School of Agro & Rural Technology
Indian Institute of Technology, Guwahati

Curriculum and Credit Distribution of M. Tech Rural Technology

Semesters	Credits
I	38
II	40
III	24
IV	24
Total	126

Revised & New Courses and Structure
1. Core Course - 09
2. Courses on Field Work and Laboratory Practices- 7
3. Elective Courses - 6
4. Project Work - 2 semesters

Course Curriculum

Semester 1		L	T	P	Credits
RT505	Technology led Rural Development and Livelihood	3	0	0	6
RT506	Rural Water Quality, Supply, and Sanitation	3	0	2	8
RT507	Renewable Energy in Agro and Rural Sector	2	0	2	6
RT508	Geospatial Technologies in Agro and Rural Sector	2	0	2	6
	Elective	3	0	0	6
	Elective	3	0	0	6
	Total Credit				38

Semester 2		L	T	P	Credits
RT509	Social and Rural Immersion	0	0	2	2
RT513	Research Methods and Analytics in Rural Development	2	0	2	6
RT515	Natural Resources Management	2	0	2	6
RT518	Agribusiness Entrepreneurship	3	0	0	6
RT519	Food Technology and Value Addition	3	0	2	8
	Elective	3	0	0	6
	Elective	3	0	0	6
	Total Credit				40

Semester 3				
Project Phase-I	0	0	24	24
Semester 4				
Project Phase-II	0	0	24	24
Total Credits for 4 semesters				**126**

List of Courses (not in any specific order)

Core Courses

1. Technology led Rural Development and Livelihood
2. Rural Water Quality, Supply, and Sanitation
3. Renewable Energy in Agro and Rural Sector
4. Geospatial Technologies in Agro-Rural Sector
5. Natural Resources Management
6. Agribusiness Entrepreneurship
7. Research Methods and Analytics in Rural Development
8. Food Technology and Value Addition
9. Social and Rural Immersion

Elective Courses

1. Product and Process Development in Food and Bioprocessing industries (RT516: 3-0-0-6)
2. Climate Smart Agriculture (RT521: 3-0-0-6)
3. Rural Marketing (RT522: 3-0-0-6)
4. Digital Agriculture and Advanced Analytics (RT524: 2-0-2-6)
5. Rural Waste Management (RT525: 3-0-0-6)
6. Rural Electrification (RT526: 3-0-0-6)

List of Relevant Elective Courses from other Departments/ Centres

CE 525:	Solid and Hazardous Waste Management	(3-0-0-6)
ME655:	Energy Conservation and Waste Heat Recovery	(3-0-0-6)
ME 654:	Wind Energy Conversion	(3-0-0-6)
EN661:	Renewable Energy Systems	(3-0-0-6)
CE 559:	Watershed Management and Remote Sensing Applications	(3-0-0-6)
CE 568:	Environmental Management of Water Resources	(3-0-0-6)
BT 606:	Food Biotechnology	(3-0-0-6)
BT 607:	Plant Biotechnology	(3-0-0-6)
BT 622:	Biofuels	(3-0-0-6)

RT505 Technology led Rural Development and Livelihood (3-0-0-6)

Rural Development: Rural development concepts; indicators of rural development; rural institutions and their administrative structure, functions; emerging issues and determinants; rural development project design and implementation; case studies on rural development facilitated by international agencies.

Livelihood: Introduction to Development and Poverty Reduction, Livelihoods concepts, major livelihood programs in India, Micro Finance to Livelihoods, Livelihoods Interventions and Principles, Livelihoods Framework, New Interventions in Livelihoods, Process and livelihoods Intervention Development, Tools for Livelihoods Assessment - Individual Level, Village Level or Community Level, market level, value chain and sub-sectoral approach.

Rural Technology: Technology and development, Appropriate technology development and dissemination, Technology Rating Level, Case studies of different technologies enabling rural development- Information and Communication Technology (ICT), Farming Practices, Agro biotechnology, Food and Forest Product Value addition, Mechanization, Waste Management, Rural Energy Solutions; Technology impact assessment.

Textbook:

1. Singh, K. (2009). *Rural development: principles, policies and management*. SAGE Publications India
2. R. Chambers (1983) *Rural Development: Putting the last first, Routlege*-Taylor and Francis group.

References:

1. McCalla, A. F., & Ayres, W. S. (1997). *Rural development: From vision to action*. The World Bank.
2. Shukla, J. P. (Ed.). (2014). *Technologies for sustainable rural development: having potential of socio-economic upliftment* (TSRD–2014) (Vol. 1).

RT506 Rural Water Quality, Supply and Sanitation (3-0-2-8)

Basic principles of rural water supply and sanitation; Water quality parameters and their environmental and health significance. Status of water supply and sanitation sector in India. Water sources, surface and ground water treatment; Specific problem in rural water supply and treatment e.g. iron, manganese, fluorides etc. Water supply through spot sources, hand pumps, open dugwell. Traditional/low cost methods of water treatment and practices; solar based disinfection; RO systems, Design of filtration system, Storm water and sullage disposal, rain water harvesting and uses. Treatment and disposal of wastewater/sewage. Various method of collection and disposal of night soil. Simple wastewater treatment system for rural areas and small communities such as stabilization ponds, advanced septic tanks (septic tank + anaerobic filter, septic tank +Anaerobic baffled reactor) constructed wetlands- Concept of isolated domestic or community based constructed wetlands for the treatment/ reuse of sewage generated from the rural areas, Rejuvenation of rural ponds receiving grey water by integrating them with constructed wetlands etc. Introduction to rural sanitation; On site sanitation system

and community latrines, concept of Eco-sanitation, trenching and composting methods, two pit latrines, aqua privy, septic tank, soak pits etc,

Laboratory: Water and Wastewater Quality Parameters: Physico-chemical analysis

Textbooks:

1. V. M. Eulers and E. W. Steel, *Municipal and Rural Sanitation*, 6th Ed., McGraw Hill Book Company, 2009
2. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, *Environmental Engineering*, McGraw-Hill International Ed., 2013.
3. S. Gupta, *Rural Water Supply and Sanitation*, Vayu Education of India, New Delhi, 2013.

References:

1. F. B. Wright, *Rural Water Supply and Sanitation*, E. Robert Krieger Publishing Company, Huntington, New York, 1977
2. K. Verma, *Decentralised Governance in Water and Sanitation in Rural India*, Academic Foundation, NEW DELHI, 2014.
3. Central Public Health and Environmental Engineering Organization, *Manual on Water Supply and Treatment*, 2nd Ed, Ministry of Urban Development, New Delhi December 1991.
4. Central Public Health and Environmental Engineering Organization, *Manual on Sewerage and Sewage Treatment Systems – Part A: Engineering*, 3rd Ed – Revised and Updated, Ministry of Urban Development, New Delhi, November 2013.
5. Central Public Health and Environmental Engineering Organization, *Manual on Solid Waste Management*, 2nd Ed, Ministry of Urban Development, New Delhi, December 1993.

RT 518 Agribusiness Entrepreneurship (3-0-0-6)

Agribusiness in India: Definition and scope of agribusiness, Historical context, Key players and stakeholders, Government policies impacting agribusiness. Understanding agricultural value chains, Role of value addition, Role of technology in enhancing value chains. Basics of operations management, Supply chain management, Quality control and certification. Marketing agricultural products, Distribution channels, Digital marketing in agribusiness. Importance of sustainability in agribusiness, Best practices, Environmental impact. Types of risks in agribusiness, Strategies for risk mitigation, Role of insurance. Case Studies

Entrepreneurship in the Agricultural and Rural Sectors: Introduction to Entrepreneurship, Definition and types, Characteristics of entrepreneurs, Role of entrepreneurship in economic development, entrepreneurial ecosystem. Developing an entrepreneurial mindset, Creativity and innovation, Identifying and evaluating business opportunities. Characteristics and challenges of rural entrepreneurship, Forms of business enterprises, Government schemes and policies. Sources of finance, Microfinance and self-help groups, VCs & AIs. Importance of business planning, Components of a business plan,

planning and execution of agro & rural enterprises. Marketing strategies, Branding and promotion, Strategies for scaling and expanding agro - rural businesses. Case studies.

Interaction with entrepreneurs and industry experts, Analysis of real-world case studies, Visits, Group projects, Presentation and evaluation of projects

References:

1. 1 Agribusiness Management: by Smita Diwase
2. 2 Entrepreneurship Development and Small Business Enterprises by Poornima M. Charantimath

RT 513 Research Methods and Analytics in Rural Development (2-0-2-6)

Lecture:

Research Concepts: Foundation of Research, Types and Methods of Research, Disciplinarity, interdisciplinarity and trans-disciplinarity; Review of Literature, Identification of Research gaps and formulation of Objectives, Planning of Research, Sampling, Qualitative and Quantitative research process, Parametric and Non-parametric models.

Design of Field Survey, Qualitative Methods- How to do interviews? Questionnaire Survey; Field survey and data gathering: preparation of questionnaire, identification of problems and prospects, data compilation and analysis.

Theory of communication; various communication models; scientific and non-scientific communication; characteristics of scientific communications; scientific writings; IMARD technique for structuring a scientific article; essentials of scientific writing. Importance of presentation techniques and their methods, importance of visual elements to create effective communication, idea generation, brainstorming and mind mapping methods.

Quantitative analytics: Types of data, collection of data, tabulation of data, diagrammatic representation of data Summarization of data: frequency table, diagrammatic representation of a frequency distribution: column diagram, frequency polygon, histogram. Descriptive & inferential statistics: Cumulative frequency diagram; Kernel Density Estimation, Measures of central tendency; Measures of dispersion. Statistical Design of Experiment, Hypothesis Testing. Correlation and Regression Analysis; Application of regression analysis in trend fitting. Concept of optimization; Introduction to non-linear regression and Machine Learning.

Spatial data understanding: raster and vector data. Introduction to GIS, Spatial analysis concept: Distance, Adjacency, Interaction and neighbourhood, Point Pattern Analysis: Clustering & Aggregating Data, Spatial interpolation. Data analytics platforms: Industry perspective and Governmental platforms (Spatial geodata base). Potential lectures from industry (state-of-the-art analytics, WebGIS and Application development portals demonstration).

Practical:

Scientific and non-scientific communication. Writing skills: Report writing, Summary and Abstract writing, Data presentation. Ethics in Communication: Copyrights and plagiarism. IPR And Scholary Publishing Practical examples of statistical analysis and

statistical modelling using software platform and Cloud based platform (Google Colab/AWS services) and Python scripting. Introduction to GIS tools and operators, spatial data handling.

References:

1. Williamson, K., *Research methods for students, academics and professionals: Information management and systems*. Elsevier, 2002.
2. James, G., Witten, D., Hastie, T., Tibshirani, R. and Taylor, J., 2023. *An introduction to statistical learning: With applications in python*. Springer Nature.
3. R. B. Burns, *Introduction to Research Methods*, SAGE Publications, 2000. 4. S. Taylor, R. Bogdan, M. DeVault, *Introduction to Qualitative Research Methods: A Guidebook and Resource*, John Wiley & Sons, 2015.

RT 515 Natural Resources Management (2-0-2-6)

Introduction to Natural Resource Bases: Concept of resource, carrying capacity, ecological footprint and sustainability; Natural resources of different geographical regions of India; Factors influencing resource availability, distribution and uses; Interrelationships among different types of natural resources; Concern on productivity issues. Resource Management Paradigms: Evolution of resource management paradigms, resource extraction, access and control system. Basic management issues associated with key natural resources viz. renewable and non-renewable. Economic valuation of resources, ecological succession, ecosystem uncertainty and irreversible change. Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches; participatory rural appraisal (PRA); role of indigenous knowledge in Natural Resources Management (NRM); Technologies for NRM: Farmers' field based technologies and tools for NRM; Case studies from few agro-ecological zones of India.

Laboratory components: Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA), Various kinds of soil analyses, Mineral/Nutrient analyses

Textbooks:

1. Lawrence K. Wang, Mu-Hao Sung Wang, Nazih K. Shammas (editors) *Integrated Natural Resources Management: 20 (Handbook of Environmental Engineering)*, Springer, 2021.
2. E.P. Odum, *Fundamentals of Ecology*, W.B. Saunders Co. USA, 574p (Indian edition), 2005.
3. D. R. Lynch, *Sustainable Natural Resource Management: For Scientists and Engineers*, Publisher: Cambridge University Press, 2009.

References:

1. M.C. Dash, *Concepts of Environmental Management for Sustainable Development* Publisher: I K International Publishing House Pvt. Ltd., 2013.
2. G. Shivakoti, U. Pradhan, H. Helmi (editors), *Redefining Diversity and Dynamics of Natural Resources Management in Asia*, Volume 1st Edition, Sustainable Natural Resources Management in Dynamic Asia, Editors:, ISBN: 9780128054543, Elsevier, 2016.

3. P. Rogers, K. F. Jalal, J. A. Boyd, *An Introduction to Sustainable Development*. Publisher: Routledge; 1 edition, ISBN-10: 1844075206, 2007.

RT516 Product and Process Development in Food & Bioprocessing industries (3- 0-0-6)

Classification of processed foods and bio-products and overview of both the industries; Concept of new product in food processing and bio-processing industries: innovation and incentives of new product development (NPD), four phases of NPD in industry- product strategy development, product design and development, product commercialization, product launch and post-launch; Strategic element of NPD: market survey and market data analysis, idea screening, product specification, product planning, safety and regulatory concerns, Life Cycle Analysis; product design and process development: process specifications, packaging system development, product testing strategies including strategies for self-life analysis, process optimization, scale-up, quality management system and statistical quality control, labeling requirement; Product commercialization: marketing strategy including positioning and pricing of the product, test marketing, supply chain design, financial performance indicators; Product launch and evaluation: launching strategies, evaluation of the lunched product, financial analysis; Case studies of process development in Industries.

Textbooks:

1. R. Earle, A. Anderson, *Food product development: Maximizing success*. CRC Press, 2001.
2. J.A. Wesselingh, K. Soren, V.E. Martin, *Design & development of biological, chemical, food and pharmaceutical products*. John Wiley & Sons, 2007.
3. 3 E.B. Magrab, S.K. Gupta, F. P. McCluskey, and P. Sandborn. *Integrated product and process design and development: the product realization process*. CRC Press, 2009.

References:

1. G.W. Fuller, *New food product development: from concept to marketplace*. CRC Press, 2016.
2. M. Sorli, S. Dragan, *Innovating in Product/Process Development: Gaining Pace in New Product Development*. Springer Science & Business Media, 2009.

RT507 Renewable Energy in Agro-Rural Sector (2-0-2-6)

Basics of Energy Introduction to Energy, Sustainable development goals, Global Energy scenario, Indian Energy Scenario, Basics of Electrical and Electronics, Types of Energy, Energy conservation and laws, Energy and Environment, Sustainability, Rural energy landscape.

Renewable Energy sources Renewable sources of Energy, Principles of - Solar Photovoltaic, Solar thermal, Biomass Energy, Wind Energy, Hydropower Energy, Muscle Power, Geothermal Energy, Tidal Energy, Nuclear Energy.

Rural Energy Applications and case studies Solar Thermal Energy Application - Decentralized Energy systems, microgrids; Wind Energy Technology Wind farms; Bio Energy - Improved Cookstoves, Biogas, Biomass Fueled Steam Generation, Biomass Gasification; Biomass based thermal power plants; Hydro Energy - Hydroelectricity, Micro and Pico hydel system; Tidal and Ocean Energy - Tide mill, Energy for irrigation, Sustainable machineries; Waste Energy Recovery - Incineration, Fuel from plastic, Fuel cell, Energy Storage.

Energy Policy Energy Economics - Levelized cost of energy (LCOE), Net present value (NPV), Internal rate of return (IRR), Plant availability (PA); Carbon Neutrality, Carbon Financing, Clean Development Mechanism (CDM), CDM Methodologies & Carbon Crediting.

Renewable Energy Lab

The renewable energy lab provides the platform to build up the basic knowledge of renewable energy sources. The students will get a hands-on on the hardware and software for simulation of different renewable energy systems. This will help student be ready with the preliminary knowledge of how different renewable energy systems.

I. Hardware Experiments

1. Performance analysis of a thermoelectric generator cookstove 1b. Performance and emission characteristics of biomass cookstove 1c. Biomass Characterization (Proximate analysis and calorific value)
2. Experiment on solar PV inverter and its performance analysis.
3. Experiment on wind turbine and its performance analysis.
4. Performance analysis of a Micro-Hydel system

II. Simulation Experiments

1. Modelling of PV cell
2. Simulation study on Wind Energy Generator
3. Simulation study on Hydel Power
4. Simulation study on Thermoelectric generator

Textbooks:

1. Nelson,V., & Starcher, K. *Introduction to renewable energy*. Vol 2. CRC Press, Taylor & Francis Group. (2016).
2. Bundschuh, J., & Chen, G. *Sustainable energy solutions in agriculture*. Vol 8. CRC Press. (2014).
3. Kreith, F.,& Goswami, D. Y. *Handbook of Energy Efficiency and Renewable Energy*. Vol 1. CRC Press. (2007)

References:

1. Garg H. P. and Prakash S. Solar Energy: *Fundamental and Application*, Vol 1. Tata McGraw Hill. (1997).
2. Louie, H. *Off-grid electrical systems in developing countries*. Springer. (2019).
3. Jelley, J. *Energy Science: principles, technologies, and impacts*. Oxford Univ Press. (2021).
4. Reddy, A. K. N. *Energy and Social Issues*. In Goldemberg, J. (Ed.), World Energy Assessment: Energy and the Challenge of Sustainability. New York: UNDP. (2000).

Renewable Energy Lab Textbook

1. Risha Mal, *Laboratory Manual on Renewable Energy*, IIT Guwahati, 2025
2. Liping Guo, *Virtual Renewable Energy Labs*, Northern Illinois University, 2024
3. *Renewable energy lab experiments*, Lehigh Carbon Community College

RT 508 Geospatial Technologies in Agro-Rural Sector (2-0-2-6)

Lecture:

Introduction to remote sensing (RS) and spatial data for agriculture: remote sensing of vegetation; Foundations of Aerial/Satellite borne sensing (Optical/ hyperspectral/ microwave), and spectroscopy. Fundamentals of Geographic Information System (GIS) tools and operations; and spatial data handling-raster and vector data. Geophysical parameter retrievals; GPS fundamentals and CORS network for precision geolocation accuracy; Field data collection-GPS Telemetry and sensor data integration. Post-processing in GIS environment; Remote Sensing and GIS for Development Research. UAV and Satellite based imaging and post-processing; RS-GIS applications in crop inventory mapping, biotic and abiotic stress in plants, and precision farming. RS-GIS for land use mapping, sustainable resources management, watersheds and their management. Land use Land cover change analysis, Change detection with Remote sensing imagery, Accuracy assessment. Understanding the scales (1:50000, 1:10000) for mapping and image interpretation; Land degradation assessment and spatio-temporal data analysis, Digital soil mapping.

Web mapping-Geoserver, National geodatabases and query, Web GIS for rural database management and end user application. Spatial planning: Resource Allocation, Network Analysis, Single criteria vs. Multiple criteria, Spatial decision support system and thematic areas (application of multi criteria analysis-MCA/AHP in spatial planning)-Spatial Decision Support System for rural Land Use Planning (SDSS/LUP). Spatial Planning in rural developmental projects: rural healthcare, education, transport connectivity, surface water management, and essential amenities. Applications and examples of RS- GIS for rural development: Selected case studies.

Practical:

Scale, topographical maps; GIS and Remote Sensing Image processing; LULC mapping and quality analysis, Spatial analyst and suitability analysis (Spatial MCA). Field survey with GPS units and spatial data logging. Raster and vector data handling in image processing tools: QGIS, SNAP, and customized Python scripts. Assignments, Mini projects and invited industry talk/demonstration in related domain.

References:

1. Rees, W.G., *Physical Principles Of Remote Sensing*, Cambridge University Press, 2001.
2. Lillesand T.M., And Kiefer R.M., *Remote Sensing And Image Interpretation*,Fourth Edition, Wiley, 1999.
3. Jones, H.G. and Vaughan, R.A., 2010. *Remote sensing of vegetation: principles, techniques, and applications*. Oxford University Press, USA.

4. P.A. Burrough and R.A.McDonnell, *Principles of Geographic Information Systems*, Oxford University Press, 1999.
5. Cutts, A. and Graser, A., 2018. *Learn QGIS: Your step-by-step guide to the fundamental of QGIS* 3.4. Packt Publishing Ltd.
6. Raju, K.V., Hegde, V.R. and Hegde, S.A., 2019. *Geospatial Technologies for Agriculture:*
   Case Studies from India. Springer International Publishing.

RT509 Social and Rural Immersion (0-0-2-2)

This course includes understanding and on field survey on rural health, sanitation, water, waste, energy, and environment management, agricultural practices, food processing, quality and safety management systems, storage practices for agro produce, rural housing, information technology, transportation, rural artisan, rural resources, rural markets and marketing practices, rural industries, capacity building and skill development, woman empowerment, entrepreneurship, factors governing social development, etc., conduct of participatory rural appraisal (PRA) survey, RRA and rural sensitization, qualitative data collection and analysis, group discussion with local community on their social issues and challenges. Preparation of field project reports and evaluations.

References:

1. Agresti A Franklin CA. *Statistics: The Art and Science of Learning from Data*. 2nd Endition. Pearson Prentice hall, 2018
2. Alley M. *The Craft of Scientific Writing*. Springer. 2018
3. Bernard HR. *Social Research Methods: Qualitative and Quantitative approaches*. Thousand Oaks, Sage, CA, 2000.
4. Black JA. Champion. DJ. and *Issues in Social Research*. John Wiley and Sons. New York, 1976.
5. Blaxter L, C. Tight K. *How to Research*. Viva Books. New Delhi. 1999.
6. Fowler FJ. *Survey Research Methods*. Applied Social Research Methods Series, Vol. 1. Sage. Newbury Park, 1988.
7. Katz M. *From Research to Manuscript A Guide to Scientific Writing*. 2nd Edition. Springer- 2009.

RT519 Food Technology and Value Addition (3-0-2-8)

Introduction to farm and forestry value addition; Concept of value chain development and relevance in social development; Global & Indian scenario of supply chain of fresh and processed produces; Traceability in supply chain; Case studies of development of supply chain of some important food crops. Overview of food processing techniques of agri-horti-produces; Introduction to engineering concepts in food processing- primary processing operations like cleaning, sorting and grading, peeling of fruits & vegetables and milling of grains; dehydration, size reduction and screening of solids, mixing, Solidliquid extraction, emulsification and forming, filtration and membrane separation, chilling, freezing, thermal processing, extrusion, dehydration, evaporation, fermentation. Storage & packaging technology for food products; Process calculations; Overview of food safety and quality system including introduction to GHP, GMP, & other essential certification systems. Case study of some commercial food product manufacturing. Laboratory:

1. Visiting a food processing unit and submit a report on their supply chain analysis
2. Manufacturing of dried fruits /vegetables including studying their Drying kinetics, rehydration, sensory and packaging & Shelf-life.
3. Manufacturing of herbal powders including studying their quality analysis, packaging & Shelflife and mass and energy balance
4. Beverage preparation from a fruit/vegetable produce and its sensory testing, Shelf-life testing and manufacturing cost analysis.

Textbooks:

1. Fellows, Peter J. *Food processing technology: principles and practice*. Elsevier, 2009.
2. 2. Earle, Richard Laurence. *Unit operations in food processing*. Elsevier, 2013.
3. Dani, Samir. *Food supply chain management and logistics: From farm to fork*. Kogan Page Publishers, 2015.

References:

1. R.T. Toledo, *Fundamentals of food process engineering*. Springer Science & Business Media, 2007.
2. S.M. Rahman, *Handbook of food preservation*. CRC press, 2007.
3. N.I.I.R. Board, *Modern Technology of Agro Processing and Agricultural Waste Products*. National Institute of Industrial Research, 2000.
4. S.S. Nielsen, *Food analysis*. Springer, 2010.

RT 521 Climate Smart Agriculture (3-0-0-6)

Climate change: concepts, causes and effects, Climate change: past, present and future, Climate change agriculture: impacts and challenges, Global agriculture, the state of Indian agriculture; Climate-smart agriculture: importance of CSA in addressing climate change, Three pillars of CSA: productivity, adaptation, mitigation; Towards more efficient and resilient systems, different approaches of CSA, dimensions of CSA,

practices of CSA, what's new with CSA? Role of technology in CSA, Precision agriculture tools for resource optimization, Various crop models, Climate-Resilient Crop Breeding, Information Communication Technologies (ICT) for CSA. Understanding farmers perception and their adaptation to climate change, the farming system, building synergies, mainstreaming CSA into national policies and programs, Financing CSA, Capacity development for CSA: strategies, case studies.to demonstrate effectiveness of CSA, Planning for resilience against multiple risk, building on community-based approaches to adaptation.

References:

1. Sameera Qayoom, Purshotam Singh, Vinod Gupta, Punit Choudhary, Susheel Kumar, Latief Ahmad Sofi, Prem Kumar, *Technology Application & Adaptation for Climate Smart Agriculture*, ISBN: 9789394023383, 2022
2. Mike Robbins, *Crops and Carbon: Paying Farmers to Combat Climate Change*, Edition: First Published: 2011 eBook Published: 17 June 2019, Imprint : Routledge
3. John T Hardy, *Climate Change: Causes, effects and solutions*, ISBN: 978-0-470-85019-0 June 2003
4. Mannava V. K. Sivakumar, James Hansen. *Climate prediction and agriculture: advances and challenges*, ISBN: 978-3-540-44649-1, 2007
5. L. Palombi, R. Sessa, *Climate smart agriculture (sourcebook), FAO*, 2013.

RT522 Rural Marketing (3-0-0-6)

Defining Rural markets, rural environment, Markets and Market structures, Functions of Marketing, Marketing mix. The Consumer Buying Behaviour Model – What Influences Rural Consumer Behaviour? – The Buyer Decision Process- The Product Adoption Process

Rural Marketing Research, processes, Segmentation and targeting, Product development and classification, Pricing strategies. Distribution in rural markets, channel behaviour, challenges, Models

Communication strategies: challenges, communication processes, developing effective communication, service marketing, use of technology, ICT in rural areas.

Role of Government: Government institutions, schemes, policies, infrastructure.

Case studies, Project work, Analysis of real-world case studies, Visits, Group projects, Presentation and evaluation of projects.

References:

1. Rural Marketing by Pradeep Kashyap
2. Agricultural marketing in India by SS Acharya and NL Agarwal

RT 524 Digital Agriculture and Advanced Analytics (2-0-2-6)

Lecture:

Data driven farming concept, Types of Agricultural Data: Environmental, Weather, Soil, Crop, and Market Data. Methods for Collecting Agricultural Data: Sensors (proximal and remote), Drones/UAV, and IoT Devices. Data Logging and Management Systems. Data Accuracy and Consistency Interoperability.

Data cleaning and preprocessing, data Transformation. IoT based sensor network and data driven decisions. Data Management and Processing-digital image processing and feature identification.

Foundations of advanced statistical learning algorithms-Artificial Neural Network, Perceptron and Neural Network architecture; Annotation and Self-supervised learning and case studies: weed detection, plant anomaly detection. Generative AI solutions for agriculture and predictive analytics; Introduction to digital twin-crop growth model and informatics.

Managing Big Data in Agriculture, Data Warehousing Solutions for Farming Operations. Integrating Sensors for Real-Time Data Collection, Big data analytics and cloud computing. Introduction to Open Geospatial Consortium (OGC) web services, OGC Geospatial Sensor Web framework; Case studies on sensor web implementations in various environmental applications. Data fusion in agricultural information system, Geo-computational methods, Basics of spatio-temporal data, Spatio-temporal data mining, Space-time cube data for decision making in agricultural systems with case studies: real time irrigation and fertilizer application. High-performance plant phenotyping (infrastructure, analytics with AIML/DL).

Practical:

Refreshing python programming and data visualization, coding and deployment platforms. IoT based sensors for agricultural data collection, Data logging. Image based data collection and post processing. Real time sensor data processing and decision support system. Advanced hands-on experience on building web services oriented systems for sensor web enablement and geospatial applications; Cloud computing practices and AI based application development for agricultural application cases: 'Kisan e-Mitra' an AI-powered chatbot, National Pest Surveillance System for tackling the loss of produce due to climate change, AI based analytics using field photographs for crop health assessment and crop health monitoring and app deployment. Mini projects and invited industry talk in related domain.

References:

1. Castrignanò, A., Buttafuoco, G., Khosla, R., Mouazen, A., Moshou, D. and Naud, O. eds., 2020. *Agricultural internet of things and decision support for precision smart farming*. Academic Press.
2. Krishnan, S., Anand, A.J., Prasanth, N., Goundar, S. and Ananth, C. eds., 2023. *Predictive Analytics in Smart Agriculture*. CRC Press.
3. Pramanik, S., Roy, S. and Bose, R. eds., 2024. *Data Driven Mathematical Modeling in Agriculture: Tools and Technologies*. CRC Press.
4. Rogel-Salazar, J., 2020. *Advanced data science and analytics with Python*. Chapman and Hall/CRC.

RT525 Rural Waste Management (3-0-0-6)

Problems associated with indiscriminate disposal of solid waste; Sources, generation, composition and properties of solid waste. Hierarchy of solid waste management, Source reduction, segregation, collection, recycling and disposal of SW; Transfer and transport, Waste processing, Recovery of resources at Gram Panchayat level. Waste processing technologies, Biological, chemical and thermal technologies- Co- pyrolysis of plastics/polythene with agricultural waste; traditional/low cost methods of biological transformation of waste and practices suited to rural society; household level, community level waste management; Animal waste/ crop waste management; Application of solid waste compost to farmland; Quality enhancement of Solid waste compost; FCO standards; Success stories-Swacch Bharat Mission; Legislation in solid waste.

Textbooks:

1. Tchobanoglous, G., Theisen and Vigil, *Integrated Solid Waste Management: Engineering Principles and Management Issues*, McGraw Hill, 1993
2. Vesilind, P. A., Worrel, W. A. and Reinhart, D. R.*, Solid Waste Engineering*, Thomson Brooks/Cole, 1st Ed., 2002.

References:

1. CPHEEO *manual on Municipal Solid Waste Management* 2016
2. *Not in my Backyard: Solid waste management in Indian cities*, Centre for Science and Environment 2016

RT526 Rural Electrification (3-0-0-6)

Introduction- Background and Purpose of Electrification, Importance of Rural Electricity Supply, Decentralised, Off-Grid Solutions, History/ expansion of electrification.
Rural Electrification and Rural Development- The Relation between Infrastructure and Growth, Electricity and Growth, Poverty, Rural Development and Income Generation, Electricity impact on Income Generation, Impact on Access, Affordability and income distribution
Micro-grids- Microgrid Performance Indicators, The Global State of Microgrids, Benefits of Rural Microgrids, Strategic Planning. Success and failure of distributed electrification, financial model of distributed electrification, Government initiatives and policies of rural electrification, Rural electrification for pumping/ motive power, MSMEs, Issues related to rural electricity supply, Agricultural feeders, Tariffs, subsidies.

Textbooks:

1. Subhes Bhattacharyya. *Rural Electrification through Decentralised Off-grid Systems in Developing Countries*. London Springer. (2013).
2. Hisham Zerriffi. *Rural Electrification*. Springer Science & Business Media. (2010).