

Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins; Storage of seeds.

Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation; Sewage system and design, maintenance, septic tank for small family.

Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practical

Measurement of environmental parameters, Temp, RH, wind velocity, cooling load; Design and layout of a dairy farm; Design and layout of a poultry house; Design and layout of a goat/sheep house; Design and layout of a farm fencing system; Design and layout of a feed/fodder system; Design and layout of a green house; Design and layout of a grain storage structure; Design and layout of a bag storage structure; Performance of domestic storage structure; Design layout of a threshing floor.

Suggested Readings

1. Banerjee, G. C. 2007. *A Text Book of Animal Husbandry*. Oxford IBH Publishing Co, New Delhi.
2. Dutta, B. N. 2016. *Estimating and Costing in Civil Engineering*. Dutta & Co, Lucknow.
3. Garg, S. K. 2010. *Water Supply Engineering*. Khanna Publishers, New Delhi.
4. Khanna, P. N. 1958. *Indian Practical Civil Engineer's Hand Book*. Engineer's Publishers, New Delhi.
5. Nathanson, J. A. 1996. *Basic Environmental Technology*. Prentice Hall of India, New Delhi.
6. Ojha, T. P. and Michael, A. M. 1966. *Principles of Agricultural Engineering*. Vol. I. Jain Brothers, Karol Bag, New Delhi.
7. Pandey, P. H. 2004. *Principles and Practices of Agricultural Structures and Environmental Control*. Kalyani Publishers, Ludhiana.
8. Rao, P. V. 2012. *Text Book of Environmental Engineering*. Prentice Hall of India, New Delhi.
9. Sahay, K. M. and Singh, K. K. 2004. *Unit Operations of Agricultural Processing*. Vikas Publishing Pvt. Ltd, Noida.

Bioenergy Systems: Design and Applications

3 (2+1)

Objective

To make the students acquainted with the different biomass sources, and the different thermochemical and biochemical processes for bioenergy and fuel production

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems.

Biomass production- wastelands, classification and their use through energy plantation; Selection of species, methods of field preparation and transplanting; Harvesting of biomass and coppicing characteristics; Biomass preparation techniques for harnessing (size reduction, densification and drying).

Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas- type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Bio-hydrogen production routes.

Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems.

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles; Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas and producer gas; Testing of diesel engine operation using dual fuels and gas alone; Performance evaluation of biomass gasifier engine system (throat less and downdraft); Study on producer gas- types, application, shaft power generation, thermal application and economics; Study of cost economics of biofuel.

Suggested Readings

1. Basu, P. 2018. *Biomass Gasification, Pyrolysis and Torrefaction*. Academic Press.
2. Butler, S. 2005. *Renewable Energy Academy: Training Wood Energy Professionals*.
3. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. *The Biodiesel Handbook*. AOCS Press.
4. Rai, G. D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
5. Reed, T. B. and Das, A. 1988. *Handbook of Biomass Downdraft Gasifier Engine Systems*. SERI.

Refrigeration and Air Conditioning

3 (2+1)

Objective

1. To make the students acquainted with the principles of refrigeration, different types of refrigerating equipment