry equal marks.
4. Draw neat diagrams wherever necessary.

SECTION "A"

Q. 1	**Define Geo-informatics and explain in short principles of Geo-informatics.**	04
Ans.	**Geo-informatics**	
	Definition: Geo-informatics as the art, science or technology dealing with the acquisition, storage, processing, production, presentation and dissemination of geo-information.	01
	Or	
	The science and technology dealing with the structure and character of spatial information, its capture, its classification and qualification, its storage, processing, portrayal and dissemination, including the infrastructure necessary to secure optimal use of this information.	
	PRINCIPLES	
	The principles of the geo-informatics are given by Ikhuoria and Rilwani 2002 as follows:	
	1. **Cartographic principles** involve map compilation, map design, and map visualization and production in analogue or digital computer environment.	03
	2. **Remote sensing** involves the acquisition of spatial data of the environment without physical contact with the objects or features being sensed by using electromagnetic energy radiation, interaction and detection principles in analogue or digital formats.	
	3. **Photogrammetric principles** involve the art and scientific processes of obtaining reliable information about the physical environment by interpreting remotely sensed aerospace data (aerial photographs and satellite imageries) in analogue or digital formats.	
	4. **Surveying principles** involve the adroit use of fundamental methods (processes)	

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	and technologies (instruments) to determine the precise position and dimensions of points (features) on the earth's surface and the presentation of the results in analogue or digital format. 5. **Global Positioning Systems (GPS)** involve precise surveying (determination of position and dimensions of points) by applying resection and satellite constellation principles and presentation of results in analogue (maps, tables) or digital formats. 6. **Geographic Information Systems (GIS)** principles involve data gathering, data processing, database management, data modeling and visualization in a digital computer environment. 7. **Automated data** capture systems include multi-spectral remote sensing processes, GPS data, map digitization and scanning, and computer input and output technologies.	
Q.2	**What is remote sensing? Give application of remote sensing in agriculture.**	04
Ans.	**Remote sensing** **Definition:** It is the process of acquiring data/information about objects/substances not in direct contact with the sensor, by gathering its inputs using electromagnetic radiation or acoustical waves that emanate from the targets of interest. **Or** It is the collection of information relating to objects without being in physical contact with them. **Remote Sensing applications in Agriculture** 1. Collection of basic data for monitoring of crop growth 2. Estimating the cropped area 3. Forecasting the crop production 4.Assessing soil moisture condition, irrigation, drainage 5. Assessing outbreak of pest and disease 6. Mapping of wastelands 7. Drought monitoring and its assessment 8. Flood mapping and damage assessment 9. Land use/cover mapping and area under forest coverage 10. Soil mapping /soil properties sensing 11. Ground water exploration	01 03

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Q. 3	**Define Nano-fertilizers and explain how nano-fertilizers are more beneficial as compared to chemical fertilizers.**	04
Ans.	**Nano-fertilizers** **Definition:** Nano-fertilizers are nutrient carriers of Nano-dimensions ranging from 30-40 nm capable of holding bountiful of nutrient ions due to their high surface area and release it slowly and steadily that commensurate with crop demand. **Nano-fertilizers are more beneficial as compared to chemical fertilizers** 1. Three times increase in Nutrient Use Efficiency (NUE). 2. 80-100 times less requirement to chemical fertilizers. 3. 10 times more stress tolerant by the crops. 4. Complete bio-source, so eco-friendly. 5. More nutrient mobilization by the plants. 6. Improvement in the crop yield. 7. Improvement in soil aggregation, moisture retention and carbon build up. 8. Improve solubility of insoluble nutrients/unavailable nutrients in soil. 9. Increase Nutrient Uptake Efficiency (NUE). 10. Reduce loss rate of fertilizer nutrients. 11. Reduce dose/quantity of nutrients and controlled slow delivery. 12. Improves soil fertility and soil productivity.	01 03
Q.4	**Define precision farming. Enlist components of the precision farming and explain any one in detail.**	04
Ans.	**Precision farming** **Definition:** It is the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production. Or It is the technique of applying the right amount of input (fertilizer, pesticide, water etc.) at the right location at the right time to enhance production, decrease input, and/or protect the environment. **Components of precision farming** **1 Global positioning system (GPS)** GPS is a navigation system based on a network of satellites that helps users to record positional information (latitude, longitude and elevation) with an accuracy of between 100	01

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	and 0.01 m. GPS allows farmers to locate the exact position of field information, such as soil type, pest occurrence, weed invasion, water holes, boundaries and obstructions. There is an automatic controlling system, with light or sound guiding panel (DGPS), antenna and receiver. GPS satellites broadcast signals that allow GPS receivers to calculate their position. The system allows farmers to reliably identify field locations so that inputs (seeds, fertilizers, pesticides, herbicides and irrigation water) can be applied to an individual field, based on performance criteria and previous input applications. Global Positioning System satellites broadcast signals that allow GPS receivers to calculate their position. This information is provided in real time, meaning that continuous position information is provided while in motion. Having precise location information at any time allows soil and crop measurements to be mapped. GPS receivers, either carried to the field or mounted on implements allow users to return to specific locations to sample or treat those areas. Uncorrected GPS signals have an accuracy of about 300 feet. **2 Sensor technologies** Various technologies such as electromagnetic, conductivity, photo electricity and ultra sound are used to measure humidity, vegetation, temperature, texture, structure, physical character, humidity, nutrient level, vapour, air etc. Remote sensing data are used to distinguish crop species, locate stress conditions, identify pests and weeds, and monitor drought, soil and plant conditions. Sensors enable the collection of immense quantities of data without laboratory analysis. **3 Geographic information system (GIS)** This system comprises hardware, software and procedures designed to support the compilation, storage, retrieval and analysis of feature attributes and location data to produce maps. GIS links information in one place so that it can be extrapolated when needed. Computerized GIS maps are different from conventional maps and contain various layers of information (e.g. yield, soil survey maps, rainfall, crops, soil nutrient levels and pests). GIS is a kind of computerized map, but its real role is using statistics and spatial methods to analyse characters and geography. A farming GIS database can provide information on filed topography, soil types, surface drainage, subsurface drainage, soil testing, irrigation, chemical application rates and crop yield. Once analyzed, this information is used to understand relationships between the various elements affecting a crop on a specific site.	03

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4 Grid soil sampling and variable-rate fertilizer (VRT) application

Variable-rate technologies (VRT) are automatic and may be applied to numerous farming operations. VRT systems set the rate of delivery of farm inputs depending on the soil type noted in a soil map. Information extrapolated from the GIS can control processes, such as seeding, fertilizer and pesticide application, herbicide selection and application at a variable rate in the right place at the right time. VRT is perhaps the most widely used PFS technology in the United States. Grid soil sampling uses the same principles of soil sampling but increases the intensity of sampling. Soil samples collected in a systematic grid also have location information that allows the data to be mapped. The goal of grid soil sampling is a map of nutrient needs, called an application map. Samples may be collected for more than one area of a field which fall in to the same range of yield, soil colour, etc. and thus the same zone. Grid soil samples are analyzed in the laboratory, and an interpretation of crop nutrient needs is made for each soil sample. Then the fertilizer application map is plotted using the entire set of soil samples. The application map is loaded into a computer mounted on a variable-rate fertilizer spreader. The computer uses the application map and a GPS receiver to direct a product-delivery controller that changes the amount and/or kind of fertilizer product, according to the application map.

5 Crop management

Satellite data provide farmers a better understanding of the variation in soil conditions and topography that influence crop performance within the field. Farmers can, therefore, precisely manage production factors, such as seeds, fertilizers, pesticides, herbicides and water control, to increase yield and efficiency.

6 Soil and plant sensors

Sensor technology is an important component of precision agriculture technology and their use has been widely reported to provide information on soil properties and plant fertility/water status. One of the most popular ways to characterize soil variability is surveying the field with soil apparent electrical conductivity (ECa) sensors that collect information continuously when pulled over the field surface. Because ECa is sensitive to changes in soil texture and salinity, these sensors provide an excellent baseline to implement site-specific management.

7 Rate controllers

Rate controllers are devices designed to control the delivery rate of chemical inputs such as

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fertilizers and pesticides, either liquid or granular. These rate controllers monitor the speed of the tractor/sprayer traveling across the field, as well as the flow rate and pressure (if liquid) of the material, making delivery adjustments in real-time to apply a target rate. Rate controllers have been available for some time and are frequently used as stand-alone systems.

8 Precision irrigation in pressurized systems

Recent developments are being released for commercial use in sprinkler irrigation by controlling the irrigation machines motion with GPS based controllers. In addition to motion control, wireless communication and sensor technologies are being developed to monitor soil and ambient conditions, along with operation parameters of the irrigation machines (i.e. flow and pressure) to achieve higher water application efficiency and utilization by the crop. These technologies show remarkable potential but further development is needed before they become commercially available.

9 Software

Applying precision agriculture technologies will frequently require the use of software to carry out diverse tasks such as display-controller interfacing, information layers mapping, pre and post processing data analysis and interpretation, farm accounting of inputs per field, and many others. The most common are software to generate maps (e.g. yield, soil); software to filtering collected data; software to generate variable rate applications maps (e.g. for fertilizer, lime, chemicals); software to overlay different maps; and software to provide advanced geostatistical features.

10 Yield monitor

Yield monitors are a combination of several components. They typically include several different sensors and other components, including a data storage device, user interface (display and key pad), and a task computer located in the combine cab, which controls the integration and interaction of these components. The sensors measure the mass or the volume of grain flow (grain flow sensors), separator speed, ground speed, grain. In the case of grains, yield is continuously recorded by measuring the force of the grain flow as it impacts a sensible plate in the clean grain elevator of the combine.

In all yield monitors, GPS receivers are used to record the location of yield data and create yield maps. Other yield monitoring systems include devices used in forage crops to keep track of weight, moisture, and other information on a per-bale basis.

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Q.5	**What is Global Positioning System (GPS)? Explain in short its components and functions.**	04
Ans.	**Global Positioning System (GPS)** It is automatic computer based device used for space and land based information system to determine precise position data.	01
	It is a satellite-based navigation system, consisting of more than 20 satellites and several supporting ground facilities, which provides accurate, three dimensional position, velocity and time, 24 hours a day, everywhere in the world and in all weather conditions. **GPS Components** 1. GPS Antenna: Antennae come in many shapes and sizes and its basic function is to receive the GPS Signal. Position data is interpreted based on antenna location. 2. GPS Receivers: There are many different types of GPS having uncorrected data needs post processed for atmospheric interferences. In differential GPS signal is corrected as data is acquired, requires an additional satellite or second receiver. Basic function of GPS receiver is to decode the signal retrieved by the antenna 3. GPS Display and Storage: Records and reports are displayed and stored by GPS display and storage components. GPS data is available to the user numerically and graphically. Data can be integrated with the receiver or provided by handheld or laptop, computer. 4. Interface: Proprietary protocol is unique to receiver manufacturer. Standardized protocol allows data exchange between many devices or interfacing with other devices 5. DGPS : is essentially a system to provide positional corrections to GPS signals. 6. GPS Ground Control Stations/Control Segment : uses measurements collected by the monitor stations to predict the behavior of each satellites orbit and atomic clocks. Prediction data is linked up to the satellites for transmission to users. 7. GPS Satellites/Space segment: The space segment includes the satellites and the rockets that launch the satellites from Cape Canaveral in Florida, U.S. Satellite are orientate the points of solar panels towards the sun and antennas towards the earth. Each satellite contains four atomic clocks.	03
	GPS functions includes : 1. **Giving a location:** Its ability to accurately triangulate your position based on the	

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	data transmissions from multiple satellites. It will give your location in coordinates, either latitude and longitude or UTMs (Universal Transverse Mercators). Developed by the **military,** UTMs are **used to pinpoint a location on a map.** 2. **Point –to-point Navigation :** This GPS navigation feature allows you to add waypoints to your trips. By using a map, the co-ordinates of a road or the point where you are standing, you can create a point to point route to the place where you are headed. 3. **Plot Navigation:** This feature in a GPS allows you to combine multiple waypoints and move point to point. Once you reach the first waypoint, the GPS can automatically point you on your way to the next one. 4. **Keeping track of your track:** Tracks are some of the most useful functions of Portable Navigation Systems. You can map where you have already been. This virtual map is called a track and you can programme the GPS system to automatically drop track-points as you travel, either over intervals of time or distance.	
Q. 6	**Define Nano-technology. Give its applications in agriculture.**	04
Ans.	**Nano-technology** **Definition:** It is the understanding and control of matter at dimensions between 1 and 100 nanometers (nm), where unique phenomenon enable novel applications. **Or** "Nano" means one-billionth, thus nanotechnology deals with materials measured in a billionth of a meter. **Applications of nano-technology in agriculture** 1. Persistence of pesticides in initial stage of crop controls the pest effectively. 2. The use of active ingredients on the applied surface remains is the most cost-effective and versatile means of controlling insect pests. But adverse weather affect the persistency of pesticide. 3. Hence, Nano-encapsulation technique is used to improve the insecticidal value. (Nano-encapsulation comprises nano-sized particles of the active ingredients being sealed by a thin-walled sac or shell) 4. Nano- encapsulation of insecticides, fungicides or nematicides help in producing formulation which effectively control of pests and prevent residues in soil.	01 03

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	5. Developing a target specific herbicide molecule encapsulated with nano-particle is aimed at specific receptor in the roots of target weeds, which enter into roots system and translocated to parts that inhibit glycolysis of food reserve in root system. 6. In rainfed areas, application of herbicides with insufficient soil moisture may lead to loss as vapour however, controlled release of encapsulated herbicides is expected to take care of the competing weeds with crops. 7. One nano-surfactant based on soybean micelles has been reported to make glyphosate-resistant crops susceptible to glyphosate when it is applied with the 'nanotechnology-derived surfactact. 8. Use of bio-nanosensors specific to contaminating pollen can help alert the possible contamination and reduces contamination. 9. Tracking of old seeds could be done with the help of nano-bar codes that are encodable, machine - readable, durable and sub-micron sized taggants. 10. Nano-coating of seeds using elemental forms of Zn, Mn, Au, Ag will protect seeds. 11. Seeds can also be imbibed with nano - encapsulations with specific bacterial strain termed as Smart seed (reduce seed rate, ensure right field stand and improved crop performance). 12. Metal oxides nano-particles and carbon nano-tube improve the germination of rainfed crops.	
Q.7.	**What is STRC approach ? Give its importance in precision farming.**	04
	It is prescribe (recommended) fertilizer doses for a given crop based on soil test values to achive the targeted yields in a specific agroclimatic region under irrigation or protective irrigated conditions by using mathematical equations for different crops and different agro climatic zones seperately. **Importance in precision farming.** 1.Increase in yield 2. Saving of inorganic fertilizers 3.Maintanance of soil health 4.Optimum management practices 5. Accelerated awareness 6.Higher economic feasibility **(Explanation is necessary)**	01 03

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Q.8	**Define Crop model. Enlist the various types of model and explain any one in detail.** Enlist various types of Models and explain simulation Model	04
Ans.	**Crop model** **Definition:** It is a simple representation of a crop. Crop models are tools of systems research which help in solving problems related to crop production. **Types of Models** 1. **Statistical models** 2. **Mechanistic models** 3. **Deterministic models** 4. **Stochastic models** 5. **Dynamic models** 6. **Static models** 7. **Simulation models** 8. **Descriptive model** 9. **Explanatory model** 1. **Simulation models**: Computer models, in general, are a mathematical representation of a real world system. One of the main goals of crop simulation models is to estimate agricultural production as a function of weather and soil conditions as well as crop management. These models use one or more sets of differential equations, and calculate both rate and state variables over time, normally from planting until harvest maturity or final harvest. 2.	01 03
Q. 9	**What is Nano-pesticide? State the formulations of nano-pesticides and its advantages.**	04
Ans.	**Nano-pesticides** **Definition:** Nano-pesticides are defined as any formulation that includes elements of nm size range and/or claims novel properties associated with these small size range. **Or** Nano-pesticides are plant protection chemicals, in which either the active ingredient or the carrier molecule is developed through nanotechnology.	01

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	Formulations of Nano-pesticides 1. **Nano-emulsions:** In this formulation active ingredient of the chemical is dispersed as nanosized droplets in water, with surfactant molecules confinedat the pesticide-water interface 2. **Nano-suspension:** They are formulated by dispersing the pesticide as solid nanosized particles in aqueous media . 3. **Polymer based nano-particles:** Polymer-based pesticide nanocarriers are majorly deployed in the slow and controlled release of active ingredients to the target site. 4. **Nano-encapsulation:** This confines the hydrophobic or hydrophilic active ingredient, surrounded by a polymer coating or membrane. 5. **Nanospheres:** These are homogeneous vesicular structures, in which thebioactive ingredient is uniformly dispersed throughout the polymer matrix. 6. **Nanogels:** These are also known hydrogel nanopartciles. These are formulated by cross linking of polymeric particles having hydrophilic groups 7. **Nano-fibres:** developed through electrospinning, thermal induced phase separation **Advantages of Nano-pesticides:** 1. Improved solubility of active ingredients. 2. Better stability of formulation 3. Slow release of active ingredient 4. Improved mobility 5. Higher surface area and Uniform leaf coverage 6. Improve pesticide utilization 7. Nano-formulations improve adhesion of droplets to plant surface 8. Eco-friendly approach	03
Q.10	**Write short notes on (Any two):**	04
Ans.	1. **Soil mapping** **Definition:** Soil mapping is the process of delineating natural bodies of soils, classifying and grouping the delineated soils into map units, and capturing soil proper information for interpreting and depicting soil spatial distribution on a map. **Purposes of soil mapping**	02

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- Synthesize the key properties of the soils in a single document using a set of codifications and legends that allow a rapid interpretation of the results.
- Describe the distribution of soil units, grouped under more or less generalized or detailed concepts, at a suitable working scale.
- Provide a graphic document which synthesizes the inventory and/or evaluation of the soil units and their corresponding distribution over the land.
- Contribute to the dissemination of knowledge about soils and their spatial distribution and properties. The soil map is often the only document allows a non-specialist access to soil information.
- Allow rapid access to soil information. As a specific, visual, synthetic and bi-dimensional representation of the soils of a specific area, the soil map should facilitate access to information which will enable rational use of the soil data provided. 02

2. Constraints of precision farming in India

- Small land holding: More than 58 percent of operational holdings in the country less than 1ha. In Punjab, Rajasthan, Haryana and Gujrat more than 20 per cent of agricultural lands have operational holding more than 4 ha.
- Heterogeneity of cropping systems and market imperfections
- Complexity of tools and techniques requiring new skills
- Lack of technical expertise knowledge and technology 02
- Infrastructure and institutional constraints including market imperfections
- High cost

3. Soil-cum-Plant Analysis Based SSNM approaches

- In this case, nutrient availability in the soil, plant nutrient demands for a higher target yield (not less than 80% of Ymax), and RE of applied nutrients are considered for developing fertilizer use schedule to achieve maximum economic yield of a crop variety.
- In order to ascertain desired crop growth, not limited by apparent or hidden huger of nutrients, soil is analyzed for all macro and micronutrients well before sowing.

Total nutrient requirement for the targeted yield and RE are estimated with the help of documented information available for similar crop growing environments.

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	SECTION "B"	
Q.11	**Write full form of**	04
	1. GIS - Geographic Information System 2. VRT- Variable Rate Technology 3. HVI - Hyperspectral Vegetation Indices 4. IRS - Indian Remote Sensing Satellite	
Q.12	**Fill in the blanks:**	
	1.) **Image processing** is an act of examining image for the purpose of identifying objects and judging their significance 2) **GIS** is powerful set of tools for collecting, storing, and retrieving the data. 3) Size of nano particle is **1 to 100 nm** 4) **Yield monitors** are crop yield measuring devices installed in harvesting equipment.	

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