Course Contents
Ph.D. in Farm Machinery and Power Engineering

I. Course Title : Advances in Farm Machinery and Power Engineering
II. Course Code : FMPE 601
III. Credit Hours : 2+1

IV. Aim of the course

To familiarize the students about modern developments in construction, design and analysis of farm machinery systems as applied in different areas of agriculture.

V. Theory

Unit I

Advances in mechanization as applicable to Indian context. Future outlook for improving agricultural productivity and reducing cost. Mechanization: Review of the applications of some of the advanced mechanization technologies and constraints in adaptability. Levels of mechanization and transition between levels.

Unit II

Sustainable mechanization management: Management of compaction of agricultural fields. Strategies to develop machinery and systems that reduce compaction. Concept of Controlled Traffic Farming (CTF) systems. Introduction of wide span mechanization to vegetable production systems to enhance productivity and sustainability.

Unit III

Optimization of production processes to minimize energy loss in agriculture. The rationale for the use of photovoltaic systems in farming. The Energy Returned on Energy Invested (EROEI) ratio as an indicator for evaluating the efficiency of renewable energy sources.

Unit IV

board sensors, computing hardware, algorithms and software. Manipulator type ag-robots: Use in food processing, dairy, horticulture, and orchard industries.

Unit V

Precision Livestock Farming (PLF): Individual identification and monitoring of animals, tractability of livestock products. Developments in livestock and building control: Radio telemetry systems to remotely monitor and record physiological parameters. Silage process and their variants. Coordination of machinery system to enhance quality of silage and forage conditioners.

VI. Practical

Case studies and presentations on: Mechanization in India-analysis of machinery data- mechanization index and relation between productivity and mechanization. Levels of mechanization in different crops. Design of traffic lanes-field geometry and generating guideline lanes for operation of machinery. Planning use of multiple

machinery-sugarcane harvesting system. Measurement of soil compaction due to heavy machinery using cone penetrometer. Machine vision system design–case studies. Challenges in development of robotic machinery in agricultural operations-case studies.

VII. Learning outcome

The students will be able to design, operate and maintain surface irrigation systems, surface and sub-surface pressurized irrigation systems, and managing crop productivity with poor quality of waters without deteriorating soil conditions.

VIII. Lecture schedule

S.No.	Topic	No. of Lectures
1.	Advances in mechanization as applicable to Indian context.	2
2.	Mechanization in large scale agricultural fields	1
3.	Mechanization in small scale agricultural fields	1
4.	Future outlook for improving agricultural productivity and reducing cost.	1
5.	Requirements of energy and fuels for machinery operations	2
6.	Case studies of the applications of some of the advanced mechanization technologies and constraints in adaptability.	2
7.	Case studies of Technology transfer mechanisms in India	1
8.	Levels of mechanization and transition between levels.	1
9.	Sustainable mechanization management.	1
10.	Management of compaction of agricultural fields.	1
11.	Strategies to develop machinery and systems that reduce compaction.	1
12.	Concept of Controlled Traffic Farming (CTF) systems.	1
13.	Introduction of wide span mechanization to vegetable production systems to enhance productivity and sustainability.	2
14.	Optimization of production processes to minimize energy loss in agriculture.	2
15.	The rationale for the use of photovoltaic systems in farming.	1
16.	The Energy Returned on Energy Invested (EROEI) ratio as an indicator for evaluating the efficiency of renewable energy sources.	2
17.	Machine vision system-hardware and software technologies, and machine learning and image analysis techniques.	1
18.	Unmanned agricultural ground vehicles (UAGVs)	1
19.	UAGVs instrumented mobile platform, on board sensors, computing hardware, algorithms and software.	1
20.	Manipulator type ag-robots: Use in food processing, dairy, horticulture, and orchard industries.	2
21.	Precision Livestock Farming (PLF): Individual identification and monitoring of animals, tractability of livestock products.	1
22.	Developments in livestock and building control: Radio telemetry systems to remotely monitor and record physiological parameters.	2
23.	Silage process and their variants. Coordination of machinery system to enhance quality of silage and forage conditioners.	1
24.	Silage and forage conditioners.	1
	Total	**32**

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,