

## **Irrigation and Drainage Engineering Department**

### **New Syllabus of IDE Dept-]**

**Course No. : IDE-231      Course Title : Fluid Mechanics and Open Channel Hydraulics**  
**Semester : III              Credits : 3(2+1)**

#### **Syllabus:**

##### **Theory:**

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon; Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices (Measurement of Discharge, Measurement of Time), Flow through Mouthpieces, Flow over Notches, Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

##### **Practical:**

Study of manometers, Study of pressure gauges, Verification of Bernoulli's theorem, Determination of coefficient of discharge of venturimeter, Determination of coefficient of discharge of orifice meter, Determination of coefficient of friction in pipeline, Determination of coefficient of discharge for rectangular notch, Determination of coefficient of discharge for

triangular notch, Determination of coefficient of discharge for trapezoidal notch, Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice, Determination of coefficient of discharge for mouth piece, Determination of metacentric height, Determination of efficiency of hydraulic ram, Study of current meter, Velocity distribution in open channels and determination of Manning's, coefficient of rugosity.

**Teaching Schedule theory with weightages(%)**

Lecture No.	Topics	Article No.	Page No.	Book	Weightage, (%)
<b>Unit I</b>					
1	<b>Properties of fluids:</b> Introduction, properties of fluid like mass density, specific weight, specific volume, specific gravity, viscosity, types of fluids,	1.1, 1.2.1, 1.2.2., 1.2.3, 1.2.4, 1.3, 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5	1-8	1	15
2	Compressibility, surface tension, and capillarity	1.5, 1.6,	22-25	1	
3	<b>Pressure and its measurement:</b> Fluid pressure at point, pascal's law, absolute, gauge, atmospheric and vacuum pressure	2.1, 2.2, 2.4,	32-33 38-39	1	
4,5,6,7	<b>Measurement of Pressure:</b> <b>Simple manometers:</b> piezometer, U-tube manometer, single column manometer, <b>Differential manometers:</b> U-tube differential Manometers, Inverted U-tube differential manometer, Mechanical gauges	2.5, 2.6, 2.7, 2.6	39-48 70-72	1 2	

<b>Unit II</b>					
8,9,10	<b>Pressure forces on plane and curved surfaces:</b> Introduction, total pressure and center of				15
	pressure, vertical plane surface submerged in liquid, horizontal plane surface submerged in liquid, inclined plane surface submerged in liquid, curved surface sub-merged in liquid.	3.1, 3.2, 3.3, 3.4, 3.5, 3.6	65- 67 81- 83 90- 92	1	
11,12	<b>Buoyancy and Floatation:</b> Introduction, buoyancy, center of buoyancy, meta-centre, metacentric height, analytical method for metacentric height	4.1, 4.2, 4.3, 4.4, 4.5, 4.6	110- 111 114- 117	1	
13	Conditions of floatation and stability of submerged and floating bodies	4.7	121- 122	1	

<b>Unit III</b>					
14	<b>Kinematics of fluid flow:</b> Introduction, methods of describing fluid motion, types of fluid flow, continuity equation, continuity equation in three-dimensions,	5.1, 5.2, 5.3, 5.4, 5.5, 5.6,	139- 141 145- 146	1	20
15	<b>Description of the flow pattern:</b> Path lines, streak lines and stream lines, stream tube ( <b>only definitions</b> )	6.4	245- 248	2	
	Rotational and irrotational flow and circulations and vorticity ( <b>only definitions</b> )	6.8 6.9	266- 267 269- 270	2	
	Velocity potential function and stream function	<b>5.8</b>	<b>152- 155</b>	<b>1</b>	
	Velocity potential function, Stream function, Equipotential lines, line of constant stream function, flow net, relation between stream function and velocity potential function ( <b>only theory</b> )	<b>5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.8.5, 5.8.6</b>			
16	<b>Dynamics of flow:</b> Introduction, equations of motion, Euler's equation of motion. Assumptions, Bernoulli's equation for real fluid,	6.1, 6.2, 6.3, 6.5, 6.6, 6.7	233- 235 239	1	
17	Venturimeter, practical applications of Bernoulli's equations Orifice meter Nozzle (Pitot-tube) Siphon	6.7.1 6.7.2 6.7.3 11.6	241- 243, 253- 255, 257-	1   1	

			258, 402		
<b>Unit IV</b>					
18,19,20	<b>Flow through notches, weirs:</b> Introduction, classification of notches and weirs,	8.1, 8.2	319- 320	1	10
	Discharge over a rectangular notch or weir	8.3	320	1	
	Discharge over a triangular notch or weir	8.4	321	1	
	Discharge over a trapezoidal notch or weir	8.6	325- 326	1	
	Discharge over a stepped notch	8.7	326	1	
	Advantages of triangular notch or weir over rectangular notch or weir	8.5	324- 325	1	
21	<b>Flow through orifices and Mouth pieces:</b> Introduction, classifications of orifices, Classifications of mouthpiece	7.1, 7.2, 7.12	285 & 306	1	
	Flow through an orifice	7.3	285- 286	1	
	Hydraulic coefficients	7.4	286- 287	1	
	Flow through an external cylindrical mouthpieces	7.13	306- 307	1	
<b>Unit V</b>					
22, 23	<b>Flow in open channels:</b> Introduction, classification of flow in channels	16.1, 16.2	664- 665	1	30

	Discharge through open channel by Chezy's formula and Manning's formula, Bazin formula, Ganguillet-Kutter's formula,	16.3, 16.4 16.4.3	666- 667 672	1
	Most economical section of channel	16.5, 16.5.1 16.5.2, 16.5.3	675- 676 678- 680 688- 689	1
	Hydraulic jump	10.1, 10.2	521- 522	3
24,25	<b>Laminar flow:</b> Introduction to laminar flow	13.1	605	2
	<b>Turbulent flow:</b> Introduction, Reynolds experiment Frictional loss in pipe flow	10.1, 10.2, 10.3	391- 394	1
	Shear stress in turbulent flow	10.4	395- 396	1
	Velocity distribution in turbulent flow in pipes	10.5	396- 397	1
26,27	<b>General equation of head loss:</b> Introduction, loss of energy in pipes	11.1 11.2	420	1
	Darcy-Weisbach equation, Chezy's equation	11.3	420- 421	1
	Minor head losses	11.4	425- 428 434- 436	1
	Hydraulic gradient and energy line	11.5	443- 444	1

28, 29	<b>Flow through network of pipes:</b>				
	Flow through pipes in series	11.7	454-455	1	
	Flow through pipes in parallel pipes	11.9	459	1	
	Flow through branched pipes	11.10	474-475	1	
	Power transmission through pipe, siphon	11.11 11.15	480-481	1	
<b>Unit VI</b>					
30, 31	<b>Dimensional analysis and similitude.</b>			1	10
	Introduction, secondary or derived quantities, dimensional homogeneity	12.1, 12.2, 12.3	502-504		
	Methods of dimensional analysis:	12.4	504-	1	
	Rayleigh's method	12.4.1	509		
	Buckingham's $\pi$ - theorem	12.4.2			
	Types of similarities (similitude)	12.6	522-523	1	
Types of forces acting in moving fluid	12.7	523-524	1		
Dimensionless numbers	12.8	524-525	1		
32	<b>Introduction of fluid machinery:</b>				
	Definition. Only names of fluid machinery. Hydraulic ram in details.	25.1, 25.5	889, 901-902	1	

### Practicals:

1. Study of manometers.
2. Study of pressure gauges.
3. Verification of Bernoulli's theorem.
4. Determination of coefficient of discharge of venturimeter

5. Determination of coefficient of discharge of orifice meter.
6. Determination of coefficient of friction in pipeline.
7. Determination of coefficient of discharge for rectangular notch
8. Determination of coefficient of discharge for triangular notch
9. Determination of coefficient of discharge for trapezoidal notch
10. Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice.
11. Determination of coefficient of discharge for mouth piece.
12. Determination of metacentric height.
13. Determination of efficiency of hydraulic ram
14. Study of current meter
- 15 -16. Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

### **Suggested reading**

#### **Text books**

<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>publication</b>
1	A text book of fluid mechanics and hydraulic mechanics (Eighth edition)	Dr. R.K. Bansal	Laxmi Publications (P) Ltd. New Delhi
2	Hydraulics and fluid mechanics (including hydraulic machines) (Thirteenth edition )	Dr- P.N. Modi & Dr. S.M. Seth	Standard Book House, Delhi-6
3	Irrigation Engineering and Hydraulic Structures	S.K.Garg	Khanna Publisher, New Delhi

#### **Reference books**

<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>
4	Fluid mechanics	Dr. Jagdish Lal	Metropolitan books CI. Pvt. Ltd. New Delhi



**Course No. : IDE- 242      Course Title : Irrigation Engineering**  
**Semester : IV              Credits : 3 (2+1)**

**Syllabus:**

**Theory:**

Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country; measurement of irrigation water: weir, flumes and orifices and other methods; open channel water conveyance system : design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution; underground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work; soil water plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies; surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations.

**Practical:**

Measurement of soil moisture by gravimetric method, Measurement of soil moisture by tensiometer, gypsum block, Determination of bulk density, Measurement of irrigation water using weir, notch, orifices, Measurement of irrigation water using flumes and siphon tubes, Measurement of infiltration using double ring infiltrometer, Determination of field capacity, wilting point using pressure plate apparatus, Determination of field capacity, wilting point using pressure field method, Estimation of evapotranspiration based on climatological data by Penman- Monteith, Hargreaves-Samani and pan evaporation, Design of irrigation open channel, Design of underground pipeline system, Estimation of irrigation efficiencies, Study of advance, recession and computation of opportunity time, Evaluation of border Irrigation method, Evaluation of furrow irrigation method, Evaluation of check basin irrigation method.

---

**Teaching Schedule:**

Lecture No.	Topics		Page No.	Book	Weightage, (%)
<b>Unit I</b>					
1	Sources of irrigation water Surface water sources Ground water resources		21-44  15-16	1  2	25
2	Present status of development and utilization of different water resources of the country			Recent notes to be circulated	
3	Major and medium irrigation schemes of India			(Recent notes to be circulated)	
4, 5	Purpose of irrigation, environmental impact of irrigation projects		FAO publication	(Recent notes to be circulated)	
6,7,8	Measurement of irrigation water: flumes and orifices and other methods	Chapter 5	290-310	1	
9,10	Open channel Water conveyance system, Design and lining of irrigation field channels, On farm structures for water conveyance, control & distribution	Chapter 5	311-347	1	
11,12	Underground pipe conveyance system: components and design	Chapter 7	351-355, 361-370	1	

13,14,15	Land grading: Criteria for land leveling Land leveling design methods (plane method) Estimation of earthwork quantities	Chapter 8	382-384 387-389 398-401	1	
<b>Unit II</b>					
16,17,18	Soil plant water relationship: Soil properties influencing irrigation such as soil texture, soil Structure, bulk density, capillary and non capillary pores, soil consistency, Volume and mass relationships of soil constituents, kinds of soil water	Chapter 9	421-429 444-445	1	35
19,20	Infiltration: Soil water potential, soil moisture characteristics Movement of water into soils: Infiltration, factors affecting infiltration rate, measurement of infiltration, Infiltration equation $y=at + b$	Chapter 9	445-450	1	
21,22	Soil moisture constants: Saturation capacity, field capacity, moisture equivalent, permanent wilting	Chapter 9	454-459 469-470	1	

	percentage, available water. Soil moisture stress and plant response				
23	Water requirements of crops: Concept of evapotranspiration (ET) Water and irrigation requirements of crops	Chapter 9	478-485	1	
24	Measurement of evapotranspiration Lysimeter experiment, field experimental plots, soil moisture depletion studies, Water balance method.	Chapter 10	488-490	1	
<b>Unit III</b>					
25	Estimation of evapotranspiration from climatological data: Balaney-Criddle method Thornthwaite formula Selection of crop coefficient for Estimating ET (crop)	Chapter 10	490-494	1	20
	Penman-Monteith (FAO 56) Jeansen-Haise, Hargreaves-Samani			Notes to be circulated	
26	Depth of irrigation: Net irrigation requirement Gross irrigation requirement	Chapter 10	518-520	1	
27	Irrigation frequency	Chapter	518-520	1	

	Irrigation period	10			
28	Irrigation efficiencies	Chapter 10	523-527	1	
<b>Unit IV</b>					
29	Surface irrigation methods: Introduction and classification	Chapter 11	554-555	1	20
30	Border Irrigation: Introduction, types, adaptability, specification Hydraulic of border irrigation, Design of Border irrigation	Chapter 11	555-564	1	
31	Check basin irrigation: Introduction, types, specifications, Hydraulic of check basin irrigation Design of check basin irrigation	Chapter 11	564-567	1	
32	Furrow irrigation: Introduction, types, specifications, Hydraulic of furrow irrigation, Design of Furrow irrigation, contour irrigation	Chapter 11	668-673	1	

**Practicals:**

- 1) Measurement of soil moisture by gravimetric method.
- 2) Measurement of soil moisture by tensiometer, gypsum block.
- 3) Determination of bulk density.
- 4) Measurement of irrigation water using weir, notch, orifices.
- 5) Measurement of irrigation water using flumes and siphon tubes.
- 6) Measurement of infiltration using double ring infiltrometer.
- 7) Determination of field capacity, wilting point using pressure plate apparatus.
- 8) Determination of field capacity, wilting point using pressure field method.
- 9) Estimation of evapotranspiration based on climatological data by Penman- Monteith, Hargreaves-Samani and pan evaporation.
- 10) Design of irrigation open channel.
- 11) Design of underground pipeline system.
- 12) Estimation of irrigation efficiencies.
- 13) Study of advance, recession and computation of opportunity time.
- 14) Evaluation of border Irrigation method.
- 15) Evaluation of furrow irrigation method.
- 16) Evaluation of check basin irrigation method.

## Suggested readings

### Text books

<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>
1	Irrigation theory and practice	A.M. Michael	Vikas publishing house Pvt. Ltd. New Delhi 2 nd Edition
2	Irrigation Water Management Principles and Practice	Dilip Kumar Majumdar	PLrentice-Hall of India Pvt. Limited. New Delhi

### Reference books

<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>
3	Land and Water Management Engineering	V.V.N. Murthy	Kalyani publishers, New Delhi
4	Irrigation Principles and Practice	Israelsen and Hunson	
5	Crop evapotraspiration (Guidelines for computing crop water requirements) FAO-56	Pereira, D. Raes, M. Smith	FAO, Rome
6	Design and Operation of Irrigation System	Ed. M.E. Jenson	ASCE

**Course No. : IDE- 353**

**Credits : 3=2+1**

**Course Title : Groundwater, Wells and Pumps Semester : III**

**Syllabus:**

**Theory:**

Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

**Practical:**

Verification of Darcy's Law, Study of different drilling equipments, Design of gravel pack and well screen, Estimation of specific yield and specific retention, Estimation of aquifer parameters by Theis method, Estimation of aquifer parameters by Coopers-Jacob method, Estimation of aquifer parameters by Chow method, Theis Recovery method, Design of well under confined and unconfined conditions, Well losses and well efficiency, Estimating ground water balance, Study of artificial ground water recharge structures, Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps, Study of centrifugal pump, Installation and testing of centrifugal pump, Study and Installation of submersible pump.



**Teaching Schedule:**

<b>Lecture No.</b>	<b>Topics</b>	<b>Article No.</b>	<b>Page No.</b>	<b>Book</b>	<b>Weightage, (%)</b>
<b>Unit I</b>					
(A)	<b>Ground water and wells</b>				20
1	<b>Occurrence and movement of ground water:</b> Origin and age of groundwater, rock properties affecting groundwater, Important definitions, hydraulic conductivity, transmissibility, coefficient of storage, specific yield, hydraulic resistance, leakage factor	--  2.2	23-28, 6-8  59-63	2, 3  1	
2	<b>Aquifer and its types</b>	1.2	7-9	1	
3	<b>Classification of wells</b> Fully penetrating tubewells and open wells, Familiarization of various types of bore wells	1.10	25-28	1	
4	<b>Steady and transient flow into partially, fully and non penetrating and open wells:</b> Steady state flow to wells in unconfined aquifers Steady state flow to wells in confined aquifers Unsteady state flow to wells in unconfined aquifers	2.3  2.4	63-71  74-76	1  1	

	Unsteady state flow to wells in confined aquifers				
<b>Unit II</b>					
5	<b>Ground water exploration techniques</b> Surface investigations of groundwater, sub surface investigations of groundwater	1.11	33-39	1	25
6	Design of open well	3.2	99-114	1	
7	<b>Methods of drilling of wells:</b> Drilling equipment and methods, Percussion drilling Rotary drilling Reverse rotary drilling	5.2 5.3 5.4 5.6 5.10 5.11	222-229 241-242 258-260	1	
8	<b>Design of tubewell and gravel pack:</b> Design of tube well, analysis of particle-size distribution of the aquifer, design of housing pipe and well casing, bore size and well depth, selection of strata to be screened	4.9 4.10 4.11 4.12	192-197	1	
9	<b>Installation of well screen:</b> Design of well screen, slot opening, percent open area, diameter of the screen	4.13	198-202	1	
10	<b>Design of gravel pack:</b> design criteria for gravel pack,	4.14	202-210	1	

	Gravel pack material, screening of gravel				
11	<b>Completion and development of well</b>	6.1, 6.2, 6.3	310- 329	1	
<b>Unit III</b>					
12	<b>Groundwater hydraulics aquifer parameters determination:</b> Theis method Cooper-Jacob method Chow method Recovery method (Theis)	2.4	75-84	1	15
13	<b>Well interference</b>	2.6	88-91	1	
14	<b>Multiple well systems</b>	4.5	179- 180	1	
15	<b>Ground water quality</b>		291- 301	2	
16	<b>Artificial ground water recharge techniques</b> Concept of artificial recharge, Recharge methods	1.12	39-42	1	
17	<b>Estimation of ground water potential</b>	Notes to be circulated			
<b>Unit IV</b>					
(B)	<b>Pumps</b>				20
18	<b>Pumping systems and machinery:</b>	10.1	486-	1	

	Principles of lifting and moving of water, water lifting devices: scoop, swing basket, Archimedean screw, counterpoise bucket lift, Persian wheel	10.2 10.3 10.4	513		
19	<b>Classification of pumps</b>		487	1	
20	<b>Centrifugal pump:</b> Classification of variable displacement pumps, principles of operation of centrifugal pumps, classification of centrifugal pump	12.1 12.2 12.3	619- 630	1	
21	<b>Power requirements in pumping</b>	12.8	640- 644	1	
22	<b>Pump characteristic curves</b>	12.9	645- 648	1	
23	<b>Pump performance:</b> Effect of change of speed on head, capacity, power and efficiency Effect of change of impeller diameter on head, capacity, power and efficiency System head curve	--	650- 652	1	
<b>Unit V</b>					
24	<b>Selection of centrifugal pump</b>	12.11	652- 657	1	20
25	<b>Design of centrifugal pumps</b>	13.1	676- 683	1	

26	<b>Centrifugal pump installation and trouble shooting:</b>	14.1			
		14.2	708-	1	
		14.3	711		
	Location, pump foundation,	14.4	716-		
	installation of centrifugal pump in shallow/deep open well and in tube well	14.5	727		
27	Trouble-shooting in centrifugal pumps		737- 744		
28	<b>Propeller pumps:</b>	16.1	797-	1	
	Introduction, principles of operation, construction,	16.2	806		
	operating characteristics,	16.3			
	installation	16.4			
29	<b>Mixed flow pumps:</b>	16.8	812-	1	
	Principles of operation,	16.9	815		
	operating characteristics and installation, selection of mixed flow pump	16.10			
30	<b>Priming and self Priming</b>	3.6	225- 226	4	
31	<b>Rotodynamic pumps:</b>	15.1			
	<b>Deep well turbine pump:</b>	15.2	747-	1	
	Introduction, principle of operation, construction,	15.3	755		
	characteristics of pump, selection of pump	15.4			
32	<b>Submersible pumps:</b>	15.11	780-	1	
	Introduction, construction,	15.12	795		
	installation, operation of	15.14			

	pump, common troubles in operation and remedies	15.16			
--	---	-------	--	--	--

### Practicals:

1. Verification of Darcy's Law
2. Study of different drilling equipments
3. Design of gravel pack and well screen
4. Estimation of specific yield and specific retention
5. Estimation of aquifer parameters by Theis method.
6. Estimation of aquifer parameters by Coopers-Jacob method.
7. Estimation of aquifer parameters by Chow method.
8. Theis Recovery method
9. Design of well under confined and unconfined conditions
10. Well losses and well efficiency
11. Estimating ground water balance
12. Study of artificial ground water recharge structures
13. Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps
14. Study of centrifugal pump.
15. Installation and testing of centrifugal pump.
16. Study and Installation of submersible pump.

### Suggested Readings

#### Text books

Sr. No.	Title	Author	Publication
1	Water well and pump engineering (9 <sup>th</sup> Edition, 2005)	A.M.Michael and S.D.Khepar	Tata McGraw-Hill publishing Company Ltd. New Delhi
2	Groundwater hydrology (2 <sup>nd</sup> Edition)	David Keith Todd	John Wiley and sons, New York (International Book Disturbing Co. Lucknow)
3	Irrigation: Theory and Practices	A.M. Michael	Vikas publishing house Pvt. Ltd. New Delhi

### Reference books

4	Groundwater Assessment and Management (11 <sup>th</sup> Edition, 2007)	K.R.Karanth	Tata McGraw-hill publishing Company Ltd. New Delhi.
5	Irrigation Engineering and Hydraulic Structures (14 <sup>th</sup> Edition, 1999)	S.K.Garg	Khanna Publisher 2-13 Nath Market Naisaraf Delhi-06
6	Groundwater hydrology (International student Edition)	Herman Bouwer	McGraw-hill publishing Company Ltd. New York.

**Course No. : IDE-354**

**Credits : 3 =2+1**

**Course Title : Drainage Engineering**

**Semester : V**

**Syllabus:**

**Theory:**

Drainage, objectives of drainage, familiarization with the drainage problems of the state. Surface drainage, drainage coefficient, types of surface drainage, design of open channel, subsurface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., drainage criteria, types and use of subsurface drainage system. Design of surface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudt's) and Ernst's drain spacing equations. Steady and unsteady state groundwater condition, dynamic equilibrium concept. Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope. Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio-drainage. Tile drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkali soils. Leaching requirements, conjunctive use of fresh and saline waters. Economic aspects of drainage.

**Practical:**

*In-situ* measurement of hydraulic conductivity by single auger hole method, *In-situ* measurement of hydraulic conductivity by inverse auger hole method, Determination of drainage coefficients, Installation of piezometer and observation well, Preparation of iso- bath and isobar maps, Determination of drainable porosity by sand tank model, Determination of drainable porosity using field method, Design of surface drainage systems, Design of subsurface drainage systems, Determination of chemical properties of soil and water (EC, pH, ESP or SAR), Cost analysis of surface and sub-surface drainage system, Visit to subsurface drainage project and drainage material manufacturing industry.



**Teaching Schedule:**

Lecture No.	Topics	Article No.	Page No.	Book	Weightage, (%)
<b>Unit I</b>					
1	Drainage: Introduction, definition, Drainage problem of the state and country, Causes and effect of waterlogging, prevention and control of waterlogging.	1.1, 1.2, 1.3, 1.4, 1.5,	1-17	1	10
2	Need of drainage, purpose of drainage, effect of Drainage requirement of various crops	1.6 1.7	18-23	1	
3	Interrelationship of irrigation and drainage	2.1, 2.2, 2.3, 2.3.1, 2.3.2	27-40	1	
<b>Unit II</b>					
4, 5	Surface drainage: Introduction, surface drainage system and components, factors affecting drainage, types of land requiring drainage Drainage coefficient	20.1 20.2	799-807	2	30
6	Types of surface drainage: Surface drainage for flat areas, Surface drainage for sloping areas, Interceptor drains	20.4- 20.6	814- 817, 821-825	2	
7, 8, 9	Design of surface drainage system: Design consideration, design of surface drainage system, hydraulic design of open channel (drain)	6.4 6.9	230-234 255-261	1	
10, 11	Subsurface drainage, Drainage properties-Structure and texture, Drainable porosity, Hydraulic conductivity	- - -	480-481 80-82 87-97	3 4 4	
12	Subsurface drainage system:  Introduction, general considerations, Components of subsurface drainage system and  different layouts of subsurface drainage system	8.1 21.1 21.3.7	352- 353 827 846- 849	1 2 2	

<b>Unit III</b>						
13, 14,	Derivation of ellipse (Hooghoudt's),	--	149-156	4	35	
15	Ernst's drain spacing equations,	8.4.3	366-369	1		
	Unsteady state equation (Glover-Dumn) without derivation	8.3.1	284-287	1		
16, 17	Dynamic equilibrium concept	2.4.4	47-48	1		
18	Drainage criteria for steady and unsteady state				Notes to be circulated	
19	Design of subsurface drainage system-problems	-	-	-	Notes to be circulated	
20, 21	Drainage materials: Drainage pipes, envelop materials and drainage structures,	21.3.2 21.3.4	830-844	2		
	Design of gravel envelope	21.3.3		2		
22, 23	Installation of subsurface drainage system	8.12.3 to 8.12.8	418-426	1		
24	Subsurface drainage system design: Procedure, hydraulic design of subsurface drains	8.3 8.8	355-358 391-400	1		
25	Mole drainage,	21.7	313-314	2		
	Bio-drainage,	8.16.3	460-466	1		
	Vertical/well drainage	-	579-580	3		
		14.1-14.5	225-228	4		
<b>Unit IV</b>						
26	Types of salt affected soil	7.3	313-315	1		25
	Chemical properties of soil,	7.10				
	Classification of soil	15.2.4	540-542	2		
27, 28	Reclamation of saline and alkali soils,	7.12.2	320-323	1		
	Leaching requirement and methods,	7.12.4 to 7.12.6	323-333			
	Gypsum requirement	7.13	337-346			

29	Salt balance	15.3	544-548	2	Notes to be circulated
30	Economic aspect of drainage- problem	8.10	438-446	1	
31	Drainage for humid area, irrigated area				
32	Conjunctive use of fresh and saline water				

### Practicals:

1. *In-situ* measurement of hydraulic conductivity by single auger hole method
2. *In-situ* measurement of hydraulic conductivity by inverse auger hole method
3. Determination of drainage coefficients
- 4-5. Installation of piezometer and observation well
6. Preparation of iso- bath and isobar maps
7. Determination of drainable porosity by sand tank model
8. Determination of drainable porosity using field method
- 9-10. Design of surface drainage systems
- 11-12. Design of subsurface drainage systems
13. Determination of chemical properties of soil and water (EC, pH, ESP or SAR)
14. Cost analysis of surface and sub-surface drainage system
- 15-16. Visit to subsurface drainage project and drainage material manufacturing industry

### Suggested Readingsd

#### Text books

Sr. No.	Title	Author	Publisher
1.	Agricultural Drainage: Principles & Practices (1 <sup>st</sup> Edition)	U.S.Kadam, R.T.Thokal, Sunil Gorantiwar, A.G.Powar	Westville Publishing House, New Delhi
2.	Drainage Principles and Applications	H. P. Ritzema	ILRI Publication 16, Netherlands.
3	Principles of Agricultural Engineering Vol. II (1 <sup>st</sup> edition)	A.M.Michael and T.P. Ojha	Jain Brothers Jodhpur
4	Drainage Engineering	J.N.Luthin	Wiley Eastern Pvt. Ltd. New Delhi

#### Reference books

Sr. No.	Title	Author	Publisher
1.	Land Drainage Principles, Methods and Applications	A.K.Bhattacharya A.M.Michael	Vikas Publishing House Pvt Ltd., New Delhi

**Course No:- IDE-365**

**Title :- CANAL IRRIGATION MANAGEMENT**

**Credit- 2=1+1**

**Semester:-VI**

**Syllabus:**

**Theory:**

Description of components of irrigation canal system, their functions, planning and layout of canal irrigation system, preliminary design procedure for irrigation project, crop water requirement, duty and delta, specific discharge of canal, design of canal by Kennedy and Lacey's theory and tractive force approach, Canal seepage and lining of canal, design of lined canal and economics.

Diversion head works and canal head regulators, theories of seepage, cross drainage works, canal falls, irrigation structures on distributory and minor, regulator and modules, maintenance of canal.

**Practical:**

Irrigation water requirement of crops based on duty, delta concept, Design of canal by Kennedy's and Lacey's theory, Design of lined irrigation canal, Planning and layout of water conveyance system, Study of canal outlets, Study of straight Glacis fall, Study of aqueduct, Conjunctive water use planning, Study of irrigation distribution schedule (Warabandi and Shejpali), Visit to canal irrigation projects.

**Teaching Schedule:**

<b>Lecture No.</b>	<b>Topic</b>	<b>Article no.</b>	<b>Page no.</b>	<b>Book</b>	<b>Weightage, (%)</b>
<b>Unit I</b>					
<b>1</b>	Introduction to irrigation development and status		xx-xxi	1	20
	<b>Components of irrigation canal system:</b>				
	Planning and layout of canal irrigation system	3.1 3.2 3.3	63-66	1	
	Distribution system for canal irrigation	3.4	66-68	1	
<b>2-3</b>	<b>Preliminary design procedure for irrigation project</b>	12.2 -12.6	251 -255	2	
	<b>Diversion head works:</b> Weir and barrage, gravity and non gravity weirs, layout of a diversion head works and components, certain important definitions  Fish ladder Canal head regulators Silt control devices	9.1 9.2 9.3.1 9.3.2 9.3.3 9.3.6 9.3.7 9.3.8	600-608     612-615 615-621 622-623	1	
<b>Unit II</b>					
<b>4</b>	<b>Crop water requirement:</b> Introduction, crop period and base period, duty and delta of a crop, certain important definitions	2.1 2.2 2.3 2.5	25-31 32-35	1	40
<b>5</b>	<b>Specific discharge of canal:</b>			1	

	Certain important definitions, Determination of required channel capacity	3.6 3.7	69-70 70-84		
<b>6,7</b>	<b>Design of canal:</b> i. Tractive force approach ii. Kennedy's theory iii. Lacey's theory Comparison of Kennedy's and Lacey's theory	4.1 – 4.4 4.7.3 4.7.4 4.7.5	90 -94 108 -116 116 – 122 122- 123	1 1 1 1	
<b>8</b>	<b>Canal seepage:</b> Causes of failure, Blight's creep theory, Lane's weighted creep theory	11.1 11.2 11.3	643-647	1	

<b>9</b>	<b>Lining of canal:</b> Advantages of lining, financial justification & economics of canal lining	5.1 5.2 5.3	184- 194	1	
<b>10,11</b>	<b>Design of lined irrigation channel</b>	5.5 5.6	195 – 200	1	
<b>Unit III</b>					
<b>12</b>	<b>Cross drainage works:</b> Types of cross drainage works, selection of drainage work, Types of cross drainage works	14.1 14.2 14.3	841-848	1	30
<b>13</b>	<b>Canal falls:</b> Definition, location, types of falls	12.1 12.2	734-744	1	
<b>14</b>	<b>Canal regulator:</b> Canal regulator works, alignment of the off-taking channel, Distributary head regulator and cross regulator	13.1 13.2 13.3 13.4	797-800	1	
<b>15</b>	<b>Canal outlet or modules:</b> Requirements of good modules, types of modules. Criteria for judging the performance of modules, certain important definitions	13.8 13.9 13.10 13.11 13.12 13.13 13.14	817 - 836	1	
<b>Unit IV</b>					
<b>16</b>	<b>Maintenance of irrigation canal</b>	4.13	175-179	1	10

**Practicals:**

- 1-2. Irrigation water requirement of crops based on duty, delta concept
- 3-4. Design of canal by Kennedy's and Lacey's theory
- 5-6. Design of lined irrigation canal
- 7-8. Planning and layout of water conveyance system
9. Study of canal outlets
- 10-11. Study of straight Glacis fall
12. Study of aqueduct
13. Conjunctive water use planning
14. Study of irrigation distribution schedule (Warabandi and Shejpali)
- 15-16. Visit to canal irrigation projects



## Suggested readings

### Text books

Sl. No.	Title	Author	Publisher
1	Irrigation Engineering and Hydraulic Structures ( 12 <sup>th</sup> Revised ed <sup>n</sup> )	Santosh Kumar Garg	Khanna Publishers, New Delhi
2	Irrigation Engineering and Hydraulic structures	S.R. Sahastrabudhe	--

### Reference books

Sl. No.	Title	Author	Publisher
3	Irrigation Theory and Practice	A.M. Michael	Vikas Publishing house Pvt. Ltd, New Delhi
4.	Operation and management of irrigation system in Maharashtra State, Second Edition, Pub No. 20	-	WALMI Publications, Aurangabad
5	Water distribution practices in Maharashtra State, Pub No. 22	-	WALMI Publications, Aurangabad

**Course No. : IDE 366**  
**Sem:-VI**

**Title: Sprinkler and Micro irrigation Systems**  
**Credits: 2(1+1)**

**Syllabus:**

**Theory:**

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;

Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

**Practical:**

Study of different components of sprinkler irrigation system, Design and installation of sprinkler irrigation system, Determination of precipitation pattern, discharge and uniformity coefficient, Cost economics of sprinkler irrigation system, Study of different components of drip irrigation, Design and installation of drip irrigation system, Determination of pressure discharge relationship and emission uniformity for given emitter, Study of different types of filters and determination of filtration efficiency, Determination of rate of injection and calibration for chemigation/fertigation, Design of irrigation and fertigation schedule for crops, Field visit to micro irrigation system and evaluation of drip system, Cost economics of drip irrigation system.

**Teaching Schedule:**

Lecture No.	Topics	Article no.	Page no.	Book	Weightage, (%)	
<b>Unit I</b>						
1	<b>Sprinkler Irrigation:</b> Introduction, problems and prospects, adaptability, limitations, types of systems , Components of the sprinkler system	3.6	578-581 37-45	2 3	20	
2	<b>Uniformity and efficiency:</b> Moisture distribution patterns and uniformity of coverage, uniformity coefficient		581-585 587-589	2 2		
<b>Unit II</b>						
3	<b>Design of Sprinkler irrigation system:</b> Inventory of resources, layout of sprinkler system, sprinkler selection and spacing, capacity of the sprinkler system	3.7	589-593 45-48	2 3	25	
4	<b>Hydraulic design of sprinkler systems:</b> Discharge of sprinkler nozzle, pressure discharge relationship, sprinkler head selection	4.1 to 4.3	49-65	3		
5	Design of sprinkler laterals, submains, main line	4.4, 4.5	65-71	3		
6	Pressure requirement and power units for sprinkler system	4.6-4.7 4.9-4.10	71-72 73-90	3 3		
7	Operation and maintenance of sprinkler, cost economics	7	123-126 595-596	3 2		
<b>Unit III</b>						
8	Micro irrigation: Introduction, merits/demerits, types, components of drip system	1.3 2.4-2.5	1-9 12-18 611-616 5-6 15-21	1 1 2 4 4		30

9	Design criteria for emitters	3.2	25-34	4	
10	Preliminary design factor for drip design		27-35	1	
	Estimation of water requirement and hydraulics of drip irrigation system	4.1 – 4.3	35-48	4	
11	Emitter design and selection,		18-22	1	
	Design of lateral, submain, main and pump	4.4	48-67	4	
<b>Unit IV</b>					
12	Clogging and filtration	6	76-79	4	25
		11	130-139	4	
13	Maintenance and chemigation	7	80-92	4	
14	Fertigation	9	107-124	4	
15	Cost economics of drip system Evaluation of drip irrigation system	4.6.1	67-68	4	
		(Notes to be circulated)			
		8.1-8.2	93-103	4	
16	Automation in drip system	(Notes to be circulated)			

### Practicals:

1. Study of different components of sprinkler irrigation system.
- 2-3. Design and installation of sprinkler irrigation system.
- 4-5. Determination of precipitation pattern, discharge and uniformity coefficient.
6. Cost economics of sprinkler irrigation system.
7. Study of different components of drip irrigation.
- 8-9. Design and installation of drip irrigation system.
- 10-11. Determination of pressure discharge relationship and emission uniformity for given emitter.
12. Study of different types of filters and determination of filtration efficiency.
13. Determination of rate of injection and calibration for chemigation/fertigation.
14. Design of irrigation and fertigation schedule for crops.
15. Field visit to micro irrigation system and evaluation of drip system.
16. Cost economics of drip irrigation system.

## Suggested readings

### Text book

Sr. No.	Title	Author	Publication
1	Trickle Irrigation Design	Jack Keller and David Karmeli	Rain Bird Sprinkler Manufacturing Co., Clendora, California, USA.
2	Irrigation: Theory and Practice, Second Edition	Michael A.M.	Vikas Publishing Vikas Pub. House New Delhi
3	Principles of Sprinkler Irrigation systems, Second Edition	Mane M.S. and Ayare B.L	Jain Brothers, New Delhi
4	Principles of Drip Irrigation Systems, Third Edition	Mane M.S and Ayare B.L. and Magar S.S.	Jain Brothers, New Delhi

### Reference books

5	Design and Evaluation of Irrigation Methods, (IARI Monograph No.1)	Michael AM, Shrimohan and KR Swaminathan	Water Technology Centre, IARI New Delhi
6	Micro Irrigation for Cash Crops, 2006	Choudhary M.L and Kadam U.S	Westville Publishing House
7.	Drip Fertigation for Higher Crop Productivity	Pawar D. D., Dingre S. K., Shinde M. G. and Kaore S. V.	MPKV/Res. Pub. No. 99/2013

**GAE- IDE-477-1: Planning, design and installation of pressurized irrigation systems.**

<b>Week</b>	<b>Topics to be covered</b>
1	Topographical survey of the designated farms for the preparation of boundary and contour maps.
2	Preparation of boundary and contour maps (preferably by GPS and use of software).
3	Design of sprinkler and drip irrigation systems for the designated farms, including cost economics.
4	Marking and layout of the sprinkler and drip irrigation systems on designated farms.
5	Installation and fitting of sprinkler irrigation system.
6	Installation and fitting of drip irrigation system.
7	Testing and performance evaluation of sprinkler irrigation system.
8	Testing and performance evaluation of drip irrigation system.
9-10	Survey design, layout and cost estimate and /or installation of sprinkler and drip irrigation systems on farmers'/Institutions' farms.

---

**GAE - IDE- 477-2: Maintenance and Management of Pressurized Irrigation Systems.**

<b>Week</b>	<b>Topics to be covered</b>
1.	Verification of the existing design and layouts of drip and sprinkler irrigation system on designated farms
2.	Performance evaluation of existing sprinkler and drip irrigation systems on designated farms
3.	Computation of water requirement and irrigation schedules by different approaches - preferably using existing softwares and mobile apps, implementation the irrigation schedules
4.	Filtration : Operation and maintenance of primary filters (screen and disc), sand and media filters, Periodical flushing of lateral and sub mains.
5.	Acid and chlorine treatments: Soil and water quality tests, problem identification determination of quantity (doses) and flow rates for application of the acid and chlorine.
6.	Types of water soluble fertilizers/ sources of fertilizers, selection and compatibility of different fertilizers, principle of mixing of fertilizers and preparation of fertigation schedules.
7.	Fertigation devices : ventury, pressure tank and fertigation pump, application of fertilizers through different devices, their comparison, suitability, ease of operation etc.
8.	Automation : concept, types and operation of different automation devices.
9.	Quality standards of different components of sprinkler and drip irrigation systems, visit to drip and sprinkler irrigation industries including IS standard labs, dealers.
10.	Market survey, preparation of project proposal for finance, different Govt. scheme and process for approval of proposals.

---

**GAE- IDE-477- 3: Cropping pattern and irrigation management in canal command for major/minor/medium irrigation projects**

<b>Week</b>	<b>Topics to be covered</b>
1	Visit to the representative minor/medium/major irrigation projects. Selection of minor/medium irrigation projects/minor or water course of major irrigation project.
2	Reconnaissance, demographical and socio-economic survey of selected of irrigation projects
3	Collection of data on existing cropping pattern, reservoir, canal network, wells, land and water (surface and ground) availability, rotation schedules, meteorological data required for irrigation water management.
4	Topographical survey of command area of the selected irrigation project, preferably using GPS and software
5	Determination of physical-chemical and irrigation properties of soils in command area, soil mapping
6	Optimization of cropping pattern based on water and land availability and by introducing recent technological advances. Optimum conjunctive utilization of water in canal command area.
7	Determination of rotation schedule for proposed optimum cropping pattern, and their implementation strategies.
8	Comparison of existing and optimized cropping pattern, Study of gaps in adoption of advanced irrigation systems in command area.
9	Performance evaluation of existing and optimized water distribution schedule (equity, adequacy and reliability)
10	Deliberations with the irrigation officials for adoption of optimized cropping pattern and water distribution schedules.

---



## GAE-IDE-477 - 4: Irrigation and Nutrient Management in Greenhouse

Week	Topics to be covered
1	Fundamentals of Greenhouse Technology, site selection, classification, components, frame and covering materials.
2	Greenhouse standards, Determination of different components/materials for the greenhouse of different sites/shapes, Economics of crop production in greenhouse.
3	Different types of media, media preparation and its fumigation, bed preparation, studies of different systems in greenhouse.
4	Instruments/equipments used in greenhouses for environmental control and monitoring.
5	Types of micro-irrigation systems for greenhouse and their components and working principles, design and layouts. Installation, operation and maintenance of micro-irrigation systems. Installation/operation and maintenance of greenhouses.
6	Estimation of irrigation water requirement of crops. Estimation of daily crop co-efficient. Use of standard methods/software, mobile apps for estimation of water requirement
7	Operation of irrigation schedules in greenhouse, water quality, determination of fertigation doses, Performance evaluation of micro irrigation system in greenhouse.
8	Nutrition application equipments and management.
9	Package of practices of different crops.
10	Visit to various industries dealing with manufacturing of micro-irrigation system and greenhouse.

---

**GAE- IDE-477-5**

**Vegetable cultivation/hydroponic and pot culture/  
Floriculture and hi-tech nursery cultivation under  
protective cover.**

<b>Week</b>	<b>Topics to be covered</b>
1	Crop selection and composition, mixing and disinfection of media for protective cultivation.
2	Protray filling, bed preparation, basal dose application, nursery preparation and layout for protective cultivation.
3	Irrigation and Fertigation system installation, testing and performance evaluation.
4	Crop plantation (Transplanting) supporting to the crop.
5	Crop nutrient and irrigation management.
6	Plant protection measures.
7	Crop nutrient, irrigation and plant protection management according to crop growth stage.
8	Crop biometric observations.
9	Harvesting and value addition.
10	Marketing of produce.

---

**ELE-IDE-482**  
**Semester:- VIII**

**Course Title:- Geo-informatics for land and water management**  
**Credit:- 3 = 2+1**

**Syllabus:**

**Theory:**

Remote Sensing : Definition, stages in Remote Sensing, Remote Sensing systems, Remote Sensing Sensors and Resolutions, Remote Sensing Platforms, Electro Magnetic Radiation, Concept of Signature & Multispectral Concept, Spectral Reflectance of Vegetation, Soil and Water, Introduction to Visual Image Interpretation : Fundamental of Visual Image Interpretation and Elements of Image Interpretation, Digital Image Processing: Introduction, Image Rectification and Restoration, Image Enhancement, Contrast Manipulation, Image Classification: Supervised Classification and Unsupervised Classification.

Introduction of GIS : GIS definitions, components of GIS, GIS software's and their products, GIS data types and structures, Data input and editing, Attribute data management, Co-ordinate system, data and map projections, GIS data analysis : vector based and raster based, GPS: Introduction and applications, Applications of Remote Sensing for Land cover and land use mapping and water resources.

Modeling : Simulation and Modeling use in water resource management: What is Model, Simulation, Application in water Resource management: Types of models: Physical models, Mathematical models, Conceptual model, Hybrid Models, Introduction to some models, Study of SWAT Model : Introduction, Overview , Land phase of Hydrological cycle (component list only) ,Routing Phase of the Hydrological cycle (component list only), Model input Overview (list of input), Model output Overview (list of output) , Study of CROPWAT Model :Description of CropWat MODEL, Input /output of Model, Calculation method used by model, Study of Aqua Crop Model: Introduction to AquaCrop, The AquaCrop model , Practical applications, The calculation scheme of AquaCrop, Input requirement and Limitations.

**Practical:**

Introduction to Remote Sensing software, Introduction to GIS software, Study of GPS and DGPS systems, LULC mapping using RS and GIS, Estimation and mapping of WR of different crops using RS and GIS, Estimation of evapotranspiration: conventional methods and RS based methods, Water feature mapping using RS, Application of SWAT Model for Irrigation Management, Estimation of crop-water requirement and Irrigation requirement using CROPWAT model, Application of Aqua-Crop Model for Planning and management in Agriculture.



	components of GIS, GIS software's and their products.	4		4-5	
10-	GIS data types and structures	4		5-11	
12	Data input and editing,	3		60-69	
	Attribute data management,	3		102-122	
	Co-ordinate system, data and map projections.	3		82-89	
		3		35-45	
13	GIS data analysis : vector based and raster based.	4		234-277	
14	GPS: Introduction and applications	2		32-35	
15-	Applications of Remote Sensing for	2	11.3, 11.4	358-363	
16	Land cover and land use mapping and water resources				
<b>UNIT-III</b>					
17-	Modeling :		Notes to be		40
19	Simulation and Modeling use in water Recourse management: What is Model, Simulation, Application in water Recourse management: Types of models: Physical models, Mathematical models, Conceptual model, Hybrid Models Introduction to some models		circulate		
20-	Study of SWAT Model :			1-2	
24	Introduction	5		6-9	
	Overview				
	Land phase of Hydrological cycle (component list only)			9-21	
	Routing Phase of the Hydrological cycle (component list only)	6	Chapter31	303-312	
	Model input Overview (list of input)		Chapter31		

	Model output Overview (list of output)			313-335
25-28	Study of CROPWAT Model: Description of CropWat model Input /output of Model Calculation method used by model	7		1 2 2-3
29-32	Study of Aqua Crop Model: Introduction to AquaCrop The AquaCrop model Practical applications The calculation scheme of AquaCrop Input requirement Limitations	8		1 1 2 2-3 4 4

### Practical Exercises

Ex. No	Title
1-2	Introduction to Remote Sensing software's
3-4	Introduction to GIS software's
5-6	Study of GPS and DGPS systems
7	LULC mapping using RS and GIS
8	Estimation and mapping of WR of different crops using RS and GIS.
9-10	Estimation of evapotranspiration: conventional methods and RS based methods.
11	Water feature mapping using RS
12-13	Application of SWAT Model for Irrigation Management
14	Estimation of crop-water requirement and Irrigation requirement using CROPWAT model.
15-16	Application of Aqua-Crop Model for Planning and management in Agriculture.

### Suggested Readings :

1. Lillesand T.M. and Kiefer R.W.-2009, Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi ([www.wileyindia.com](http://www.wileyindia.com))
2. George Joseph. Fundamentals of Remote Sensing, 2009. Universities Press Pvt. Ltd., Hyderabad ([www.universitiespress.com](http://www.universitiespress.com))

3. Lan Heywood, Sarah Comelius, Steve Carver and Srinivasa Raju., 2006. An Introduction of Geographical Information Systems. Person Education in South Asia, Published by : Dorling Kindersley (India) Pvt. Ltd.
4. Kang-Tsung Chang, Introduction to Geographical Information System, 2008, McGraw Hill. ([www.tatamcgrawhill.com](http://www.tatamcgrawhill.com))
5. SWAT Theoretical Documentation version 2009 (Document Download link <http://swat.tamu.edu/documentation/>)
6. SWAT User manual version 2000 (Document Download link <http://swat.tamu.edu/documentation/>)
7. Cropwat Documentation , ( Document Download link <http://agromet-cost.bo.ibimet.cnr.it/fileadmin/cost718/repository/cropwat.pdf>)  
Software download link <http://www.fao.org/land-water/databases-and-software/cropwat/en/>
8. 4.AquaCrop training handbooks:FAO Document Download link: <http://www.fao.org/3/a-i6051e.pdf>
9. P.A.Burrough and R.A. McDonnell, Principles of Geographical Information System, 2000, Oxford, University
10. Jhon R. Jensen Introductory Digital Image Processing: A Remote Sensing Prospecting, Prentice-Hall, Englewood Cliffs, New Jersey.

<b>Course No: - ELE-IDE 483</b>	<b>Course Title: - Lift Irrigation System Design and Management</b>
<b>Semester: - VIII</b>	<b>Credit:- 3=2+1</b>

**Syllabus:**

**Theory**

Site selection for lift irrigation and reconnaissance survey, survey and mapping of field, cropping pattern and computing water requirement, selection of site for intake and jackwell, computing total head and power requirement, design of intake chambers, inlet pipe and pump house, selection of pump, pump layout and connection. Design and layout of rising main, distribution system and delivery chamber, working out water rates.

**Practicals:**

Selection of site for lift irrigation scheme and reconnaissance survey, Survey and mapping of field, including 'L' section, Estimation of water availability and computing water, requirement, Design of intake well, Design of intake pipe, Design of sump well, Design of jack well, Computation of total head and power requirement, Selection of pump, Economic of lift irrigation project, Field visit to lift irrigation project

**Teaching Schedule:**

<b>Lecture No.</b>	<b>Topics</b>	<b>Article No./ Page No.</b>	<b>Book</b>	<b>Weightage, (%)</b>
<b>Unit I</b>				
1	Introduction to lift irrigation, necessity and role of lift irrigation schemes in irrigation development	249-250	1,2	10
2	Assessment of feasibility of lift irrigation project	250-251	1	
3, 4	Selection of site and reconnaissance survey for lift irrigation scheme	257-260	1, 2	
<b>Unit II</b>				
5, 6	Survey and leveling procedure i) Chain and Compass survey	159-161 293-298	3	30



	ii) Plain Table Survey iii) Dumpy/Automatic level	371-379		
7	Water availability	251, 255-256	1	
8	Computation of water requirement and capacity of project	25-35	4	
<b>Unit III</b>				
9	Components of lift irrigation scheme i) Intake well-function, type, constructional details	260-262	1	20
10	Sump well	268-269	1	
11	Jack well	270-271	1	
12, 13	Intake pipe and rising main	278-280	1	
		263-264	2	
<b>Unit IV</b>				
14	Pumps	487	5	30
15	Pump house	271-275	1	
16	Delivery/distribution chamber	282-283	1	
17	Electrical equipments and accessories	275-276	1	
18	Valves and water Hammer Control Devices	633-635	1	
		281-282	1	
19	Design of intake well	262-263	1	
20	Design of intake pipe	264-667	1	
21	Design of sump well	269-270	1	
22	Specification of jack well	274-275	1	
23	Pump house structure	272-273	1	
24	Layout of rising main	280-281	1	
25	Design of rising main	420-421	6	
26, 27	Computation of power requirement	209-213	1	
		238-241		
<b>Unit V</b>				

28, 29	Operation of lift irrigation scheme (Pump)	277-278	1	10
30, 31	Economics of lift irrigation project	697-704	1	
32	Norms for fixing economic water rate	283-285	1	

### Practicals:

1. Selection of site for lift irrigation scheme and reconnaissance survey,
- 2-3. Survey and mapping of field, including 'L' section
- 4-5. Estimation of water availability and computing water requirement
6. Design of intake well
7. Design of intake pipe
8. Design of sump well
9. Design of jack well
10. Computation of total head and power requirement
11. Selection of pump
- 12-13. Economic of lift irrigation project
- 14-16. Field visit to lift irrigation project

### Suggested readings

#### Text books

Sr. No.	Title	Author	Publication
1	Irrigation Theory and Practices (II <sup>nd</sup> edition 2008)	A.M.Michael	Vikas Publishing House Pvt. Ltd.
2	Technical aspects of agricultural project. Volume – I		NABARD Publication, November 1989
3	Surveying and leveling	T.P. Kanetkar, S.V.Kulkarni	Punde Vidyapeeth, Griha Prakashan, Pune
4	Irrigation Engineering and Hydraulic Structures	S.K.Garg	Khanna Publishers, Delhi
5	Water, Well and Pumps	A.M.Michael and S.D.Khepkar	Tata McGraw Hill Publication Co. Ltd. New Delhi
6	A Text Book of Fluid mechanics and Hydraulic machines (Eighth edition)	R.K.Bansal	Laxmi Publications (p) Ltd. New Delhi

**Course No: ELE-IDE 484**

**Course Title: ENVIRONMENTAL ENGINEERING**

**Semester:- VIII**

**Credit: 3 (1 + 2)**

**Syllabus:**

**Theory:**

Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

**Practical:**

Determination of turbidity; pH solution; Suspended solids; Dissolved solids; Total solids; Determination of temporary hardness; Determination of permanent hardness; Determination of fluorides and chlorides, Determination of dissolved oxygen, Determination of BOD, Determination of COD, Collection of air samples and their analysis; Estimation of water demand; Design of water distribution system; Design of sewer system; Visit to treatment plant.

**Teaching Schedule with weightages**

<b>Lecture No.</b>	<b>Topics</b>	<b>Article No.</b>	<b>Page No.</b>	<b>Book</b>	<b>Weightages (%)</b>
<b>Unit I</b>					
1	Importance or safe water supply		9-10	1	10
2	Quantity water, rate of demand and factor affecting rate of demand		12-13	1	
3-4	Estimating population		28-38	1	
<b>Unit II</b>					
5	Sources of water supply-types		45-72	1	20
6	Intakes: types		258-	1	

			262		
7,8,9	Conveyance of water: pipes various materials		262-270	1	
10, 11	Water quality analysis		109-134	1	
12	Standards of drinking water		19-25	3	
<b>Unit III</b>					
13-18	Water treatments: sedimentations coagulations of water filtration disinfection water softening		142-143 158-160 179-181 203-221 224-225	1	30
<b>Unit IV</b>					
19	Sanitation: introduction, purpose		233-235	2	20
20, 21	Sewage disposal		197-201	2	
22	Sewers: definition and types		344-345	1	
23, 24	Design of sewers		411-418	1	
25, 26	Septic tank		202-206	2	
27, 28	Types and methods of Sludge disposal		193-	2	

			197		
<b>Unit V</b>					
29	Air pollution		253- 258	2	20
30	Types of pollutants and their effects		Notes		
31, 32	ISI standards for pollutants		Notes		

**Practicals:**

- 1-2. Determination of turbidity; pH solution; Suspended solids; Dissolved solids; Total solids;
3. Determination of temporary hardness;
4. Determination of permanent hardness;
5. Determination of fluorides and chlorides,
6. Determination of dissolved oxygen
7. Determination of BOD
8. Determination of COD
9. Collection of air samples and their analysis;
10. Estimation of water demand;
11. Design of water distribution system;
- 12-13. Design of sewer system;
- 14-16. Visit to treatment plant.

<b>Course No:- ELE-IDE-485</b>	<b>Course Title:- Landscape Irrigation Design And Management</b>
<b>Semester :- VIII</b>	<b>Credit:- 3=2+1</b>

**Syllabus:**

**Theory**

Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems, types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

**Practical:**

Study of irrigation equipment's for landscapes; Design and installation of irrigation system for landscape, determination of water requirement. Determination of power requirement, pump selection. Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments, Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc., Visit to landscape irrigation system and its evaluation.

**Teaching Schedule:**

<b>Lecture No.</b>	<b>Topics</b>	<b>Article No.</b>	<b>Page No.</b>	<b>Book</b>	<b>Weightages (%)</b>
<b>Unit I</b>					
1	Conventional method :Hose irrigation, Quick release coupling system	3.5	34-37	2	10
2	Modern irrigation systems-importance, status, merits and demerits	3.3	22-23	2	

3	Pop up sprinklers-Spray pop up,shrub pop up, Bubbler	-	600-601	1	
4&5	Drip irrigation types, emitter selection criteria	2.2-2.6	12-26	2	
<b>Unit II</b>					
6 &7	Computation of water requirement for various landscapes by FAO Penman-Montieth and Pan evaporimeter method	-	480-482 501-515	1	30
8&9	Main components of landscape irrigation system	3.5	23-37 581-587	2 1	
10	Types of landscapes- scope, objective, inventory for landscape gardening		17-56 589-592	3 1	
11	Plan of landscape work and general principles				
12	Styles/ types of landscape gardens				
<b>Unit III</b>					
13	Design criteria and procedure for sprinkler nozzle	4.1 - 4.16	49-58	2	30
14	Types of pipes- pressure rating, sizing and selection	-	352-355	1	
15&16	Design of sprinkler irrigation pipe network on flat and sloping land. Determination of number of subunits/valves	4.10	589-595 77-78	1 2	
17	Distribution of moisture under pop up sprinkler irrigation and overlapping of	4.3 & 6.1	64-65 114-	2	

	pop up sprinklers		116		
18	Computation of system capacity	4.7	71-72	2	
19	Design of pump unit –Power requirement and pump selection	4.9	75-77	2	
20	Evaluation of pop up sprinkler irrigation system, uniformity, pressure-discharge etc	-	587-589	1	
21	Selection of landscape irrigation system	Notes to be prepared			
<b>Unit IV</b>					
22	Automation of micro-irrigation system - Time based - Volume based - Sensor based	-	96-99	4	30
23 &24	Automation valves and their applications	Notes to be prepared			
25	Types of automation controllers and their applications	Notes to be prepared			
26	Sensors used for automation	Notes to be prepared			
27	Maintains of landscape irrigation system		597-599	1	
28 &29	Maintenance irrigation system-acidification and Chlorination requirement	7.4	84-92	5	
30	Fertigation system for landscape irrigation	-	603-606	1	
31	Optimization of pipe network in pop up sprinkler irrigation system	Notes to be prepared			
32	Cost estimation of landscape irrigation system	-	595-596	1	



**Practicals:**

1. Study of the components of landscape irrigation system.
2. Preparation of layout for landscape irrigation system by using AUTOCAD.
3. Hydraulic design of main and sub-main
4. Design of pop up sprinkler irrigation system
5. Estimation of water requirement of different landscapes.
6. Selection of power requirement and capacity for pump.
7. Calculation of the pressures in various components under landscape irrigation system
8. Irrigation scheduling for existing landscape gardening.
9. Installation of pop up sprinkler irrigation system.
10. Studies of different filtration system.
11. Studies of different fertigation system.
12. Study of components of automation controllers and valves.
13. Field evaluation of the landscape irrigation system
14. Field visit to the landscape irrigation garden.
- 15-16. Field visit to automatic irrigation system.

**BOOKS:****Text books**

S. N.	Title	Author	Publication
1	Irrigation Theory and Practice Second Edition, 2008	A.M.Michael	Vikas Pub. House Pvt. Ltd. New Delhi.
2	Principles of sprinkler irrigation	M.S.Mane, B.L.Ayare	Jain Brothers, New Delhi
3.	Landscape gardening and design with plants	S. K. Bhattacharjee	Avishkar Publishers, Distributors, Jaipur (Raj.)
4	Trickle irrigation design	Jack Keller, David Karmelli	RainbirdSprinkler manufacturing, California,
5	Principles of drip irrigation	M.S.Mane, B.L.Ayare, S.S.Magar	Jain Brothers, New Delhi

**Reference books:-**

<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>
1	Trickle irrigation for crop production- design, operation and management	F.S.Nakayama, D.A. Bucks	Elsevier Publication
2	Irrigation systems: design and operation	D. karmelli, G. Peri. M.Todes	Oxford University Press, Capetown 1985

**Suggested readings****Text books**

<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>
1	Fundamentals of water supply and sanitary engineering	S.C.Rangwala	Charotar publishing house Anand, India
2	Environmental engineering Water supply, sanitary engineering and pollution	A. Kamala, D.L. Kanth rao	Rata McGraw- Hill New Delhi
3	Manual for rural supply by, 1 <sup>st</sup> edition, 1989	SKAT	Divyajoyti Prakashan Jodhpur

