3. Giri, N. K. 2013. *Automobile Mechanics (SI Units)*. Khanna Publishers, Delhi.
4. Jain, S. C. and Rai, C. R. 2013. *Farm Tractor, Maintenance and Repair*. Standard Publisher and Distributers, Delhi.
5. Singh, K. 2020. *Automobile Engineering*. Standard Publisher and Distributers, Delhi.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Michigan.

Groundwater, Wells and Pumps 3 (2+1)

Objective

To make the students acquainted with the quality of ground water, equipment and methods for construction of wells, and different types of water lifting devices

Theory

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of groundwater, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells.

Darcy's law, determination of hydraulic conductivity by laboratory and field method; Groundwater hydraulics- Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells.

Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise groundwater development, safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of groundwater.

Quality of groundwater, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water.

Pumping systems: Water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump.

Practical

Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods; Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field; Study of different drilling equipment; Sieve analysis for gravel and well screens design; testing of well screen; Estimation of specific yield and specific retention; Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis Recovery method; Design of well; Study of well

losses and well efficiency; Determination of safe yield by Hill's method; Determination of various parameters on groundwater quality; Study on various types of wells; Estimation of groundwater balance; Study of various artificial ground- water recharge structures; Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump; Visit to a drilling site; Visit to a groundwater project and a river lift project.

Suggested Readings

1. Garg, S. P. 1987. *Groundwater and Tube Wells*. Oxford & IBH Publishing Co. Ltd., New Delhi.
2. Lal, R. 1993. *Irrigation Hydraulics*. Ajiwan Shiksha Sansthan, Allahabad.
3. Michael, A. M., Khepar, S. D. and Sondhi, S. K. 2008. *Water Well & Pump Engineering*. Tata Mc-Graw Hill.
4. Nagabhusaniah, H. S. 2020. *Groundwater in Hydrosphere*. CBS Publishers and Distributors, New Delhi.
5. Raghunath, H. M. 2007. *Groundwater*. New Age Publications, New Delhi.
6. Todd, D. K. and Mays, L. W. 2011. *Groundwater Hydrology*. John Wiley & Sons, New York.

Sensors, Artificial Intelligence and Robotics in Agriculture 3 (2+1)

Objective

To enable the student to know the

1. Basics and selection of sensors for different agricultural applications
2. Application of artificial intelligence and AI programming techniques
3. Problem-solving through search and knowledge representation and reasoning with AI
4. Use of open source hardware (arduino and raspberry pi); robot programming, controlling algorithm and basics on neural network

Sensors Fundamentals: Introduction to sensors and transducers; Need for sensors in the agriculture; Sensor Classification; Units of measurements; Sensor characteristics, Active and passive sensors– static characteristics, dynamic characteristics- first and second order sensors; Photoelectric effect – Photo dielectric effect – Hall effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect – Pyroelectric effect- Magneto mechanical effect (magnetostriction) – Magneto resistive effect.

Basics of detector materials/ sensor type (Silicon diod, InGaAS- etc.) and their characteristics. Fundamentals of visual, NIR, IR and FTIR spectroscopy, Remote sensing, data acquisition and their analysis; Training and validation of sensor and its results.

Sensors in different applications: Occupancy and motion detectors; Position, displacement, and level; Velocity and acceleration; Force, strain, and tactile Sensors; Pressure sensors, Temperature sensors, Optical sensors and electromagnetic wave detector.

Capacitance sensors; Weather sensors, imaging sensors and their application in agriculture.

Principle and working of sensors for soil moisture, soil temperature, chlorophyll meter, colour sensor, spectral sensor, temperature sensor, humidity sensor, wind speed, motion sensors, position sensor etc.