# Water Resources Engineering

**Grades: 9** **Credit hrs: 4** **Working hrs: 128**

## 1. Introduction

Water Resources engineering course provide knowledge of the irrigation system and management. Its will design the crop production technique and its management. Its deals with the canal design, hydrology and flood. And the course is also give the basic knowledge of hydropower system.

This curriculum comprises of fundamental conceptual principles and practices, an introduction of irrigation, water requirement, method of irrigation, various irrigation structures, canal, water logging and drainage, hydrology and flood estimation and waterpower engineering. It will be delivered using both the conceptual and theoretical inputs through presentation, discussion, reflective reading and group works as well as practical and real world experiences through different practical activities.

The curriculum has been offered as per the structure of National Curriculum Framework 2076. It provides a comprehensive outline of level-wise competencies, grade-wise leaning outcomes and scope and sequence of contents, suggested practical/project activities, learning facilitation process and assessment strategies so as to enhance the learning on the subject systematic.

## 2. Competencies

On completion of the course, the students will have the following competencies:

1. Develop a sense of irrigation system, types and uses.
2. Explain awareness about effects of irrigation.
3. Create idea to develop irrigation system.
4. Knowledge of irrigation structure
5. Acquire skills to design a canal.
6. Create idea about the hydrology.
7. Develop a sense of hydropower plant.

## 3. Grade wise learning Outcomes

| UNIT | Content Area | Learning outcomes |
|---|---|---|
| 1 | **Introduction of irrigation** | 1.1 Define irrigation<br>1.2 Explain Necessity of irrigation<br>1.3 Compare Advantages and Disadvantages of irrigation<br>1.4 Explain Sources of water for irrigation<br>1.5 Define Gross command area(GCA)<br>1.6 Define Cultivable command area(CCA)<br>**1.7** Define Net command area(NCA) |
| 2 | **Water requirement** | 2.1. Define Crop season<br>2.2. Explain Crop types<br>2.3. Define Base Hrs.<br>2.4. Define Kor Hrs. and Kor depth<br>2.5. Define Crop Hrs.<br>2.6. Define Delta and Duty<br>2.7. Compute Duty delta relationship<br>2.8. Explain Factors affecting duty<br>**2.9.** Explain Water requirement of different crops |
| 3 | **Method of irrigation** | 3.1. Explain Surface irrigation<br>3.1.1. Uncontrolled flooding<br>3.1.2. Check flooding<br>3.1.3. Furrow irrigation<br>3.1.4. Zig zag method<br>3.1.5. Contour Farming<br>3.1.6. Basin Flooding<br>3.1.7. Contour laterals<br>3.2. Define Sub surface irrigation<br>3.2.1 Define Drip irrigation<br>3.2.2 Define Sprinkler irrigation |

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| 4 | **Various irrigation structures** | 4.1. Explain Head works: Definition, and types<br>4.1.1. Canal head regulator<br>4.1.2. Cross Regulator<br>4.1.3. Cannel fall<br>4.1.4. weir and barrage<br>4.1.5. Under sluice and silt excluder.<br>4.2. Explain Cross-Drainage works<br>4.2.1. Aqueducts<br>4.2.2. Siphon aqueducts<br>4.2.3. Super passage<br>4.2.4. Siphon<br>4.2.5. Level crossing<br>4.2.6. Inlet and outlet<br>*prepare for the field trip to observe the various irrigation structures* |
| 5 | **Canal** | 5.1. Compare Classification of canal and their alignment<br>5.2. Explain Canal losses, canal lining<br>River training works-definition, Types, objectives |
| 6 | **Water logging and drainage** | 6.1. Define water logging<br>6.2. Explain Causes and effects of water logging<br>6.3. Describe Remedial measures<br>6.4. Explain Causes of canal damages, maintenance tasks<br>Hill irrigation practice in Nepal |
| 7 | **Hydrology and flood estimation** | 7.1. Define hydrology<br>7.2. Explain hydrologic cycle<br>7.3. Describe measurement of Rainfall by Rain Gauges<br>7.4. Explain rainfall runoff process<br>7.5. Define infiltration |

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| | | 7.6. Define Evaporation and transpiration<br>7.7. Describe Factors affecting runoff<br>7.8. Describe Estimation of flood by rational method<br>7.9. Explain Estimation of peak flood by Empirical methods<br>7.10. Compute Stream/River discharge determination (float method, velocity rod method, current meter, velocity area method)<br>7.11. Define Ground water hydrology<br>7.12. Explain Types of aquifers<br>7.13 Compute Ground water movement-Darcy's Law |
| 8 | **Waterpower engineering (Hydropower)** | 8.1. Introduce water power engineering<br>8.2. Describe hydropower development in Nepal<br>8.3. Draw flow duration curve<br>8.4. Define Firm (or primary) power and secondary (or Surplus) power<br>8.5. Define Power system and load<br>8.6. Define Load factor, utilization factor and capacity factor<br>8.7. Draw General layout plan of hydropower project<br>8.8. Define Run of River (ROR) and Picking type of hydropower plant (PROR)<br>8.9. Introduce hydraulic turbine and types of hydraulic turbine.<br>*prepare for the field trip to observe the hydropower project* |

## 4. Scope and Sequence of Contents

| Unit | Scope | Content | Hrs. |
|---|---|---|---|
| **1.** | Introduction of irrigation | 1.1 Definition of irrigation<br>1.2 Necessity of irrigation<br>1.3 Advantages and Disadvantages of irrigation<br>1.4 Sources of water for irrigation<br>1.5 Gross command area(GCA)<br>1.6 Cultivable command area(CCA)<br>1.7 Net command area(NCA) | **5** |
| 2. | Water requirement | 2.10. Crop season<br>2.11. Crop types<br>2.12. Base Hrs.<br>2.13. Kor Hrs. and Kor depth<br>2.14. Crop Hrs.<br>2.15. Delta and Duty<br>2.16. Duty delta relationship<br>2.17. Factors affecting duty<br>**2.18.** Water requirement of different crops | **7** |
| 3 | Method of irrigation | 2 Surface irrigation<br>3.1.8. Uncontrolled flooding<br>3.1.9. Check flooding<br>3.1.10. Furrow irrigation<br>3.1.11. Zig zag method<br>3.1.12. Contour Farming<br>3.1.13. Basin Flooding<br>3.1.14. Contour laterals<br>3 Sub surface irrigation<br>4 Drip irrigation | **8** |

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| | | 5 Sprinkler irrigation | |
| **4** | Various irrigation structures | 4.1. Head works: Definition, and types<br>4.3.5 Canal head regulator.<br>4.3.6 Cross Regulator.<br>4.3.7 Cannel fall.<br>4.3.8 weir and barrage, notch.<br>4.3.9 Under sluice and silt excluder.<br>4.2. Cross-Drainage works<br>4.2.1. Aqueducts.<br>4.2.2. Siphon aqueducts<br>4.2.3. Super passage<br>4.2.4. Siphon<br>4.2.5. Level crossing<br>4.2.6. Inlet and outlet<br>*prepare for the field trip to observe the various irrigation structures* | **10** |
| **5** | Canal | 5.1. Classification of canal and their alignment<br>5.2. Canal losses, canal lining<br>5.3. River training works. | **6** |
| 6 | Water logging and drainage | 6.1. Definition of water logging<br>6.2. Causes and effects of water logging<br>6.3. Causes of canal damages, maintenance tasks.<br>6.4. Remedial measures | **8** |

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| | | **6.5.** Hill irrigation practice in Nepal | |
| 7 | Hydrology and flood estimation | 7.1. Definition of hydrology<br>7.2. The hydrologic cycle<br>7.3. Measurement of Rainfall by Rain Gauges<br>7.4. Rainfall runoff process<br>7.5. Infiltration<br>7.6. Evaporation and transpiration<br>7.7. Factors affecting runoff<br>7.8. Estimation of flood by rational method<br>7.9. Estimation of peak flood by Empirical methods<br>7.10. Stream/River discharge determination (float method, velocity rod method, current meter, velocity area method)<br>7.11. Ground water hydrology<br>7.12. Aquifers and its types<br>7.13. Ground water movement-Darcy's Law | **10** |
| 8 | **Waterpower engineering** | 8.1.Introduction<br>8.2.Hydropower development in Nepal<br>8.3.Flow duration curve<br>8.4.Firm (or primary) power and secondary (or Surplus) power& total power<br>8.5.Power system and load<br>8.6.Load factor, utilization factor and capacity factor<br>8.7.General layout plan of hydropower project<br>8.8.Run of River (ROR) and Picking type of | **10** |

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| | | hydropower plant (PROR), storage plant.<br>8.9.Introduction and types of hydraulic turbine.<br>*prepare for the field trip to observe the hydropower project* | |
| | | **Total** | **64** |

## 5. Suggested Practical and Project Works

Practical and project work is an integral part of technical and vocational subjects. They are carried out to consolidate the practical learning experiences. Some of the suggested practical and project work activities are mentioned below. As these are the basic and fundamental practical and project works, the teacher can adapt or introduce more relevant to their context and students' needs.

| Unit | Scope | Content Area | Hrs. |
|---|---|---|---|
| **1** | **Introduction of irrigation** | 1.1. Identify surface and ground of sources of water<br>1.2. Identify Gross command area from a map(GCA)<br>1.3. Identify Cultivable command area from a map(CCA)<br>Identify Net command area from a map( NCA) | **11** |
| **2** | **water requirement** | 2.1. Perform field identification of Kor Hrs. and kor depth for different crops<br>2.2. Perform field identification of Delta and Duty for different types of crops | **9** |
| **3** | **Method of irrigation** | 3.1. observe land preparation for Check flooding<br>3.2. observe land preparation for Ferrow irrigation<br>3.3. observe land preparation for Zig zag method | **10** |

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|---|---|---|---|
| | | 3.4. observe land preparation for Contour farming<br>3.5. observe land preparation Basin flooding<br>3.6. observe land preparation for Drip irrigation<br>3.7. Observe sprinkler irrigation system | |
| **4** | **Various irrigation structures** | 4.1. Prepare general layout drawing of Head works<br>4.2. Prepare cross sectional drawing of Canal head regulator<br>4.3. Prepare sectional drawing of Cannel falls<br>4.4. Prepare Sectional drawing of under Sluice and silt excluder.<br>4.5. Draw typical section of Aqueducts<br>4.6. Draw typical section of Siphon aqueducts<br>4.7. Draw typical section of Super passage<br>4.8. Observe hydraulics structure | **15** |
| **5** | **Canal design concept** | 5.1. Draw typical cross sectional drawing of canal<br>5.2. Draw typical drawing of river training works including spur | **8** |
| **6** | **Water logging and drainage** | 6.1. Draw typical layout drawings of hill irrigation system | **3** |
| **7** | **Hydrology and flood estimation** | 7.1. Calculate discharge from velocity method | **4** |
| **8** | **Waterpower engineering** | 8.1 Draw typical drawing of layout plan of hydropower project | **4** |
| | | **Total** | **64** |

## 6. Learning Facilitation Process

Learning facilitation process is determined according to the content to be dealt in the subject. It's also an art of teacher. The teacher should utilize such teaching methods and techniques that are appropriate to the contents and needs of the students. In facilitating

the course, various approaches, methods and techniques are used. To be particular, the following major methods and strategies are used in this subject:

- Group Discussion
- Field Visit and report presentation
- Research
- Practical Works
- Demonstration
- Audio/Visual Class
- Web surfing
- Project Works
- Problem Solving.

## 7. Student Evaluation

Evaluation is an integral part of learning process. Both formative and summative modes of evaluation are emphasized. Formative evaluation will be conducted so as to provide regular feedback for students, teachers and parents/guardians about how student learning is. Class tests, unit tests, oral question-answer, home assignment etc, are some ways of formative evaluation.

There will be separate evaluation of theoretical and practical learning. Summative evaluation embraces theoretical examination, practical examination and evaluation of research work or innovative work.

### (a) Internal Evaluation

Internal evaluation covers 50 Percent weightage. Internal evaluation consists of Practical Activities (Practical works and projects works) (35 Percent), (b) Marks from trimester examinations (10 Percent), and (c) Classroom participation (5 Percent). Practical work should be based on list of activities mentioned in this curriculum. Project works should be based on the mentioned lists or created by teachers. Mark distribution for internal evaluation (practical work and project work) will be as follows:

| S.N. | Mani activities | Activities in detail | Percent |
|---|---|---|---|
| 1 | Participation | Participation in attendance, homework, classwork, project work, practical works etc. | 5 |
| 2 | Practical work | Conduction of practical work activities | 15 |
| | | Record keeping of practical work activities | 3 |
| 3 | Project work | Conduction of project work activities | 10 |
| | | Record keeping of project work activities | 2 |
| 4 | Viva | Viva of practical work and project work activities | 5 |
| 6 | Internal exam | First trimester 5 marks and Second trimester 5 marks | 10 |
| Total | | | 50 |

**Note:**

(i) Practical examination will be conducted in the presence of internal and external supervisors. Evaluation of experiment will focus both the product of work and skills competencies of student in using apparatus.

**(ii)** Project work assessment is the internal assessment of reports and presentation of their project works either individually or group basis. In case of group presentation, every member of the group should submit a short reflection on the presented report in their own language. Records of project works must be attested by external supervisor.

**(b) External Evaluation**

External evaluation of the students will be based on the written examination. It carries 50 percent of the total weightage. Questions for the external examination will be based on the specification grid developed by Curriculum Development Centre. Examination question paper will be developed using various levels of revised Bloom's taxonomy including remembering level, understanding level, application level and higher ability (analyzing, evaluating, creating).

# Specification Grid

Grade: 9 Subjects : **Water Resources Engineering** Time : 2 hrs.

| Unit | Content | Credit hrs. | Knowledge and Understand | | | Application | | | Higher Ability | | | Total Question Number | | | Total Question | Marks Weight | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MCQ | Short | Long | MCQ | Short | Long | MCQ | Short | Long | MCQ | Short | Long | | MCQ | Short | Long | |
| 1 | Introduction of irrigation | 5 | | | | | | | | | | | | | | | | | 4 |
| 2 | Water requirement | 7 | | | | | | | | | | | | | | | | | 5 |
| 3 | Method of irrigation | 8 | | | | | | | | | | | | | | | | | 6 |
| 4 | Various irrigation structures | 10 | | | | | | | | | | | | | | | | | 8 |
| 5 | Canal | 6 | | | | | | | | | | | | | | | | | 5 |
| 6 | Water logging and drainage | 8 | 7 | 1 | 0 | 2 | 2 | 1 | 0 | 2 | 1 | 9 | 5 | 2 | 16 | 9 | 25 | 16 | 6 |
| 7 | Hydrology and flood estimation | 10 | | | | | | | | | | | | | | | | | 8 |
| 8 | Waterpower engineering | 10 | | | | | | | | | | | | | | | | | 8 |
| | Total | 64 | 7 | 1 | 0 | 2 | 2 | 1 | 0 | 2 | 1 | 9 | 5 | 2 | 16 | 9 | 25 | 16 | 50 |