Course Title: Recent trends in Soil Physics
Course Code: Soil 601
Credit hours: 2 (2+0)

Theory

UNIT I: Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system, soil-plant-atmospheric continuum(SPAC).

UNIT II: Fundamentals of fluid flow, Poiseuilles law, Laplace' sequation, Darcy's law in saturate dandun saturated flows; development of differential equations in saturate dandun saturated water flow, capillary conductivity and diffusivity; limitations of Darcy'slaw ;numerical solution for one dimensional water flow.

UNIT III: Theories of horizontal and vertical in filtration under different boundary conditions.

UNIT IV: Movement of salts in soils, models form iscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

UNIT V: Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfering soils, differential equation of heat flow, measurement of thermal conductivity of soil;
Soil, Plant, Water relations-Plant uptake of soil moisture, Water balance and energy balance in the field; irrigation and water use efficiency.

UNIT VI: Soil crust and clod formation; structural management of puddled rice soils; soil conditioning-concept, soils conditioners-types, characteristics, working principles, significance in agriculture.

UNIT VII: Solar and terres trial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapo transpiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using in fra-red thermometer.

Teaching methods/activities: Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome: Experience on the knowledge of soil physical properties and processes in relation to plant growth.

Suggested Readings

- Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley &Sons.
- Hanks and Ascheroft. 1980. *Applied Soil Physics*. Springer Verlag. Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
- Hillel D. 1980. *Environmental Soil Physi*cs. Academic Press.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS,New Delhi.
- Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. WileyInterscience.

- Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker. Oswal MC.1994. *SoilPhysics*. Oxford & IBH.
- Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed.Longman.

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Course Title: Modern concept in soil fertility
Course Code: Soil 602
Credit hours: 2 (2+0)

Theory

UNIT I:

Nutrient availability-concept and relationships, modern concepts of nutrients availability; soil colloids and nutrient availability; soil amendments and availability maintenance of nutrients, soil solution and plant growth; nutrient response functions and availability indices.

UNIT II:

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT III:

Chemical equilibria (including solid-solution equilbria) involving nutrientions in soils, particularly in submerged soils; Kinetic studies of nutrients in soils.

UNIT IV:

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V:

Modern concepts in fertilizer application ;soil fertility evaluation techniques ;role of soil tests in fertilizer use recommendations ;site- specific nutrient management for precision agriculture.

UNIT VI :

Monitoring physical, chemical and biological changes in soils;permanent manorial trials and long-term fertilizer experiments ;soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

UNIT VII: Carbon-a nutrient central to soil fertility; carbon cycle in nature, stocks, pools and fluxes; green house effect and climate change; carbon sequestration vis-à-vis sustenance of soil quality and crop productivity.

Suggested Readings

- Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons. Barker V Allen &Pilbeam David J. 2007. *Handbook of Plant Nutrition*.CRC / Taylor & Francis.
- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed.Pearson Educ.
- Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood &Sons.
- Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*
- International Potash Institute, Switzerland
- Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC /Taylor & Francis.
- Kannaiyan S, Kumar K & Govindarajan K. 2004. *BiofertilizersTechnolo*gy. Scientific Publ.
- Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture.* 2nd Ed. Soil Science Society of America, Madison.
- Prasad R & Power JF. 1997. *Soil Fertility Management for SustainableAgriculture*. CRC Press.

- Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus,Sulphur, Micronutrients.* John Wiley & Sons.
- Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison.Tisdale SL, Nelson WL, Beaton JD &Havlin JL. 1990. *Soil Fertility and Fertilizers.* 5th Ed. Macmillan Publ.

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Course Title: Physical chemistry of soil
Course Code: Soil 603
Credit hours: 2 (2+0)

Theory

UNIT I:

Colloidal chemistry of inorganic and organic components of soils– their formation, clay organic interaction.

UNIT II:

Predictive approaches for cation exchange equilibria- thermo dynamics, empirical and diffuse double layer theory (DDL)- relationships among different selectivity coefficients; structure. and properties of diffuse double layer.

UNIT III:

Thermodynamics of nutrient transformations in soils; Climate change effects on mineralogy and surface properties of variable charge; cationic and anionic exchange and their models, molecular interaction.

UNIT IV:

Adsorption/desorption isotherms- Langmuir adsorption is otherm,Freundlich adsorption isotherm, normalized exchange isother m, BET equation; selective and non- selective adsorption of ionson inorganic surfaces and organic surfaces of soil materials(citationof utilityin agricultural system).

UNIT V:

Common solubility equilibria-carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electro chemical properties of clays(citation of examples from agricultural use).

Suggested Readings

- Bear RE. 1964. *Chemistry of the Soil.* Oxford & IBH.
- Bolt GH &Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
- Fried M &Broeshart H. 1967. *Soil Plant System in Relation to InorganicNutrition.* Academic Press.
- Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. JohnWiley & Sons.
- Greenland DJ & Hayes MHB. 1978. *Chemistry of Soil Constituents*. JohnWiley & Sons.
- Jurinak JJ. 1978. *Chemistry of Aquatic Systems*. Dept. of Soil Science &Biometeorology, Utah State Univ.
- McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.Sparks DL. 1999. *Soil Physical Chemistry*. 2nd Ed. CRC Press.
- Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ.Press.
- Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley.

- van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley& Sons.

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Course Title: Soil genesis and micromorphology
Course Code: Soil 604
Credit hours: 2 (2+0)

Theory

UNIT I:
Pedogenic evolution of soils; soil composition and characterization.

UNIT II:
Weathering and soil formation–factors and pedogenic processes; stability and weathering sequences of minerals.

UNIT III :

Assessment of soil profile development by mineralogical and chemical analysis.

UNIT IV:
Micro- pedological features of soils–their structure, fabric analysis, role in genesis and classification.

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed.Pearson Edu.
- Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.
- Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
- Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS,New Delhi.
- Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. NewDelhi
- Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
- USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.

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Course Title: Modelling of soil plant system
Course Code: Soil 607
Credit hours: 2 (2+0)

Theory

UNIT I :

Introduction, terms and definitions; classification of models; Taylor series; numerical methods of differentiation and integration

UNIT II :

High level computer language: FORTRAN-its commands and usage; testing and evaluation of model.

UNIT III :

Description of spatially homogeneous models; K transformation model; nitrogen and phosphorus dynamics in soil

UNIT IV :

Spatially heterogeneous models; equation of continuity; Simulation of water flow through soil; Explicit and Explicit-Implicit method; simulation of solute movement through soil with variable moisture flux by explicit-implicit method

UNIT V :

Nutrient uptake model: Integration of nutrient movement in soil (mass flow and diffusion) and uptake by plants (Michaelis- Menten kinetics); Nutrient uptake model:Solubility and free ion activity model

Suggested reading

- Theory and Principles of Simulation Modeling in Soil-Plant System. S.C. Datta, Capital Publishing Company, New Delhi, 2008Modeling Carbon and Nitrogen Dynamics for Soil Management. 2001, Edited by
- M.J. Shaffer, L. Ma and S. Hansen, Lewis Publishers, Boca Raton, Fl Mathematical Models in Agriculture - A Quantitative approach to problems in agriculture and related science. J. Frame and J.H.M Thornley, Butterworth andCo.Ltd., 1984
- Modeling Plant and Soil System. J. Hanks and J.T. Richie (Eds.) Agronomy Bulletin No.31, ASA, SSSA Madison, Wisconsin, USA.
- Simulation of Accumulation and Leaching in Soils. M.lFrissel, and P. Reinger Oxford and IBM Pub.Co. New Delhi 1974.
- Regression Methods - A tool for data Analysis, RJ. Freud and P.D. Minton, Marcel Dekker Inc., New York.
- Schaum's Outline Series- Theory and Problems of programming with Fortran. S. Lipschutz and A. Poe., McGraw-Hill Book Co., Singapore.
- Simulation of ecophysiologica1 processes of growth in several annual crops. F.W.T Penning de Vries, D.M. Jansen, H.F.M. Ten Berge and A, Baker, PUDOC, Wageningen 1989.

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Course Title: Recent trends in soil microbial biodiversity
Course Code: 609
Credit Hours: (2+1)

Theory:

Unit I .
Microbial evaluation and biodiversity, Microbial communities in ecosystems, New insights in below ground diverse of plant performance.

Unit II :
Qualitative ecology of microorganisms; Biomass and activities.

Unit III :
Nitrogen fixing organisms, Trends in diversity of N fixing organisms. Molecularapproaches in characterising N fixing microorganisms.

Unit IV:
Serology and molecular characterization, ecological aspects of biodetermination, soil waste and water management.

Unit V:
Biodegradability, testing and monitoring of the bioremediation of xerobioticpollutants and bacterial fertilizers.

Practicals:

- Determination of soil microbes using classical techniques.
- Determination of soil microbial diversity using molecular techniques.
- Estimation of soil microbial biomass carbon, nitrogen and phosphorus.
- Estimation of key soil enzyme activities.
- Community level physiological profiling of microbial diversity.

Suggested Reading materials:

1.Soil Microbiology and Biochemistry by E.A.Paul and F.E.Clark
2.Soil Biotechnology by J.M.Lynch
3.Prescott's Microbiology by J.M.Willey,Linda M. Sherwood and C.J.Woolverton.
4.Advances In Agricultural Microbiology by N.S. Subba Rao

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