

Government of Pakistan

National Vocational and Technical Training Commission

Prime Minister's Hunarmand Pakistan Program

"Skills for All"



Course Contents / Lesson Plan

Course Title: Digital and Precision Agriculture

Duration: 3 Months

Revised Edition

Trainer Name	
Course Title	Digital and Precision Agriculture
Objectives and Expectations	<p>Employable skills and hands on practice for Digital and Precision Agriculture</p> <p>This course provides a comprehensive and interdisciplinary educational opportunity tailored for individuals aspiring to embark on careers in Digital and Precision Agriculture. The primary goal of the curriculum is to furnish students with the requisite knowledge and competencies essential for the effective implementation and utilization of cutting-edge technologies in agricultural practices. Throughout the duration of this course, students will be immersed in the foundational concepts and applications of digital and precision technologies within the agricultural domain. The curriculum is meticulously crafted to empower students with a robust skill set, enabling them to adeptly apply technological advancements to enhance efficiency and productivity in farming operations.</p> <p>Expectations:</p> <p>The curriculum for Digital and Precision Agriculture aims to equip students with the knowledge and skills needed to leverage modern technology for efficient and sustainable agricultural practices.</p> <ol style="list-style-type: none"> i. Proficiency in utilizing digital and precision technologies such as sensors, GPS, and satellite imagery for data collection and analysis in agriculture. ii. Opportunities for hands-on experiences, field visits, internships, and projects to apply theoretical knowledge in real-world agricultural settings. iii. Develop problem-solving skills to address challenges in digital agriculture, considering both technological and agricultural perspectives.
Entry-level of trainees	Intermediate
Learning Outcomes of the course	<p>By the end of this course, students will be able:</p> <ul style="list-style-type: none"> ➤ To gain overview of different Precision Agriculture Technologies <ul style="list-style-type: none"> • Global Positioning System (GPS) • Yield Monitoring • Site-Specific Fertilization • Smart Irrigation Systems • Spot-Application of Pesticides • Conductivity Survey and Mapping • Unmanned Aerial Vehicles • Artificial Intelligence ➤ Acquire proficiency in various soil sampling methodologies, encompassing practical applications and considerations. ➤ Explore and known about interpolation techniques relevant to precision agriculture, understanding their significance in data analysis and decision-making. ➤ Artificial Intelligence <ul style="list-style-type: none"> • Fundamental concepts of machine learning • Overview of machine learning and deep learning • Extensive overview of traditional machine learning and deep learning methodologies • Strategies to optimize the performance of the models through hyper parameter tuning • Gain information about dataset repositories crucial for model training • Difference between classification and detection algorithms in the field of agriculture • Hands-on training session of classification algorithms in agriculture domain.
Course Execution Plan	<p>The total duration of the course: 3 months (12 Weeks)</p> <p>Class hours: 4 hours per day</p>

	<p>Theory: 20% Practical: 80% Weekly hours: 20 hours per week Total contact hours: 240 hours</p>
Companies offering jobs in the respective trade	<ol style="list-style-type: none"> 1- AgTech Startups 2- Freelancing 3- Precision Agriculture Technology Providers 4- Government agency 5- Research Institutions
Job Opportunities	<ul style="list-style-type: none"> • Digital and Precision Agriculture Specialist/Consultant • Research Assistant • Agriculture Surveyor • Freelancer
No of Students	25
Learning Place	Classroom / Lab/Ground
Instructional Resources	<ul style="list-style-type: none"> • https://www.sciencedirect.com/book/9780443189531/precision-agriculture • Precision Agriculture' 19 by John V. Stafford, ISBN: 9789086863372 • https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf <p>Digital and Precision Agriculture</p> <ul style="list-style-type: none"> • Haroon, Z., Cheema, M. J. M., Saleem, S., Amin, M., Anjum, M. N., Tahir, M. N., ... & Khan, F. (2023). Potential of Precise Fertilization through Adoption of Management Zones Strategy to Enhance Wheat Production. <i>Land</i>, 12(3), 540. • Khan, F., Zafar, N., Tahir, M. N., Aqib, M., Waheed, H., & Haroon, Z. (2023). A mobile-based system for maize plant leaf disease detection and classification using deep learning. <i>Frontiers in Plant Science</i>, 14, 1079366. • Khan, F., Zafar, N., Tahir, M. N., Aqib, M., Saleem, S., & Haroon, Z. (2022). Deep learning-based approach for weed detection in potato crops. <i>Environmental Sciences Proceedings</i>, 23(1), 6. • Haroon, Z., Cheema, M. J. M., Saleem, S., Anjum, M. N., Amin, M., Tahir, M. N., ... & Khan, F. (2022). Development of Management Zones for Site-Specific Fertilization in Mustard fields. <i>Environmental Sciences Proceedings</i>, 23(1), 1. <p>GPS Websites</p> <ul style="list-style-type: none"> • https://www.cnmoc.usff.navy.mil/Our-Commands/United-States-Naval-Observatory/Precise-Time-Department/Global-Positioning-System/Global-Positioning-System-Overview/How Stuff Works GPS: Good everyday language explanation • https://transportation.trimble.com/sites/default/files/file/2021-11/Trimble%20Gateway%20T511%20Install%20Guide.pdf <p>Videos Links</p> <ul style="list-style-type: none"> • https://www.youtube.com/watch?v=-rKJDTD4qDY • https://www.youtube.com/watch?v=9G6Ceqvpxac • https://youtu.be/xHCcWjgciec?si=u0UJwLbjhwQbxsRB

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| | <ul style="list-style-type: none">• https://youtu.be/Ilh1Vg7NPEk |
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MODULES

Weeks	Module Title	Day	Hour	Learning Units	Tasks
Week 1	Introduction to the course Overview and status of Digital and Precision Agriculture (PA)	1	1	Introduction about course	Task 1,2,3
			2	Digital Agriculture	
			3	Precision Agriculture	
			4	Basic Agriculture and different regions of Pakistan.	
		2	1	What is a Precision Agriculture? Objectives	
			2	Elements of Precision Agriculture	
			3	GPS and GIS	
			4	Auto Steering System Variable rate application	
		3	1	Introduction to Electronics	
			2	Electronics materials	
			3	Resistors, Capacitor, Inductor, Transistor, diode, Integrated circuits, Transformer, Regulator, Crystal, LEDs, batteries, Switches and potentiometer	
			4	Current, resistance and ohm's law, digital logic, Polarity, analogue vs digital	
		4	1	Introduction to Microcontrollers	
			2	Types of Microcontrollers	
			3,4	Introduction to Arduino	
		5	1-4	Environmental Benefits of Precision Agriculture	
		Week 2	Positioning systems, GPS and DGPS	1	
2,3	Discussion and evaluation of tasks				
4	What is the GPS?				-
2	1			History of the GPS	
	2			GPS Components	Task 4
	3			Global Navigation Space Systems	

			(GNSS)				
			4	Working of GPS			
		3	1	GPS Determination			
			2	Errors			
			3	Differential GPS			
			4	Application of GPS Technology			
		4	1	Data collection and visualization by using hand held GPS			
			2	Data collection and visualization by using hand held GPS	Task 5		
			3	Discussion			
			4	Spatial Reference Systems			
		5	1	Datum			
			2	Geoid			
			3	Coordinate Systems			
			4	Introduction ArcMap Software			
		Week 3	Soil Sampling	1	1	Installation of ArcMap	
					2	Introduction of ArcMap	
3	Discussion						
4	Field Visit				Task 6		
2	1			Selection of study area			
	2			Boundary Demarcation by RTK-GPS.			
	3			Discussion			
	4			Soil Sampling			
3	1			Sampling Techniques	Task 7		
	2			Traditional Sampling			
	3-4			Targeted Sampling	Task 8		
4	1			Grid based pattern established			
	2-4			Data collection from the proximal sensor	Task 9		
5	1-4						
Week 4	Interpolation Techniques			1	1	Prepared a database for Analysis	Task 10
					2-3		
		4	Collected data from different areas.				
		2	1	Interpolation Techniques			
			1-2	Lab performance	Task 11		
			3-4	IDW	Task 12		
		3	1-4	Kriging	task 13		

		4	1-2	Comparison between interpolation techniques		
			3	Discussion		
		4	Test		Task 14	
		5	1-2	Introduction to Artificial Intelligence		
			3-4	Machine Learning overview		
Week 5	Artificial Intelligence Introduction to Machine Learning	1	1	Supervised Learning		
			2	Unsupervised Learning		
			3	Reinforcement Learning		Task 15
			4	Dataset Repositories for model training, Dataset acquisition from real-field		Task 16
		2	1	Linear Regression with one variable		
			2	Cost Function Intuition		
			3-4	Gradient Descent		
		3	1-2	Learning Rate		
			3-4	Model Training Problem		Task 16
		4	1-2	How to select Learning Rate		Task 17
			3-4	Logistic Regression, Feature Scaling, Feature Engineering, Decision Boundary		
			5	1-2	Polynomial Regression	
				3	Problems Related to polynomial Regression	
			4	What is Overfitting	Task 19	
Week 6	Midterm					
Week 7	Data Collection and Training Model	1	1	Classification Overview		
			2	Classification Overview		
			3	Multiclass Classification		
			4	Multi Label Classification		
		2	1	Classification Vs. Detection		Task 17
			2	State-of-the-Art Classification and Detection Algorithm		
			3	Regularization to Prevent Overfitting		
			4	Regularized Logistic Regression		
		3	1	Artificial Neural Network (ANN)		
			2	Comparison between Human Neuron with ANN		
3	Structure of ANN					
4	Activation Function (Binary			Task 18		

			classification, Multi classification)	
		4	1 Adam Optimization	
			2 Neural Network Layers	
			3 Tensor flow Implementation	
			4 Data in Tensor flow	Task 19
		5	1 Building a Neural Network Architecture	
			2 Dense Layer Vectorized	
			3 Introduction to Google Colab, Implementation of Classification Algorithm	Task 20
			4 Implementation of detection algorithm	Task 21
Week 8	Introduction to Flutter	1	1-2 Overview of the Flutter framework	
			3 Overview of Flutter framework	
			4 Overview of Flutter framework	
		2	1 Setting up the development environment	
			2 Setting up the development environment	
			3 Understanding Dart syntax and principles	
			4 Understanding Dart syntax and principles	
		3	1 Building simple Flutter UI components	
			2 Building simple Flutter UI components	

			3	Building simple Flutter UI components			
			4	Building simple Flutter UI components Freelancing and built a CV	Task 22		
		4	1	Deep dive into Dart syntax and principles			
			2	Deep dive into Dart syntax and principles			
			3	Deep dive into Dart syntax and principles			
			4	Deep dive into Dart syntax and principles			
		5	1	Hands-on coding exercises in Dart	Task 23		
			2	Hands-on coding exercises in Dart			
			3	Hands-on coding exercises in Dart			
			4	Hands-on coding exercises in Dart			
		Week 9	Mobile App Development with Flutter - Part 2	1	1	Advanced Flutter UI components	
					2-3	Advanced Flutter UI components	
					4	Advanced Flutter UI components	Task 24
				2	1	Initial integration of Flutter UI with ML backend	
					2	Initial integration of Flutter UI with ML backend	
					3-4	Initial integration of Flutter UI with ML backend	
3	1			Initial integration of Flutter UI with ML backend	Task 25		
	2			Initial integration of Flutter UI with ML backend			
	3-4			Initial integration of Flutter UI with ML backend			
4	1			Initial integration of Flutter UI with ML backend	Task 26		
	2	Initial integration of Flutter UI with ML backend	Task 27				

			3-4	Initial integration of Flutter UI with ML backend	Task 28
		5	1	Initial integration of Flutter UI with ML backend	
			2	Initial integration of Flutter UI with ML backend	
			3-4	Initial integration of Flutter UI with ML backend	Task 29
Week 10	Integrating Machine Learning Models in Flutter	1	1	Incorporating ML models into Flutter apps	
			2	Incorporating ML models into Flutter apps	Task 30
			3-4	Incorporating ML models into Flutter apps	
		2	1	Communication between Flutter and ML backend	
			2	Communication between Flutter and ML backend	
			3-4	Communication between Flutter and ML backend	Task 31
		3	1	Testing ML model integration	
			2	Testing ML model integration	
			3	Testing ML model integration	
			4	Testing ML model integration	Task 32
		4	1	Testing ML model integration	
			2	Testing ML model integration	Task 33
			3	Testing ML model integration	
			4	Debugging and troubleshooting	Task 34
		5	1	Debugging and troubleshooting	
			2	Debugging and troubleshooting	

			3-4	Debugging and troubleshooting	Task 35
Week 11	Development of Crop Disease Detection App	1	1-4	Creating a user-friendly interface	Task 36
		2	1-4	Implementing features for capturing and processing images	Task 37
		3	1-4	Integrating ML models with the Flutter app	Task 38
		4	1-4	Comprehensive testing and debugging	
		5	1-2	Optimizing app performance	
3-4	App publication		Task 39		
Week 12	Final Exams 42 <ul style="list-style-type: none"> • Develop a study area map in ArcMap • Train a deep learning model • Create a Flutter app with a navigation drawer that allows users to navigate between different screens. 				Task 40-42

Tasks for Certificate in Digital and Precision Agriculture

Task No	Task	Description	Week
1.	Enlisting of technologies	Enlist Precision Technologies Used in Pakistan	Week 1
2.	Use of Multi-meter	Use of Multi-meter (Voltage and Current Measurements).	
3.	Breadboard wiring practice	Make a simple circuit of LED blinking on bread-board.	
4.	GPS	Using mobile GPS and hand held GPS	Week 2
5.	Datum	Enlist the different datum we are using	
6.	RTK-GPS	Demarcate the study area using RTK-GPS	Week 3
7.	Grid-pattern Establishment	10*10 grid pattern establishment.	
8.	Data Collection	Soil sampled collected by proximal sensor	
9.	Interpolation	Enlist different interpolation techniques	
10.	IDW	Note down the procedure of IDW	
11.	Kriging	Note down the procedure of Kriging and what variables are needed	Week 4
12.	Comparison	What is basic difference in IDW and Kriging	
13.	Test	Survey and mapping by yourself	
14.	Reinforcement Learning	What is reinforcement learning	Week 5
15.	Dataset Repositories	Explore different dataset repositories for model training	
16.	Real-time Data Acquisition	Collection of diverse and distinct dataset from real-field	
17.	Model Training Problems	What are the problems during model training	
18.	Learning rate (lr)	How to select the lr for achieving the maximum throughput from the applied model	Week 7
19.	Overfitting	What is overfitting and how to prevent it	
20.	Classification Vs. Detection	Difference between classification and detection algorithms from the point of view of application	
21.	Data in Tensor flow	How to import the dataset for training the AI model	
22.	Google Colab	Introduction to google colaboratory for model training	
23.	Hands-on training of classification model	Implementation of classification model	Week 9

24.	Hands-on training of detection model	Implementation of detection model	
25.	Setup Flutter Project	Create a new Flutter project and set up the necessary dependencies for integrating machine learning models.	
26.	TensorFlow Lite Integration	Integrate TensorFlow Lite into your Flutter app to enable running machine learning models on mobile devices.	Week 10
27.	Load Pre-trained Model	Use a pre-trained image detection model (such as MobileNet or SSD) and load it into your Flutter app.	
28.	Image Preprocessing	Learn and implement image preprocessing techniques to prepare the selected image for the machine learning model.	
29.	Display Results	Display the results of the image detection, including labels and confidence scores, in your Flutter app	Week 11
30.	Real-time Image Detection	Optimize the performance of your Flutter app by exploring techniques like background processing for image detection.	

**Motivational Lectures and resources
Digital and Precision Agriculture**

Precision Agriculture motivation video

<https://www.youtube.com/watch?v=-rKJDTD4qDY>

Digital Agriculture motivation video

<https://www.youtube.com/watch?v=9G6Ceqvpxac>

<https://youtu.be/xHCcWjgciec?si=u0UJwLbjhwQbxsRB>

<https://youtu.be/llh1Vg7NPEk>

MOTIVATIONAL LECTURES LINKS.

<u>TOPIC</u>	<u>SPEAKER</u>	<u>LINK</u>
How to Face Problems In Life	Qasim Ali Shah	https://www.youtube.com/watch?v=OrQte08MI90
Just Control Your Emotions	Qasim Ali Shah	https://www.youtube.com/watch?v=JzFs_yJt-w
How to Communicate Effectively	Qasim Ali Shah	https://www.youtube.com/watch?v=PhHAQEGehKc
Your ATTITUDE is Everything	Tony Robbins Les Brown David Goggins Jocko Willink Wayne Dyer Eckart Tolle	https://www.youtube.com/watch?v=5fS3rj6eIFg
Control Your EMOTIONS	Jim Rohn Les Brown TD Jakes Tony Robbins	https://www.youtube.com/watch?v=chn86sH005U
Defeat Fear, Build Confidence	Shaykh Atif Ahmed	https://www.youtube.com/watch?v=s10dzfbozd4
Wisdom of the Eagle	Learn Kurooji	https://www.youtube.com/watch?v=bEU7V5rJTtw
The Power of ATTITUDE	Titan Man	https://www.youtube.com/watch?v=r8LJ5X2ejqU
STOP WASTING TIME	Arnold Schwarzenegger	https://www.youtube.com/watch?v=kzSBrJmXqdg
Risk of Success	Denzel Washington	https://www.youtube.com/watch?v=tbnzAVRZ9Xc

* The online success stories of renowned professional can also be obtained from **Annex-II**

Workplace/Institute Ethics Guide

Work ethic is a standard of conduct and values for job performance. The modern definition of what constitutes good work ethics often varies. Different businesses have different expectations. Work ethic is a belief that hard work and diligence have a moral benefit and an inherent ability, virtue, or value to strengthen character and individual abilities. It is a set of values-centered on the importance of work and manifested by determination or desire to work hard.

The following ten work ethics are defined as essential for student success:

1. Attendance:

Be at work every day possible, plan your absences don't abuse leave time. Be punctual every day.

2. Character:

Honesty is the single most important factor having a direct bearing on the final success of an individual, corporation, or product. Complete assigned tasks correctly and promptly. Look to improve your skills.

3. Team Work:

The ability to get along with others including those you don't necessarily like. The ability to carry your weight and help others who are struggling. Recognize when to speak up with an idea and when to compromise by blend ideas together.

4. Appearance:

Dress for success set your best foot forward, personal hygiene, good manner, remember that the first impression of who you are can last a lifetime

5. Attitude:

Listen to suggestions and be positive, accept responsibility. If you make a mistake, admit it. Values workplace safety rules and precautions for personal and co-worker safety. Avoids unnecessary risks. Willing to learn new processes, systems, and procedures in light of changing responsibilities.

6. Productivity:

Do the work correctly, quality and timelines are prized. Get along with fellows, cooperation is the key to productivity. Help out whenever asked, do extra without being asked. Take pride in your work, do things the best you know-how. Eagerly focuses energy on accomplishing tasks, also referred to as demonstrating ownership. Takes pride in work.

7. Organizational Skills:

Make an effort to improve, learn ways to better yourself. Time management; utilize time and resources to get the most out of both. Take an appropriate approach to social interactions at work. Maintains focus on work responsibilities.

8. Communication:

Written communication, being able to correctly write reports and memos.
Verbal communications, being able to communicate one on one or to a group.

9. Cooperation:

Follow institute rules and regulations, learn and follow expectations. Get along with fellows, cooperation is the key to productivity. Able to welcome and adapt to changing work situations and the application of new or different skills.

10. Respect:

Work hard, work to the best of your ability. Carry out orders, do what's asked the first time. Show respect, accept, and acknowledge an individual's talents and knowledge. Respects diversity in the workplace, including showing due respect for different perspectives, opinions, and suggestions.