Seventh Semester IWEM

Sl. No	Course Title	Periods Per Week			Credit
		L	T	P	
1.	Irrigation and Drainage Engineering	3	1	0	4
2.	Pressurized Irrigation System	2	1	0	3
3.	Water and Wastewater Engineering	3	1	0	4
4.	Open Channel and Fluvial Hydraulics	3	1	0	4
5.	Ground Water Hydrology	3	1	0	4
6.	Irrigation Engineering Lab	0	0	2	1
7.	Water Quality Lab	0	0	2	1
8.	Projects and Seminar*/Dissertation**				5
9.	45 days summer training & presentation				1
Total Credits					27

1. Irrigation and Drainage Engineering **Credits 4(3 1 0)**

Unit 1

Basic Soil-Water Physics: Physical properties of soils and water, Soil water content and potentials, Flow of water in saturated and unsaturated soils

Unit 2

Irrigation Development Planning: Factors affecting irrigation development in the tropics, Water sources for irrigation quantity and quality, Water application methods, Soil/hydrologic/crop data needs, Soil-water-plant-atmosphere continuum (SPAC), Crop/Irrigation Water Requirements and Scheduling of irrigation

Unit 3

Irrigation Network and Hydraulics: Irrigation systems components, Diversion, conveyance and distribution systems

Irrigation and Drainage Structures: Pumps for irrigation and drainage, Design of canal and appurtenant structures, Flow measuring devices

Unit 4

Planning and Design of Irrigation Systems: Design and evaluation of surface irrigation systems, Volume balance surface irrigation system design, Land grading and earthwork calculations, Sprinkler irrigation system design and evaluation, Drip irrigation system design and evaluation, Irrigation Efficiency, irrigation management

Unit 5

Drainage of Irrigated Lands: Drainage surveys/investigations, Drainage criteria, Design discharges, Steady and non-steady flow to drains, Design of Surface and Subsurface Drainage Systems, Design of pipe drainage systems

TEXT BOOKS:

1. Black, C.A. (1986): Methods of Soil Analysis, 2nd Ed. ASA Monograph. Madison Wisconsin
2. Cuenca, R.H. (1989): Irrigation System Design: An Engineering Approach, Prentice Hall, NJ.
3. Singh, Bharat, "Fundamentals of Irrigation Engineering", Nem Chand and Brothers, Roorkee
4. Michel, A.M, "irrigation Theory and Practices, Vikash Publishing House.
5. Hillel, D. (1980): Fundamentals of Soil Physics, Academic Press.
6. Hoffman, G. J., Howell, T.A. and Solomon, K.H. (1990): Management of Farm Irrigation Systems (Monograph), ASAE.

7. Jensen, M.E. (ed.) (1983): Design and Operation of Farm Irrigation Systems, Monograph No. 3, ASAE.
8. Jensen, M.E., Burman, R.D. and Allen, R.G. (Editors) (1990): Evapotranspiration and Irrigation Water Requirements, American Society of Civil Engineers, New York.
9. Ritzema H. P. (Editor-in-Chief) (1994): Drainage Principles and Applications, ILRI publication 16, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.
10. Smedema, L. K. and D.W. Rycroft (1983): Land Drainage, Cornell University Press, Ithaca, New York.
11. Walker, W.R. and Skogerboe, G.V. (1987): Surface Irrigation – Theory and Practice, Prentice Hall.

2. Pressurized Irrigation Systems **Credits 3 (2 1 0)**

Unit 1
Sprinkler irrigation: an overview, types of systems, system components, design objective, uniformity, Adequacy and efficiency of application
Unit 2
Design of different types of sprinklers; Design of pipelines, laterals, manifold, submain and mains; Design of traveler sprinkler system, layout, hose selection, gun sprinklers
Unit 3
An introduction of trickle or drip irrigation, overview of types of system, various components of trickle systems, clogging and filtration, system flushing and maintenance.
Unit 4
Trickle / drip irrigation planning factors, emitter selection and design criteria,Trickle system design strategy and trickle lateral design.
Unit 5
Trickle manifold design, trickle system design synthesis and pressurized irrigation system selection.

TEXT BOOKS:
1. Benami, A. and Often, A. 1983. Irrigation Engineering, Haifa Israel: Irrigation Engineering Scientific
2. Publication (IESP).
3. Cuenca, R.H. 1989. Irrigation System Design, Englewood Cliffs, New Jersey: Princeton Hall.
4. Hillel, D. (Editor). 1982. Advances in Irrigation, New York. Academic Press.
5. Keller, J. and Bliesner, Ron D. 1990. Sprinkle and Trickle Irrigation.
6. Michael, A.M. 1978. Irrigation Theory and Practices, New Delhi, Vikas Publishing House.
7. Nakayama, F.S. and Bucks D.A. (Eds) 1986. Trickle Irrigation for Crop Production. Design, Operation and Management.

3. Water and Wastewater Engineering **Credits 3 (2 1 0)**

Unit 1
Wastewater Quantity Estimation: Generation and collection of wastewater, Estimation of wastewater quantity; Variation in quantity of wastewater; Wastewater Collection Systems: Sanitary, storm and combined sewerage systems, Quantities of sanitary wastes and storm water, Design and analysis of wastewater conveyance system
Unit 2
Wastewater Quality Enhancement: Philosophy of treatment; Unit operations and processes; Physical, chemical and biological methods; Domestic Wastewater Treatment**:** Wastewater characteristics; Wastewater Treatment: Design of pre-treatment, secondary treatment, and tertiary treatment, disposal systems, Wastewater disposal standards.
Unit 3
Physical Unit Processes: Screening; Commutation; Grit Removal; Equilization; Sedimentation;

Unit 4

Introduction to Microbiology: Microbial ecology and Growth kinetics; Types of microorganisms; aerobic vs. anaerobic processes**;** Biological Unit Processes: Aerobic treatment; Suspended growth aerobic treatment processes; Activated sludge process and its modifications; Attached growth aerobic processes; Tricking filters and Rotating biological contactors; Anaerobic treatment; suspended growth, attached growth, fluidized bed and sludge blanket systems; nitrification, denitrification; Phosphorus removal

Unit 5

Chemical Unit Processes: Coagulation-Flocculation; Filtration; Disinfections; Aeration and Gas transfer; Precipitation; Softening; Adsorption and Ion exchange; Membrane processes

Unit 6

Sludge Treatment: Sludge stabilization, treatment, Thickening; Digestion; Dewatering; Sludge drying; Composting, aerobic and anaerobic digestion of sludges

Unit 7

Wastewater Treatment Plant Characteristics: Sequencing of unit operations and processes; Plant layout; Hydraulic considerations; Natural Wastewater Treatment Systems**:** Ponds and Lagoons; Wetlands and Root-zone systems.

Wastewater utilization and reuse

TEXT BOOKS:

1. Sewage Disposal and Air pollution Engineering by S.K. Garg, (Environmental Engg. Vol- II), Khanna publishers, New Delhi (2010)
2. Environmental Engineering by Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Mc Graw-Hill International Editions, NewYork (1985)

REFERENCE BOOKS:

1. Water and Waste water Technology, Mark. J Hammer and Mark. J Hammer, Eastern Economy Edition, PHI-Learning, New Delhi (2008)
2. Wastewater Engineering Treatment, Disposal & Reuse by Met Calf & Eddy, Tata McGraw – Hill publishing Co. Ltd., New Delhi.
3. Environmental Engineering by Davis Cornvel, McGraw Hill Book Co., New York. (2000)
4. Water and waste water Engineering by G.M. Fair, J.C. Geyer, and Okum, John Wiley & Sons, New York (1998)
5. Waste water Engineering by M.N Raoand A.K Dutta,, Oxford & IBH Publishing Co. Ltd. (2000)

4. Open Channel and Fluvial Hydraulics **Credits 4 (3 1 0)**

Unit 1

Introduction to Open Channel Flow, Basic Features, Uniform Flow, Critical flow, Specific Energy, Hydraulic Jump, Computer Assisted Calculations

Unit 2

State Gradually Varied Flow, Governing Differential Equation, Characteristics and Classification, Methods of Computation

Unit 3

Transient Gradually Varied Flow, Saint Venant's Equation, Kinematic Wave Theory, Hydraulic Routing Through Channels, Overland Flow & Computer Oriented Algorithms

Unit 4

Fluvial Hydraulics: Origin, Properties of sediments, size, shape, fall velocity and its effects, orientation, grain size distribution, Difference between rigid and alluvial channels, Incipient motion of sediment particles, Different approaches to study sediment motion, lift force approach, tractive force approach, theoretical and sub theoretical analysis of Shield, White and others. Types of bed forms or regimes of flow Characteristics and types of sediment load, Theories of bed load and suspended load and total load.

TEXTBOOKS:

1. Chow, V.T., Open Channel Hydraulics. Tata McGraw Hill.
2. Garde, R.J. and Rangaraju, K.G., Mechanics of Sediment Transport and Alluvial Stream Problems.
3. Ranga Raju, K.G., Flow through Open Channels.
4. Subramanya, K., Flow in open channels, Tata McGraw Hill.

5. Ground Water Hydrology **Credits 4 (3 1 0)**

Unit 1

Fundamentals of Groundwater Flow and Groundwater Wells: Basics of groundwater: aquifer, hydraulic head, storage characteristics, Darcy's law: hydraulic conductivity, heterogeneity and anisotropy, aquifer flow and transmissivity, Equations of groundwater flow, Radial flow to wells, pumping tests, Multiple well arrays, wells near hydrogeologic boundaries

Unit 2

Groundwater Resources Assessment: Groundwater exploration: reconnaissance survey, surface and subsurface geophysical investigation, test drilling, Hydrologic assessment: infiltration and groundwater recharge, water balance method, rainfall runoff models, and regional groundwater flow model.

Unit 3

Environmental Issues: Overcharging, Over exploitation: groundwater mining, land subsidence due to pumping, Groundwater quality and contamination, Saltwater intrusion

Groundwater Management: Concepts of basin management: quantity and quality aspects Alternative basin yield, Evaluation of perennial yield, Modeling tools and techniques for management, Integrated use of surface water and groundwater, Artificial recharge

Unit 4

Groundwater Pollution: Pollution sources: point and non-point sources, Movement and attenuation of pollutants in aquifers, Transport processes: advection, dispersion, sorption and decay, mathematical treatment, Solute transport equation, initial and boundary conditions, Mathematical statement of pollution problems; solution approaches

Unit 5

Management of Groundwater Pollution: General principles, Data requirement and database management, Groundwater protection, A comprehensive groundwater management program, Vulnerability assessment, Data collection and monitoring strategy, Pollution remediation

TEXT BOOKS:

1. Das Gupta, A. (1993): Groundwater Contamination, Environmental Systems Review No.34, Environmental System Information Center, AIT.
2. Kashef, A.I. (1986): Groundwater Engineering, McGraw Hill, New York.
3. Roscoe Moss Company (1990): Handbook of Groundwater Development, John Wiley & Sons.
4. U.S. Department of Interior, Bureau of Reclamation (1995):Groundwater Manual, Water resources Publication
5. LLC Fetter, C.W. (1993): Contaminant Hydrogeology, Macmillan Publishing Company, New York.