# IRRIGATION AND DRAINAGE ENGINEERING

**ENCE 354**

**Lecture : 4** **Year : III**
**Tutorial : 2** **Part : II**
**Practical : 0**

**Course Objectives:**

The objective of this course is to provide students the knowledge and skills for planning, design, construction, operation, maintenance and management of irrigation and drainage systems. After completion of this course students will be able to estimate irrigation and drainage requirements, design and layout of irrigation and drainage structures and river training works.

**1 Introduction (4 hours)**

1.1 Definition, need and advantages of irrigation and drainage
1.2 Disadvantages of over irrigation and waterlogging
1.3 Status, need and challenges of irrigation development in Nepal
1.4 Crops, their seasons and periods, cropping pattern and intensity
1.5 Commanded areas and irrigation intensity
1.6 Methods of field irrigation and their suitability
1.7 Planning of irrigation and drainage projects

**2 Irrigation Water Requirements and Water Availability (6 hours)**

2.1 Relation between duty, delta and crop periods
2.2 Crop water requirements by Penman's method
2.3 Operational water requirements; Losses due to seepage and evaporation
2.4 Effective rainfall
2.5 Irrigation efficiencies and irrigation water requirements
2.6 Soil-moisture-irrigation relation
2.7 Depth and frequency of irrigation
2.8 Design discharges for canals
2.9 Water available at source compared to irrigation requirement

**3 Canal Irrigation System and Design of Canals (10 hours)**

3.1 Classification of canals
3.2 Components of a canal irrigation system
3.3 Alignment of canals
3.4 Canal standards and balancing canal depth
3.5 Canal distribution system and methods of water distribution
3.6 Sediment transport in canals and tractive force approach of canal design
3.7 Design of non-alluvial stable canals
3.8 Silt theories and design of alluvial canals by Lacey and Kennedy
3.9 Design of lined canals with economic analysis

**4 Diversion Headworks (14 hours)**

4.1 River stages and suitable location of headworks
4.2 Component parts of weir/barrage (Detail drawing)
4.3 Bligh's, Lane's and Khosla's seepage theories for foundation
4.4 Design of weir and barrage with sloping glacies (Crest, length and thickness of impervious floor)
4.5 Design of under sluice and silt excluder
4.6 Design of head regulator (Crest, length and thickness of impervious floor)
4.7 Design considerations of settling basin and silt ejector

**5 River Training Works (4 hours)**

5.1 River characteristics and need of river training
5.2 Classification and methods of river training
5.3 Design of guide bund and launching apron
5.4 Spurs (Types and design considerations)
5.5 Flood control (Structural and non-structural methods)

**6 Canal Regulating Structures (8 hours)**

6.1 Alignment of the off-taking channels
6.2 Function of head and cross regulators, outlets, drops and escapes
6.3 Design of regulators and escapes (Crest, length and thickness of impervious floor)
6.4 Types of outlet; Design of pipe outlet (Free and submerged)
6.5 Types of drop; Design of vertical drop (Crest, length and thickness of impervious floor)

**7 Cross-Drainage Structures (6 hours)**

7.1 Need of cross-drainage works
7.2 Types and selection of cross-drainage structures with sketch
7.3 Design of siphon aqueduct (Detail drawing, drainage waterway and barrel, canal waterway and transition, RCC aqueduct, length and thickness of impervious floor, protection works)

**8 Waterlogging and Drainage (8 hours)**

8.1 Causes and effects of waterlogging
8.2 Symptoms of waterlogging and their detection
8.3 Preventive and remedial measures of waterlogging in irrigated land
8.4 Drainage of irrigated field and land reclamation
8.5 Surface drainage systems and their design
  8.5.1 Layout planning of drainage and types of surface drains
  8.5.2 Internal drainage of bunded fields (Drain design discharge)
  8.5.3 External drainage of lands from flooding

8.5.4 Design of surface drains (water level, maximum and minimum slopes and cross section)
8.5.5 Remodeling of existing natural drains

8.6 Subsurface drainage systems and their design
8.6.1 Layout of subsurface drainage system
8.6.2 Flow of ground water to drains and spacing of tile drains
8.6.3 Economic diameter of tile drains

**Tutorial** **(30 hours)**

1. Derivation of duty, delta and base period relation
2. Crop water and irrigation water requirements and water availability
3. Soil-moisture-irrigation relation, depth and frequency of irrigation
4. Balancing depth for excavating canals
5. Design of non-alluvial stable canals
6. Design of alluvial canals
7. Design of lined canals
8. Design of hydraulic structure on permeable strata by Khosla's seepage theory
9. Design of weir and barrage with sloping glacies
10. Design of under sluice and settling basin
11. Design of head regulator of main canal at headworks
12. Design of guide bund and launching apron
13. Design of cross and head regulators
14. Design of free and submerged pipe outlets
15. Design of vertical drop (Sharda Type)
16. Design of siphon aqueduct
17. Estimation of drain design discharge for bunded fields
18. Design of surface drains
19. Design of sub-surface tile drains

**Assignment and Field Observation**

1. Individual assignment with report on "Irrigation water requirement for a commanded area (Manual and using software) and water availability at headworks of a selected river"
2. Visual presentation/demonstration of structural components and hydraulic processes of irrigation and drainage system
3. Field based observation of an irrigation system and submission of individual report with sketches and functions of observed irrigation structures

**Final Exam**

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

| Chapter | Hours | Marks distribution* |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 6 | 6 |
| 3 | 10 | 8 |
| 4 | 14 | 12 |
| 5 | 4 | 6 |
| 6 | 8 | 8 |
| 7 | 6 | 8 |
| 8 | 8 | 8 |
| **Total** | **60** | **60** |

* There may be minor deviation in marks distribution.

**References**


1. Garg, S. K. (2023). Irrigation engineering and hydraulic structures. Khanna Publishers.
2. Singh, G. (2021). Irrigation engineering. Standard Book House.
3. Varshney, R. S., Gupta, S. C., Gupta, R. L. (2005). Theory and design of irrigation structures (Vols. 1 and 2). Nem Chand & Bros.
4. Novák, P., Moffat, A. I. B., Nalluri, C., Narayanan, R. (2007). Hydraulic structures. Spon / Taylor & Francis.
5. Department of Irrigation, (1990). Design manuals for irrigation projects in Nepal, PDSP manuals, M.3 Hydro-meteorology and M.9 Drainage manual. Government of Nepal.
6. Garg, S. K. (2010). Hydrology and water resources engineering. Khanna Publishers.
7. Jha, P. C., Devkota, N. (2024). Irrigation and drainage engineering. Heritage Publishers & Distributors.