IX. List of Practicals

S.No.	Topic	No of Practicals
1.	Case studies of Mechanization in India	1
2.	Case studies of Mechanization in SAARC countries	1
3.	To find mechanization index.	1
4.	Relation between productivity and mechanization in India and Punjab.	1
5.	Relation between productivity and mechanization in developed countries.	1
6.	Levels of mechanization in cereal crops like paddy, Wheat etc.	1
7.	Levels of mechanization in Horticulture crops	1
8.	Levels of mechanization in cotton crop and pulses and oilseed crops	1
9.	Design of traffic lanes-field geometry and generating guideline lanes for operation of machinery.	1
10.	Planning use of multiple machinery-sugarcane harvesting system.	1
11.	Measurement of soil compaction due to heavy machinery using cone penetrometer.	1
12.	Machine vision system design–case studies.	1
13.	Machine vision system design–case studies.	1
14.	Unmanned agricultural ground vehicles (UAGVs) for different applications like spraying, imaging etc.	1
15.	Challenges in development of robotic machinery in agricultural operations-case studies.	1
16.	Developments in livestock and building control: Radio telemetry systems to remotely monitor and record physiological parameters.	1
	Total	**16**

X. Suggested Reading

- Chen G. (ed). 2018. *Advances in Agricultural Machinery and Technologies*. Boca Raton: CRC Press, https://doi.org/10.1201/9781351132398.
- Edwards GTC, Hinge G, Skou-Nielsen N and Villa-Henriksen A. 2017. *Route Planning Evaluation of a Prototype Optimized in Field Route Planner for Neutral Material Flow Agricultural Operations*. *Biosystems Engineering* **153**: 149-157. https://www.sciencedirect.com/science/article/pii/S1537511016303713.
- Seyyedhasani H. 2017. *Using the Vehicle Routing Problem* (*VRP*) *to Provide Logistic Solutions in Agriculture*. Ph.D. dissertation. University of Kentucky, Kentucky, USA. https://www. researchgate.net/publication/264791116_Advances in Agricultural Machinery Management A Review.
- Srivastava A K. 2006. *Engineering Principles of Agricultural Machines*. 2nd Edition American Society of Agricultural and Biological Engineers (ISBN) 1-892769-50-6 ASAE Publication 801M0206.

I. Course Title : Advances in Machinery for Precision Agriculture

II. Course Code : FMPE 602

III. Credit Hours : 2+1

IV. Aim of the course

Detailed study of the hardware system used in precision agriculture (PA) and techniques of using them in precision agriculture.

V. Theory

Unit I

Global navigation satellite system (GNNS). Satellite ranging: Accuracy, standards,

components of GIS, data layers, map component, attribute table component, function of a GIS, resolution. Data formats: Vector or raster. GIS for precision farming, data analysis, field calculator, convert to grid, interpolation, reclassification, image classification, band math, interpretation of analysis, farm management information systems, and crop intelligence.

Unit II

Yield Monitors: Components, Differential GPS Receiver, GNSS Receiver, mass flow sensors. Impact plates, measuring volume with a photoelectric sensor. Using microwave radiation, and Gamma rays to estimate volume, volumetric flow sensing and alternatives. Grain moisture sensor, fan speed sensor, elevator speed sensor, header position, yield monitor data, cotton yield monitors.

Unit III

Sources of soil variability, general soil sampling basics, systematic variability, selecting a soil sampling strategy. Parameters: Electrical conductivity, electromagnetic sensors, sensing mechanical impedance. Proximal plant sensing systems, crops canopy reflectance and fluorescence. Machine vision thermal sensors, mechanical sensors, acoustic sensors.

Unit IV

Remote sensing platforms: Aircraft or satellite. Sensors: Imaging or non imaging, active or passive. Making use of reflected energy or emitted energy. The spectral signature of vegetation, vegetation indices, application to agriculture, nutrient management, weed management, disease and insect management, water management.

VI. Practical

Simple programming for automating precision farming calculations. Mathematics of longitude and latitude. Spatial statistics, soil sampling and understanding soil testing results for precision farming, calculations. Supporting management zones, understanding soil, water and yield variability in precision farming. Developing prescriptive soil nutrient maps, essential plant nutrients, fertilizer sources, and application rates calculations. Deriving and using an equation to calculate economic optimum fertilizer and seeding rates cost of crop production.

VII. Learning outcome

Ability to understand design and operate PA systems.

VIII. Lecture schedule

S.No.	Topic	No. of Lectures
1.	Introduction about Global navigation satellite system (GNNS	1
2.	Satellite ranging including accuracy, standards etc.	1
3.	Differential GNSS Receiver, RTK etc.	1
4.	Components of GIS, data layers, map component,	1
5.	Attribute table component, function of a GIS, resolution.	1
6.	Data formats: Vector or raster.	1
7.	GIS for precision farming, data analysis, field calculator, convert to grid,	1
8.	Interpolation, reclassification, image classification, band math and interpretation of analysis.	1

S.No.	Topic	No. of Lectures
9.	Farm management information systems, and crop intelligence.	1
10.	Introduction about Yield monitors and its components	1
11.	Mass flow and impact plate sensors, measuring volume with a photoelectric sensor. Lecture 12: Microwave radiation and Gamma rays to estimate volume,	1
12.	Different types of grain moisture sens	1
13.	Fan speed sensor, elevator speed sensor, header position, yield monitor data,	1
14.	Yield monitors for non-grain crops	1
15.	Sources of soil variability, general soil sampling basics, systematic variability Lecture 17: Selecting a soil sampling strategy.	1
16.	Proximal and remote sensing based soil sensors	1
17.	Electromagnetic based sensors for soil electrical conductivity measurement	1
18.	Sensing mechanical impedance based sensors for soil compaction	1
19.	Spectroscopy for determination of soil properties	1
20.	Introduction about proximal plant sensing systems	1
21.	Remote sensing platforms: Aircraft or satellite.	1
22.	Type of plant sensors: Imaging or non imaging, active or passive.	1
23.	Use of reflected or emitted energy for vegetation detection	1
24.	The spectral signature of vegetation, vegetation indices, application to agriculture	1
25.	Sensing system for nutrient management,	1
26.	Crops canopy reflectance and fluorescence.	1
27.	Machine vision thermal sensors, mechanical sensors, acoustic sensors	1
28.	Sensors for weed detection and management	1
29.	Sensing Techniques for disease and insect management,	1
30.	Different type of sensors/devices for water management.	1
	Total	**30**

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Simple programming for automating precision farming calculations	1
2.	Mathematics of longitude and latitude	1
3.	Spatial and temporal statistics using GIS	1
4.	Soil sampling strategies, understanding and results for precision farming	1
5.	Creation of management zones	1
6.	Measurement of yield variability in the field	1
7.	Measurement of soil Compaction in the field	1
8.	Measurement of soil EC in the field	1
9.	Measurement of soil pH in the field	1
10.	Developing and understanding prescriptive soil nutrient maps	1
11.	Measurement of essential plant nutrients in the field	1
12.	Fertilizer sources, and application rates calculations	1
13.	Deriving and using an equation to calculate economic optimum fertilizer	1
14.	Calculation of optimum seeding rates for optimized returns	1
15.	Cost of crop production using precision technologies.	1
	Total	**15**

X. Suggested Reading

- Clay DE, Clay SA and Bruggeman SA. 2017. *Practical Mathematics for Precision Farming*. American Society of Agronomy, Madison, WI, USA.
- Ram T, Lohan SK, Singh R and Singh P. 2014. *Precision Farming: A New approach*. Astral International Pvt. Ltd., New Delhi, India. ISBN: ISBN 978-81-7035-827-5 (Hardbound) ISBN 978-93-5130-258-2 (International Edition).
- Shannon DK, Clay DE and Kitchen NR Newell. 2018. *Precision Agriculture Basics*. American Society of Agronomy, Inc., Madison, WI, USA.
- Singh AK and Chopra UK. 2007. *Geoinformatics Applications in Agriculture*. New India Publishing Agency, New Delhi, India.
- Van-Henten EJ, Goense D and Lokhorst C. (ed). 2009. *Precision Agriculture*. Wageningen Academic Publishers, Wageningen, Netherlands.

I. Course Title : Energy Conservation and Management in Production Agriculture

II. Course Code : FMPE 603

III. Credit Hours : 3+0

IV. Aim of the course

Detailed study of the hardware system used in precision agriculture (PA) and techniques of using them in precision agriculture.

V. Theory

Unit I

Global navigation satellite system (GNNS). Satellite ranging: Accuracy, standards, components of GIS, data layers, map component, attribute table component, function of a GIS, resolution. Data formats: Vector or raster. GIS for precision farming, data analysis, field calculator, convert to grid, interpolation, reclassification, image classification, band math, interpretation of analysis, farm management information systems, and crop intelligence.

Unit II

Yield Monitors: Components, Differential GPS Receiver, GNSS Receiver, mass flow sensors. Impact plates, measuring volume with a photoelectric sensor. Using microwave radiation, and Gamma rays to estimate volume, volumetric flow sensing and alternatives. Grain moisture sensor, fan speed sensor, elevator speed sensor, header position, yield monitor data, cotton yield monitors.

Unit III

Sources of soil variability, general soil sampling basics, systematic variability, selecting a soil sampling strategy. Parameters: Electrical conductivity, electromagnetic sensors, sensing mechanical impedance. Proximal plant sensing systems, crops canopy reflectance and fluorescence. Machine vision thermal sensors, mechanical sensors, acoustic sensors.

Unit IV

Remote sensing platforms: Aircraft or satellite. Sensors: Imaging or non imaging, active or passive. Making use of reflected energy or emitted energy. The spectral signature of vegetation, vegetation indices, application to agriculture, nutrient management, weed management, disease and insect management, water management.